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(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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☒ None

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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	34	Harbold, J. M., et al., "Highly nonlinear As-S-Se glasses for all-optical switching", OPTICS LETTERS, Vol. 27, No. 2, January 15, 2002, pages 119-121.	
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	1	20070021670	A1	2007-01-25	Mandelis et al.	
	2	20110282167	A1	2011-11-17	Ridder et al.	
	3	20120239013	A1	2012-09-20	Islam	

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	Application Number	
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	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

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	1	Pan, Yingtian, et al., "Hand-held arthroscopic optical coherence tomography for in vivo high-resolution imaging of articular cartilage", Journal of Biomedical Optics 8(4), October 2003, pages 648-654.	
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	9	Choi, Seung-Ho, et al., "Observation of Optical Precursors in Water", Physical Review Letters, Volume 92, Number 19, May 14, 2004, pages 193903-1-193903-.3.
	10	Pierce, Mark C., et al., "Advances in Optical Coherence Tomography imaging for Dermatology", Optical Coherence Tomography Advances, The Journal of Investigative Dermatology, September 3, 2004, pages 458-463.
	11	"State-Specific Trends in Chronic Kidney Failure - United States, 1990-2001", Morbidity and Mortality Weekly Report, Department of Health and Human Services Centers for Disease Control and Prevention, Vol. 53, No. 39, copied from internet: file://C:\Documents and Settings\eturlo\Desktop\State-Specific Trends in Chronic Kidney ... 2/12/10, October 8, 2004, pages 918-920.
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	28	U.S. Appln. Serial No. 10/652,276, "System and Method for Voice Control of Medical devices," by Mohammed N. Islam, abandoned (074036.0129) Date filed: August 29, 2003	
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	30	U.S. Appln. Serial No. 12/206432, "System and Method for Voice Control of Medical Devices," by Mohammed N. Islam, pending (074036.0154) Date filed: September 8, 2008	

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	Attorney Docket Number	OMNI 0101 PUSA5

	31	U.S. Patent and Trademark Office, Office Action for USSN 12/206,432, filed 09/08/2008, Mohammed N, Islam, Attorney Docket No. 074036.0154, Date filed: March 12, 2009
	32	U.S. Patent and Trademark Office, Notice of Allowance and Fee(s) Due for USSN 12/206,432, filed 09/08/2008, Mohammed N. Islam, Attorney Docket No. 074036.0154, Date filed: August 28, 2009
	33	International Search Report and Written Opinion for International Application No. PCT/US2013/075700 dated April 24, 2014
	34	International Preliminary Report on Patentability for International Application No. PCT/US2013/075700 dated July 9, 2015

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Name/Print	David S. Bir	Registration Number	38383

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First Named Inventor	Mohammed N. ISLAM
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	2	6619835	B2	2003-09-16	Kita	
	3	9326712	B1	2016-05-03	Kiani	
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	3	20120316455	A1	2012-12-13	Rahman, et al.	
	4	20140275854	A1	2014-09-18	Venkatraman, et al.	
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	1	U.S. Provisional Application No. 61/350,673; titled: OPTICOUSTIC SENSOR; Inventor: Massi Joe E. Kiani; filed on June 2, 2010.	
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	2	8472108		2013-06-25	Islam	
	3	8180422	B2	2012-05-15	Rebec	

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	1	102010012987	DE	A1	2010-10-07	FRAUNHOFER GES FORSCHUNG		

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	2	2005013843	WO	A2	2005-02-17	The Regents of the University of California		
	3	2007061772	WO	A2	2007-05-31	OMNI SCIENCES, INC.		
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	1	Ooi ET, Zhang XQ, Chen JH, Soh PH, Ng K, Yeo JH, "Non-invasive glucose measurement using multiple laser diodes," Optical Diagnostic and Sensing VII, edited by Gerard L. Cote, Alexander V. Priezzhev, Proc. of SPIE Vol. 6445, 64450K , (2007).	
	2	Schulz, I., J. Putzger, A. Niklas, M. Brandt, A. Jager, A. Hardt, S. Knorzer, K.A. Hiller, S. Loffler, G. Schmalz, S.N. Danilov, S. Giglberger, M. Hirmer, S.D. Ganichev, G. Monkman, "PPG signal acquisition and analysis on in vitro tooth model for dental pulp vitality assessment," ARC Submission 16, (2012).	
	3	Drexler, C., Hirmer, M., Danilov, S., Giglberger, S., Putzger, J., Niklas, A., Jager, A., Hiller, K., Loffler, S., Schmalz, G., Redlich, B., Schulz, I., Monkman, G., Ganichev, S. "Infrared spectroscopy for clinical diagnosis of dental pulp vitality." Infrared, Millimeter, and Terahertz Waves (IRMMW-THz), 2012 37th International Conference on. IEEE (2012).	
	4	Hirmer, Marion, Danilov, Sergey, Giglberger, Stephan, Putzger, Jurgen, Niklas, Andreas, Jager, Andreas, Hiller, Karl-Anton, Loffler, Susanne, Schmalz, Gottfried, Redlich, Britta, Schulz, Irene, Monkman, Gareth, Ganichev, Sergey. "Spectroscopic Study of Human Teeth and Blood from Visible to Terahertz Frequencies for Clinical Diagnosis of Dental Pulp Vitality." Journal of Infrared, Millimeter, and Terahertz Waves 33.3 (2012): 366-375.	
	5	Na, J, J.H. Baek, S.Y. Ryu, C. Lee, B.H. Lee, "Tomographic imaging of incipient dental-caries using optical coherence tomography and comparison with various modalities," Optical Review, vol. 16, no. 4, pp. 426-431 (2009).	
	6	VINAY V. ALEXANDER ET AL.; Modulation Instability High Power All-Fiber Supercontinuum Lasers And Their Applications; Optical Fiber Technology 18; 2012; pages 349-374	

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	Attorney Docket Number	OMNI 0101 PUSA5

	7	ROBERT S. JONES ET AL.; Near-Infrared Transillumination At 1310-nm For The Imaging Of Early Dental Decay; Volume 11; No. 18; Optics Express 2259; September 8, 2003
	8	Extended European Search Report for European Application No. 13867874.3 dated July 15, 2016
	9	Extended European Search Report for European Application No. 13867892.5 dated July 22, 2016

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	Attorney Docket Number	OMNI 0101 PUSA5

	1	Final Office Action dated October 21, 2016 for U.S. Application No. 14/875,709	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

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Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
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Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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	1	20060058683	A1	2006-03-16	Chance	
	2	20160327476	A1	2016-11-10	ISLAM	

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	1	101849821	CN	B	2013-07-04	Univ Huazhong Science Tech		
	2	2012135952	WO	A1	2012-10-11	The Governing Council Of The University Of Toronto		

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	1	Extended European Search Report for European Application No. 17156625.0 dated March 20, 2017	

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Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
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Attorney Docket Number	OMNI 0101 PUSA5

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	1	5795300	A	1998-08-18	Bryars	
	2	6731967	B1	2004-05-04	Turcott	
	3	7648463	B1	2010-01-19	Elhag et al.	
	4	8172761	B1	2012-05-08	Rulkov et al.	
	5	8315682	B2	2012-11-20	Such et al.	
	6	8954135	B2	2015-02-10	Yuen et al.	
	7	9241676	B2	2016-01-26	Lisogurski et al.	

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	1	J.G. WEBSTER; Design Of Pulse Oximeters; Medical Science Series; Taylor & Francis Group; CRC Press; October 23, 1997; 260 pps	
	2	H. HARRY ASADA ET AL.; Mobile Monitoring With Wearable Photoplethysmographic Biosensors; IEEE Engineering In Medicine And Biology Magazine, June 2003; 13 pps	
	3	UNITED STATES DISTRICT COURT EASTERN DISTRICT OF TEXAS MARSHALL DIVISION; Defendant And Counter Claimant Apple Inc.'s Amended Answer, Affirmative Defenses, And Counterclaims To Complaint Of Plaintiff And Counter Defendant Omni Medsci, Inc.; Document 38; July 19, 2018; 32 pps	

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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	1	5368224	A	1994-11-29	Richardson et al.	
	2	5746206	A	1998-05-05	Mannheimer	
	3	5795300	A	1998-08-18	Bryars	
	4	5919134	A	1999-07-06	Diab	
	5	6031603	A	2000-02-29	Fine et al	
	6	6325978	B1	2001-12-04	Labuda et al.	
	7	6701170	B2	2004-03-02	Stetson	
	8	6708048	B1	2004-03-16	Chance	

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	9	6731967	B1	2004-05-04	Turcott	
	10	6916096	B2	2005-07-12	Eberl et al.	
	11	7184148	B2	2007-02-27	Alphonse	
	12	7332784	B2	2008-02-19	Mills et al.	
	13	7468036	B1	2008-12-23	Rulkov et al.	
	14	7648463	B1	2010-01-19	Elhag et al.	
	15	8172761	B1	2012-05-08	Rulkov et al.	
	16	8180591	B2	2012-05-15	Yuen et al.	
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	18	8315682	B2	2012-11-20	Such et al.	
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	20	8475367	B1	2013-07-02	Yuen et al.	
	21	8755871	B2	2014-06-17	Weng et al.	
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	28	9596990	B2	2017-03-21	Park et al.	
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	31	9757040	B2	2017-09-12	Islam	
	32	9820658	B2	2017-11-21	Tran	
	33	9861286	B1	2018-01-09	Islam	
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	1	20050049468	A1	2005-03-03	Carlson et al.	
	2	20050209516	A1	2005-09-22	Fraden	
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	5	20120310062	A1	2012-12-06	Li et al.	
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	1	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit A), 66 pps	
	2	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit B), 73 pps	
	3	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit C), 85 pps	
	4	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit D), 38 pps	

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	13	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit M), 119 pps	
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	27	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit AA), 75 pps	
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	30	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit DD), 240 pps	
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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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	1	LI et al, A Wireless Reflective Pulse Oximeter with Digital Baseline Control for Unfiltered Photoplethysmograms, (June 2012) IEEE Transactions on Biomedical Circuits and Systems, Vol. 6, No. 3, 10 pages.	
	2	HUMPHREYS et al., Noncontact Simultaneous Dual Wavelength Photoplethysmography: A Further Step Toward Noncontact Pulse Oximetry, (2007) Review of Scientific Instruments 78, 044304, American Institute of Physics, 6 pages.	
	3	MENDELSON et al., A Wearable Reflectance Pulse Oximeter for Remote Physiological Monitoring, (Aug./Sept. 2006) Proceedings of the 28th IEEE EMBS Annual International Conference New York City, NY, 4 pages.	
	4	UNITED STATES DISTRICT COURT EASTERN DISTRICT OF TEXAS MARSHALL DIVISION; Omni Medsci, Inc. vs. Apple Inc.; Civil Action No. 2:18-cv-00134 Jury Trial Demanded; Defendant's Invalidity Contentions; August 28, 2018; 33 pps	
	5	VALERY V. TUCHIN ET AL.; Finger Tissue Model and Blood Perfused Skin Tissue Phantom; Proc. of SPIE Vol. 7898; 2011; pps. 1-11	
	6	ZENZO MIWA ET AL.; Pulpal Blood Flow in Vital and Nonvital Young Permanent Teeth Measured by Transmitted-Light Photoplethysmography: A Pilot Study; Pediatric Dentistry 2002; pps. 1-5	

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5746206	A	1998-05-05	Mannheimer	
	2	6505133	B1	2003-01-07	Hanna et al.	
	3	8172761	B1	2012-05-08	Rulkov et al.	
	4	9241676	B2	2016-01-26	Lisogurski et al.	
	5	9596990	B2	2017-03-21	Park et al.	

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	1	20050049468	A1	2005-03-03	Carlson et al.	

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	2	20100217099	A1	2010-08-26	LeBoeuf et al.	
	3	20120197093	A1	2012-08-02	LeBoeuf et al.	

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	1	Inter Partes Review No. IPR2019-00910; Petition for Inter Partes Review of U.S. Patent No. 9,757,040; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-96; dated April 10, 2019	
	2	Inter Partes Review No. IPR2019-00911; Petition for Inter Partes Review of U.S. Patent No. 9,861,286; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-83; dated April 10, 2019	
	3	Inter Partes Review No. IPR2019-00912; Petition for Inter Partes Review of U.S. Patent No. 9,885,698; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-94; dated April 10, 2019	
	4	Inter Partes Review No. IPR2019-00913; Petition for Inter Partes Review of U.S. Patent No. 9,651,533; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-96; dated April 10, 2019	

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	5	Inter Partes Review No. IPR2019-00914; Petition for Inter Partes Review of U.S. Patent No. 9,861,286; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-90; dated April 10, 2019	
	6	Inter Partes Review No. IPR2019-00915; Petition for Inter Partes Review of U.S. Patent No. 9,885,698; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-91; dated April 10, 2019	
	7	Inter Partes Review No. IPR2019-00916; Petition for Inter Partes Review of U.S. Patent No. 9,651,533; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-90; dated April 10, 2019	
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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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	1	5084880		1992-01-28	Esterowitz, et al.	
	2	5180378		1993-01-19	Kung, et al.	
	3	5400165		1995-03-21	Gnauck, et al.	
	4	5458122		1995-10-17	Hethuin	
	5	5617871		1997-04-08	Burrows	
	6	5631758		1997-05-20	Knox, et al.	
	7	5687734		1997-11-18	Dempsey, et al.	
	8	5696778		1997-12-09	MacPherson	

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	9	5704351		1998-01-06	Mortara, et al.	
	10	5718234		1998-02-17	Warden, et al.	
	11	5748103		1998-05-05	Flach, et al.	
	12	5855550		1999-01-05	Lai, et al.	
	13	5862803		1999-01-26	Besson, et al.	
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	15	5912749		1999-06-15	Harstead, et al.	
	16	5944659		1999-08-31	Flach, et al.	
	17	5957854		1999-09-28	Besson, et al.	
	18	6014249		2000-01-11	Fermann, et al.	
	19	6043927		2000-03-28	Islam	

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	20	6289238		2001-09-11	Besson, et al.	
	21	6333803		2001-12-25	Kurotori, et al.	
	22	6364834		2002-04-02	Reuss, et al.	
	23	6381391		2002-04-30	Islam, et al.	
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	26	6441747		2002-08-27	Khair, et al.	
	27	6443890		2002-09-03	Schulze, et al.	
	28	6454705		2002-09-24	Cosentino, et al.	
	29	6480656		2002-11-12	Islam, et al.	
	30	6549702		2003-04-15	Islam, et al.	

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	31	6603910		2003-08-05	Islam, et al.	
	32	6659947		2003-12-09	Carter, et al.	
	33	6802811		2004-10-12	Slepian	
	34	7167300		2007-01-23	Fermann, et al.	
	35	7209657		2007-04-24	Islam	
	36	7263288		2007-08-28	Islam	
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	38	6885683		2005-04-26	FERMANN ET AL.	
	39	6281471		2001-08-28	SMART	
	40	6340806		2002-01-22	SMART ET AL.	
	41	6301271		2001-10-09	SANDERS ET AL.	

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	42	7294105		2007-11-13	ISLAM	
	43	7787503		2010-08-31	WADSWORTH	
	44	7800818		2010-09-21	MATTSSON	
	45	8000574		2011-08-16	BUCHTER	
	46	6611643		2003-08-26	BIRK	
	47	6246896		2001-06-12	DUMOULIN	
	48	6285897		2001-09-04	KILCOYNE	
	49	6847336		2005-01-25	LEMELSON	
	50	5246004		1993-09-21	Clarke, et al.	
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	1	20020013518		2002-01-31	West, Kenneth G. ; et al.	
	2	20020019584		2002-02-14	Schulze, Arthur E. ; et al.	
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	Attorney Docket Number	OMNI 0101 PUSA5

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	12	20060268393		2006-11-30	Islam; Mohammed N.	
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	1	200189362	WO		2001-11-29	West Kenneth G et al.		

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	1	ISTEPANIAN, ROBERT H., "The Comparative Performance of Mobile Telemedical Systems based on the IS-54 and GSM Cellular Telephone Standards"; Journal of Telemedicine and Telecare 1999; pp 97-104	
	2	ARIS, ISHAK BIN, "An Internet-Based Blood Pressure Monitoring System for Patients"; Journal of Telemedicine and Telecare 2001; pp 51-53.	
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Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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	1	NELLCOR; Charts 1-3: NELLCOR-533; U.S. Patent No. 9,651,533 vs. Nellcor; Omni MedSci, Inc. v. Apple Inc., pps. 1-155; May 22, 2019	
	2	LISOGURSKI; Charts 1-3: LISOGURSKI-533; U.S. Patent No. 9,651,533 vs. Lisogurski; Omni MedSci, Inc. v. Apple Inc., pps. 1-84; May 22, 2019	
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	4	PARK; Charts 1-3: Park-533; U.S. Patent No. 9,651,533 vs. Park; Omni MedSci, Inc. v. Apple Inc., pps. 1-171; May 22, 2019	
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	1	4972331		1990-11-20	Chance	
	2	5774213	A	1998-06-30	Trebino et al.	
	3	5855550	A	1999-01-05	Lai et al.	
	4	6044283	A	2000-03-28	Fein et al.	
	5	6898451	B2	2005-05-24	Wuori	
	6	7278966	B2	2007-10-09	Hjelt et al.	
	7	9651533	B2	2017-05-16	Islam	
	8	9757040	B2	2017-09-12	Islam	

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	9	9861286	B1	2018-01-09	Islam	
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	1	20120041767	A1	2012-02-16	Hoffman et al.	

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	1	Declaration of Brian W. Anthony, PhD regarding USPN 9,651,533 filed in IPR2019-00913 & IPR2019-00916 (April 10, 2019)	
	2	Declaration of Brian W. Anthony, PhD regarding USPN 9,757,040 filed in IPR2019-00910 & IPR2019-00917 (April 10, 2019)	

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	3	Declaration of Brian W. Anthony, PhD regarding USPN 9,861,286 filed in IPR2019-00911 & IPR2019-00914 (April 10, 2019)	
	4	Declaration of Brian W. Anthony, PhD regarding USPN 9,885,698 filed in IPR2019-00912 & IPR2019-00915 (April 10, 2019)	
	5	Proof of Service of Summons in Omni MedSci, Inc. v. Apple Inc., No. 2:18-cv-134 (E.D. Tex.) (Dkt. #12) (April 13, 2018)	
	6	U.S. Provisional Application No. 61/747,487 filed December 31, 2012	
	7	U.S. Provisional Application No. 61/747,472 filed December 31, 2012	
	8	U.S. Provisional Application No. 61/747,477 filed December 31, 2012	
	9	U.S. Provisional Application No. 61/754,698 filed January 21, 2013	
	10	JOSEPH D. BRONZINO; "The Biomedical Engineering Handbook", (1995)	
	11	M. KRANTZ, ET AL., The mobile fitness coach: Towards individualized skill assessment using personalized mobile devices, Pervasive and Mobile Computing (June 2012)	
	12	S. PATEL, ET AL., A review of wearable sensors and systems with application rehabilitation, Journal of Neuroengineering & Rehabilitation 2012 9:21	
	13	ScienceDirect Report on M. KRANTZ, ET AL., The mobile fitness coach: Towards individualized skill assessment using personalized mobile devices, Pervasive and Mobile Computing (2012), available at https://www.sciencedirect.com/science/article/pii/S1574119212000673?via%3Dihub (2018 Elsevier B.V.)	

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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	14	Shaw, et al, IR Supercontinuum Generation in As-Se Photonic Crystal Fiber, Optical Society of America, Copyright 2005, 3 pages	
	15	PCT/US06/44451, Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or the Declaration, November 29, 2007, 12 pages	
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	23	G. Edwards, et al., "Comparison of OPA and Mark-III FEL for Tissue Ablation at 6.45 Microns," Department of Physics and Free Electron Laser Laboratory, Duke University, 2002, 7 pages
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	29	U.S. Appln. Serial No. 10/757,341, "System and Method for Voice Control of Medical devices," by Mohammed N. Islam, issued (074036.0132) Date filed: January 13, 2004
	30	U.S. Appln. Serial No. 12/206432, "System and Method for Voice Control of Medical Devices," by Mohammed N. Islam, pending (074036.0154) Date filed: September 8, 2008
	31	U.S. Patent and Trademark Office, Office Action for USSN 12/206,432, filed 09/08/2008, Mohammed N, Islam, Attorney Docket No. 074036.0154, Date filed: March 12, 2009
	32	U.S. Patent and Trademark Office, Notice of Allowance and Fee(s) Due for USSN 12/206,432, filed 09/08/2008, Mohammed N. Islam, Attorney Docket No. 074036.0154, Date filed: August 28, 2009

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	1	Lee, Ju Han, et al., "Continuous-wave supercontinuum laser based on an erbium-doped fiber ring cavity incorporating a highly nonlinear optical fiber", OPTICS LETTERS, Vol. 30, No. 19, October 1, 2005, pages 2599-2601.
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	13	de Boer, Johannes F., et al., "Imaging thermally damaged tissue by polarization sensitive optical coherence tomography", OPTICS EXPRESS 212, Vol. 3, No. 6, September 14,1998, pages 212-218.	
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	23	Seefeldt, Michael, et al., "Compact white-light source with an average output power of 2.4 Wand 900 nm spectral bandwidth", Optics Communications 216, pages 199-202.
	24	Wang, Yimin, et al., "Ultrahigh-resolution optical coherence tomography by broadband continuum generation from a photonic crystal fiber", OPTICS LETTERS, Vol. 28, No. 3, February 1, 2003, pages 182-184.
	25	Bizheva, K, et al., "Compact, broad-bandwidth fiberlaserforsub-2-pm axial resolution optical coherence tomography in the 1300-nm wavelength region," OPTICS LETTERS, Vol. 28, No. 9, May 1, 2003, pages 707-709.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5267152	A	1993-11-30	Yang et al.	
	2	7356364	B1	2008-04-08	Bullock et al.	

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	1	20070021670	A1	2007-01-25	Mandelis et al.	
	2	20110282167	A1	2011-11-17	Ridder et al.	
	3	20120239013	A1	2012-09-20	Islam	

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	1	International Search Report and Written Opinion for International Application No. PCT/US2013/075736 dated April 7, 2014	
	2	International Preliminary Report on Patentability for International Application No. PCT/US2013/075736 dated July 9, 2015	

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	1	7318909	B2	2008-01-15	Lehmann et al.	
	2	8180422	B2	2012-05-15	Rebec	
	3	9207121	B2	2015-12-08	Adler	

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	1	20030107739	A1	2003-06-12	Lehmann et al.	
	2	20030109055	A1	2003-06-12	Lehmann et al.	
	3	20030152307	A1	2003-08-14	Drasek et al.	

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	4	20050133691	A1	2005-06-23	Doppke et al.	
	5	20060283931	A1	2006-12-21	Polli et al.	
	6	20110267688	A1	2011-11-03	Kleppe et al.	
	7	20130327966	A1	2013-12-12	Fidler et al.	
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	1	2005013843	WO	A2	2005-02-17	The Regents of the University of California		
	2	2007061772	WO	A2	2007-05-31	OMNI SCIENCES, INC.		
	3	2009130464	WO	A1	2009-10-29	UNIVERSITY OF MANCHESTER		
	4	102010012987	DE	A1	2010-10-07	FRAUNHOFER GES FORSCHUNG		

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	1	ROBERT S. JONES ET AL.; Near-Infrared Transillumination At 1310-nm For The Imaging Of Early Dental Decay; Volume 11, No. 18; Optics Express 2259; September 8, 2003	
	2	Extended European Search Report for European Application No. 13867892.5 dated July 22, 2016	
	3	Extended European Search Report for European Application No. 13867874.3 dated July 15, 2016	
	4	VINAY V. ALEXANDER ET AL.; Modulation Instability High Power All-Fiber Supercontinuum Lasers And Their Applications; Optical Fiber Technology 18; 2012; pages 349-374	
	5	Final Office Action dated October 21, 2016 for U.S. Application No. 14/875,709	

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	2	6731967	B1	2004-05-04	Turcott	
	3	7648463	B1	2010-01-19	Elhag et al.	
	4	8172761	B1	2012-05-08	Rulkov et al.	
	5	8315682	B2	2012-11-20	Such et al.	
	6	8954135	B2	2015-02-10	Yuen et al.	
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	1	J.G. WEBSTER; Design Of Pulse Oximeters; Medical Science Series; Taylor & Francis Group; CRC Press; October 23, 1997; 260 pps	
	2	H. HARRY ASADA ET AL.; Mobile Monitoring With Wearable Photoplethysmographic Biosensors; IEEE Engineering In Medicine And Biology Magazine, June 2003; 13 pps	
	3	UNITED STATES DISTRICT COURT EASTERN DISTRICT OF TEXAS MARSHALL DIVISION; Defendant And Counter Claimant Apple Inc.'s Amended Answer, Affirmative Defenses, And Counterclaims To Complaint Of Plaintiff And Counter Defendant Omni Medsci, Inc.; Document 38; July 19, 2018; 32 pps	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
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	Attorney Docket Number	OMNI 0101 PUSA5

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
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Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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	First Named Inventor	Mohammed N. ISLAM
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	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	1	LI et al, A Wireless Reflective Pulse Oximeter with Digital Baseline Control for Unfiltered Photoplethysmograms, (June 2012) IEEE Transactions on Biomedical Circuits and Systems, Vol. 6, No. 3, 10 pages.	
	2	HUMPHREYS et al., Noncontact Simultaneous Dual Wavelength Photoplethysmography: A Further Step Toward Noncontact Pulse Oximetry, (2007) Review of Scientific Instruments 78, 044304, American Institute of Physics, 6 pages.	
	3	MENDELSON et al., A Wearable Reflectance Pulse Oximeter for Remote Physiological Monitoring, (Aug./Sept. 2006) Proceedings of the 28th IEEE EMBS Annual International Conference New York City, NY, 4 pages.	
	4	UNITED STATES DISTRICT COURT EASTERN DISTRICT OF TEXAS MARSHALL DIVISION; Omni Medsci, Inc. vs. Apple Inc.; Civil Action No. 2:18-cv-00134 Jury Trial Demanded; Defendant's Invalidity Contentions; August 28, 2018; 33 pps	

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Name/Print	David S. Bir	Registration Number	38383

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Application Number	
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First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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	1	5368224	A	1994-11-29	Richardson et al.	
	2	5746206	A	1998-05-05	Mannheimer	
	3	5795300	A	1998-08-18	Bryars	
	4	5919134	A	1999-07-06	Diab	
	5	6031603	A	2000-02-29	Fine et al	
	6	6325978	B1	2001-12-04	Labuda et al.	
	7	6701170	B2	2004-03-02	Stetson	
	8	6708048	B1	2004-03-16	Chance	

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	9	6731967	B1	2004-05-04	Turcott	
	10	6916096	B2	2005-07-12	Eberl et al.	
	11	7184148	B2	2007-02-27	Alphonse	
	12	7332784	B2	2008-02-19	Mills et al.	
	13	7468036	B1	2008-12-23	Rulkov et al.	
	14	7648463	B1	2010-01-19	Elhag et al.	
	15	8172761	B1	2012-05-08	Rulkov et al.	
	16	8180591	B2	2012-05-15	Yuen et al.	
	17	8310336	B2	2012-11-13	Muhsin et al.	
	18	8315682	B2	2012-11-20	Such et al.	
	19	8463576	B2	2013-06-11	Yuen et al.	

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	20	8475367	B1	2013-07-02	Yuen et al.	
	21	8755871	B2	2014-06-17	Weng et al.	
	22	8945017	B2	2015-02-03	Venkatraman et al.	
	23	8954135	B2	2015-02-10	Yuen et al.	
	24	9142117	B2	2015-09-22	Muhsin et al.	
	25	9179876	B2	2015-11-10	Ochs et al.	
	26	9192329	B2	2015-11-24	Al-Ali	
	27	9241676	B2	2016-01-26	Lisogurski et al.	
	28	9596990	B2	2017-03-21	Park et al.	
	29	9651533	B2	2017-05-16	Islam	
	30	9675250	B2	2017-06-13	Tverskoy	

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	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	31	9757040	B2	2017-09-12	Islam	
	32	9820658	B2	2017-11-21	Tran	
	33	9861286	B1	2018-01-09	Islam	
	34	9885698	B2	2018-02-06	Islam	
	35	RE44875	E	2014-04-29	Kiani et al.	

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	1	20050049468	A1	2005-03-03	Carlson et al.	
	2	20050209516	A1	2005-09-22	Fraden	
	3	20110237911	A1	2011-09-29	Lamego et al.	
	4	20120203077	A1	2012-08-09	He et al.	

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	5	20120310062	A1	2012-12-06	Li et al.	
	6	20130303921	A1	2013-11-14	CHU et al.	

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	1	2005270544	JP	A	2005-10-06	Seiko Instruments Inc.		

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	1	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit A), 66 pps	
	2	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit B), 73 pps	
	3	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit C), 85 pps	
	4	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit D), 38 pps	

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	6	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit F), 40 pps	
	7	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit G), 66 pps	
	8	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit H), 74 pps	
	9	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit I), 102 pps	
	10	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit J), 64 pps	
	11	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit K), 77 pps	
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	13	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit M), 119 pps	
	14	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit N), 50 pps	
	15	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit O), 63 pps	

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	16	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit P), 78 pps	
	17	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit Q), 69 pps	
	18	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit R), 61 pps	
	19	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit S), 50 pps	
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	21	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit U), 334 pps	
	22	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit V), 137 pps	
	23	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit W), 384 pps	
	24	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit X), 291 pps	
	25	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit Y), 120 pps	
	26	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit Z), 53 pps	

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	27	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit AA), 75 pps	
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	2	5774213	A	1998-06-30	Trebino et al.	
	3	5855550	A	1999-01-05	Lai et al.	
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	8	9757040	B2	2017-09-12	Islam	

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	3	Declaration of Brian W. Anthony, PhD regarding USPN 9,861,286 filed in IPR2019-00911 & IPR2019-00914 (April 10, 2019)	
	4	Declaration of Brian W. Anthony, PhD regarding USPN 9,885,698 filed in IPR2019-00912 & IPR2019-00915 (April 10, 2019)	
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	29	Curriculum Vitae of Brian W. Anthony, PhD (Nov. 18, 2018)	
	30	Amended Joint Claim Construction and Prehearing Statement filed in Case No. 2:18-cv-134-RWS (Dkt. #102) (Jan. 11, 2019)	
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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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Application Number	
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First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5746206	A	1998-05-05	Mannheimer	
	2	6505133	B1	2003-01-07	Hanna et al.	
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	4	9241676	B2	2016-01-26	Lisogurski et al.	
	5	9596990	B2	2017-03-21	Park et al.	

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	1	20050049468	A1	2005-03-03	Carlson et al.	

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	1	Inter Partes Review No. IPR2019-00910; Petition for Inter Partes Review of U.S. Patent No. 9,757,040; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-96; dated April 10, 2019	
	2	Inter Partes Review No. IPR2019-00911; Petition for Inter Partes Review of U.S. Patent No. 9,861,286; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-83; dated April 10, 2019	
	3	Inter Partes Review No. IPR2019-00912; Petition for Inter Partes Review of U.S. Patent No. 9,885,698; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-94; dated April 10, 2019	
	4	Inter Partes Review No. IPR2019-00913; Petition for Inter Partes Review of U.S. Patent No. 9,651,533; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-96; dated April 10, 2019	

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	5	Inter Partes Review No. IPR2019-00914; Petition for Inter Partes Review of U.S. Patent No. 9,861,286; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-90; dated April 10, 2019	
	6	Inter Partes Review No. IPR2019-00915; Petition for Inter Partes Review of U.S. Patent No. 9,885,698; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-91; dated April 10, 2019	
	7	Inter Partes Review No. IPR2019-00916; Petition for Inter Partes Review of U.S. Patent No. 9,651,533; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-90; dated April 10, 2019	
	8	Inter Partes Review No. IPR2019-00917; Petition for Inter Partes Review of U.S. Patent No. 9,757,040; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-93; dated April 10, 2019	

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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The information provided by you in this form will be subject to the following routine uses:

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

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Application Number	
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First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	4063106		1977-12-13	Ashkin, et al.	
	2	4158750		1979-06-19	Sakoe, et al.	
	3	4221997		1980-09-09	Flemming	
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	9	4523884		1985-06-18	Clement, et al.	
	10	4605080		1986-08-12	Lemelson	
	11	4641292		1987-02-03	Tunnell, et al.	
	12	4704696		1987-11-03	Reimer, et al.	
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	16	4958910		1990-09-25	Taylor, et al.	
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	20	5086401		1992-02-04	Glassman, et al.	
	21	5134620		1992-07-28	Huber	
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	31	5305427		1994-04-19	Nagata	
	32	5313306		1994-05-17	Kuban, et al.	
	33	5323404		1994-06-21	Grubb	
	34	5345538		1994-09-06	Narayannan, et al.	
	35	5408409		1995-04-18	Glassman, et al.	
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	44	6014249		2000-01-11	Fermann, et al.	
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	54	6350261		2002-02-26	Domankevitz, et al.	
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	75	7167300		2007-01-23	Fermann, et al.	
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	82	6640117		2003-10-28	Makarewicz	
	83	6788965		2004-09-07	RUCHTI	
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	97	7697966		2010-04-13	MONFRE	
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	1	1148666	EP		2001-10-24	Grant Andrew R et al.		
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	3	09715240	WO		1997-05-01	BRANT		
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	Attorney Docket Number	OMNI 0101 PUSA5

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	1	Pan, Yingtian, et al., "Hand-held arthroscopic optical coherence tomography for in vivo high-resolution imaging of articular cartilage", Journal of Biomedical Optics 8(4), October 2003, pages 648-654.
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	23	G. Edwards, et al., "Comparison of OPA and Mark-III FEL for Tissue Ablation at 6.45 Microns," Department of Physics and Free Electron Laser Laboratory, Duke University, 2002, 7 pages
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	31	U.S. Patent and Trademark Office, Office Action for USSN 12/206,432, filed 09/08/2008, Mohammed N, Islam, Attorney Docket No. 074036.0154, Date filed: March 12, 2009
	32	U.S. Patent and Trademark Office, Notice of Allowance and Fee(s) Due for USSN 12/206,432, filed 09/08/2008, Mohammed N. Islam, Attorney Docket No. 074036.0154, Date filed: August 28, 2009

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	3	2007061772	WO	A2	2007-05-31	OMNI SCIENCES, INC.		
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Application Number	
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First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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	1	5084880		1992-01-28	Esterowitz, et al.	
	2	5180378		1993-01-19	Kung, et al.	
	3	5400165		1995-03-21	Gnauck, et al.	
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	42	7294105		2007-11-13	ISLAM	
	43	7787503		2010-08-31	WADSWORTH	
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	1	20020013518		2002-01-31	West, Kenneth G. ; et al.	

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	1	200189362	WO		2001-11-29	West Kenneth G et al.		
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	3	200228123	WO		2002-04-04	Whittington Charles Lynn		
	4	2013012938	WO		2013-01-24	Raskin, et al.		

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	1	ISTEPANIAN, ROBERT H., "The Comparative Performance of Mobile Telemedical Systems based on the IS-54 and GSM Cellular Telephone Standards"; Journal of Telemedicine and Telecare 1999; pp 97-104	
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	4	BORLINGHAUS, R., "Colours Count: how the challenge of fluorescence was solved in confocal microscopy," in Modern Research and Educational Topics in Microscopy, A. Mendez-Vilas and J. Diaz, eds, pp. 890-899, Formatex (2007)	
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See attached certification statement.

Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

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Name/Print	David S. Bir	Registration Number	38383

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	1	7,969,558	B2	2011-06-28	Hall	
	2	8158175	B2	2012-04-17	Bourg, Jr.	
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	1	Segtnan, Vegard H., et al. "Screening of acrylamide contents in potato crisps using process variable settings and near-infrared spectroscopy." Molecular nutrition & food research 50.9 (2006): 811-817.	
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	10	Ni, Yongnian, Minghua Mei, and Serge Kokot. "Analysis of complex, processed substances with the use of NIR spectroscopy and chemometrics: Classification and prediction of properties—The potato crisps example." Chemometrics and Intelligent Laboratory Systems 105.2 (2011): 147-156.
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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See attached certification statement.

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SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6885683		2005-04-26	FERMANN ET AL.	
	2	6281471	B1	2001-08-28	SMART	
	3	6340806		2002-01-22	SMART ET AL.	
	4	6301271	B1	2001-10-09	SANDERS ET AL.	
	5	7294105	B1	2007-11-13	ISLAM	

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	1	20100046067	A1	2010-02-25	FERMANN ET AL.	

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	2	20080105665	A1	2008-05-08	KONDO	

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	1	STEPANIAN, ROBERT H., "The Comparative Performance of Mobile Telemedical Systems based on the IS-54 and GSM Cellular Telephone Standards"; Journal of Telemedicine and Telecare 1999; pp 97-104	
	2	ARIS, ISHAK BIN, "An Internet-Based Blood Pressure Monitoring System for Patients"; Journal of Telemedicine and Telecare 2001; pp 51-53.	

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	1	5084880		1992-01-28	Esterowitz, et al.	
	2	5180378		1993-01-19	Kung, et al.	
	3	5400165		1995-03-21	Gnauck, et al.	
	4	5458122		1995-10-17	Hethuin	
	5	5617871		1997-04-08	Burrows	
	6	5631758		1997-05-20	Knox, et al.	
	7	5687734		1997-11-18	Dempsey, et al.	
	8	5696778		1997-12-09	MacPherson	

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	9	5704351		1998-01-06	Mortara, et al.	
	10	5718234		1998-02-17	Warden, et al.	
	11	5748103		1998-05-05	Flach, et al.	
	12	5855550		1999-01-05	Lai, et al.	
	13	5862803		1999-01-26	Besson, et al.	
	14	5867305		1999-02-02	Waarts, et al.	
	15	5912749		1999-06-15	Harstead, et al.	
	16	5944659		1999-08-31	Flach, et al.	
	17	5957854		1999-09-28	Besson, et al.	
	18	6014249		2000-01-11	Fermann, et al.	
	19	6043927		2000-03-28	Islam	

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	20	6289238		2001-09-11	Besson, et al.	
	21	6333803		2001-12-25	Kurotori, et al.	
	22	6364834		2002-04-02	Reuss, et al.	
	23	6381391		2002-04-30	Islam, et al.	
	24	6402691		2002-06-11	Peddicord, et al.	
	25	6407853		2002-06-18	Samson, et al.	
	26	6441747		2002-08-27	Khair, et al.	
	27	6443890		2002-09-03	Schulze, et al.	
	28	6454705		2002-09-24	Cosentino, et al.	
	29	6480656		2002-11-12	Islam, et al.	
	30	6549702		2003-04-15	Islam, et al.	

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	31	6603910		2003-08-05	Islam, et al.	
	32	6659947		2003-12-09	Carter, et al.	
	33	6802811		2004-10-12	Slepian	
	34	7167300		2007-01-23	Fermann, et al.	
	35	7209657		2007-04-24	Islam	
	36	7263288		2007-08-28	Islam	
	37	7519253		2009-04-14	Islam	

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	1	20020013518		2002-01-31	West, Kenneth G. ; et al.	
	2	20020019584		2002-02-14	Schulze, Arthur E. ; et al.	

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	3	20020032468		2002-03-14	Hill, Michael R.S. ; et al.	
	4	20020082612		2002-06-27	Moll, Frederic H. ; et al.	
	5	20020109621		2002-08-15	Khair, Mohammad ; et al.	
	6	20020115914		2002-08-22	Russ, Tomas	
	7	20020178003		2002-11-28	Gehrke, James K. ; et al.	
	8	20040174914		2004-09-09	Fukatsu, Susumu	
	9	20040240037		2004-12-02	Harter, Donald J.	
	10	20050111500		2005-05-26	Harter, Donald J. ; et al.	
	11	20060245461		2006-11-02	Islam; Mohammed N.	
	12	20060268393		2006-11-30	Islam; Mohammed N.	
	13	20070078348		2007-04-05	Holman; Hoi-Ying N.	

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	14	20090028193		2009-01-29	Islam; Mohammed N.	
	15	20090204110		2009-08-13	Islam; Mohammed N.	

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	1	200189362	WO		2001-11-29	West Kenneth G et al.		
	2	200227640	WO		2002-04-04	Whittington Charles Lynn et al.		
	3	200228123	WO		2002-04-04	Whittington Charles Lynn		

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	4063106		1977-12-13	Ashkin, et al.	
	2	4158750		1979-06-19	Sakoe, et al.	
	3	4221997		1980-09-09	Flemming	
	4	4275266		1981-06-23	Lasar	
	5	4374618		1983-02-22	Howard	
	6	4403605		1983-09-13	Tanikawa	
	7	4462080		1984-07-24	Johnstone, et al.	
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	9	4523884		1985-06-18	Clement, et al.	
	10	4605080		1986-08-12	Lemelson	
	11	4641292		1987-02-03	Tunnell, et al.	
	12	4704696		1987-11-03	Reimer, et al.	
	13	4728974		1988-03-01	Nio, et al.	
	14	4762455		1988-08-09	Coughlan, et al.	
	15	4776016		1988-10-04	Hansen	
	16	4958910		1990-09-25	Taylor, et al.	
	17	4989253		1991-01-29	Liang, et al.	
	18	5078140		1992-01-07	Kwoh	
	19	5084880		1992-01-28	Esterowitz, et al.	

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	20	5086401		1992-02-04	Glassman, et al.	
	21	5134620		1992-07-28	Huber	
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	23	5180378		1993-01-19	Kung, et al.	
	24	5191628		1993-03-02	Byron	
	25	5218655		1993-06-08	Mizrahi	
	26	5230023		1993-07-20	Nakano	
	27	5267256		1993-11-30	Saruwatari, et al.	
	28	5267323		1993-11-30	Kimura	
	29	5300097		1994-04-05	Lerner, et al.	
	30	5303148		1994-04-12	Mattson, et al.	

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	31	5305427		1994-04-19	Nagata	
	32	5313306		1994-05-17	Kuban, et al.	
	33	5323404		1994-06-21	Grubb	
	34	5345538		1994-09-06	Narayannan, et al.	
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	38	5695493		1997-12-09	Nakajima, et al.	
	39	5696778		1997-12-09	MacPherson	
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	42	5950629		1999-09-14	Taylor, et al.	
	43	5970457		1999-10-19	Brant, et al.	
	44	6014249		2000-01-11	Fermann, et al.	
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	51	6301273		2001-10-09	Sanders, et al.	
	52	6337462		2002-01-08	Smart	

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	53	6340806		2002-01-22	Smart, et al.	
	54	6350261		2002-02-26	Domankevitz, et al.	
	55	6374006		2002-04-16	Islam, et al.	
	56	6407853		2002-06-18	Samson, et al.	
	57	6436107		2002-08-20	Wang, et al.	
	58	6442430		2002-08-27	Ferek-Petric	
	59	6450172		2002-09-17	Hartlaub, et al.	
	60	6453201		2002-09-17	Daum, et al.	
	61	6458120		2002-10-01	Shen, et al.	
	62	6462500		2002-10-08	L'Hegarat, et al.	
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	64	6567431		2003-05-20	Tabirian, et al.	
	65	6605080		2003-08-12	Altshuler, et al.	
	66	6625180		2003-09-23	Bufetov, et al.	
	67	6631025		2003-10-07	Islam, et al.	
	68	6659999		2003-12-09	Anderson, et al.	
	69	6760148		2004-07-06	Islam	
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	71	6885683		2005-04-26	Fermann, et al.	
	72	6943936		2005-09-13	Islam, et al.	
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	75	7167300		2007-01-23	Fermann, et al.	
	76	7259906		2007-08-21	Islam	
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	1	20020032468		2002-03-14	Hill, Michael R.S. ; et al.	
	2	20020082612		2002-06-27	Moll, Frederic H. ; et al.	
	3	20020128846		2002-09-12	Miller, Steven C.	
	4	20020178003		2002-11-28	Gehrke, James K. ; et al.	
	5	20040174914		2004-09-09	Fukatsu, Susumu	

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	1	EP1148666	EP		2001-10-24	Grant Andrew R et al.		
	2	WO01150959	WO		2001-07-19	SUHM		
	3	WO09715240	WO		1997-05-01	BRANT		
	4	WO97049340	WO		1997-12-31	WANG		

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	First Named Inventor	Mohammed N. ISLAM
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	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

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	1	7787503	B2	2010-08-31	WADSWORTH	
	2	7800818	B2	2010-09-21	MATTSSON	
	3	8000574	B2	2011-08-16	BUCHTER	
	4	6611643	B2	2003-08-26	BIRK	

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	1	SUN, Y., C.F. Booker, S. Kumari, R.N. Day, M. Davidson, A. Periasamy, "Characterization of an orange acceptor fluorescent protein for sensitized spectral fluorescence resonant energy transfer microscopy using a white-light laser," Journal of Biomedical Optics, Vol. 14, no. 5, paper 054009 (2009).	
	2	BORLINGHAUS, R., "Colours Count: how the challenge of fluorescence was solved in confocal microscopy," in Modern Research and Educational Topics in Microscopy, A. Mendez-Vilas and J. Diaz, eds, pp. 890-899, Formatex (2007)	
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	4	BORLINGHAUS, R.T., L. Kuschel, "White Light Laser: The Ultimate Source for Confocal Microscopy," http://www.leica-microsystems.com/science-lab/white-light-laser (June 27, 2012).	
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	6		

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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	1	Islam, M. N., et al., "Broad bandwidths from frequency-shifting solitons in fibers", OPTICS LETTERS, Vol. 14, No. 7, April 1, 1989, pages 370-372.
	2	Islam, M. N., et al., "Femtosecond distributed soliton spectrum in fibers", J. Opt. Soc. Am. B, Vol. 6, No. 6, June 1989, pages 1149-1158.
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	34	Harbold, J. M., et al., "Highly nonlinear As-S-Se glasses for all-optical switching", OPTICS LETTERS, Vol. 27, No. 2, January 15, 2002, pages 119-121.	
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	45	Faralli, S., et al., "Impact of Double Rayleigh Scattering Noise in Distributed Higher Order Raman Pumping Schemes", IEEE Photonics Technology Letters, Vol. 15, No. 6, June 2003, pages 804-806.
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	47	Avdokhin, A. V., et al, "Continuous-wave, high-power, Raman continuum generation in holey fibers", OPTICS LETTERS, Vol. 28, No. 15, August 1, 2003, pages 1353-1355.
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	49	Slusher, Richard, et al., "Highly nonlinear composite chalcogenide/polymer fibers", OSA 2004, 1 page.
	50	Thongtrangan, Issada, et al., "Minimally invasive spinal surgery: a historical perspective", Neurosurg. Focus, Volume 16, Article 13, January 2004, pages 1-10.

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	First Named Inventor	Mohammed N. ISLAM
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Application Number	
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Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5747806		1998-05-05	Khalil	
	2	6115673		2000-09-05	Malin	
	3	6512936	B1	2003-01-28	MONFRE et al.	
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	9	6587702	B1	2003-07-01	RUCHTI	
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	2	MALIN, S.F., T.L. Ruchti, T.B. Blank, S.N. Thennadil, S.L. Monfre, "Noninvasive prediction of glucose by near-infrared diffuse reflectance spectroscopy," Clinical Chemistry, vol. 45, no. 9, pp. 1651-1658 (1999).	
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	1	6181414		2001-01-30	Raz et al.	
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	First Named Inventor	Mohammed N. ISLAM
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	Attorney Docket Number	OMNI 0101 PUSA5

	6	MICHAELS, C.A., T. MASIELLO, P.M. CHU, "Fourier transform spectrometry with a near infrared supercontinuum source," Optical Society of America, CLEO/IQEC Conference, paper CMDD6 (2009).	
	7	MICHAELS, C.A., T. MASIELLO, P.M. CHU, "Fourier transform spectrometry with a near-infrared supercontinuum source," Applied Spectroscopy, Vol. 63, no. 5, pp. 538-543 (2009).	
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	12	REICH, G. "Near-infrared spectroscopy and imaging: basic principles and pharmaceutical applications," Advanced Drug Delivery Reviews, vol. 57, pp. 1109-1143 (2005).	
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	17	SONDERMANN, N., K.A. KOVAR, "Identification of ecstasy in complex matrices using near-infrared spectroscopy," Forensic Science International, vol. 102, pp. 133-147 (1999).
	18	RAMBLA, F.J., S. GARRIGUES, M. DeLa GUARDIA, "PLS-NIR determination of total sugar, glucose, fructose and sucrose in aqueous solutions of fruit juices," Analytica Chimica Acta, vol. 344, pp. 41-53 (1997).

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Name/Print	David S. Bir	Registration Number	38383

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	1	8157730	B2	2012-04-17	LeBoeuf, et al.	
	2	8430310	B1	2013-04-30	Ho, et al.	
	3	8509882	B2	2013-08-13	Albert, et al.	
	4	8788002	B2	2014-07-22	LeBoeuf, et al.	
	5	8948832	B2	2015-02-03	Hong, et al.	

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	1	20080086318	A1	2008-04-10	Gilley, et al.	

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	2	20090287067	A1	2009-11-19	Dorogusker, et al.	
	3	20130281795	A1	2013-10-24	Varadan	
	4	20140081100	A1	2014-03-20	Muhsin, et al.	
	5	20150011851	A1	2015-01-08	Mehta, et al.	

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	1	WO2013012938		A1	2013-01-24	Raskin, et al.		
	2	WO2015084376		A1	2015-06-11	Han, et al.		

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	2	7890158	B2	2011-02-15	Rowe, et al.	
	3	8213007	B2	2012-07-03	Wang, et al.	
	4	7848605	B2	2010-12-07	Ridder, et al.	
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	3	20100160794	A1	2010-06-24	Banet, et al.	
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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ABSTRACT

A wearable device includes a measurement device to measure a physiological parameter adapted to be placed on a wrist or an ear of a user. A plurality of semiconductor light sources such as light emitting diodes generate corresponding output light having an initial light intensity. A receiver includes spatially separated detectors receiving reflected light from the output lights and coupled to analog to digital converters. The receiver is configured to synchronize to the semiconductor source(s). The measurement device improves signal-to-noise ratio of the output signal by increasing light intensity relative to the initial light intensity and by increasing a pulse rate. Further improvement in signal-to-noise ratio is achieved by using change detection, where the receiver compares the signals with light on and with light off.

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WHAT IS CLAIMED IS:

1. A system for measuring one or more physiological parameters and for use with a smart phone or tablet, the system comprising:

a wearable device adapted to be placed on a wrist or an ear of a user, including a light source comprising a plurality of semiconductor sources that are light emitting diodes, each of the light emitting diodes configured to generate an output optical light having one or more optical wavelengths;

the wearable device comprising one or more lenses configured to receive a portion of at least one of the output optical lights and to direct a lens output light to tissue;

the wearable device further comprising a detection system configured to receive at least a portion of the lens output light reflected from the tissue and to generate an output signal having a signal-to-noise ratio, wherein the detection system is configured to be synchronized to the light source;

wherein the detection system comprises a plurality of spatially separated detectors, and wherein at least one analog to digital converter is coupled to at least one of the spatially separated detectors;

wherein a detector output from the at least one of the plurality of spatially separated detectors is coupled to an amplifier having a gain configured to improve detection sensitivity;

the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a speaker, a voice input module, one or more buttons or knobs, a microprocessor and a touch screen, the smart phone or tablet configured to receive and process at least a portion of the output signal, wherein the smart phone or tablet is configured to store and display the processed output signal, and wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link;

a cloud configured to receive over the wireless transmission link an output status comprising the at least a portion of the processed output signal, to process the received output status to generate processed data, and to store the processed data;

wherein the output signal is indicative of one or more of the physiological parameters, and the cloud is configured to store a history of at least a portion of the one or more physiological parameters over a specified period of time;

the wearable device configured to increase the signal-to-noise ratio by increasing light intensity of at least one of the plurality of semiconductor sources from an initial light intensity and by

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increasing a pulse rate of at least one of the plurality of semiconductor sources from an initial pulse rate; and

the detection system further configured to:

generate a first signal responsive to light received while the light emitting diodes are off,

generate a second signal responsive to light received while at least one of the light emitting diodes is on, and

increase the signal-to-noise ratio by comparing the first signal and the second signal.

2. The system of Claim 1, wherein the wearable device is configured to use artificial intelligence in making decisions associated with at least a portion of the output signal.

3. The system of Claim 2, wherein the wearable device is at least in part configured to identify an object, and to compare a property of at least some of the output signal to a threshold.

4. The system of Claim 3, wherein the wearable device is configured to perform pattern identification or classification based on at least a part of the output signal.

5. The system of Claim 4, wherein at least one of the spatially separated detectors is located at a first distance from at least one of the light emitting diodes and at least another of the spatially separated detectors is located at a second distance from the at least one of the light emitting diodes, and the at least one of the spatially separated detectors is configured to generate a third signal responsive to light from the at least one light emitting diode and the at least another of the spatially separated detectors is configured to generate a fourth signal responsive to the light from the at least one of the light emitting diodes; and

wherein at least one of the spatially separated detectors is located at a third distance from a first one of the light emitting diodes and at a fourth distance from a second one of the light emitting diodes, and is configured to generate a fifth signal responsive to light from the first light emitting diode and a sixth signal responsive to light from the second light emitting diode, and wherein the first

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distance is different from the second distance, and the third distance is different from the fourth distance.

6. The system of Claim 5, wherein the wearable device further comprises a reflective surface positioned to reflect at least a portion of the lens output light reflected from the tissue.

7. A system for measuring one or more physiological parameters and for use with a smart phone or tablet, the system comprising:

a wearable device adapted to be placed on a wrist or an ear of a user, and including a light source comprising a plurality of semiconductor sources, each of the semiconductor sources configured to generate an output light having one or more optical wavelengths;

the wearable device comprising one or more lenses configured to receive a portion of at least one of the output lights and to deliver a lens output light to tissue;

the wearable device further comprising a detection system configured to receive at least a portion of the lens output light reflected from the tissue and to generate an output signal having a signal-to-noise ratio, wherein the detection system is configured to be synchronized to the light source;

wherein the detection system comprises a plurality of spatially separated detectors, and wherein at least one analog to digital converter is coupled to at least one of the spatially separated detectors;

the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a speaker, a voice input module, one or more buttons or knobs, a microprocessor and a touch screen, the smart phone or tablet configured to receive and process at least a portion of the output signal, wherein the smart phone or tablet is configured to store and display the processed output signal, and wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link;

a cloud configured to receive over the wireless transmission link an output status comprising the at least a portion of the processed output signal, to process the received output status to generate processed data, and to store the processed data;

wherein the output signal is indicative of one or more of the physiological parameters;

the wearable device configured to increase the signal-to-noise ratio by increasing light intensity of at least one of the semiconductor sources from an initial light intensity and by increasing a pulse rate of at least one of the semiconductor sources from an initial pulse rate; and

the detection system further configured to:

generate a first signal responsive to light received while the semiconductor sources are off,

generate a second signal responsive to light received while at least one of the semiconductor sources is on, and

increase the signal-to-noise ratio by comparing the first signal and the second signal.

8. The system of Claim 7, wherein the wearable device is at least in part configured to identify an object, and a property of at least some of the output signal is compared by at least one of the wearable device, the smart phone or tablet to a threshold.

9. The system of Claim 8, wherein a detector output from at least one of the plurality of spatially separated detectors is coupled to an amplifier having a gain configured to improve detection sensitivity.

10. The system of Claim 9, wherein the wearable device is configured to use artificial intelligence to process at least a portion of the output signal.

11. The system of Claim 10, wherein the artificial intelligence comprises pattern identification or classification.

12. The system of Claim 10, wherein the wearable device is configured to perform pattern identification or classification based on at least a part of the output signal.

13. The system of Claim 12, wherein at least one of the spatially separated detectors is located at a first distance from at least one of the light emitting diodes and at least another of the spatially separated detectors is located at a second distance from the at least one of the light emitting diodes, and the at least one of the spatially separated detectors is configured to generate a third signal

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responsive to light from the at least one light emitting diode and the at least another of the spatially separated detectors is configured to generate a fourth signal responsive to the light from the at least one of the light emitting diodes; and

wherein at least one of the spatially separated detectors is located at a third distance from a first one of the light emitting diodes and at a fourth distance from a second one of the light emitting diodes, and is configured to generate a fifth signal responsive to light from the first light emitting diode and a sixth signal responsive to light from the second light emitting diode, and wherein the first distance is different from the second distance, and the third distance is different from the fourth distance.

14. The system of Claim 13, wherein the wearable device further comprises a reflective surface positioned to reflect at least a portion of the lens output light reflected from the tissue.

15. A system for measuring one or more physiological parameters and for use with a smart phone or tablet, the system comprising:

a wearable device adapted to be placed on a wrist or an ear of a user, including a light source comprising a plurality of semiconductor sources that are light emitting diodes, each of the light emitting diodes configured to generate an output optical light having one or more optical wavelengths;

the wearable device comprising one or more lenses configured to receive a portion of at least some of the output optical light and to deliver a lens output light to tissue;

the wearable device further comprising a detection system configured to receive at least a portion of the lens output light reflected from the tissue and to generate an output signal having a signal-to-noise ratio, wherein the detection system is configured to be synchronized to the light source;

wherein the detection system comprises a plurality of spatially separated detectors, and wherein at least one analog to digital converter is coupled to at least one of the spatially separated detectors;

the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a microphone, a speaker, one or more buttons or knobs, a microprocessor and a touch screen, the smart phone or tablet configured to receive and process at least a portion of the output signal, wherein the smart phone or tablet is configured to store and display the processed output signal, and

wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link;

a cloud configured to receive over the wireless transmission link an output status comprising the at least a portion of the processed output signal, to process the received output status to generate processed data, and to store the processed data;

wherein the output signal is indicative of one or more of the physiological parameters;

the wearable device configured to increase the signal-to-noise ratio by increasing light intensity of at least one of the plurality of semiconductor sources from an initial light intensity; and

the detection system further configured to:

generate a first signal responsive to light received while the light emitting diodes are off,

generate a second signal responsive to light received while at least one of the light emitting diodes is on, and

increase the signal-to-noise ratio by comparing the first signal and the second signal.

16. The system of Claim 15, wherein the wearable device is at least in part configured to detect an object, and a property of at least some of the output signal is compared to a threshold.

17. The system of Claim 15, wherein a detector output from at least one of the plurality of spatially separated detectors is coupled to an amplifier having a gain configured to be adjusted to improve detection sensitivity.

18. The system of Claim 15, wherein the wearable device is configured to use artificial intelligence in making decisions associated with at least a portion of the output signal.

19. The system of claim 18 wherein the artificial intelligence comprises a pattern matching algorithm.

20. The system of claim 18 wherein the artificial intelligence comprises spectral fingerprinting.

21. The system of Claim 15, wherein the wearable device is configured to perform pattern identification or classification based on at least a part of the output signal.

22. The system of Claim 21, wherein the pattern identification or classification comprises a pattern matching algorithm or spectral fingerprinting.

23. The system of Claim 15, wherein the wearable device further comprises a reflective surface positioned to reflect at least a portion of light reflected from the tissue.

SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. application Serial No. 16/272,069 filed February, 11, 2019, which is a continuation of U.S. application Serial No. 16/029,611 filed July 8, 2018 (now U.S. Patent No. 10,201,283), which is a continuation of U.S. application Serial No. 15/888,052 filed February 4, 2018 (now U.S. Patent No. 10,136,819), which is a continuation of U.S. application Serial No. 15/212,549 filed July 18, 2016 (now U.S. Patent No. 9,885,698), which is a continuation of U.S. application Serial No. 14/650,897 filed June 10, 2015 (now U.S. Patent No. 9,494,567), which is a U.S. National Phase of PCT/US2013/075700 filed December 17, 2013, which claims the benefit of U.S. provisional application Serial No. 61/747,472 filed December 31, 2012, the disclosures of all of which are hereby incorporated in their entirety by reference herein.

[0002] This application is also a continuation of U.S. application Serial No. 16/004,359 filed June 9, 2018, which is a continuation of U.S. application Serial No. 14/109,007 filed December 17, 2013 (now U.S. Patent No. 9,993,159), which claims the benefit of U.S. provisional application Serial No. 61/747,553 filed December 31, 2012, the disclosures of all of which are hereby incorporated in their entirety by reference herein.

[0003] This application is also a continuation of U.S. application Serial No.16/188,194 filed November 12, 2018, which is a continuation of U.S. Application No. 16/004,154 filed June 8, 2018 (now U.S. Patent No. 10,126,283), which is a continuation of U.S. Application No. 15/855,201 filed December 27, 2017 (now U.S. Patent No. 9,995,722), which is a continuation of U.S. Application No. 15/711,907 filed September 21, 2017 (now U.S. Patent No. 9,897,584), which is a divisional of U.S. Application No. 15/357,225 filed November 21, 2016 (now U.S. Patent No. 9,797,876), which is a continuation of U.S. Application No. 14/650,981 filed June 10, 2015 (now U.S. Patent No. 9,500,634), which is the U.S. national phase of PCT Application No. PCT/US2013/075767 filed December 17, 2013, which claims the benefit of U.S. provisional

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application Ser. No. 61/747,485 filed Dec. 31, 2012, the disclosures of all of which are hereby incorporated by reference in their entirety.

[0004] This application is also a continuation of U.S. application Serial No. 16/241,628 filed January 7, 2019, which is a continuation of U.S. Serial No. 16/015,737 filed June 22, 2018 (now U.S. Patent No. 10,172,523), which is a continuation of U.S. Serial No. 15/594,053 filed May 12, 2017 (now U.S. Patent No. 10,188,299), which is a continuation of U.S. application Serial No. 14/875,709 filed October 6, 2015 (now U.S. Patent No. 9,651,533), which is a continuation of U.S. application Serial No. 14/108,986 filed December 17, 2013 (now U.S. Patent No. 9,164,032), which claims the benefit of U.S. provisional application Serial No. 61/747,487 filed December 31, 2012, the disclosures of all of which are hereby incorporated in their entirety by reference herein.

[0005] This application is also a continuation of U.S. Application Ser. No. 16/284,514 filed February 25, 2019, which is a continuation of U.S. Application Ser. No. 16/016,649 filed June 24, 2018 (now U.S. Patent No. 10,213,113), which is a continuation of U.S. Application Ser. No. 15/860,065 filed January 2, 2018 (now U.S. Patent No. 10,098,546), which is a Continuation of U.S. Application Ser. No. 15/686,198 filed August 25, 2017 (now U.S. Patent No. 9,861,286), which is a continuation of U.S. Application Ser. No. 15/357,136 filed November 21, 2016 (now U.S. Patent. No. 9,757,040), which is a continuation of U.S. Application Ser. No. 14/651,367 filed June 11, 2015 (now U.S. Patent No. 9,500,635), which is the U.S. national phase of PCT Application No. PCT/US2013/075736 filed December 17, 2013, which claims the benefit of U.S. provisional application Ser. No. 61/747,477 filed Dec. 31, 2012 and U.S. provisional application Ser. No. 61/754,698 filed Jan. 21, 2013, the disclosures of all of which are hereby incorporated by reference in their entirety.

[0006] This application is related to U.S. provisional application Serial Nos. 61/747,477 filed Dec. 31, 2012; Ser. No. 61/747,481 filed Dec. 31, 2012; Ser. No. 61/747,485 filed Dec. 31, 2012; Ser. No. 61/747,487 filed Dec. 31, 2012; Ser. No. 61/747,492 filed Dec. 31, 2012; Ser. No. 61/747,553 filed Dec. 31, 2012; and Ser. No. 61/754,698 filed Jan. 21, 2013, the disclosures of all of which are hereby incorporated in their entirety by reference herein.

[0007] This application is also related to International Application PCT/US2013/075736 entitled Short-Wave Infrared Super-Continuum Lasers For Early Detection Of Dental Caries; U.S. Application 14/108,995 filed December 17, 2013 entitled Focused Near-Infrared Lasers For Non-Invasive Vasectomy And Other Thermal Coagulation Or Occlusion Procedures (U.S. Pat. App. Pub. No. US2014/0188092A1); International Application PCT/US2013/075767 entitled Short-Wave Infrared Super-Continuum Lasers For Natural Gas Leak Detection, Exploration, And Other Active Remote Sensing Applications; U.S. Application 14/108,986 filed December 17, 2013 entitled Short-Wave Infrared Super-Continuum Lasers For Detecting Counterfeit Or Illicit Drugs And Pharmaceutical Process Control (now U.S. Patent No. 9,164,032); U.S. Application 14/108,974 filed December 17, 2013 entitled Non-Invasive Treatment Of Varicose Veins (U.S. Pat. App. Pub. No. US2014/018894A1); and U.S. Application 14/109,007 filed December 17, 2013 entitled Near-Infrared Super-Continuum Lasers For Early Detection Of Breast And Other Cancers (now U.S. Patent No. 9,993,159), the disclosures of all of which are hereby incorporated in their entirety by reference herein.

BACKGROUND

[0008] With the growing obesity epidemic, the number of individuals with diabetes is also increasing dramatically. For example, there are over 200 million people who have diabetes. Diabetes control requires monitoring of the glucose level, and most glucose measuring systems available commercially require drawing of blood. Depending on the severity of the diabetes, a patient may have to draw blood and measure glucose four to six times a day. This may be extremely painful and inconvenient for many people. In addition, for some groups, such as soldiers in the battlefield, it may be dangerous to have to measure periodically their glucose level with finger pricks.

[0009] Thus, there is an unmet need for non-invasive glucose monitoring (e.g., monitoring glucose without drawing blood). The challenge has been that a non-invasive system requires adequate sensitivity and selectivity, along with repeatability of the results. Yet, this is a very large market, with an estimated annual market of over $10B in 2011 for self-monitoring of glucose levels.

[0010] One approach to non-invasive monitoring of blood constituents or blood analytes is to use near-infrared spectroscopy, such as absorption spectroscopy or near-infrared diffuse reflection or transmission spectroscopy. Some attempts have been made to use broadband light sources, such as tungsten lamps, to perform the spectroscopy. However, several challenges have arisen in these efforts. First, many other constituents in the blood also have signatures in the near-infrared, so spectroscopy and pattern matching, often called spectral fingerprinting, is required to distinguish the glucose with sufficient confidence. Second, the non-invasive procedures have often transmitted or reflected light through the skin, but skin has many spectral artifacts in the near-infrared that may mask the glucose signatures. Moreover, the skin may have significant water and blood content. These difficulties become particularly complicated when a weak light source is used, such as a lamp. More light intensity can help to increase the signal levels, and, hence, the signal-to-noise ratio.

[0011] As described in this disclosure, by using brighter light sources, such as fiber-based supercontinuum lasers, super-luminescent laser diodes, light-emitting diodes or a number of laser diodes, the near-infrared signal level from blood constituents may be increased. By shining light through the teeth, which have fewer spectral artifacts than skin in the near-infrared, the blood constituents may be measured with less interfering artifacts. Also, by using pattern matching in spectral fingerprinting and various software techniques, the signatures from different constituents in the blood may be identified. Moreover, value-add services may be provided by wirelessly communicating the monitored data to a handheld device such as a smart phone, and then wirelessly communicating the processed data to the cloud for storing, processing, and transmitting to several locations.

SUMMARY OF EXAMPLE EMBODIMENTS

[0012] In one embodiment, a smart phone or tablet comprises one or more laser diodes configured to be pulsed and to generate light having one or more optical wavelengths, wherein at least a portion of the one or more optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers. A first one or more lenses is configured to receive a portion of the light from the one or more laser diodes and to direct at least some portion of the received light

to tissue. An array of laser diodes is configured to be pulsed and to generate light having one or more optical wavelengths, wherein at least a portion of the one or more optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers. A second one or more lenses is configured to receive a portion of the light from the array of laser diodes, the array of laser diodes and the second one or more lenses configured to form the light into a plurality of spots and to direct at least some of the spots to tissue. An infrared camera is configured to be synchronized to the at least one of the one or more laser diodes to receive at least a portion of light reflected from the tissue from at least one of the one or more laser diodes, wherein the infrared camera generates data based at least in part on the received light. The infrared camera is further configured to be synchronized to the array of laser diodes to receive light from at least a portion of the plurality of spots reflected from the tissue, and wherein the infrared camera generates additional data based at least in part on the received light. The infrared camera is further configured to: receive light while the one or more laser diodes and the array of laser diodes are off and convert the received light into a first signal; and receive light while at least some of the one or more laser diodes or some of the array of laser diodes are on, and convert the received light into a second signal, the received light including at least a part of the portion of the light from the at least one of the one or more laser diodes reflected from the tissue, or at least a part of the portion of the light from the array of laser diodes reflected from the tissue. The smart phone or tablet is configured to generate a two-dimensional or three-dimensional image using a difference between the first signal and the second signal, and using at least part of the data or at least part of the additional data from the infrared camera. The smart phone or tablet further comprises a wireless receiver, a wireless transmitter, a display, a voice input module, and a speaker.

[0013] Embodiments may include a smart phone or tablet comprising one or more laser diodes configured to be pulsed and to generate light having one or more optical wavelengths, wherein at least a portion of the one or more optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers. A first one or more lenses is configured to receive a portion of the light from the one or more laser diodes and to direct at least some portion of the received light to tissue. An array of laser diodes is configured to be pulsed and to generate light having one or more optical wavelengths, wherein at least a portion of the one or more optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers. A

second one or more lenses is configured to receive a portion of the light from the array of laser diodes, the array of laser diodes and the second one or more lenses configured to form the light into a plurality of spots and to direct at least some of the spots to tissue. An infrared camera is configured to be synchronized to the at least one of the one or more laser diodes to receive at least a portion of light reflected from the tissue from at least one of the one or more laser diodes, and wherein the infrared camera generates data based at least in part on the received light. The infrared camera is further configured to be synchronized to the array of laser diodes to receive light from at least a portion of the plurality of spots reflected from the tissue, wherein the infrared camera generates additional data based at least in part on the received light. The smart phone or tablet is configured to generate a two-dimensional or three-dimensional image using at least part of the data or part of the additional data from the infrared camera. The smart phone or tablet further comprises a wireless receiver, a wireless transmitter, a display, a voice input module, and a speaker.

[0014] In one embodiment, a smart phone or tablet comprises one or more laser diodes configured to be pulsed and to generate light having one or more optical wavelengths, wherein at least a portion of the one or more optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers. A first one or more lenses is configured to receive a portion of the light from the one or more laser diodes and to direct at least some portion of the received light to tissue. An array of laser diodes is configured to be pulsed and to generate light having one or more optical wavelengths, wherein at least a portion of the one or more optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers. A second one or more lenses is configured to receive a portion of the light from the array of laser diodes, the array of laser diodes and the second one or more lenses configured to form the light into a plurality of spots and to direct at least some of the spots to tissue, wherein the plurality of spots are also formed at least in part by using an assembly in front of the array of laser diodes. An infrared camera is configured to be synchronized to the at least one of the one or more laser diodes to receive at least a portion of light reflected from the tissue from at least one of the one or more laser diodes, wherein the infrared camera generates data based at least in part on the received light. The infrared camera is further configured to be synchronized to the array of laser diodes to receive light from at least a portion of the plurality of spots reflected from the tissue, wherein the

infrared camera generates additional data based at least in part on the received light. The smart phone or tablet is configured to generate a two-dimensional or three-dimensional image using at least part of the data or part of the additional data from the infrared camera. The smart phone or tablet further comprises a wireless receiver, a wireless transmitter, a display, a voice input module, and a speaker.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] For a more complete understanding of the present disclosure, and for further features and advantages thereof, reference is now made to the following description taken in conjunction with the accompanying drawings, in which:

[0016] FIG. 1 plots the transmittance versus wavenumber for glucose in the mid-wave and long-wave infrared wavelengths between approximately 2.7 to 12 microns.

[0017] FIG. 2 illustrates measurements of the absorbance of different blood constituents, such as glucose, hemoglobin, and hemoglobin A1c. The measurements are done using an FTIR spectrometer in samples with a 1 mm path length.

[0018] FIG. 3A shows the normalized absorbance of water and glucose (not drawn to scale). Water shows transmission windows between about 1500-1850 nm and 2050-2500 nm.

[0019] FIG. 3B illustrates the absorbance of hemoglobin and oxygenated hemoglobin overlapped with water.

[0020] FIG. 4A shows measured absorbance in different concentrations of glucose solution over the wavelength range of about 2000 to 2400 nm. This data is collected using a SWIR super-continuum laser with the sample path length of about 1.1 mm.

[0021] FIG. 4B illustrates measured absorbance in different concentrations of glucose solution over the wavelength range of about 1550 to 1800 nm. The data is collected using a SWIR super-continuum laser with a sample path length of about 10 mm.

[0022] FIG. 5 illustrates the spectrum for different blood constituents in the wavelength range of about 2 to 2.45 microns (2000 to 2450 nm).

[0023] FIG. 6 shows the transmittance versus wavelength in microns for the ketone 3-hydroxybutyrate. The wavelength range is approximately 2 to 16 microns.

[0024] FIG. 7 illustrates the optical absorbance for ketones as well as some other blood constituents in the wavelength range of about 2100 to 2400 nm.

[0025] FIG. 8A shows the first derivative spectra of ketone and protein at concentrations of 10 g/L (left). In addition, the first derivative spectra of urea, creatinine, and glucose are shown on the right at concentrations of 10 g/L.

[0026] FIG. 8B illustrates the near infrared absorbance for triglyceride.

[0027] FIG. 8C shows the near-infrared reflectance spectrum for cholesterol.

[0028] FIG. 8D illustrates the near-infrared reflectance versus wavelength for various blood constituents, including cholesterol, glucose, albumin, uric acid, and urea.

[0029] FIG. 9 shows a schematic of the human skin. In particular, the dermis may comprise significant amounts of collagen, elastin, lipids, and water.

[0030] FIG. 10 illustrates the absorption coefficients for water (including scattering), adipose, collagen, and elastin.

[0031] FIG. 11 shows the dorsal of the hand, where a differential measurement may be made to at least partially compensate for or subtract out the skin interference.

[0032] FIG. 12 shows the dorsal of the foot, where a differential measurement may be made to at least partially compensate for or subtract out the skin interference.

[0033] FIG. 13A shows an embodiment that may comprise multiple collimated or focused light beams.

[0034] FIG. 13B illustrates a typical human nail tissue structure and the capillary vessels below it.

[0035] FIG. 14 shows the attenuation coefficient for seven nail samples that are allowed to stand in an environment with a humidity level of 14%. These coefficients are measured using an FTIR spectrometer over the near-infrared wavelength range of approximately 1 to 2.5 microns. Below is also included the spectrum of glucose.

[0036] FIG. 15 illustrates the structure of a tooth.

[0037] FIG. 16A shows the attenuation coefficient for dental enamel and water versus wavelength from approximately 600nm to 2600nm.

[0038] FIG. 16B illustrates the absorption spectrum of intact enamel and dentine in the wavelength range of approximately 1.2 to 2.4 microns.

[0039] FIG. 17 shows the near infrared spectral reflectance over the wavelength range of approximately 800nm to 2500nm from an occlusal tooth surface. The black diamonds correspond to the reflectance from a sound, intact tooth section. The asterisks correspond to a tooth section with an enamel lesion. The circles correspond to a tooth section with a dentine lesion.

[0040] FIG. 18A illustrates a clamp design of a human interface to cap over one or more teeth and perform a non-invasive measurement of blood constituents.

[0041] FIG. 18B shows a mouth guard design of a human interface to perform a non-invasive measurement of blood constituents.

[0042] FIG. 19 illustrates a block diagram or building blocks for constructing high power laser diode assemblies.

[0043] FIG. 20 shows a platform architecture for different wavelength ranges for an all-fiber-integrated, high powered, super-continuum light source.

[0044] FIG. 21 illustrates one embodiment of a short-wave infrared (SWIR) super-continuum (SC) light source.

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[0045] FIG. 22 shows the output spectrum from the SWIR SC laser of FIG. 21 when about 10m length of fiber for SC generation is used. This fiber is a single-mode, non-dispersion shifted fiber that is optimized for operation near 1550 nm.

[0046] FIG. 23 illustrates high power SWIR-SC lasers that may generate light between approximately 1.4-1.8 microns (top) or approximately 2-2.5 microns (bottom).

[0047] FIG. 24 schematically shows that the medical measurement device can be part of a personal or body area network that communicates with another device (e.g., smart phone or tablet) that communicates with the cloud. The cloud may in turn communicate information with the user, healthcare providers, or other designated recipients.

[0048] FIGURE 25 shows the experimental set-up for a reflection-spectroscopy based stand-off detection system.

[0049] FIGURE 26 shows what might be an eventual flow-chart of a smart manufacturing process.

DETAILED DESCRIPTION

[0050] As required, detailed embodiments of the present disclosure are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the disclosure that may be embodied in various and alternative forms. The figures are not necessarily to scale; some features may be exaggerated or minimized to show details of particular components. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a representative basis for teaching one skilled in the art to variously employ the present disclosure.

[0051] Various ailments or diseases may require measurement of the concentration of one or more blood constituents. For example, diabetes may require measurement of the blood glucose and HbA1c levels. On the other hand, diseases or disorders characterized by impaired glucose metabolism may require the measurement of ketone bodies in the blood. Examples of impaired glucose metabolism diseases include Alzheimer's, Parkinson's, Huntington's, and Lou Gehrig's or

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amyotrophic lateral sclerosis (ALS). Techniques related to near-infrared spectroscopy or hyper-spectral imaging may be particularly advantageous for non-invasive monitoring of some of these blood constituents.

[0052] Hyper-spectral images may provide spectral information to identify and distinguish between spectrally similar materials, providing the ability to make proper distinctions among materials with only subtle signature differences. In the SWIR wavelength range, numerous gases, liquids and solids have unique chemical signatures, particularly materials comprising hydro-carbon bonds, O-H bonds, N-H bonds, etc. Therefore, spectroscopy in the SWIR may be attractive for stand-off or remote sensing of materials based on their chemical signature, which may complement other imaging information.

[0053] One embodiment of remote sensing that is used to identify and classify various materials is so-called "hyper-spectral imaging." Hyper-spectral sensors may collect information as a set of images, where each image represents a range of wavelengths over a spectral band. Hyper-spectral imaging may deal with imaging narrow spectral bands over an approximately continuous spectral range. As an example, in hyper-spectral imaging the sun may be used as the illumination source, and the daytime illumination may comprise direct solar illumination as well as scattered solar (skylight), which is caused by the presence of the atmosphere. However, the sun illumination changes with time of day, clouds or inclement weather may block the sun light, and the sun light is not accessible in the night time. Therefore, it would be advantageous to have a broadband light source covering the SWIR that may be used in place of the sun to identify or classify materials in remote sensing or stand-off detection applications.

[0054] In one embodiment, a SWIR camera or infrared camera system may be used to capture the images. The camera may include one or more lenses on the input, which may be adjustable. The focal plane assemblies may be made from mercury cadmium telluride material (HgCdTe), and the detectors may also include thermo-electric coolers. Alternately, the image sensors may be made from indium gallium arsenide (InGaAs), and CMOS transistors may be connected to each pixel of the InGaAs photodiode array. The camera may interface wirelessly or with a cable (e.g., USB, Ethernet cable, or fiber optics cable) to a computer or tablet or smart phone, where the images may be captured and processed. These are a few examples of infrared

cameras, but other SWIR or infrared cameras may be used and are intended to be covered by this disclosure.

[0055] Described herein are just some examples of the beneficial use of near-infrared or SWIR lasers for active remote sensing or hyper-spectral imaging. However, many other spectroscopy and identification procedures can use the near-infrared or SWIR light consistent with this disclosure and are intended to be covered by the disclosure. As one example, the fiber-based super-continuum lasers may have a pulsed output with pulse durations of approximately 0.5-2nsec and pulse repetition rates of several Megahertz. Therefore, the active remote sensing or hyper-spectral imaging applications may also be combined with LIDAR-type applications. Namely, the distance or time axis can be added to the information based on time-of-flight measurements. For this type of information to be used, the detection system would also have to be time-gated to be able to measure the time difference between the pulses sent and the pulses received. By calculating the round-trip time for the signal, the distance of the object may be judged. In another embodiment, GPS (global positioning system) information may be added, so the active remote sensing or hyper-spectral imagery would also have a location tag on the data. Moreover, the active remote sensing or hyper-spectral imaging information could also be combined with two-dimensional or three-dimensional images to provide a physical picture as well as a chemical composition identification of the materials. These are just some modifications of the active remote sensing or hyper-spectral imaging system described in this disclosure, but other techniques may also be added or combinations of these techniques may be added, and these are also intended to be covered by this disclosure.

[0056] Described herein are just some examples of the beneficial use of near-infrared or SWIR lasers for active remote sensing or hyper-spectral imaging. However, many other spectroscopy and identification procedures can use the near-infrared or SWIR light consistent with this disclosure and are intended to be covered by the disclosure. As one example, the fiber-based super-continuum lasers may have a pulsed output with pulse durations of approximately 0.5-2nsec and pulse repetition rates of several Megahertz. Therefore, the active remote sensing or hyper-spectral imaging applications may also be combined with LIDAR-type applications. Namely, the distance or time axis can be added to the information based on time-of-flight measurements. For this type of information to be used, the detection system would also have to

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be time-gated to be able to measure the time difference between the pulses sent and the pulses received. By calculating the round-trip time for the signal, the distance of the object may be judged. In another embodiment, GPS (global positioning system) information may be added, so the active remote sensing or hyper-spectral imagery would also have a location tag on the data. Moreover, the active remote sensing or hyper-spectral imaging information could also be combined with two-dimensional or three-dimensional images to provide a physical picture as well as a chemical composition identification of the materials. These are just some modifications of the active remote sensing or hyper-spectral imaging system described in this disclosure, but other techniques may also be added or combinations of these techniques may be added, and these are also intended to be covered by this disclosure.

[0057] In some instances, it may be desirable to create multiple locations of focused light on the varicose vein. For example, the speed of the treatment may be increased by causing thermal coagulation or occlusion at multiple locations. Multiple collimated or focused light beams may be created in one assembly. In this embodiment, optionally a surface cooling apparatus may be used, where a cooling fluid may be flowed either touching or in close proximity to the skin. Also, in this particular embodiment a cylindrical assembly may optionally be used, where the cylindrical length may be several millimeters in length and defined by a clamp or mount placed on or near the leg. In one embodiment, a window and/or lenslet array is also shown on the cylindrical surface for permitting the light to be incident on the skin and varicose vein at multiple spots. The lenslet array may comprise circular, spherical or cylindrical lenses, depending on the type of spots desired. As before, one advantage of placing the lenslet array in close proximity to the skin and varicose vein may be that a high NA, lens may be used. Also, the input from the lens and/or mirror assembly to the lenslet array may be single large beam, or a plurality of smaller beams. In one embodiment, a plurality of spots may be created by the lenslet array to cause a plurality of locations of thermal coagulation in the varicose vein. Any number of spots may be used and are intended to be covered by this disclosure.

[0058] In a non-limiting example, a plurality of spots may be used, or what might be called a fractionated beam. The fractionated laser beam may be added to the laser delivery assembly or delivery head in a number of ways. In one embodiment, a screen-like spatial filter may be placed in the pathway of the beam to be delivered to the biological tissue. The screen-

like spatial filter can have opaque regions to block the light and holes or transparent regions, through which the laser beam may pass to the tissue sample. The ratio of opaque to transparent regions may be varied, depending on the application of the laser. In another embodiment, a lenslet array can be used at or near the output interface where the light emerges. In yet another embodiment, at least a part of the delivery fiber from the infrared laser system to the delivery head may be a bundle of fibers, which may comprise a plurality of fiber cores surrounded by cladding regions. The fiber cores can then correspond to the exposed regions, and the cladding areas can approximate the opaque areas not to be exposed to the laser light. As an example, a bundle of fibers may be excited by at least a part of the laser system output, and then the fiber bundle can be fused together and perhaps pulled down to a desired diameter to expose to the tissue sample near the delivery head. In yet another embodiment, a photonic crystal fiber may be used to create the fractionated laser beam. In one non-limiting example, the photonic crystal fiber can be coupled to at least a part of the laser system output at one end, and the other end can be coupled to the delivery head. In a further example, the fractionated laser beam may be generated by a heavily multi-mode fiber, where the speckle pattern at the output may create the high intensity and low intensity spatial pattern at the output. Although several exemplary techniques are provided for creating a fractionated laser beam, other techniques that can be compatible with optical fibers are also intended to be included by this disclosure.

[0059] Although the output from a fiber laser may be from a single or multi-mode fiber, different spatial spot sizes or spatial profiles may be beneficial for different applications. For example, in some instances it may be desirable to have a series of spots or a fractionated beam with a grid of spots. In one embodiment, a bundle of fibers or a light pipe with a plurality of guiding cores may be used. In another embodiment, one or more fiber cores may be followed by a lenslet array to create a plurality of collimated or focused beams. In yet another embodiment, a delivery light pipe may be followed by a grid-like structure to divide up the beam into a plurality of spots. These are specific examples of beam shaping, and other apparatuses and methods may also be used and are consistent with this disclosure.

[0060] As used throughout this document, the term "couple" and or "coupled" refers to any direct or indirect communication between two or more elements, whether or not those elements are physically connected to one another. As used throughout this disclosure, the term

"spectroscopy" means that a tissue or sample is inspected by comparing different features, such as wavelength (or frequency), spatial location, transmission, absorption, reflectivity, scattering, refractive index, or opacity. In one embodiment, "spectroscopy" may mean that the wavelength of the light source is varied, and the transmission, absorption or reflectivity of the tissue or sample is measured as a function of wavelength. In another embodiment, "spectroscopy" may mean that the wavelength dependence of the transmission, absorption or reflectivity is compared between different spatial locations on a tissue or sample. As an illustration, the "spectroscopy" may be performed by varying the wavelength of the light source, or by using a broadband light source and analyzing the signal using a spectrometer, wavemeter, or optical spectrum analyzer.

[0061] As used throughout this document, the term "fiber laser" refers to a laser or oscillator that has as an output light or an optical beam, wherein at least a part of the laser comprises an optical fiber. For instance, the fiber in the "fiber laser" may comprise one of or a combination of a single mode fiber, a multi-mode fiber, a mid-infrared fiber, a photonic crystal fiber, a doped fiber, a gain fiber, or, more generally, an approximately cylindrically shaped waveguide or light-pipe. In one embodiment, the gain fiber may be doped with rare earth material, such as ytterbium, erbium, and/or thulium. In another embodiment, the mid-infrared fiber may comprise one or a combination of fluoride fiber, ZBLAN fiber, chalcogenide fiber, tellurite fiber, or germanium doped fiber. In yet another embodiment, the single mode fiber may include standard single-mode fiber, dispersion shifted fiber, non-zero dispersion shifted fiber, high-nonlinearity fiber, and small core size fibers.

[0062] As used throughout this disclosure, the term "pump laser" refers to a laser or oscillator that has as an output light or an optical beam, wherein the output light or optical beam is coupled to a gain medium to excite the gain medium, which in turn may amplify another input optical signal or beam. In one particular example, the gain medium may be a doped fiber, such as a fiber doped with ytterbium, erbium or thulium. In one embodiment, the "pump laser" may be a fiber laser, a solid state laser, a laser involving a nonlinear crystal, an optical parametric oscillator, a semiconductor laser, or a plurality of semiconductor lasers that may be multiplexed together. In another embodiment, the "pump laser" may be coupled to the gain medium by using a fiber coupler, a dichroic mirror, a multiplexer, a wavelength division multiplexer, a grating, or a fused fiber coupler.

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[0063] As used throughout this document, the term "super-continuum" and or "supercontinuum" and or "SC" refers to a broadband light beam or output that comprises a plurality of wavelengths. In a particular example, the plurality of wavelengths may be adjacent to one-another, so that the spectrum of the light beam or output appears as a continuous band when measured with a spectrometer. In one embodiment, the broadband light beam may have a bandwidth of at least 10 nm. In another embodiment, the "super-continuum" may be generated through nonlinear optical interactions in a medium, such as an optical fiber or nonlinear crystal. For example, the "super-continuum" may be generated through one or a combination of nonlinear activities such as four-wave mixing, the Raman effect, modulational instability, and self-phase modulation.

[0064] As used throughout this disclosure, the terms "optical light" and or "optical beam" and or "light beam" refer to photons or light transmitted to a particular location in space. The "optical light" and or "optical beam" and or "light beam" may be modulated or unmodulated. In one embodiment, the "optical light" and or "optical beam" and or "light beam" may originate from a fiber, a fiber laser, a laser, a light emitting diode, a lamp, a pump laser, or a light source. In general, the "near-infrared (NIR)" region of the electromagnetic spectrum covers between approximately 0.7 microns (700 nm) to about 2.5 microns (2500nm). However, it may also be advantageous to use just the short-wave infrared between approximately 1.4 microns (1400 nm) and about 2.5 microns (2500 nm). One reason for preferring the SWIR over the entire NIR may be to operate in the so-called "eye-safe" window, which corresponds to wavelengths longer than about 1400 nm. Therefore, for the remainder of the disclosure the SWIR will be used for illustrative purposes. However, it should be clear that the discussion that follows could also apply to using the NIR wavelength range, or other wavelength bands.

Spectrum for Glucose

[0065] One molecule of interest is glucose. The glucose molecule has the chemical formula $C_6H_{12}O_6$, so it has a number of hydro-carbon bonds. An example of the infrared transmittance of glucose 100 is illustrated in FIG. 1. The vibrational spectroscopy shows that the strongest lines for bending and stretching modes of C--H and O--H bonds lie in the wavelength range of approximately 6-12 microns. However, light sources and detectors are more difficult in

the mid-wave infrared and long-wave infrared, and there is also strongly increasing water absorption in the human body beyond about 2.5 microns. Although weaker, there are also non-linear combinations of stretching and bending modes between about 2 to 2.5 microns, and first overtone of C--H stretching modes between approximately 1.5-1.8 microns. These signatures may fall in valleys of water absorption, permitting non-invasive detection through the body. In addition, there are yet weaker features from the second overtones and higher-order combinations between about 0.8-1.2 microns; in addition to being weaker, these features may also be masked by absorption in the hemoglobin. Hence, the short-wave infrared (SWIR) wavelength range of approximately 1.4 to 2.5 microns may be an attractive window for near-infrared spectroscopy of blood constituents.

[0066] As an example, measurements of the optical absorbance 200 of hemoglobin, glucose and HbA1c have been performed using a Fourier-Transform Infrared Spectrometer--FTIR. As FIG. 2 shows, in the SWIR wavelength range hemoglobin is nearly flat in spectrum 201 (the noise at the edges is due to the weaker light signal in the measurements). On the other hand, the glucose absorbance 202 has at least five distinct peaks near 1587 nm, 1750 nm, 2120 nm, 2270 nm and 2320 nm.

[0067] FIG. 3A overlaps 300 the normalized absorbance of glucose 301 with the absorbance of water 302 (not drawn to scale). It may be seen that water has an absorbance feature between approximately 1850 nm and 2050 nm, but water 302 also has a nice transmission window between approximately 1500-1850 nm and 2050 to 2500 nm. For wavelengths less than about 1100 nm, the absorption of hemoglobin 351 and oxygenated hemoglobin 352 in FIG. 3B has a number of features 350, which may make it more difficult to measure blood constituents. Also, beyond 2500 nm the water absorption becomes considerably stronger over a wide wavelength range. Therefore, an advantageous window for measuring glucose and other blood constituents may be in the SWIR between 1500 and 1850 nm and 2050 to 2500 nm. These are exemplary wavelength ranges, and other ranges can be used that would still fall within the scope of this disclosure.

[0068] One further consideration in choosing the laser wavelength is known as the "eye safe" window for wavelengths longer than about 1400 nm. In particular, wavelengths in the eye

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safe window may not transmit down to the retina of the eye, and therefore, these wavelengths may be less likely to create permanent eye damage. The near-infrared wavelengths have the potential to be dangerous, because the eye cannot see the wavelengths (as it can in the visible), yet they can penetrate and cause damage to the eye. Even if a practitioner is not looking directly at the laser beam, the practitioner's eyes may receive stray light from a reflection or scattering from some surface. Hence, it can always be a good practice to use eye protection when working around lasers. Since wavelengths longer than about 1400 nm are substantially not transmitted to the retina or substantially absorbed in the retina, this wavelength range is known as the eye safe window. For wavelengths longer than 1400 nm, in general only the cornea of the eye may receive or absorb the light radiation.

[0069] Beyond measuring blood constituents such as glucose using FTIR spectrometers, measurements have also been conducted in another embodiment using super-continuum lasers, which will be described later in this disclosure. In this particular embodiment, some of the exemplary preliminary data for glucose absorbance are illustrated in FIGS. 4A and 4B. The optical spectra 401 in FIG. 4A for different levels of glucose concentration in the wavelength range between 2000 and 2400 nm show the three absorption peaks near 2120 nm (2.12 μm), 2270 nm (2.27 μm) and 2320 nm (2.32 μm). Moreover, the optical spectra 402 in FIG. 4B for different levels of glucose concentration in the wavelength range between 1500 and 1800 nm show the two broader absorption peaks near 1587 nm and 1750 nm. It should be appreciated that although data measured with FTIR spectrometers or super-continuum lasers have been illustrated, other light sources can also be used to obtain the data, such as super-luminescent laser diodes, light emitting diodes, a plurality of laser diodes, or even bright lamp sources that generate adequate light in the SWIR.

[0070] Although glucose has a distinctive signature in the SWIR wavelength range, one problem of non-invasive glucose monitoring is that many other blood constituents also have hydro-carbon bonds. Consequently, there can be interfering signals from other constituents in the blood. As an example, FIG. 5 illustrates the spectrum 500 for different blood constituents in the wavelength range of 2 to 2.45 microns. The glucose absorption spectrum 501 can be unique with its three peaks in this wavelength range. However, other blood constituents such as triacetin 502, ascorbate 503, lactate 504, alanine 505, urea 506, and BSA 507 also have spectral features in this

wavelength range. To distinguish the glucose 501 from these overlapping spectra, it may be advantageous to have information at multiple wavelengths. In addition, it may be advantageous to use pattern matching algorithms and other software and mathematical methods to identify the blood constituents of interest. In one embodiment, the spectrum may be correlated with a library of known spectra to determine the overlap integrals, and a threshold function may be used to quantify the concentration of different constituents. This is just one way to perform the signal processing, and many other techniques, algorithms, and software may be used and would fall within the scope of this disclosure.

Ketone Bodies Monitoring

[0071] Beyond glucose, there are many other blood constituents that may also be of interest for health or disease monitoring. In another embodiment, it may be desirous to monitor the level of ketone bodies in the blood stream. Ketone bodies are three water-soluble compounds that are produced as by-products when fatty acids are broken down for energy in the liver. Two of the three are used as a source of energy in the heart and brain, while the third is a waste product excreted from the body. In particular, the three endogenous ketone bodies are acetone, acetoacetic acid, and beta-hydroxybutyrate or 3-hydroxybutyrate, and the waste product ketone body is acetone.

[0072] Ketone bodies may be used for energy, where they are transported from the liver to other tissues. The brain may utilize ketone bodies when sufficient glucose is not available for energy. For instance, this may occur during fasting, strenuous exercise, low carbohydrate, ketogenic diet and in neonates. Unlike most other tissues that have additional energy sources such as fatty acids during periods of low blood glucose, the brain cannot break down fatty acids and relies instead on ketones. In one embodiment, these ketone bodies are detected.

[0073] Ketone bodies may also be used for reducing or eliminating symptoms of diseases or disorders characterized by impaired glucose metabolism. For example, diseases associated with reduced neuronal metabolism of glucose include Parkinson's disease, Alzheimer's disease, amyotrophic lateral sclerosis (ALS, also called Lou Gehrig's disease), Huntington's disease and epilepsy. In one embodiment, monitoring of alternate sources of ketone bodies that may be

administered orally as a dietary supplement or in a nutritional composition to counteract some of the glucose metabolism impairments is performed. However, if ketone bodies supplements are provided, there is also a need to monitor the ketone level in the blood stream. For instance, if elevated levels of ketone bodies are present in the body, this may lead to ketosis; hyperketonemia is also an elevated level of ketone bodies in the blood. In addition, both acetoacetic acid and beta-hydroxybutyric acid are acidic, and, if levels of these ketone bodies are too high, the pH of the blood may drop, resulting in ketoacidosis.

[0074] The general formula for ketones is $C_nH_{2n}O$. In organic chemistry, a ketone is an organic compound with the structure RC(=O)R', where R and R' can be a variety of carbon-containing substituents. It features a carbonyl group (C=O) bonded to two other carbon atoms. Because the ketones contain the hydrocarbon bonds, there might be expected to be features in the SWIR, similar in structure to those found for glucose.

[0075] The infrared spectrum 600 for the ketone 3-hydroxybutyrate is illustrated in FIG. 6. Just as in glucose, there are significant features in the mid- and long-wave infrared between 6 to 12 microns, but these may be difficult to observe non-invasively. On the other hand, there are some features in the SWIR that may be weaker, but they could potentially be observed non-invasively, perhaps through blood and water.

[0076] The optical spectra 700 for ketones as well as some other blood constituents are exemplified in FIG. 7 in the wavelength range of 2100 nm to 2400 nm. In this embodiment, the absorbance for ketones is 701, while the absorbance for glucose is 702. However, there are also features in this wavelength range for other blood constituents, such as urea 703, albumin or blood protein 704, creatinine 705, and nitrite 706. In this wavelength range of 2100 to 2400 nm, the features for ketone 701 seem more spectrally pronounced than even glucose.

[0077] Different signal processing techniques can be used to enhance the spectral differences between different constituents. In one embodiment, the first or second derivatives of the spectra may enable better discrimination between substances. The first derivative may help remove any flat offset or background, while the second derivative may help to remove any sloped offset or background. In some instances, the first or second derivative may be applied after curve

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fitting or smoothing the reflectance, transmittance, or absorbance. For example, FIG. 8A illustrates the derivative spectra for ketone 801 and glucose 802, which can be distinguished from the derivative spectra for protein 803, urea 804 and creatinine 805. Based on FIG. 8A, it appears that ketones 801 may have a more pronounced difference than even glucose 802 in the wavelength range between 2100 and 2400 nm. Therefore, ketone bodies should also be capable of being monitored using a non-invasive optical technique in the SWIR, and a different pattern matching library could be used for glucose and ketones.

Hemoglobin A1c Monitoring

[0078] Another blood constituent that may be of interest for monitoring of health or diseases is hemoglobin A1c, also known as HbA1c or glycated hemoglobin (glycol-hemoglobin or glycosylated hemoglobin). HbA1c is a form of hemoglobin that is measured primarily to identify the average plasma glucose concentration over prolonged periods of time. Thus, HbA1c may serve as a marker for average blood glucose levels over the previous months prior to the measurements.

[0079] In one embodiment, when a physician suspects that a patient may be diabetic, the measurement of HbA1c may be one of the first tests that are conducted. An HbA1c level less than approximately 6% may be considered normal. On the other hand, an HbA1c level greater than approximately 6.5% may be considered to be diabetic. In diabetes mellitus, higher amounts of HbA1c indicate poorer control of blood glucose levels. Thus, monitoring the HbA1c in diabetic patients may improve treatment. Current techniques for measuring HbA1c require drawing blood, which may be inconvenient and painful. The point-of-care devices use immunoassay or boronate affinity chromatography, as an example. Thus, there is also an unmet need for non-invasive monitoring of HbA1c.

[0080] FIG. 2 illustrates the FTIR measurements of HbA1c absorbance 203 over the wavelength range between 1500 and 2400 nm for a concentration of approximately 1 mg/ml. Whereas the absorbance of hemoglobin 201 over this wavelength range is approximately flat, the HbA1c absorbance 203 shows broad features and distinct curvature. Although the HbA1c absorbance 203 does not appear to exhibit as pronounced features as glucose 202, the non-

invasive SWIR measurement should be able to detect HbA1c with appropriate pattern matching algorithms. Moreover, the spectrum for HbA1c may be further enhanced by using first or second derivative data, as seen for ketones in FIG. 8A. Beyond absorption, reflectance, or transmission spectroscopy, it may also be possible to detect blood constituents such as HbA1c using Raman spectroscopy or surface-enhanced Raman spectroscopy. In general, Raman spectroscopy may require higher optical power levels.

[0081] As an illustration, non-invasive measurement of blood constituents such as glucose, ketone bodies, and HbA1c has been discussed thus far. However, other blood constituents can also be measured using similar techniques, and these are also intended to be covered by this disclosure. In other embodiments, blood constituents such as proteins, albumin, urea, creatinine or nitrites could also be measured. For instance, the same type of SWIR optical techniques might be used, but the pattern matching algorithms and software could use different library features or functions for the different constituents.

[0082] In yet another embodiment, the optical techniques described in this disclosure could also be used to measure levels of triglycerides. Triglycerides are bundles of fats that may be found in the blood stream, particularly after ingesting meals. The body manufactures triglycerides from carbohydrates and fatty foods that are eaten. In other words, triglycerides are the body's storage form of fat. Triglycerides are comprised of three fatty acids attached to a glycerol molecule, and measuring the level of triglycerides may be important for diabetics. The triglyceride levels or concentrations in blood may be rated as follows: desirable or normal may be less than 150 mg/dl; borderline high may be 150-199 mg/dl; high may be 200-499 mg/dl; and very high may be 500 mg/dl or greater. FIG. 8B illustrates one example of the near-infrared absorbance 825 for triglycerides. There are distinct absorbance peaks in the spectrum that should be measurable. The characteristic absorption bands may be assigned as follows: (a) the first overtones of C--H stretching vibrations (1600-1900 nm); (b) the region of second overtones of C--H stretching vibrations (1100-1250 nm); and, (c) two regions (2000-2200 nm and 1350-1500 nm) that comprise bands due to combinations of C--H stretching vibrations and other vibrational modes.

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[0083] A further example of blood compositions that can be detected or measured using near-infrared light includes cholesterol monitoring. For example, FIG. 8C shows the near-infrared reflectance spectrum for cholesterol 850 with wavelength in microns (μm). Distinct absorption peaks are observable near 1210 nm (1.21 μm), 1720 nm (1.72 μm), and between 2300-2500 nm (2.3-2.5 μm). Also, there are other features near 1450 nm (1.45 μm) and 2050 nm (2.05 μm). In FIG. 8D the near-infrared reflectances 875 are displayed versus wavelength (nm) for various blood constituents. The spectrum for cholesterol 876 is overlaid with glucose 877, albumin 878, uric acid 879, and urea 880. As may be noted from FIG. 8D, at about 1720 nm and 2300 nm, cholesterol 876 reaches approximate reflectance peaks, while some of the other analytes are in a more gradual mode. Various signal processing methods may be used to identify and quantify the concentration of cholesterol 876 and/or glucose 877, or some of the other blood constituents.

[0084] As illustrated by FIGS. 5 and 7, one of the issues in measuring a particular blood constituent is the interfering and overlapping signal from other blood constituents. The selection of the constituent of interest may be improved using a number of techniques. For example, a higher light level or intensity may improve the signal-to-noise ratio for the measurement. Second, mathematical modeling and signal processing methodologies may help to reduce the interference, such as multivariate techniques, multiple linear regression, and factor-based algorithms, for example. For instance, a number of mathematical approaches include multiple linear regression, partial least squares, and principal component regression (PCR). Also, as illustrated in FIG. 8A, various mathematical derivatives, including the first and second derivatives, may help to accentuate differences between spectra. In addition, by using a wider wavelength range and using more sampling wavelengths may improve the ability to discriminate one signal from another. Moreover, it may be advantageous to pulse the light source with a particular pulse width and pulse repetition rate, and then the detection system can measure the pulsed light returned from or transmitted through the tissue. Using a lock-in type technique (e.g., detecting at the same frequency as the pulsed light source and also possibly phase locked to the same signal), the detection system may be able to reject background or spurious signals and increase the signal-to-noise ratio of the measurement. In one particular embodiment, high signal-to-noise ratio may be achieved using a fiber-based super-continuum (SC) light source (described further herein). Other light sources may also be used, including a plurality of laser diodes, super-luminescent laser

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diodes, or fiber lasers. In one embodiment, an all-fiber-integrated, high-powered SC light source may be elegant for its simplicity. The light may be first generated from a seed laser diode (LD). For example, the seed LD may be a distributed feedback (DFB) laser diode with a wavelength near 1542nm or 1550nm, with approximately 0.5–2.0ns pulsed output, and with a pulse repetition rate between one kilohertz and about 100MHz or more.

[0085] Beyond having a pulse width, the laser output can also have a preferred repetition rate. For pulse repetition rates above around 10MHz, where multiple pulses fall within a thermal diffusion time, the tissue response may be more related to the energy deposited or the fluence of the laser beam. The separation between pulses or a sub-group of pulses may also be selected so that the tissue sample can reach thermal equilibrium between pulses. Also, the pulse pattern may or may not be periodic. In one embodiment, there may be several pulses used per spot, where the pulse pattern is selected to obtain a desired thermal profile. The laser beam may then be moved to a new spot and then another pulse train delivered to that spot. In one embodiment, there can be several seconds of pre-cooling, the laser can be exposed on the tissue for several seconds, and then there may also be post-cooling. Although particular examples of laser duration and repetition rate are described, other values may also be used consistent with this disclosure. For example, depending on the application and mechanisms, the pulse rate could range all the way from continuous wave to 100's of Megahertz.

[0086] The above are just examples of some of the methods of improving the ability to discriminate between different constituents, but other techniques may also be used and are intended to be covered by this disclosure.

[0087] In one embodiment, a SWIR camera or infrared camera system may be used to capture the images. The camera may include one or more lenses on the input, which may be adjustable. The focal plane assemblies may be made from mercury cadmium telluride material (HgCdTe), and the detectors may also include thermo-electric coolers. Alternately, the image sensors may be made from indium gallium arsenide (InGaAs), and CMOS transistors may be connected to each pixel of the InGaAs photodiode array. The camera may interface wirelessly or with a cable (e.g., USB, Ethernet cable, or fiber optics cable) to a computer or tablet or smart phone, where the images may be captured and processed. These are a few examples of infrared

cameras, but other SWIR or infrared cameras may be used and are intended to be covered by this disclosure.

[0088] By use of an active illuminator, a number of advantages may be achieved. First, the variations due to sunlight and time-of-day may be factored out. The effects of the weather, such as clouds and rain, might also be reduced. Also, higher signal-to-noise ratios may be achieved. For example, one way to improve the signal-to-noise ratio would be to use modulation and lock-in techniques. In one embodiment, the light source may be modulated, and then the detection system would be synchronized with the light source. In a particular embodiment, the techniques from lock-in detection may be used, where narrow band filtering around the modulation frequency may be used to reject noise outside the modulation frequency. In an alternate embodiment, change detection schemes may be used, where the detection system captures the signal with the light source on and with the light source off. Again, for this system the light source may be modulated. Then, the signal with and without the light source is differenced. This may enable the sun light changes to be subtracted out. In addition, change detection may help to identify objects that change in the field of view. In the following some exemplary detection systems are described.

Interference from Skin

[0089] Several proposed non-invasive glucose monitoring techniques rely on transmission, absorption, and/or diffuse reflection through the skin to measure blood constituents or blood analytes in veins, arteries, capillaries or in the tissue itself. However, on top of the interference from other blood constituents or analytes, the skin also introduces significant interference. For example, chemical, structural, and physiological variations occur that may produce relatively large and nonlinear changes in the optical properties of the tissue sample. In one embodiment, the near-infrared reflectance or absorbance spectrum may be a complex combination of the tissue scattering properties that result from the concentration and characteristics of a multiplicity of tissue components including water, fat, protein, collagen, elastin, and/or glucose. Moreover, the optical properties of the skin may also change with environmental factors such as humidity, temperature and pressure. Physiological variation may also cause changes in the tissue measurement over time and may vary based on lifestyle, health,

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aging, etc. The structure and composition of skin may also vary widely among individuals, between different sites within an individual, and over time on the same individual. Thus, the skin introduces a dynamic interference signal that may have a wide variation due to a number of parameters.

[0090] FIG. 9 shows a schematic cross-section of human skin 900, 901. The top layer of the skin is epidermis 902, followed by a layer of dermis 903 and then subcutaneous fat 904 below the dermis. The epidermis 902, with a thickness of approximately 10-150 microns, may provide a barrier to infection and loss of moisture and other body constituents. The dermis 903 ranges in thickness from approximately 0.5 mm to 4 mm (averages approximately 1.2 mm over most of the body) and may provide the mechanical strength and elasticity of skin.

[0091] In the dermis 903, water may account for approximately 70% of the volume. The next most abundant constituent in the dermis 903 may be collagen 905, a fibrous protein comprising 70-75% of the dry weight of the dermis 903. Elastin fibers 906, also a protein, may also be plentiful in the dermis 903, although they constitute a smaller portion of the bulk. In addition, the dermis 903 may contain a variety of structures (e.g., sweat glands, hair follicles with adipose rich sebaceous glands 907 near their roots, and blood vessels) and other cellular constituents.

[0092] Below the dermis 903 lies the subcutaneous layer 904 comprising mostly adipose tissue. The subcutaneous layer 904 may be by volume approximately 10% water and may be comprised primarily of cells rich in triglycerides or fat. With this complicated structure of the skin 900, 901, the concentration of glucose may vary in each layer according to a variety of factors including the water content, the relative sizes of the fluid compartments, the distribution of capillaries, the perfusion of blood, the glucose uptake of cells, the concentration of glucose in blood, and the driving forces (e.g., osmotic pressure) behind diffusion.

[0093] To better understand the interference that the skin introduces when attempting to measure glucose, the absorption coefficient for the various skin constituents should be examined. For example, FIG. 10 illustrates 1000 the absorption coefficients for water (including scattering) 1001, adipose 1002, collagen 1003 and elastin 1004. Note that the absorption curves for water

1001 and adipose 1002 are calibrated, whereas the absorption curves for collagen 1003 and elastin 1004 are in arbitrary units. Also shown are vertical lines demarcating the wavelengths near 1210 nm 1005 and 1720 nm 1006. In general, the water absorption increases with increasing wavelength. With the increasing absorption beyond about 2000 nm, it may be difficult to achieve deeper penetration into biological tissue in the infrared wavelengths beyond approximately 2500 nm.

[0094] Although the absorption coefficient may be useful for determining the material in which light of a certain infrared wavelength will be absorbed, to determine the penetration depth of the light of a certain wavelength may also require the addition of scattering loss to the curves. For example, the water curve 1001 includes the scattering loss curve in addition to the water absorption. In particular, the scattering loss can be significantly higher at shorter wavelengths. In one embodiment, near the wavelength of 1720 nm (vertical line 1006 shown in FIG. 10), the adipose absorption 1002 can still be higher than the water plus scattering loss 1001. For tissue that contains adipose, collagen and elastin, such as the dermis of the skin, the total absorption can exceed the light energy lost to water absorption and light scattering at 1720 nm. On the other hand, at 1210 nm the adipose absorption 1002 can be considerably lower than the water plus scattering loss 1001, particularly since the scattering loss can be dominant at these shorter wavelengths.

[0095] The interference for glucose lines observed through skin may be illustrated by overlaying the glucose lines over the absorption curves 1000 for the skin constituents. For example, FIG. 2 illustrated that the glucose absorption 202 included features centered around 1587 nm, 1750 nm, 2120 nm, 2270 nm and 2320 nm. On FIG. 10 vertical lines have been drawn at the glucose line wavelengths of 1587 nm 1007, 1750 nm 1008, 2120 nm 1009, 2270 nm 1010 and 2320 nm 1011. In one embodiment, it may be difficult to detect the glucose lines near 1750 nm 1008, 2270 nm 1010 and 2320 nm 1011 due to significant spectral interference from other skin constituents. On the other hand, the glucose line near 1587m 1007 may be more easily detected because it peaks while most of the other skin constituents are sloped downward toward an absorption valley. Moreover, the glucose line near 2120 nm 1009 may also be detectable for similar reasons, although adipose may have conflicting behavior due to local absorption minimum and maximum nearby in wavelength.

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[0096] Thus, beyond the problem of other blood constituents or analytes having overlapping spectral features (e.g., FIG. 5), it may be difficult to observe glucose spectral signatures through the skin and its constituents of water, adipose, collagen and elastin. One approach to overcoming this difficulty may be to try to measure the blood constituents in veins that are located at relatively shallow distances below the skin. Veins may be more beneficial for the measurement than arteries, since arteries tend to be located at deeper levels below the skin. Also, in one embodiment it may be advantageous to use a differential measurement to subtract out some of the interfering absorption lines from the skin. For example, an instrument head may be designed to place one probe above a region of skin over a blood vein, while a second probe may be placed at a region of the skin without a noticeable blood vein below it. Then, by differencing the signals from the two probes, at least part of the skin interference may be cancelled out.

[0097] Two representative embodiments for performing such a differential measurement are illustrated in FIG. 11 and FIG. 12. In one embodiment shown in FIG. 11, the dorsal of the hand 1100 may be used for measuring blood constituents or analytes. The dorsal of the hand 1100 may have regions that have distinct veins 1101 as well as regions where the veins are not as shallow or pronounced 1102. By stretching the hand and leaning it backwards, the veins 1101 may be accentuated in some cases. A near-infrared diffuse reflectance measurement may be performed by placing one probe 1103 above the vein-rich region 1101. To turn this into a differential measurement, a second probe 1104 may be placed above a region without distinct veins 1102. Then, the outputs from the two probes may be subtracted 1105 to at least partially cancel out the features from the skin. The subtraction may be done preferably in the electrical domain, although it can also be performed in the optical domain or digitally/mathematically using sampled data based on the electrical and/or optical signals. Although one example of using the dorsal of the hand 1100 is shown, many other parts of the hand can be used within the scope of this disclosure. For example, alternate methods may use transmission through the webbing between the thumb and the fingers 1106, or transmission or diffuse reflection through the tips of the fingers 1107.

[0098] In another embodiment, the dorsal of the foot 1200 may be used instead of the hand. One advantage of such a configuration may be that for self-testing by a user, the foot may

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be easier to position the instrument using both hands. One probe 1203 may be placed over regions where there are more distinct veins 1201, and a near-infrared diffuse reflectance measurement may be made. For a differential measurement, a second probe 1204 may be placed over a region with less prominent veins 1202, and then the two probe signals may be subtracted, either electronically or optically, or may be digitized/sampled and processed mathematically depending on the particular application and implementation. As with the hand, the differential measurements may be intended to compensate for or subtract out (at least in part) the interference from the skin. Since two regions are used in close proximity on the same body part, this may also aid in removing some variability in the skin from environmental effects such as temperature, humidity, or pressure. In addition, it may be advantageous to first treat the skin before the measurement, by perhaps wiping with a cloth or treated cotton ball, applying some sort of cream, or placing an ice cube or chilled bag over the region of interest.

[0099] Although two embodiments have been described, many other locations on the body may be used using a single or differential probe within the scope of this disclosure. In yet another embodiment, the wrist may be advantageously used, particularly where a pulse rate is typically monitored. Since the pulse may be easily felt on the wrist, there is underlying the region a distinct blood flow. Other embodiments may use other parts of the body, such as the ear lobes, the tongue, the inner lip, the nails, the eye, or the teeth. Some of these embodiments will be further described below. The ear lobes or the tip of the tongue may be advantageous because they are thinner skin regions, thus permitting transmission rather than diffuse reflection. However, the interferenee from the skin is still a problem in these embodiments. Other regions such as the inner lip or the bottom of the tongue may be contemplated because distinct veins are observable, but still the interference from the skin may be problematic in these embodiments. The eye may seem as a viable alternative because it is more transparent than skin. However, there are still issues with scattering in the eye. For example, the anterior chamber of the eye (the space between the cornea and the iris) comprises a fluid known as aqueous humor. However, the glucose level in the eye chamber may have a significant temporal lag on changes in the glucose level compared to the blood glucose level.

[0100] In some instances, it may be desirable to create multiple locations of focused light. One way to accomplish this may be to slide the assemblies and/or the light source. In yet another

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embodiment shown in FIGURE 13A, multiple collimated or focused light beams may be created in one assembly 1320. In this embodiment, optionally a surface cooling apparatus 1324 may be used, where a cooling fluid may be flowed either touching or in close proximity to the skin 1321. Also, in this particular embodiment a cylindrical assembly may optionally be used, where the cylindrical length may be several millimeters in length and defined by a clamp or mount 1323 placed on or near the leg. The light input 1327 may be received from a light source, which may use a fiber or fiber bundles to couple the light to the lens/mirror assembly 1326. A lens and/or mirror assembly 1326 may be used to couple the light input 1327 to the lenslet array or window 1325, either directly or indirectly. The lens and/or mirror assembly 1326 may also be coupled to the clamp or mount assembly 1323.

[0101] In the embodiment of FIGURE 13A, a window and/or lenslet array 1325 is also shown on the cylindrical surface for permitting the light to be incident on the skin 1321 and varicose vein 1322 at multiple spots. The lenslet array 1325 may comprise circular, spherical or cylindrical lenses, depending on the type of spots desired. As before, one advantage of placing the lenslet array 1325 in close proximity to the skin 1321 may be that a high NA lens may be used. Also, the input from the lens and/or mirror assembly to the lenslet array 1325 may be a single large beam, or a plurality of smaller beams. In one embodiment, a plurality of spots may be created by the lenslet array 1325. Although four spots are shown in FIGURE 13A, any number of spots may be used and are intended to be covered by this disclosure.

[0102] Different combinations of these techniques may be employed, and other techniques may also be used and are intended to be covered by this disclosure. For example, in some instances only focused light may be used, in other instances only surface cooling or cryogenic sprays may be used, and in yet other embodiments a combination of the two may be used. Moreover, the clamps, mounts and holders are shown in simple design for illustrative purposes, but human factors engineering may be used to make these more user friendly or ergonomic design. These and other variations are also intended to be covered by this disclosure.

[0103] The lens and/or mirror assemblies may comprise one or more lenses, microscope objectives, curved or flat mirrors, lens tipped fibers, or some combination of these elements. As an example, the optics such as used in a camera may be employed in this arrangement, provided

that the optics are substantially transparent at the light wavelengths being used. Moreover, reflections and losses through the optics may be reduced by applying anti-reflection coatings, and chromatic dispersion may be reduced by using reflective optics rather than refractive optics. Although a particular method of focusing the light has been described, other methods may also be used and are intended to be covered by this disclosure.

[0104] Because of the complexity of the interference from skin in non-invasive glucose monitoring (e.g., FIG. 10), other parts of the body without skin above blood vessels or capillaries may be alternative candidates for measuring blood constituents. One embodiment may involve transmission or reflection through human nails. As an example, FIG. 13B illustrates a typical human nail tissue structure 1300 and the capillary vessels below it. The fingernail 1301 is approximately 1 mm thick, and below this resides a layer of epidermis 1302 with a thickness of approximately 1 mm. The dermis 1304 is also shown, and within particularly the top about 0.5 mm of dermis are a significant number of capillary vessels. To measure the blood constituents, the light exposed on the top of the fingernail must penetrate about 2-2.5 mm or more, and the reflected light (round trip passage) should be sufficiently strong to measure. In one embodiment, the distance required to penetrate could be reduced by drilling a hole in the fingernail 1301.

[0105] In this alternative embodiment using the fingernail, there may still be interference from the nail's spectral features. For example, FIG. 14 illustrates the attenuation coefficient 1400 for seven nail samples that are allowed to stand in an environment with a humidity level of 14%. These coefficients are measured using an FTIR spectrometer over the near-infrared wavelength range of approximately 1 to 2.5 microns. These spectra are believed to correspond to the spectra of keratin contained in the nail plate. The base lines for the different samples are believed to differ because of the influence of scattering. Several of the absorption peaks observed correspond to peaks of keratin absorption, while other features may appear from the underlying epidermis and dermis. It should also be noted that the attenuation coefficients 1400 also vary considerably depending on humidity level or water content as well as temperature and other environmental factors. Moreover, the attenuation coefficient may also change in the presence of nail polish of various sorts.

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[0106] Similar to skin, the large variations in attenuation coefficient for fingernails also may interfere with the absorption peaks of glucose. As an example, in FIG. 14 below the fingernail spectrum is also shown the glucose spectrum 1401 for two different glucose concentrations. The vertical lines 1402, 1403, 1404, 1405 and 1406 are drawn to illustrate the glucose absorption peaks and where they lie on the fingernail spectra 1400. As is apparent, the nail has interfering features that may be similar to skin, particularly since both have spectra that vary not only in wavelength but also with environmental factors. In one embodiment, it may be possible to see the glucose peaks 1402 and 1404 through the fingernail, but it may be much more difficult to observe the glucose peaks near 1403, 1405 and 1406.

Transmission or Reflection Through Teeth

[0107] Yet another embodiment may observe the transmittance or reflectance through teeth to measure blood constituents or analytes. FIG. 15 illustrates an exemplary structure of a tooth 1500. The tooth 1500 has a top layer called the crown 1501 and below that a root 1502 that reaches well into the gum 1506 and bone 1508 of the mouth. The exterior of the crown 1501 is an enamel layer 1503, and below the enamel is a layer of dentine 1504 that sits atop a layer of cementum 1507. Below the dentine 1504 is a pulp region 1505, which comprises within it blood vessels 1509 and nerves 1510. If the light can penetrate the enamel 1503 and dentine 1504, then the blood flow and blood constituents can be measured through the blood vessels in the dental pulp 1505. While it may be true that the amount of blood flow in the dental pulp 1505 may be less since it comprises capillaries, the smaller blood flow could still be advantageous if there is less interfering spectral features from the tooth.

[0108] The transmission, absorption and reflection from teeth has been studied in the near infrared, and, although there are some features, the enamel and dentine appear to be fairly transparent in the near infrared (particularly wavelengths between 1500 and 2500 nm). For example, the absorption or extinction ratio for light transmission has been studied. FIG. 16A illustrates the attenuation coefficient 1600 for dental enamel 1601 (filled circles) and the absorption coefficient of water 1602 (open circles) versus wavelength. Near-infrared light may penetrate much further without scattering through all the tooth enamel, due to the reduced scattering coefficient in normal enamel. Scattering in enamel may be fairly strong in the visible,

but decreases as approximately 1/wavelength^3 (i.e., inverse of the wavelength cubed) with increasing wavelength to a value of only 2-3 cm^{-1} at 1310 nm and 1550 nm in the near infrared. Therefore, enamel may be virtually transparent in the near infrared with optical attenuation 1-2 orders of magnitude less than in the visible range.

[0109] As another example, FIG. 16B illustrates the absorption spectrum 1650 of intact enamel 1651 (dashed line) and dentine 1652 (solid line) in the wavelength range of approximately 1.2 to 2.4 microns. In the near infrared there are two absorption bands around 1.5 and 2 microns. The band with a peak around 1.57 microns may be attributed to the overtone of valent vibration of water present in both enamel and dentine. In this band, the absorption is greater for dentine than for enamel, which may be related to the large water content in this tissue. In the region of 2 microns, dentine may have two absorption bands, and enamel one. The band with a maximum near 2.1 microns may belong to the overtone of vibration of PO hydroxyapatite groups, which is the main substance of both enamel and dentine. Moreover, the band with a peak near 1.96 microns in dentine may correspond to water absorption (dentine may contain substantially higher water than enamel).

[0110] In addition to the absorption coefficient, the reflectance from intact teeth and teeth with dental caries (e.g., cavities) has been studied. In one embodiment, FIG. 17 shows the near infrared spectral reflectance 1700 over the wavelength range of approximately 800 nm to 2500 nm from an occlusal (e.g., top/bottom) tooth surface 1704. The curve with black diamonds 1701 corresponds to the reflectance from a sound, intact tooth section. The curve with asterisks * 1702 corresponds to a tooth section with an enamel lesion. The curve with circles 1703 corresponds to a tooth section with a dentine lesion. Thus, when there is a lesion, more scattering occurs and there may be an increase in the reflected light.

[0111] For wavelengths shorter than approximately 1400 nm, the shapes of the spectra remain similar, but the amplitude of the reflection changes with lesions. Between approximately 1400 nm and 2500 nm, an intact tooth 1701 has low reflectance (e.g., high transmission), and the reflectance appears to be more or less independent of wavelength. On the other hand, in the presence of lesions 1702 and 1703, there is increased scattering, and the scattering loss may be wavelength dependent. For example, the scattering loss may decrease as 1/(wavelength)^3--so, the

scattering loss decreases with longer wavelengths. When there is a lesion in the dentine 1703, more water can accumulate in the area, so there is also increased water absorption. For example, the dips near 1450 nm and 1900 nm correspond to water absorption, and the reflectance dips are particularly pronounced in the dentine lesion 1703. One other benefit of the absorption, transmission or reflectance in the near infrared may be that stains and non-calcified plaque are not visible in this wavelength range, enabling better discrimination of defects, cracks, and demineralized areas.

[0112] Compared with the interference from skin 1000 in FIG. 10 or fingernails 1400 in FIG. 14, the teeth appear to introduce much less interference for non-invasive monitoring of blood constituents. The few features in FIG. 16B or 17 may be calibrated out of the measurement. Also, using an intact tooth 1701 may further minimize any interfering signals. Furthermore, since the tooth comprises relatively hard tissue, higher power from the light sources in the near infrared may be used without damaging the tissue, such as with skin.

Human Interface for Measurement System

[0113] A number of different types of measurements may be used to sample the blood in the dental pulp. The basic feature of the measurements should be that the optical properties are measured as a function of wavelength at a plurality of wavelengths. As further described below, the light source may output a plurality of wavelengths, or a continuous spectrum over a range of wavelengths. In a preferred embodiment, the light source may cover some or all of the wavelength range between approximately 1400 nm and 2500 nm. The signal may be received at a receiver, which may also comprise a spectrometer or filters to discriminate between different wavelengths. The signal may also be received at a camera, which may also comprise filters or a spectrometer. In an alternate embodiment, the spectral discrimination using filters or a spectrometer may be placed after the light source rather than at the receiver. The receiver usually comprises one or more detectors (optical-to-electrical conversion element) and electrical circuitry. The receiver may also be coupled to analog to digital converters, particularly if the signal is to be fed to a digital device.

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[0114] Referring to FIG. 15, one or more light sources 1511 may be used for illumination. In one embodiment, a transmission measurement may be performed by directing the light source output 1511 to the region near the interface between the gum 1506 and dentine 1504. In one embodiment, the light may be directed using a light guide or a fiber optic. The light may then propagate through the dental pulp 1505 to the other side, where the light may be incident on one or more detectors or another light guide to transport the signal to a spectrometer, receiver or camera 1512. In another embodiment, the light source may be directed to one or more locations near the interface between the gum 1506 and dentine 1504 (in one example, could be from the two sides of the tooth). The transmitted light may then be detected in the occlusal surface above the tooth using a spectrometer, receiver, or camera 1512. In yet another embodiment, a reflectance measurement may be conducted by directing the light source output 1511 to, for example, the occlusal surface of the tooth, and then detecting the reflectance at a spectrometer, receiver or camera 1513. Although a few embodiments for measuring the blood constituents through a tooth are described, other embodiments and techniques may also be used and are intended to be covered by this disclosure.

[0115] The human interface for the non-invasive measurement of blood constituents may be of various forms. In one embodiment, a "clamp" design 1800 may be used cap over one or more teeth, as illustrated in FIG. 18A. The clamp design may be different for different types of teeth, or it may be flexible enough to fit over different types of teeth. For example, different types of teeth include the molars (toward the back of the mouth), the premolars, the canine, and the incisors (toward the front of the mouth). One embodiment of the clamp-type design is illustrated in FIG. 18A for a molar tooth 1808. The C-clamp 1801 may be made of a plastic or rubber material, and it may comprise a light source input 1802 and a detector output 1803 on the front or back of the tooth.

[0116] The light source input 1802 may comprise a light source directly, or it may have light guided to it from an external light source. Also, the light source input 1802 may comprise a lens system to collimate or focus the light across the tooth. The detector output 1803 may comprise a detector directly, or it may have a light guide to transport the signal to an external detector element. The light source input 1802 may be coupled electrically or optically through 1804 to a light input 1806. For example, if the light source is external in 1806, then the coupling

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element 1804 may be a light guide, such as a fiber optic. Alternately, if the light source is contained in 1802, then the coupling element 1804 may be electrical wires connecting to a power supply in 1806. Similarly, the detector output 1803 may be coupled to a detector output unit 1807 with a coupling element 1805, which may be one or more electrical wires or a light guide, such as a fiber optic. This is just one example of a clamp over one or more teeth, but other embodiments may also be used and are intended to be covered by this disclosure.

[0117] In yet another embodiment, one or more light source ports and sensor ports may be used in a mouth-guard type design. For example, one embodiment of a dental mouth guard 1850 is illustrated in FIG. 18B. The structure of the mouth guard 1851 may be similar to mouth guards used in sports (e.g., when playing football or boxing) or in dental trays used for applying fluoride treatment, and the mouth guard may be made from plastic or rubber materials, for example. As an example, the mouth guard may have one or more light source input ports 1852, 1853 and one or more detector output ports 1854, 1855. Although six input and output ports are illustrated, any number of ports may be used.

[0118] Similar to the clamp design described above, the light source inputs **1852**, **1853** may comprise one or more light sources directly, or they may have light guided to them from an external light source. Also, the light source inputs **1852**, **1853** may comprise lens systems to collimate or focus the light across the teeth. The detector outputs **1854**, **1855** may comprise one or more detectors directly, or they may have one or more light guides to transport the signals to an external detector element. The light source inputs **1852**, **1853** may be coupled electrically or optically through **1856** to a light input **1857**. For example, if the light source is external in **1857**, then the one or more coupling elements **1856** may be one or more light guides, such as a fiber optic. Alternately, if the light sources are contained in **1852**, **1853**, then the coupling element **1856** may be one or more electrical wires connecting to a power supply in **1857**. Similarly, the detector outputs **1854**, **1855** may be coupled to a detector output unit **1859** with one or more coupling elements **1858**, which may be one or more electrical wires or one or more light guides, such as a fiber optic. This is just one example of a mouth guard design covering a plurality of teeth, but other embodiments may also be used and are intended to be covered by this disclosure. For instance, the position of the light source inputs and detector output ports could be

exchanged, or some mixture of locations of light source inputs and detector output ports could be used.

[0119] Also, if reflectance from the teeth is to be measured, then the light sources and detectors may be on the same side of the tooth. Moreover, it may be advantageous to pulse the light source with a particular pulse width and pulse repetition rate, and then the detection system can measure the pulsed light returned from or transmitted through the tooth. Using a lock-in type technique (e.g., detecting at the same frequency as the pulsed light source and also possibly phase locked to the same signal), the detection system may be able to reject background or spurious signals and increase the signal-to-noise ratio of the measurement.

[0120] Other elements may be added to the human interface designs of FIG. 18 and are also intended to be covered by this disclosure. For instance, in one embodiment it may be desirable to have replaceable inserts that may be disposable. Particularly in a doctor's office or hospital setting, the same instrument may be used with a plurality of patients. Rather than disinfecting the human interface after each use, it may be preferable to have disposable inserts that can be thrown away after each use. In one embodiment, a thin plastic coating material may enclose the clamp design of FIG. 18A or mouth guard design of FIG. 18B. The coating material may be inserted before each use, and then after the measurement is exercised the coating material may be peeled off and replaced. Such a design may save the physician or user considerable time, while at the same time provide the business venture with a recurring cost revenue source. Any coating material or other disposable device may be constructed of a material having suitable optical properties that may be considered during processing of the signals used to detect any anomalies in the teeth.

Light Sources for Near Infrared

[0121] In general, the near-infrared (NIR) region of the electromagnetic spectrum covers between approximately 0.7 microns (700 nm) to about 2.5 microns (2500nm). However, it may also be advantageous to use just the short-wave infrared between approximately 1.4 microns (1400 nm) and about 2.5 microns (2500 nm). One reason for preferring the SWIR over the entire NIR may be to operate in the so-called "eye-safe" window, which corresponds to wavelengths

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longer than about 1400 nm. While the SWIR is used for illustrative purposes, it should be clear that the discussion that follows could also apply to using the NIR wavelength range, or other wavelength bands. There are a number of light sources that may be used in the near infrared. To be more specific, the discussion below will consider light sources operating in the so-called short wave infrared (SWIR), which may cover the wavelength range of approximately 1400 nm to 2500 nm. Other wavelength ranges may also be used for the applications described in this disclosure, so the discussion below is merely provided for exemplary types of light sources. The SWIR wavelength range may be valuable for a number of reasons. First, the SWIR corresponds to a transmission window through water and the atmosphere. For example, 302 in FIG. 3A and 1602 in FIG. 16A illustrate the water transmission windows. Also, through the atmosphere, wavelengths in the SWIR have similar transmission windows due to water vapor in the atmosphere. Second, the so-called "eye-safe" wavelengths are wavelengths longer than approximately 1400 nm. Third, the SWIR covers the wavelength range for nonlinear combinations of stretching and bending modes as well as the first overtone of C--H stretching modes. Thus, for example, glucose and ketones among other substances may have unique signatures in the SWIR. Moreover, many solids have distinct spectral signatures in the SWIR, so particular solids may be identified using stand-off detection or remote sensing. For instance, many explosives have unique signatures in the SWIR.

[0122] Different light sources may be selected for the SWIR based on the needs of the application. Some of the features for selecting a particular light source include power or intensity, wavelength range or bandwidth, spatial or temporal coherence, spatial beam quality for focusing or transmission over long distance, and pulse width or pulse repetition rate. Depending on the application, lamps, light emitting diodes (LEDs), laser diodes (LD's), tunable LD's, super-luminescent laser diodes (SLDs), fiber lasers or super-continuum sources (SC) may be advantageously used. Also, different fibers may be used for transporting the light, such as fused silica fibers, plastic fibers, mid-infrared fibers (e.g., tellurite, chalcogenides, fluorides, ZBLAN, etc), or a hybrid of these fibers.

[0123] Lamps may be used if low power or intensity of light is required in the SWIR, and if an incoherent beam is suitable. In one embodiment, in the SWIR an incandescent lamp that can be used is based on tungsten and halogen, which have an emission wavelength between

approximately 500 nm to 2500 nm. For low intensity applications, it may also be possible to use thermal sources, where the SWIR radiation is based on the black body radiation from the hot object. Although the thermal and lamp based sources are broadband and have low intensity fluctuations, it may be difficult to achieve a high signal-to-noise ratio in a non-invasive blood constituent measurement due to the low power levels. Also, the lamp based sources tend to be energy inefficient.

[0124] In another embodiment, LED's can be used that have a higher power level in the SWIR wavelength range. LED's also produce an incoherent beam, but the power level can be higher than a lamp and with higher energy efficiency. Also, the LED output may more easily be modulated, and the LED provides the option of continuous wave or pulsed mode of operation. LED's are solid state components that emit a wavelength band that is of moderate width, typically between about 20 nm to 40 nm. There are also so-called super-luminescent LEDs that may even emit over a much wider wavelength range. In another embodiment, a wide band light source may be constructed by combining different LEDs that emit in different wavelength bands, some of which could preferably overlap in spectrum. One advantage of LEDs as well as other solid state components is the compact size that they may be packaged into.

[0125] In yet another embodiment, various types of laser diodes may be used in the SWIR wavelength range. Just as LEDs may be higher in power but narrower in wavelength emission than lamps and thermal sources, the LDs may be yet higher in power but yet narrower in wavelength emission than LEDs. Different kinds of LDs may be used, including Fabry-Perot LDs, distributed feedback (DFB) LDs, distributed Bragg reflector (DBR) LDs. Since the LDs have relatively narrow wavelength range (typically under 10 nm), in one embodiment a plurality of LDs may be used that are at different wavelengths in the SWIR. For example, in a preferred embodiment for non-invasive glucose monitoring, it may be advantageous to use LDs having emission spectra near some or all of the glucose spectral peaks (e.g., near 1587 nm, 1750 nm, 2120 nm, 2270 nm, and 2320 nm). The various LDs may be spatially multiplexed, polarization multiplexed, wavelength multiplexed, or a combination of these multiplexing methods. Also, the LDs may be fiber pig-tailed or have one or more lenses on the output to collimate or focus the light. Another advantage of LDs is that they may be packaged compactly and may have a spatially coherent beam output. Moreover, tunable LDs that can tune over a range of wavelengths are also

available. The tuning may be done by varying the temperature, or electrical current may be used in particular structures, such as distributed Bragg reflector LDs. In another embodiment, external cavity LDs may be used that have a tuning element, such as a fiber grating or a bulk grating, in the external cavity.

[0126] In another embodiment, super-luminescent laser diodes may provide higher power as well as broad bandwidth. An SLD is typically an edge emitting semiconductor light source based on super-luminescence (e.g., this could be amplified spontaneous emission). SLDs combine the higher power and brightness of LDs with the low coherence of conventional LEDs, and the emission band for SLD's may be 5 to 100 nm wide, preferably in the 60 to 100 nm range. Although currently SLDs are commercially available in the wavelength range of approximately 400 nm to 1700 nm, SLDs could and may in the future be made to cover a broader region of the SWIR.

[0127] In yet another embodiment, high power LDs for either direct excitation or to pump fiber lasers and SC light sources may be constructed using one or more laser diode bar stacks. As an example, FIG. 19 shows an example of the block diagram 1900 or building blocks for constructing the high power LDs. In this embodiment, one or more diode bar stacks 1901 may be used, where the diode bar stack may be an array of several single emitter LDs. Since the fast axis (e.g., vertical direction) may be nearly diffraction limited while the slow-axis (e.g., horizontal axis) may be far from diffraction limited, different collimators 1902 may be used for the two axes.

[0128] Then, the brightness may be increased by spatially combining the beams from multiple stacks 1903. The combiner may include spatial interleaving, it may include wavelength multiplexing, or it may involve a combination of the two. Different spatial interleaving schemes may be used, such as using an array of prisms or mirrors with spacers to bend one array of beams into the beam path of the other. In another embodiment, segmented mirrors with alternate high-reflection and anti-reflection coatings may be used. Moreover, the brightness may be increased by polarization beam combining 1904 the two orthogonal polarizations, such as by using a polarization beam splitter. In one embodiment, the output may then be focused or coupled into a large diameter core fiber. As an example, typical dimensions for the large diameter core fiber range from approximately 100 microns in diameter to 400 microns or more. Alternatively or in addition, a custom beam shaping module 1905 may be used, depending on the particular

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application. For example, the output of the high power LD may be used directly 1906, or it may be fiber coupled 1907 to combine, integrate, or transport the high power LD energy. These high power LDs may grow in importance because the LD powers can rapidly scale up. For example, instead of the power being limited by the power available from a single emitter, the power may increase in multiples depending on the number of diodes multiplexed and the size of the large diameter fiber. Although FIG. 19 is shown as one embodiment, some or all of the elements may be used in a high power LD, or additional elements may also be used.

SWIR Super-Continuum Lasers

[0129] Each of the light sources described above have particular strengths, but they also may have limitations. For example, there is typically a trade-off between wavelength range and power output. Also, sources such as lamps, thermal sources, and LEDs produce incoherent beams that may be difficult to focus to a small area and may have difficulty propagating for long distances. An alternative source that may overcome some of these limitations is an SC light source. Some of the advantages of the SC source may include high power and intensity, wide bandwidth, spatially coherent beam that can propagate nearly transform limited over long distances, and easy compatibility with fiber delivery.

[0130] Supercontinuum lasers may combine the broadband attributes of lamps with the spatial coherence and high brightness of lasers. By exploiting a modulational instability initiated supercontinuum (SC) mechanism, an all-fiber-integrated SC laser with no moving parts may be built using commercial-off-the-shelf (COTS) components. Moreover, the fiber laser architecture may be a platform where SC in the visible, near-infrared/SWIR, or mid-IR can be generated by appropriate selection of the amplifier technology and the SC generation fiber. But until now, SC lasers were used primarily in laboratory settings since typically large, table-top, mode-locked lasers were used to pump nonlinear media such as optical fibers to generate SC light. However, those large pump lasers may now be replaced with diode lasers and fiber amplifiers that gained maturity in the telecommunications industry.

[0131] In one embodiment, an all-fiber-integrated, high-powered SC light source 2000 may be elegant for its simplicity (FIG. 20). The light may be first generated from a seed laser

diode 2001. For example, the seed LD 2001 may be a distributed feedback laser diode with a wavelength near 1542 or 1550 nm, with approximately 0.5-2.0 ns pulsed output, and with a pulse repetition rate between a kilohertz to about 100 MHz or more. The output from the seed laser diode may then be amplified in a multiple-stage fiber amplifier 2002 comprising one or more gain fiber segments. In one embodiment, the first stage pre-amplifier 2003 may be designed for optimal noise performance. For example, the pre-amplifier 2003 may be a standard erbium-doped fiber amplifier or an erbium/ytterbium doped cladding pumped fiber amplifier. Between amplifier stages 2003 and 2006, it may be advantageous to use band-pass filters 2004 to block amplified spontaneous emission and isolators 2005 to prevent spurious reflections. Then, the power amplifier stage 2006 may use a cladding-pumped fiber amplifier that may be optimized to minimize nonlinear distortion. The power amplifier fiber 2006 may also be an erbium-doped fiber amplifier, if only low or moderate power levels are to be generated.

[0132] The SC generation 2007 may occur in the relatively short lengths of fiber that follow the pump laser. In one exemplary embodiment, the SC fiber length may range from a few millimeters to 100m or more. In one embodiment, the SC generation may occur in a first fiber 2008 where the modulational-instability initiated pulse break-up primarily occurs, followed by a second fiber 2009 where the SC generation and spectral broadening primarily occurs.

[0133] In one embodiment, one or two meters of standard single-mode fiber (SMF) after the power amplifier stage may be followed by several meters of SC generation fiber. For this example, in the SMF the peak power may be several kilowatts and the pump light may fall in the anomalous group-velocity dispersion regime--often called the soliton regime. For high peak powers in the dispersion regime, the nanosecond pulses may be unstable due to a phenomenon known as modulational instability, which is basically parametric amplification in which the fiber nonlinearity helps to phase match the pulses. As a consequence, the nanosecond pump pulses may be broken into many shorter pulses as the modulational instability tries to form soliton pulses from the quasi-continuous-wave background. Although the laser diode and amplification process starts with approximately nanosecond-long pulses, modulational instability in the short length of SMF fiber may form approximately 0.5 ps to several-picosecond-long pulses with high intensity. Thus, the few meters of SMF fiber may result in an output similar to that produced by mode-locked lasers, except in a much simpler and cost-effective manner.

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[0134] The short pulses created through modulational instability may then be coupled into a nonlinear fiber for SC generation. The nonlinear mechanisms leading to broadband SC may include four-wave mixing or self-phase modulation along with the optical Raman effect. Since the Raman effect is self-phase-matched and shifts light to longer wavelengths by emission of optical photons, the SC may spread to longer wavelengths very efficiently. The short-wavelength edge may arise from four-wave mixing, and often times the short wavelength edge may be limited by increasing group-velocity dispersion in the fiber. In many instances, if the particular fiber used has sufficient peak power and SC fiber length, the SC generation process may fill the long-wavelength edge up to the transmission window.

[0135] Mature fiber amplifiers for the power amplifier stage 2006 include ytterbium-doped fibers (near 1060 nm), erbium-doped fibers (near 1550 nm), erbium/ytterbium-doped fibers (near 1550 nm), or thulium-doped fibers (near 2000 nm). In various embodiments, candidates for SC fiber 2009 include fused silica fibers (for generating SC between 0.8-2.7 μm), mid-IR fibers such as fluorides, chalcogenides, or tellurites (for generating SC out to 4.5 μm or longer), photonic crystal fibers (for generating SC between 0.4 and 1.7 μm), or combinations of these fibers. Therefore, by selecting the appropriate fiber-amplifier doping for 2006 and nonlinear fiber 2009, SC may be generated in the visible, near-IR/SWIR, or mid-IR wavelength region.

[0136] The configuration 2000 of FIG. 20 is just one particular example, and other configurations can be used and are intended to be covered by this disclosure. For example, further gain stages may be used, and different types of lossy elements or fiber taps may be used between the amplifier stages. In another embodiment, the SC generation may occur partially in the amplifier fiber and in the pig-tails from the pump combiner or other elements. In yet another embodiment, polarization maintaining fibers may be used, and a polarizer may also be used to enhance the polarization contrast between amplifier stages. Also, not discussed in detail are many accessories that may accompany this set-up, such as driver electronics, pump laser diodes, safety shut-offs, and thermal management and packaging.

[0137] One example of an SC laser that operates in the SWIR used in one embodiment is illustrated in FIG. 21. This SWIR SC source 2100 produces an output of up to approximately 5W over a spectral range of about 1.5 to 2.4 microns, and this particular laser is made out of

polarization maintaining components. The seed laser 2101 is a distributed feedback (DFB) laser operating near 1542 nm producing approximately 0.5 nanosecond (ns) pulses at an about 8 MHz repetition rate. The pre-amplifier 2102 is forward pumped and uses about 2 m length of erbium/ytterbium cladding pumped fiber 2103 (often also called dual-core fiber) with an inner core diameter of 12 microns and outer core diameter of 130 microns. The pre-amplifier gain fiber 2103 is pumped using a 10 W 940 nm laser diode 2105 that is coupled in using a fiber combiner 2104.

[0138] In this particular 5W unit, the mid-stage between amplifier stages 2102 and 2106 comprises an isolator 2107, a band-pass filter 2108, a polarizer 2109 and a fiber tap 2110. The power amplifier 2106 uses a 4 m length of the 12/130 micron erbium/ytterbium doped fiber 2111 that is counter-propagating pumped using one or more 30 W 940 nm laser diodes 2112 coupled in through a combiner 2113. An approximately 1-2 meter length of the combiner pig-tail helps to initiate the SC process, and then a length of PM-1550 fiber 2115 (polarization maintaining, single-mode, fused silica fiber optimized for 1550 nm) is spliced 2114 to the combiner output.

[0139] If an output fiber of about 10 m in length is used, then the resulting output spectrum 2200 is shown in FIG. 22. The details of the output spectrum 2200 depend on the peak power into the fiber, the fiber length, and properties of the fiber such as length and core size, as well as the zero dispersion wavelength and the dispersion properties. For example, if a shorter length of fiber is used, then the spectrum actually reaches to longer wavelengths (e.g., a 2m length of SC fiber broadens the spectrum to ~2500 nm). Also, if extra-dry fibers are used with less O--H content, then the wavelength edge may also reach to a longer wavelength. To generate more spectrum toward the shorter wavelengths, the pump wavelength (in this case .about.1542 nm) should be close to the zero dispersion wavelength in the fiber. For example, by using a dispersion shifted fiber or so-called non-zero dispersion shifted fiber, the short wavelength edge may shift to shorter wavelengths.

[0140] Although one particular example of a 5 W SWIR-SC has been described, different components, different fibers, and different configurations may also be used consistent with this disclosure. For instance, another embodiment of the similar configuration 2100 in FIG. 21 may be used to generate high powered SC between approximately 1060 and 1800 nm. For this

embodiment, the seed laser 2101 may be a 1064 nm distributed feedback (DFB) laser diode, the pre-amplifier gain fiber 2103 may be a ytterbium-doped fiber amplifier with 10/125 microns dimensions, and the pump laser 2105 may be a 10 W 915 nm laser diode. In the mid-stage, a mode field adapter may be included in addition to the isolator 2107, band pass filter 2108, polarizer 2109 and tap 2110. The gain fiber 2111 in the power amplifier may be a 20 m length of ytterbium-doped fiber with 25/400 microns dimension for example. The pump 2112 for the power amplifier may be up to six pump diodes providing 30 W each near 915 nm, for example. For this much pump power, the output power in the SC may be as high as 50 W or more.

[0141] In another embodiment, it may be desirous to generate high power SWIR SC over 1.4-1.8 microns and separately 2-2.5 microns (the window between 1.8 and 2 microns may be less important due to the strong water and atmospheric absorption). For example, the top SC source of FIG. 23 can lead to bandwidths ranging from about 1400 nm to 1800 nm or broader, while the lower SC source of FIG. 23 can lead to bandwidths ranging from about 1900 nm to 2500 nm or broader. Since these wavelength ranges are shorter than about 2500 nm, the SC fiber can be based on fused silica fiber. Exemplary SC fibers include standard single-mode fiber SMF, high-nonlinearity fiber, high-NA fiber, dispersion shifted fiber, dispersion compensating fiber, and photonic crystal fibers. Non-fused-silica fibers can also be used for SC generation, including chalcogenides, fluorides, ZBLAN, tellurites, and germanium oxide fibers.

[0142] In one embodiment, the top of FIG. 23 illustrates a block diagram for an SC source 2300 capable of generating light between approximately 1400 and 1800 nm or broader. As an example, a pump fiber laser similar to FIG. 21 can be used as the input to a SC fiber 2309. The seed laser diode 2301 can comprise a DFB laser that generates, for example, several milliwatts of power around 1542 or 1553 nm. The fiber pre-amplifier 2302 can comprise an erbium-doped fiber amplifier or an erbium/ytterbium doped double clad fiber. In this example a mid-stage amplifier 2303 can be used, which can comprise an erbium/ytterbium doped double-clad fiber. A bandpass filter 2305 and isolator 2306 may be used between the pre-amplifier 2302 and mid-stage amplifier 2303. The power amplifier stage 2304 can comprise a larger core size erbium/ytterbium doped double-clad fiber, and another bandpass filter 2307 and isolator 2308 can be used before the power amplifier 2304. The output of the power amplifier can be coupled to the SC fiber 2309 to generate

the SC output 2310. This is just one exemplary configuration for an SC source, and other configurations or elements may be used consistent with this disclosure.

[0143] In yet another embodiment, the bottom of FIG. 23 illustrates a block diagram for an SC source 2350 capable of generating light between approximately 1900 and 2500 nm or broader. As an example, the seed laser diode 2351 can comprise a DFB or DBR laser that generates, for example, several milliwatts of power around 1542 or 1553 nm. The fiber pre-amplifier 2352 can comprise an erbium-doped fiber amplifier or an erbium/ytterbium doped double-clad fiber. In this example a mid-stage amplifier 2353 can be used, which can comprise an erbium/ytterbium doped double-clad fiber. A bandpass filter 2355 and isolator 2356 may be used between the pre-amplifier 2352 and mid-stage amplifier 2353. The power amplifier stage 2354 can comprise a thulium doped double-clad fiber, and another isolator 2357 can be used before the power amplifier 2354. Note that the output of the mid-stage amplifier 2353 can be approximately near 1550 nm, while the thulium-doped fiber amplifier 2354 can amplify wavelengths longer than approximately 1900 nm and out to about 2100 nm. Therefore, for this configuration wavelength shifting may be required between 2353 and 2354. In one embodiment, the wavelength shifting can be accomplished using a length of standard single-mode fiber 2358, which can have a length between approximately 5 and 50 meters, for example. The output of the power amplifier 2354 can be coupled to the SC fiber 2359 to generate the SC output 2360. This is just one exemplary configuration for an SC source, and other configurations or elements can be used consistent with this disclosure. For example, the various amplifier stages can comprise different amplifier types, such as erbium doped fibers, ytterbium doped fibers, erbium/ytterbium co-doped fibers and thulium doped fibers. One advantage of the SC lasers illustrated in FIGS. 20-23 are that they may use all-fiber components, so that the SC laser can be all-fiber, monolithically integrated with no moving parts. The all-integrated configuration can consequently be robust and reliable.

[0144] FIGS. 20-23 are examples of SC light sources that may be advantageously used for SWIR light generation in various medical diagnostic and therapeutic applications. However, many other versions of the SC light sources may also be made that are intended to also be covered by this disclosure. For example, the SC generation fiber could be pumped by a mode-locked laser, a gain-switched semiconductor laser, an optically pumped semiconductor laser, a solid state laser,

other fiber lasers, or a combination of these types of lasers. Also, rather than using a fiber for SC generation, either a liquid or a gas cell might be used as the nonlinear medium in which the spectrum is to be broadened.

[0145] Even within the all-fiber versions illustrated such as in FIG. 21, different configurations could be used consistent with the disclosure. In an alternate embodiment, it may be desirous to have a lower cost version of the SWIR SC laser of FIG. 21. One way to lower the cost could be to use a single stage of optical amplification, rather than two stages, which may be feasible if lower output power is required or the gain fiber is optimized. For example, the pre-amplifier stage 2102 might be removed, along with at least some of the mid-stage elements. In yet another embodiment, the gain fiber could be double passed to emulate a two stage amplifier. In this example, the pre-amplifier stage 2102 might be removed, and perhaps also some of the mid-stage elements. A mirror or fiber grating reflector could be placed after the power amplifier stage 2106 that may preferentially reflect light near the wavelength of the seed laser 2101. If the mirror or fiber grating reflector can transmit the pump light near 940 nm, then this could also be used instead of the pump combiner 2113 to bring in the pump light 2112. The SC fiber 2115 could be placed between the seed laser 2101 and the power amplifier stage 2106 (SC is only generated after the second pass through the amplifier, since the power level may be sufficiently high at that time). In addition, an output coupler may be placed between the seed laser diode 2101 and the SC fiber, which now may be in front of the power amplifier 2106. In a particular embodiment, the output coupler could be a power coupler or divider, a dichroic coupler (e.g., passing seed laser wavelength but outputting the SC wavelengths), or a wavelength division multiplexer coupler. This is just one further example, but a myriad of other combinations of components and architectures could also be used for SC light sources to generate SWIR light that are intended to be covered by this disclosure.

Wireless Link to the Cloud

[0146] The non-invasive blood constituent or analytes measurement device may also benefit from communicating the data output to the "cloud" (e.g., data servers and processors in the web remotely connected) via wired and/or wireless communication strategies. The non-invasive devices may be part of a series of biosensors applied to the patient, and collectively these

devices form what might be called a body area network or a personal area network. The biosensors and non-invasive devices may communicate to a smart phone, tablet, personal data assistant, computer, and/or other microprocessor-based device, which may in turn wirelessly or over wire and/or fiber optically transmit some or all of the signal or processed data to the internet or cloud. The cloud or internet may in turn send the data to doctors or health care providers as well as the patients themselves. Thus, it may be possible to have a panoramic, high-definition, relatively comprehensive view of a patient that doctors can use to assess and manage disease, and that patients can use to help maintain their health and direct their own care.

[0147] In a particular embodiment 2400, the physiological measurement device or non-invasive blood constituent measurement device 2401 may comprise a transmitter 2403 to communicate over a first communication link 2404 in the body area network or personal area network to a receiver in a smart phone, tablet cell phone, PDA, or computer 2405. For the measurement device 2401, it may also be advantageous to have a processor 2402 to process some of the physiological data, since with processing the amount of data to transmit may be less (hence, more energy efficient). The first communication link 2404 may operate through the use of one of many wireless technologies such as Bluetooth, Zigbee, WiFi, IrDA (infrared data association), wireless USB, or Z-wave, to name a few. Alternatively, the communication link 2404 may occur in the wireless medical band between 2360 and 2390 MHz, which the FCC allocated for medical body area network devices, or in other designated medical device or WMTS bands. These are examples of devices that can be used in the body area network and surroundings, but other devices could also be used and are included in the scope of this disclosure.

[0148] The personal device 2405 may store, process, display, and transmit some of the data from the measurement device 2401. The device 2405 may comprise a receiver, transmitter, display, voice control and speakers, and one or more control buttons or knobs and a touch screen. Examples of the device 2405 include smart phones such as the Apple iPhones.RTM. or phones operating on the Android or Microsoft systems. In one embodiment, the device 2405 may have an application, software program, or firmware to receive and process the data from the measurement device 2401. The device 2405 may then transmit some or all of the data or the processed data over a second communication link 2406 to the internet or "cloud" 2407. The second communication link 2406 may advantageously comprise at least one segment of a wireless

transmission link, which may operate using WiFi or the cellular network. The second communication link 2406 may additionally comprise lengths of fiber optic and/or communication over copper wires or cables.

[0149] The internet or cloud 2407 may add value to the measurement device 2401 by providing services that augment the physiological data collected. In a particular embodiment, some of the functions performed by the cloud include: (a) receive at least a fraction of the data from the device 2405; (b) buffer or store the data received; (c) process the data using software stored on the cloud; (d) store the resulting processed data; and (e) transmit some or all of the data either upon request or based on an alarm. As an example, the data or processed data may be transmitted 2408 back to the originator (e.g., patient or user), it may be transmitted 2409 to a health care provider or doctor, or it may be transmitted 2410 to other designated recipients.

[0150] The cloud 2407 may provide a number of value-add services. For example, the cloud application may store and process the physiological data for future reference or during a visit with the healthcare provider. If a patient has some sort of medical mishap or emergency, the physician can obtain the history of the physiological parameters over a specified period of time. In another embodiment, if the physiological parameters fall out of acceptable range, alarms may be delivered to the user 2408, the healthcare provider 2409, or other designated recipients 2410. These are just some of the features that may be offered, but many others may be possible and are intended to be covered by this disclosure. As an example, the device 2405 may also have a GPS sensor, so the cloud 2407 may be able to provide time, data and position along with the physiological parameters. Thus, if there is a medical emergency, the cloud 2407 could provide the location of the patient to the healthcare provider 2409 or other designated recipients 2410. Moreover, the digitized data in the cloud 2407 may help to move toward what is often called "personalized medicine." Based on the physiological parameter data history, medication or medical therapies may be prescribed that are customized to the particular patient.

[0151] Beyond the above benefits, the cloud application 2407 and application on the device 2405 may also have financial value for companies developing measurement devices 2401 such as a non-invasive blood constituent monitor. In the case of glucose monitors, the companies make the majority of their revenue on the measurement strips. However, with a non-invasive

monitor, there is no need for strips, so there is less of an opportunity for recurring costs (e.g., the razor/razor blade model does not work for non-invasive devices). On the other hand, people may be willing to pay a periodic fee for the value-add services provided on the cloud 2407. Diabetic patients, for example, would probably be willing to pay a periodic fee for monitoring their glucose levels, storing the history of the glucose levels, and having alarm warnings when the glucose level falls out of range. Similarly, patients taking ketone bodies supplement for treatment of disorders characterized by impaired glucose metabolism (e.g., Alzheimer's, Parkinson's, Huntington's or ALS) may need to monitor their ketone bodies level. These patients would also probably be willing to pay a periodic fee for the value-add services provided on the cloud 2407. Thus, by leveraging the advances in wireless connectivity and the widespread use of handheld devices such as smart phones that can wirelessly connect to the cloud, businesses can build a recurring cost business model even using non-invasive measurement devices.

[0152] In addition, it may be advantageous to use pattern matching algorithms and other software and mathematical methods to identify the blood constituents of interest. In one embodiment, the spectrum may be correlated with a library of known spectra to determine the overlap integrals, and a threshold function may be used to quantify the concentration of different constituents. This is just one way to perform the signal processing, and many other techniques, algorithms, and software may be used and would fall within the scope of this disclosure.

[0153] Described herein are just some examples of the beneficial use of near-infrared or SWIR lasers for non-invasive monitoring of glucose, ketones, HbA1 c and other blood constituents. However, many other medical procedures can use the near-infrared or SWIR light consistent with this disclosure and are intended to be covered by the disclosure.

[0154] In another specific embodiment, experiments have been performed for stand-off detection of solid targets with diffuse reflection spectroscopy using a fiber-based super-continuum source (further described herein). In particular, the diffuse reflection spectrum of solid samples such as explosives (TNT, RDX, PETN), fertilizers (ammonium nitrate, urea), and paints (automotive and military grade) have been measured at stand-off distances of 5m. Although the measurements were done at 5m, calculations show that the distance could be anywhere from a few meters to over 150m. These are specific samples that have been tested, but more generally

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other materials (particularly comprising hydro-carbons) could also be tested and identified using similar methods. The experimental set-up 2500 for the reflection-spectroscopy-based stand-off detection system is shown in FIGURE 25, while details of the SC source 2501 are described in this disclosure in FIGURES 20,21, and 23. First, the diverging SC output is collimated to a 1 cm diameter beam using a 25 mm focal length, 90 degrees off-axis, gold coated, parabolic mirror 2502. To reduce the effects of chromatic aberration, refractive optics are avoided in the setup. All focusing and collimation is done using metallic mirrors that have almost constant reflectivity and focal length over the entire SC output spectrum. The sample 2504 is kept at a distance of 5m from the collimating mirror 2502, which corresponds to a total round trip path length of 10m before reaching the collection optics 2505. A 12cm diameter silver coated concave mirror 2505 with a 75cm focal length is kept 20cm to the side of the collimation mirror 2502. The mirror 2505 is used to collect a fraction of the diffusely reflected light from the sample, and focus it into the input slit of a monochromator 2506. Thus, the beam is incident normally on the sample 2504, but detected at a reflection angle of tan-1(0.2/5) or about 2.3 degrees. Appropriate long wavelength pass filters mounted in a motorized rotating filter wheel are placed in the beam path before the input slit 2506 to avoid contribution from higher wavelength orders from the grating (300 grooves/mm, 2μm blaze). The output slit width is set to 2mm corresponding to a spectral resolution of 10.8nm, and the light is detected by a 2mm x 2mm liquid nitrogen cooled (77K) indium antimonide (InSb) detector 2507. The detected output is amplified using a trans-impedance pre-amplifier 2507 with a gain of about 105V/A and connected to a lock-in amplifier 2508 setup for high sensitivity detection. The chopper frequency is 400Hz, and the lock-in time constant is set to 100ms corresponding to a noise bandwidth of about 1Hz. These are exemplary elements and parameter values, but other or different optical elements may be used consistent with this disclosure.

PROCESS ANALYTICAL TECHNOLOGY (PAT)

[0155] One definition of process analytical technology, PAT, is "a system for designing, analyzing and controlling manufacturing through timely evaluations (i.e., during processing) of significant quality and performance attributes of raw and in-process materials and processes, with the goal of ensuring final product quality." Near-infrared or SWIR spectroscopy may have applications in the PAT of the pharmaceutical industry by providing, for example, quantitative

analysis of multiple components in a sample and in pack quantification of drugs in formulation, as well as quality of a drug and quality control of complex excipients used in formulation. The PAT process may benefit from near-infrared or SWIR spectroscopy for some steps, such as: raw material identification, active pharmaceutical ingredient applications, drying, granulation, blend uniformity and content uniformity. Some of the strengths of near-infrared or SWIR spectroscopy include: radiation has good penetration properties, and, thus, minimal sample preparation may be required; measurement results may be obtained rapidly, and simultaneous measurements may be obtained for several parameters; non-destructive methods with little or no chemical waste; and organic chemicals that comprise most pharmaceutical products have unique spectra in the near-infrared and SWIR ranges, for example.

[0156] One goal of the manufacturing process and PAT may be the concept of a "smart" manufacturing process, which may be a system or manufacturing operation responding to analytical data generated in real-time. Such a system may also have an in-built "artificial intelligence" as decisions may be made whether to continue a manufacturing operation. For example, with respect to the raw materials, integration of the quality measurement into smart manufacturing processes could be used to improve manufacturing operations by ensuring that the correct materials of the appropriate quality are used in the manufacture. Similarly, a smart blender would be under software control and would respond to the real-time spectral data collected.

[0157] FIGURE 26 illustrates what might be an eventual flow-chart 2600 of a smart manufacturing process. The manufacturing process 2601 may have as input the process feed 2602 and result in a process output 2603. A process controller 2604 may at least partially control the manufacturing process 2601, and the controller 2604 may receive inputs from the closed loop control (process parameters) 2605 as well as the on-line monitoring of process parameters 2606. The feedback loops in the process could refine the manufacturing process 2601 and improve the quality of the process output 2603. These are particular embodiments of the use of near-infrared or SWIR spectroscopy in the PAT of the pharmaceutical industry, but other variations, combinations, and methods may also be used and are intended to be covered by this disclosure.

[0158] The discussion thus far has included use of near-infrared or SWIR spectroscopy in applications such as identification of counterfeit drugs, detection of illicit drugs, and

pharmaceutical process control. Although drugs and pharmaceuticals are one example, many other fields and applications may also benefit from the use of near infrared or SWIR spectroscopy, and these may also be implemented without departing from the scope of this disclosure. As just another example, near-infrared or SWIR spectroscopy may also be used as an analytic tool for food quality and safety control. Applications in food safety and quality assessment include contaminant detection, defect identification, constituent analysis, and quality evaluation. The techniques described in this disclosure are particularly valuable when non-destructive testing is desired at stand-off or remote distances.

[0159] Although the present disclosure has been described in several embodiments, a myriad of changes, variations, alterations, transformations, and modifications may be suggested to one skilled in the art, and it is intended that the present disclosure encompass such changes, variations, alterations, transformations, and modifications as falling within the spirit and scope of the appended claims.

[0160] While exemplary embodiments are described above, it is not intended that these embodiments describe all possible forms of the disclosure. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the spirit and scope of the disclosure. Additionally, the features of various implementing embodiments may be combined to form further embodiments of the disclosure. While various embodiments may have been described as providing advantages or being preferred over other embodiments with respect to one or more desired characteristics, as one skilled in the art is aware, one or more characteristics may be compromised to achieve desired system attributes, which depend on the specific application and implementation. These attributes include, but are not limited to: cost, strength, durability, life cycle cost, marketability, appearance, packaging, size, serviceability, weight, manufacturability, ease of assembly, etc. The embodiments described herein that are described as less desirable than other embodiments or prior art implementations with respect to one or more characteristics are not outside the scope of the disclosure and may be desirable for particular applications.

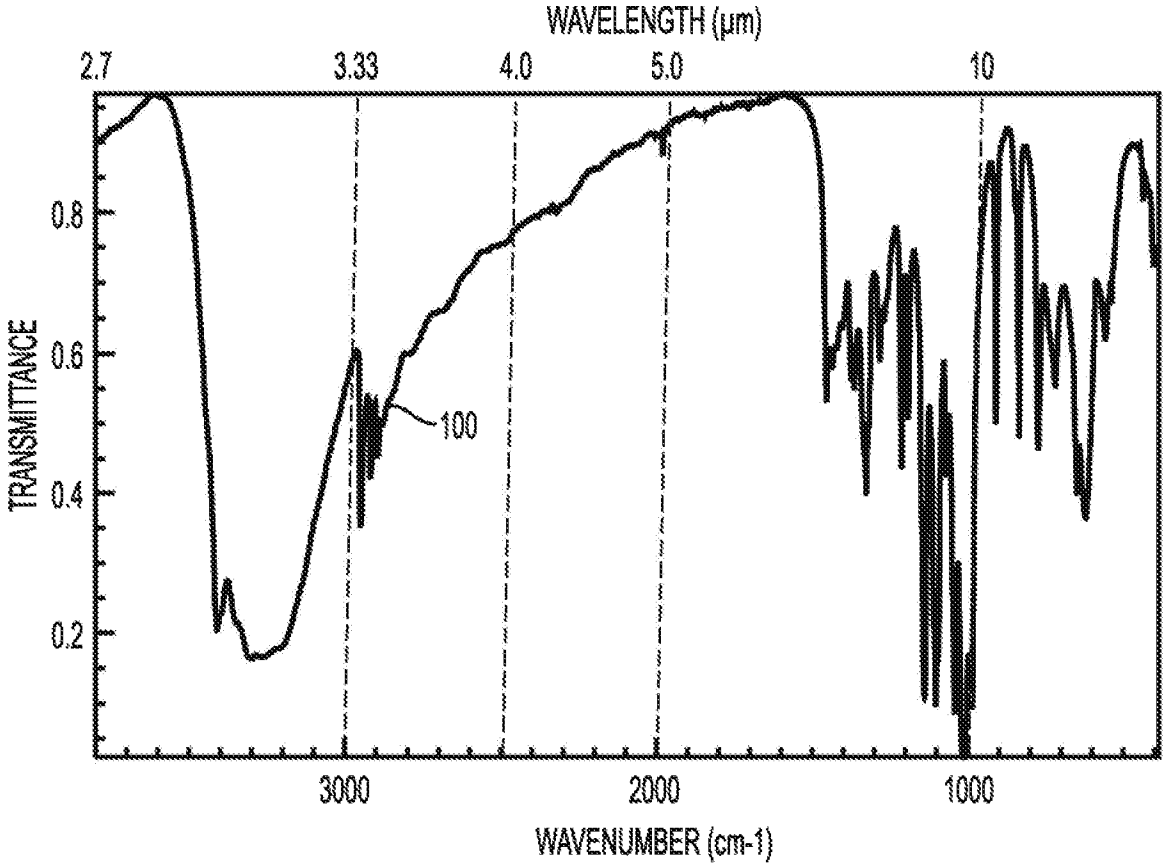
WAVELENGTH (μm)
2.7
3.33
4.0
5.0
10
TRANSMITTANCE
0.8
0.6
0.4
0.2
100
3000
2000
1000
WAVENUMBER (cm-1)

FIG. 1

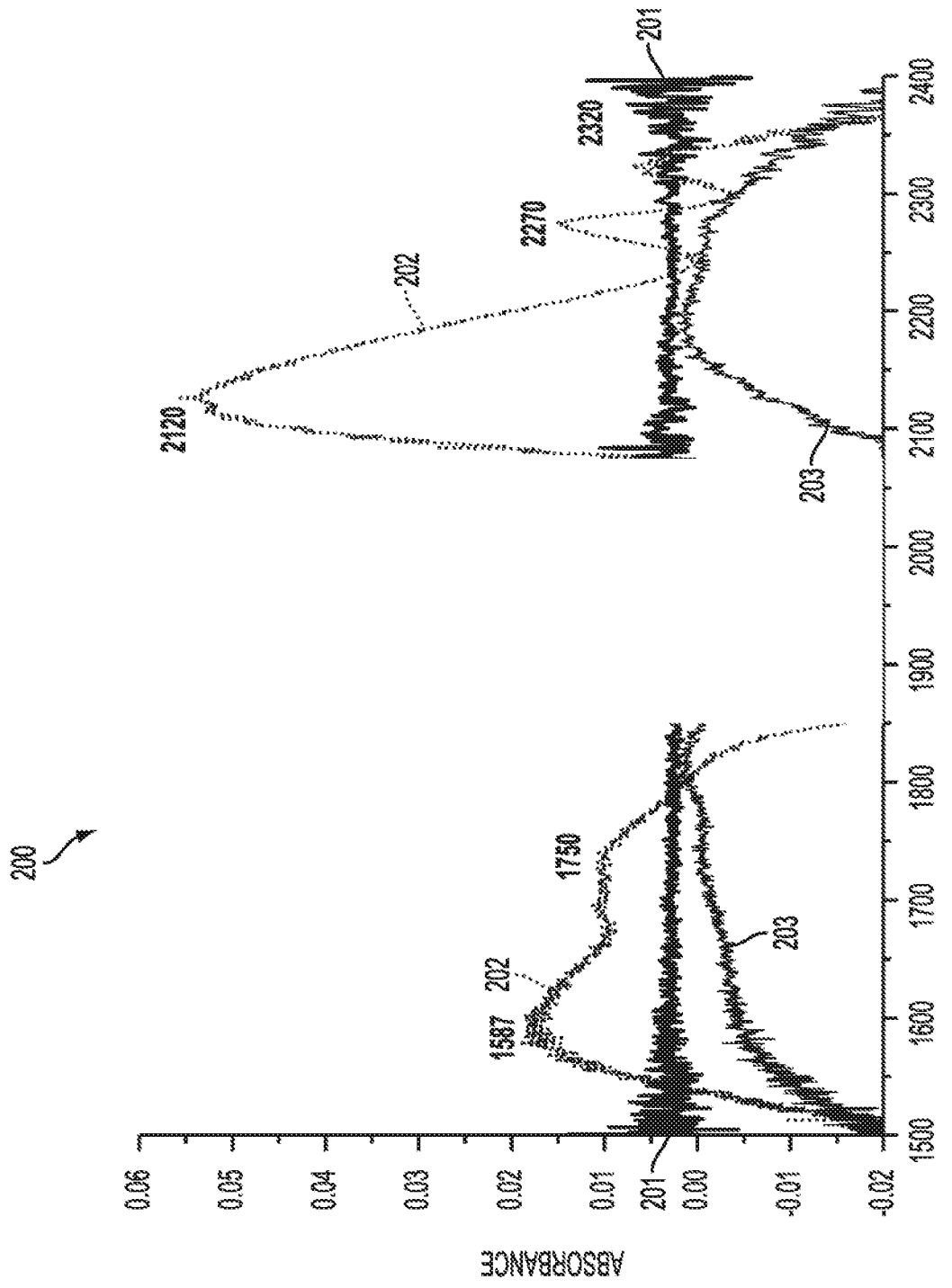
200
ABSORBANCE
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
WAVELENGTH (nm)
201
202
203
1587
1750
2120
2270
2320

FIG. 2

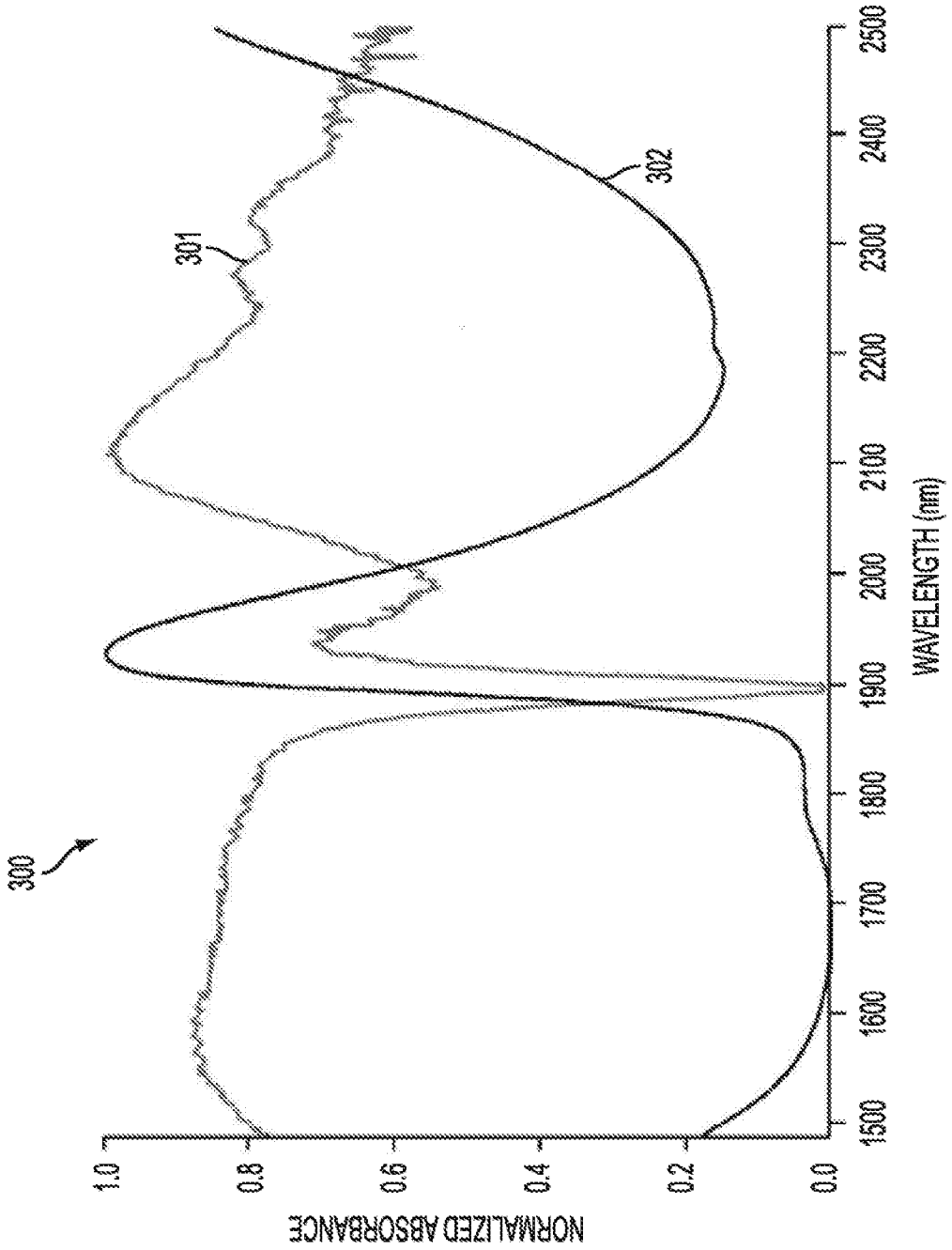
300
301
302
NORMALIZED ABSORBANCE
1.0
0.8
0.6
0.4
0.2
0.0
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
WAVELENGTH (nm)

FIG. 3A

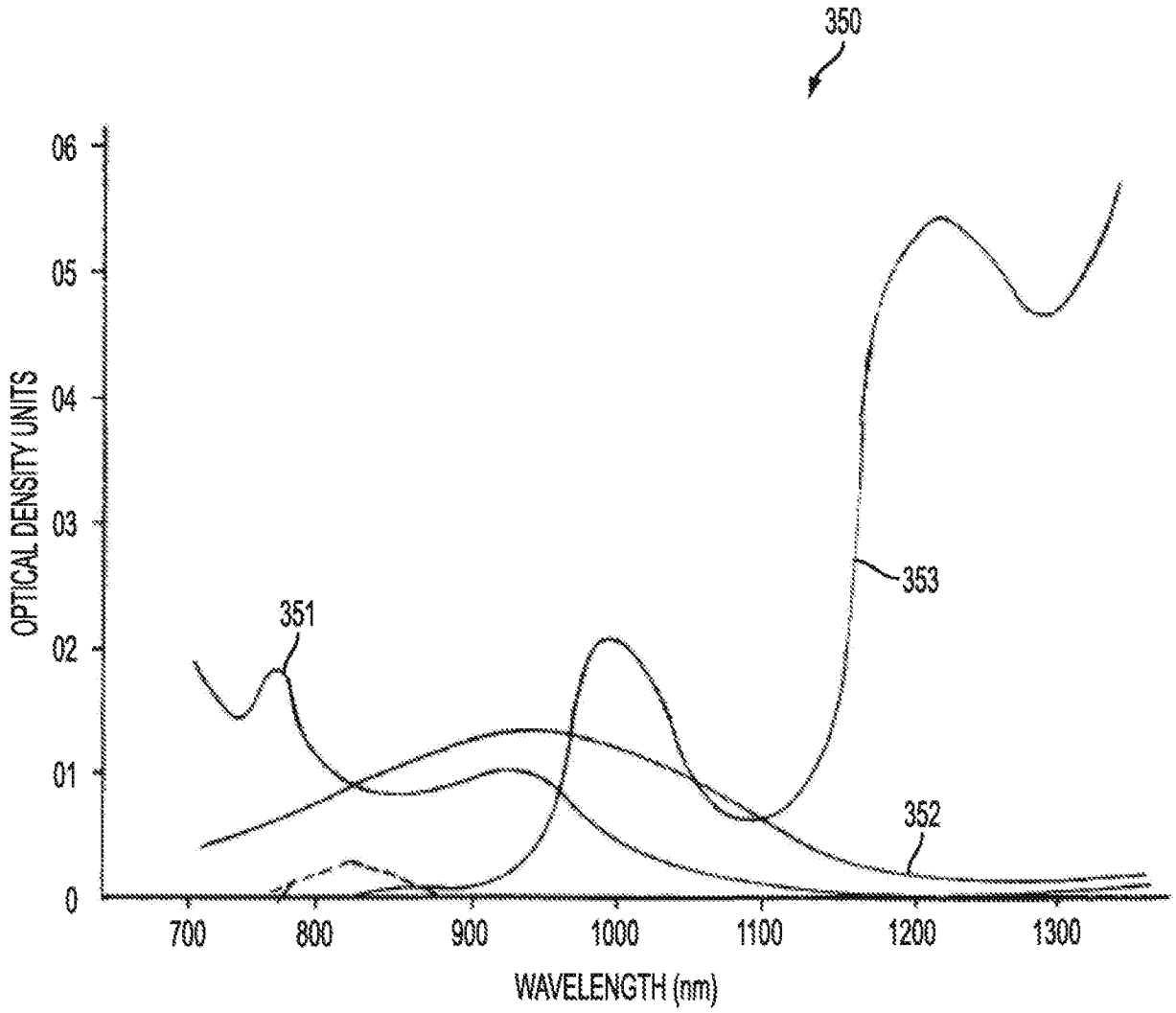
350
06
05
04
03
02
01
0
OPTICAL DENSITY UNITS
351
353
352
700
800
900
1000
1100
1200
1300
WAVELENGTH (nm)

FIG. 3B

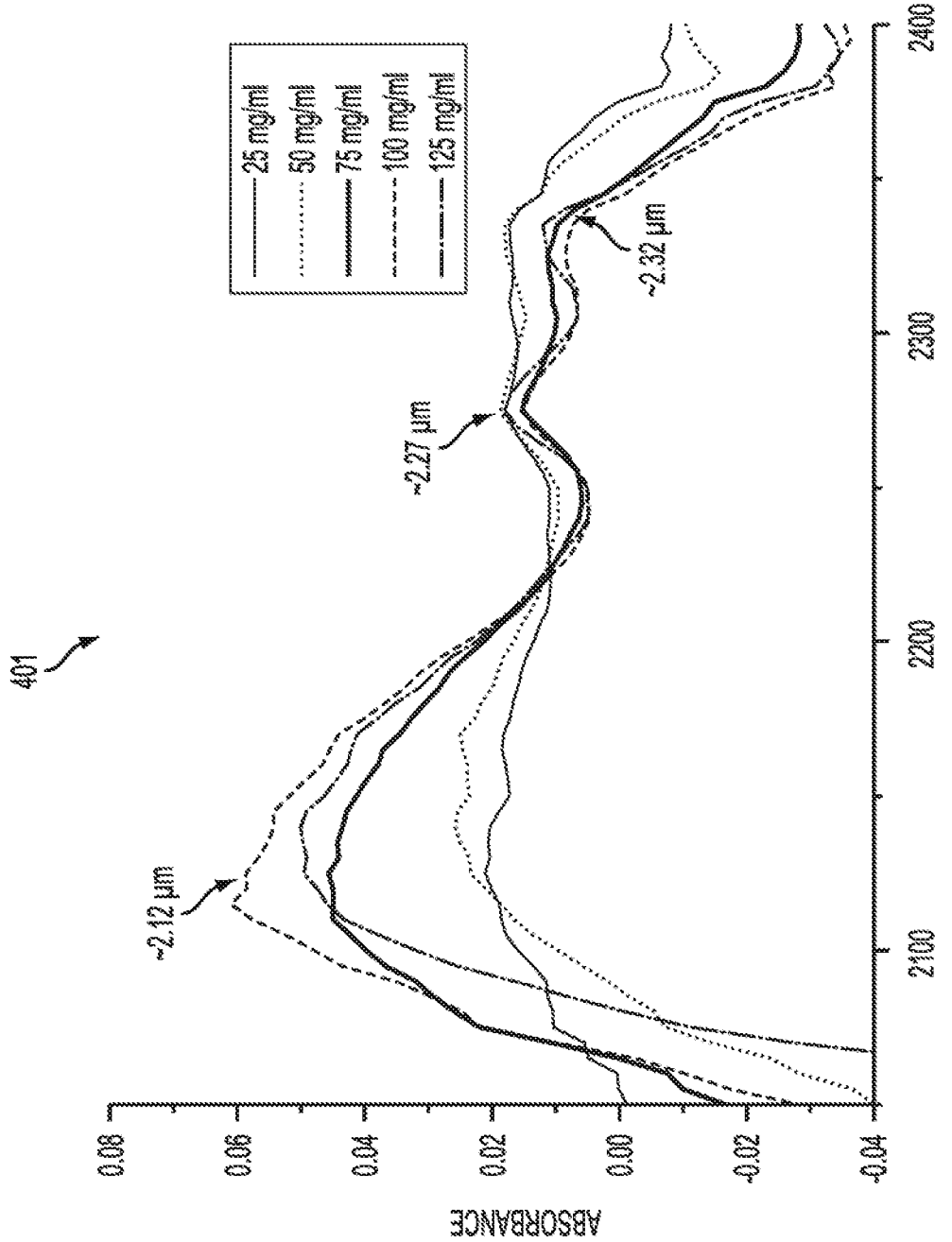
401
25 mg/ml
50 mg/ml
75 mg/ml
100 mg/ml
125 mg/ml
~2.12 µm
~2.27 µm
~2.32 µm
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
ABSORBANCE
2100
2200
2300
2400
WAVELENGTH (nm)

FIG. 4A

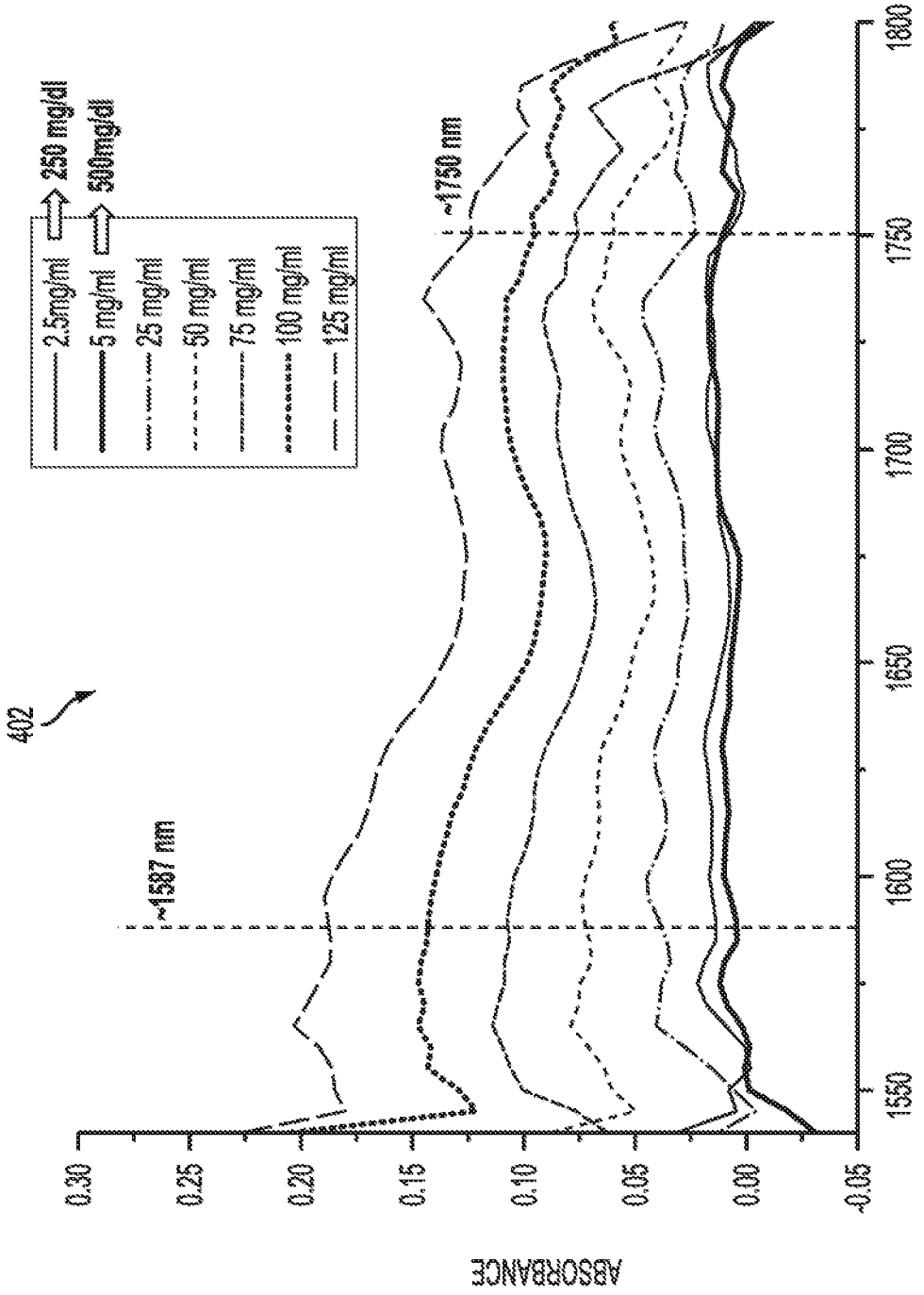
402
2.5mg/ml
5 mg/ml
25 mg/ml
50 mg/ml
75 mg/ml
100 mg/ml
125 mg/ml
250 mg/dl
500mg/dl
~1587 nm
~1750 nm
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
ABSORBANCE
1550
1600
1650
1700
1750
1800
WAVELENGTH (nm)

FIG. 4B

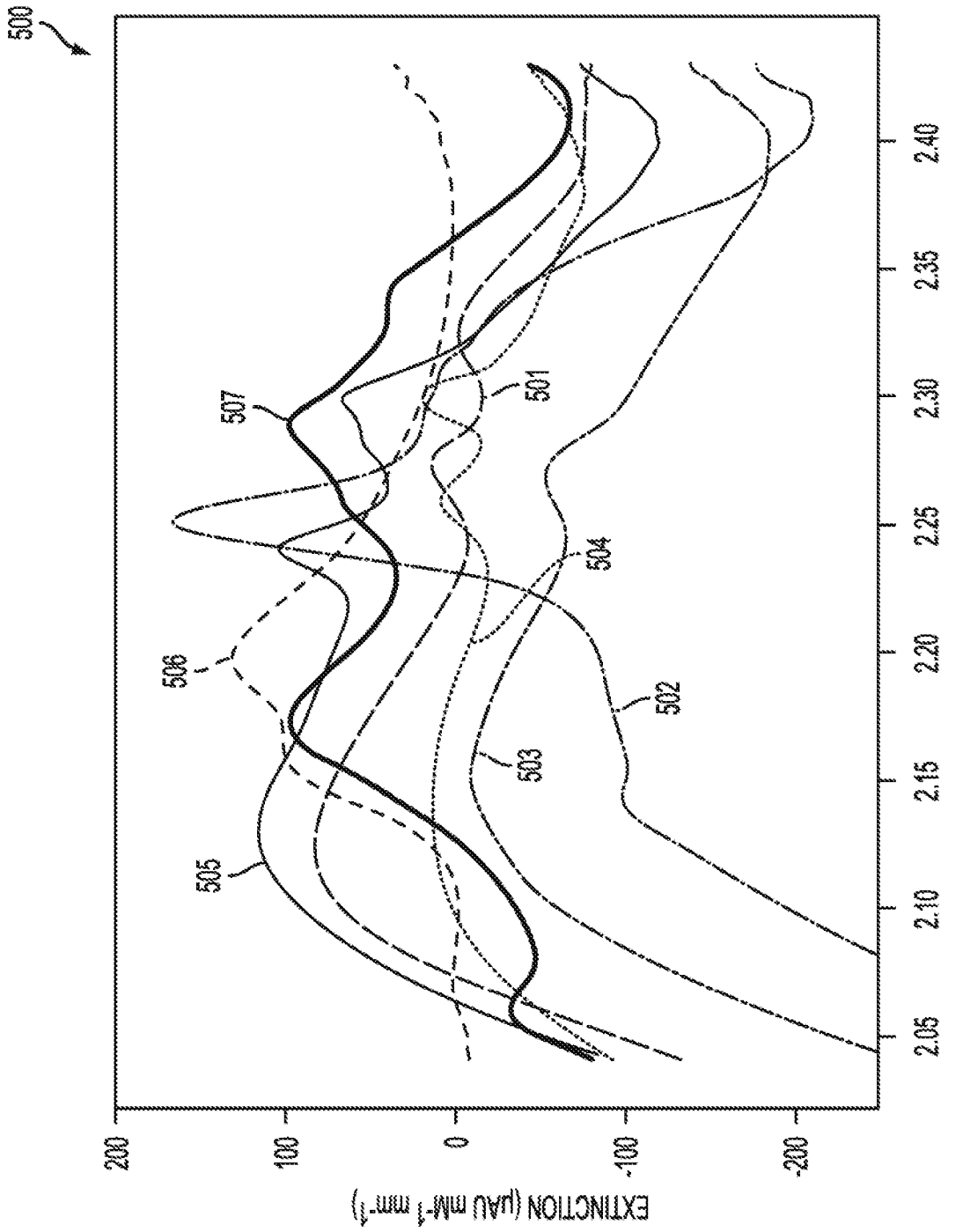
500
200
100
0
-100
-200
EXTINCTION (μAU mM⁻¹ mm⁻¹)
2.05
2.10
2.15
2.20
2.25
2.30
2.35
2.40
WAVELENGTH (μm)
501
502
503
504
505
506
507

FIG. 5

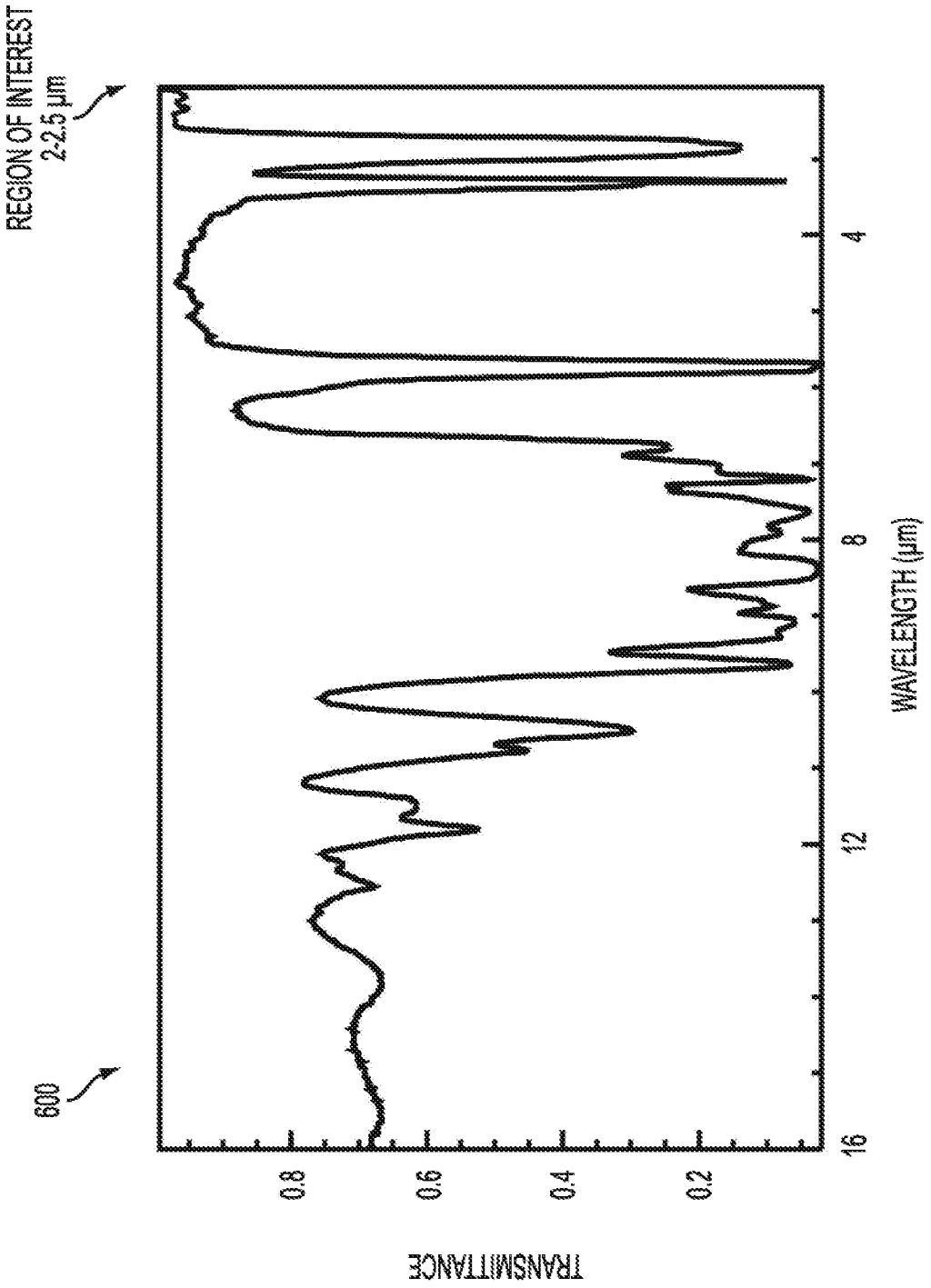
REGION OF INTEREST
2-2.5 µm
600
TRANSMITTANCE
0.8
0.6
0.4
0.2
4
8
12
16
WAVELENGTH (µm)

FIG. 6

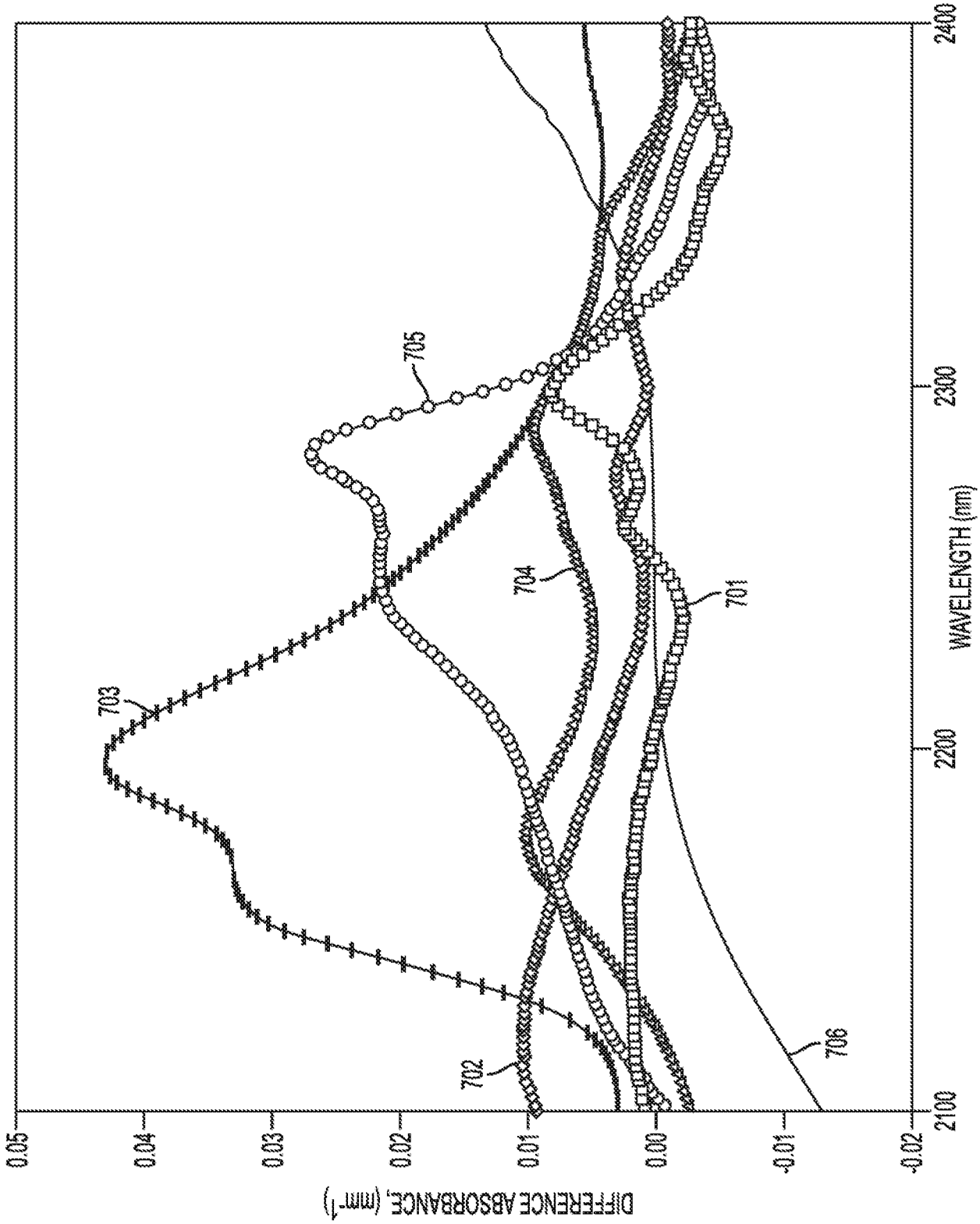
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
-0.02
DIFFERENCE ABSORBANCE, (mm-1)
2100
2200
2300
2400
WAVELENGTH (nm)
701
702
703
704
705
706

FIG. 7

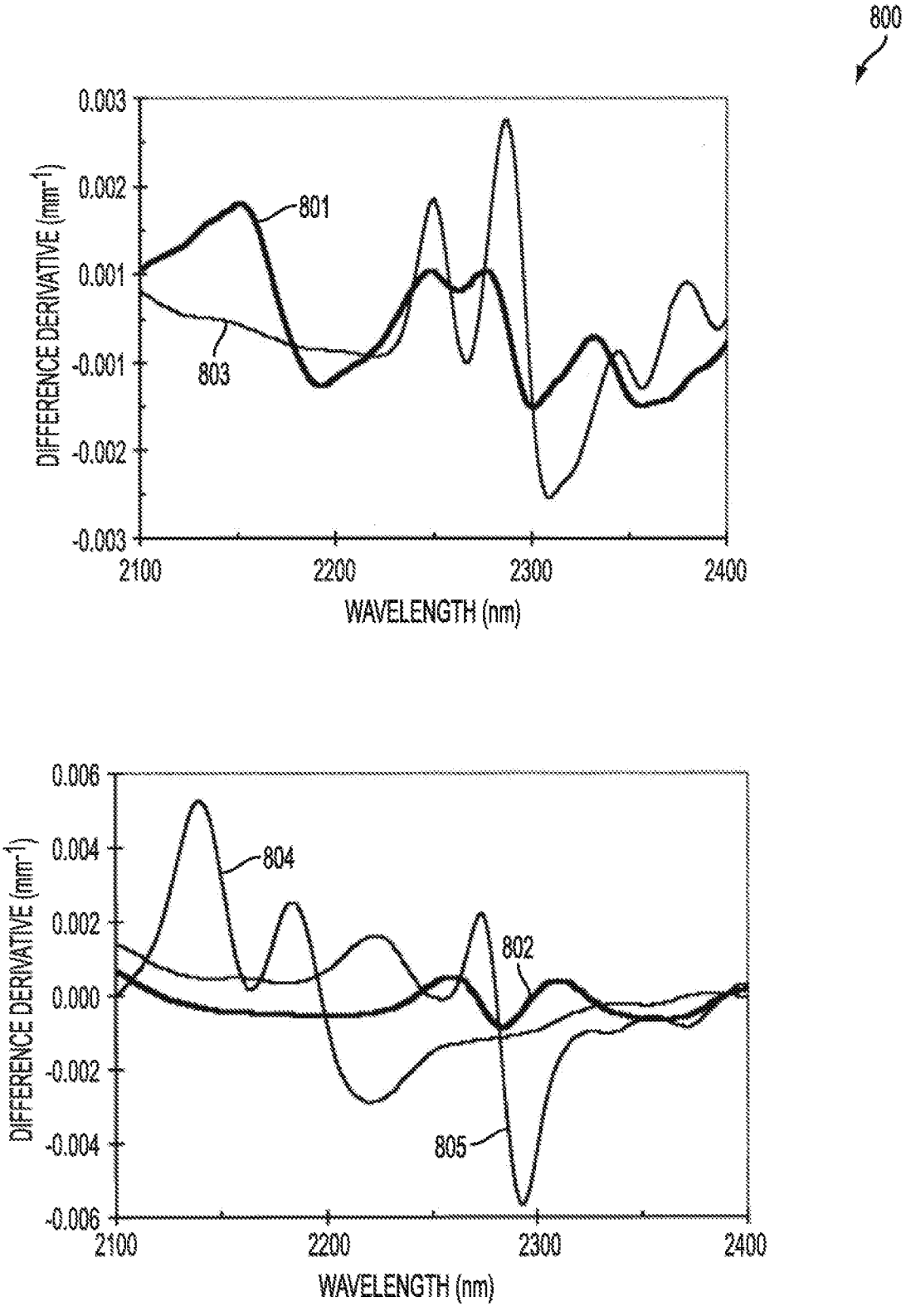
800
0.003
0.002
0.001
-0.001
-0.002
-0.003
DIFFERENCE DERIVATIVE (mm-1)
801
803
2100
2200
2300
2400
WAVELENGTH (nm)
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
DIFFERENCE DERIVATIVE (mm-1)
804
802
805
2100
2200
2300
2400
WAVELENGTH (nm)

FIG. 8A

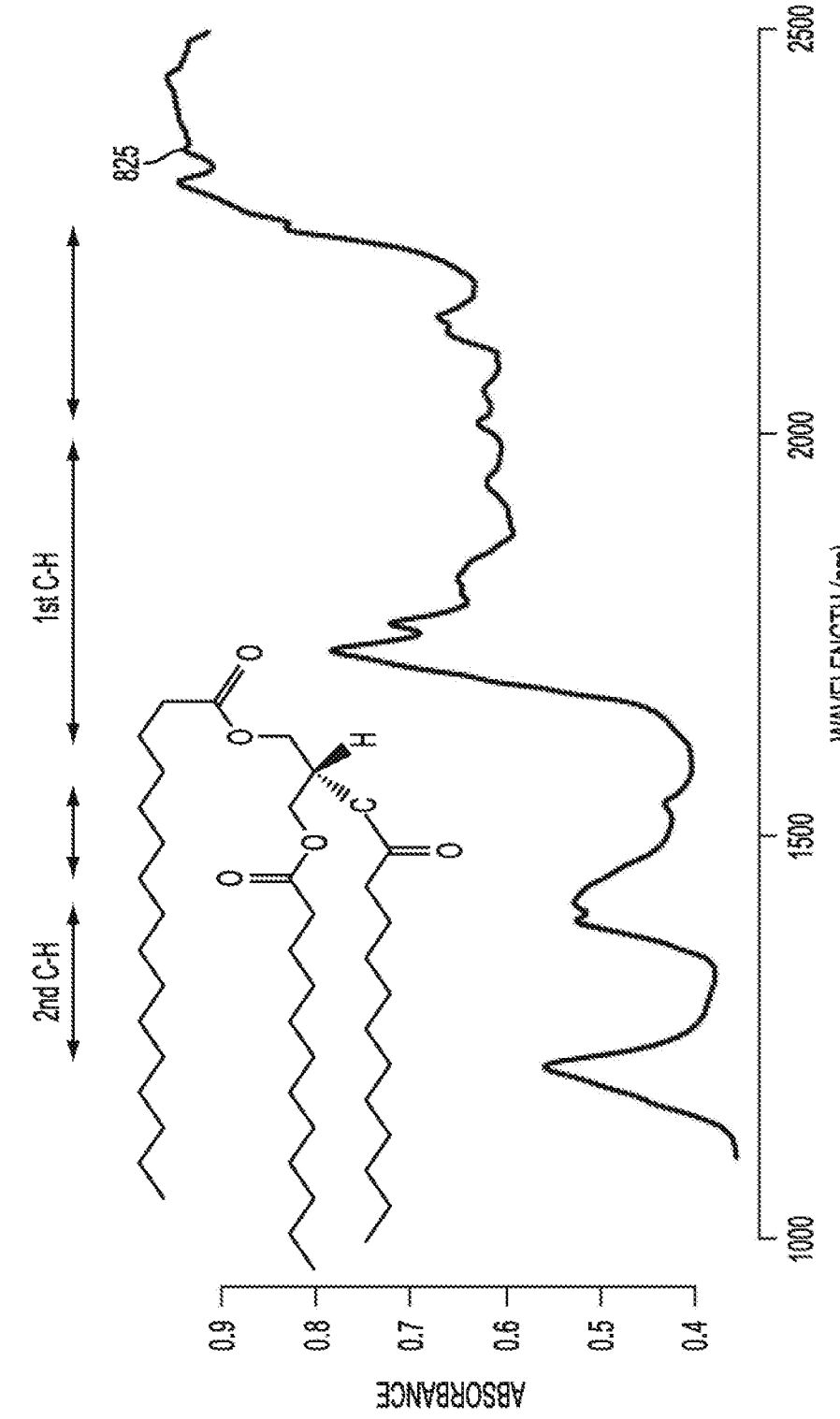
825
1st C-H
2nd C-H
ABSORBANCE
0.9
0.8
0.7
0.6
0.5
0.4
1000
1500
2000
2500
WAVELENGTH (nm)

FIG. 8B

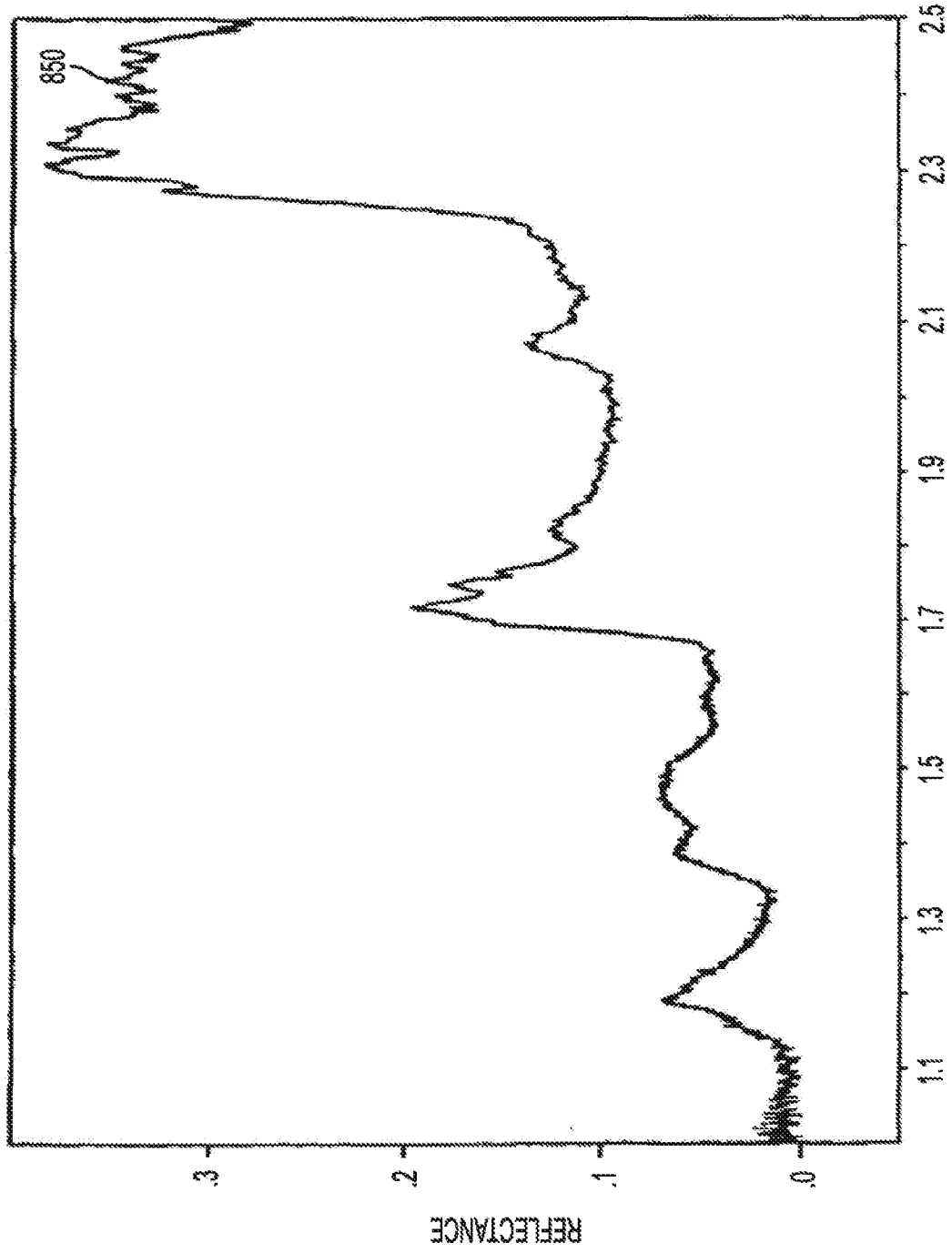

FIG. 8C

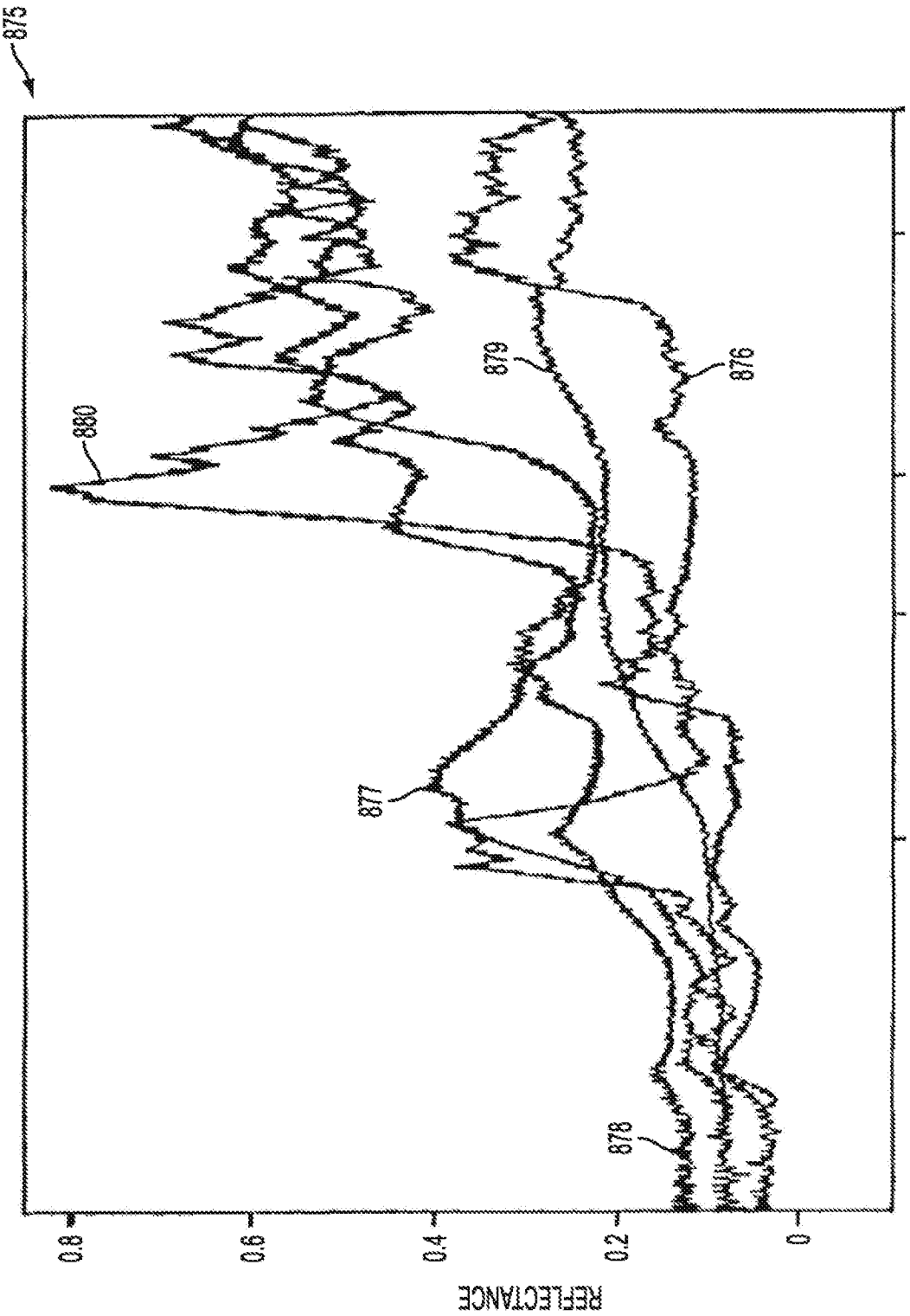
875
880
879
876
877
878
0.8
0.6
0.4
0.2
0
REFLECTANCE
1,500
2,000
2,500
WAVELENGTH (nm)

FIG. 8D

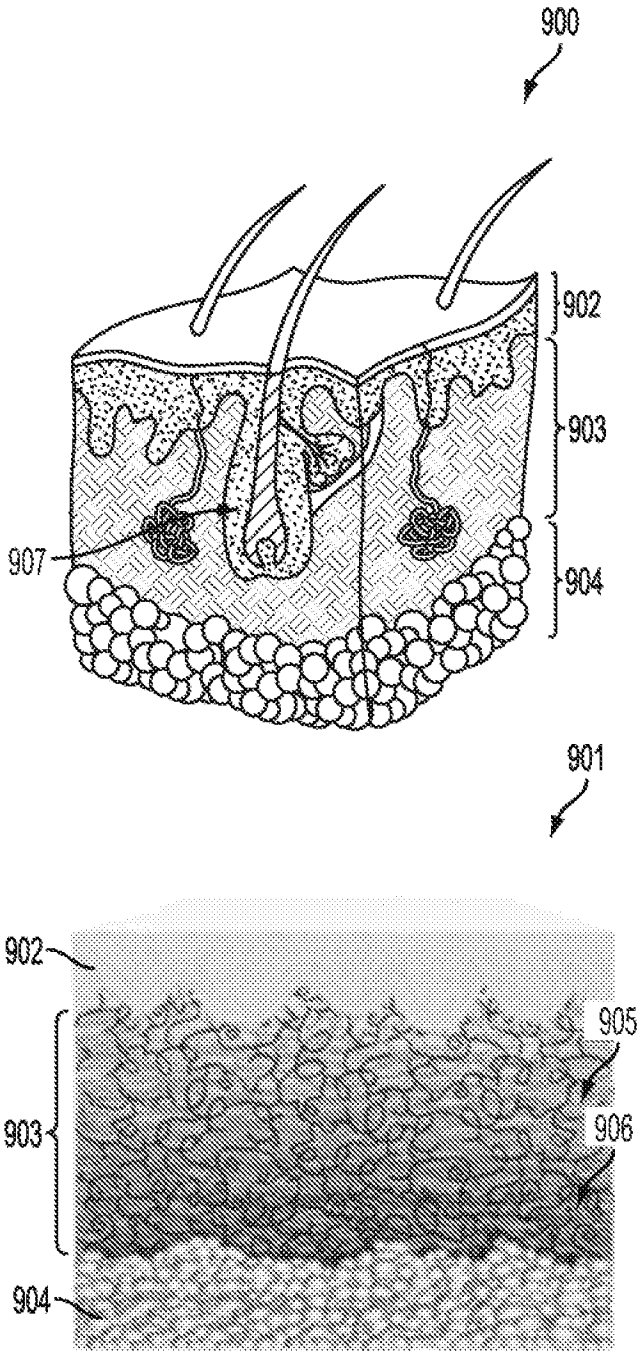

FIG. 9

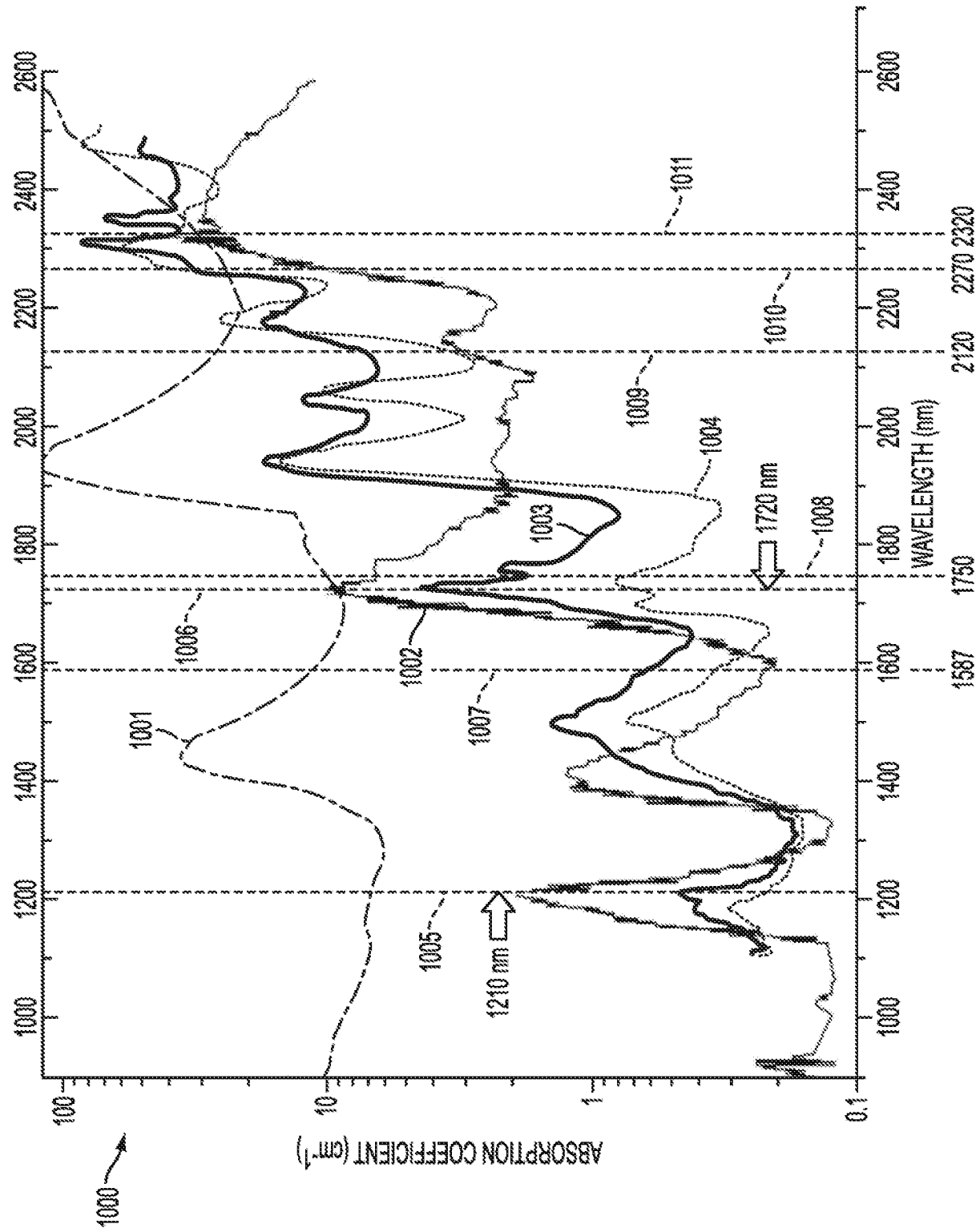
1000
ABSORPTION COEFFICIENT (cm-1)
100
10
1
0.1
1000
1200
1400
1600
1800
2000
2200
2400
2600
WAVELENGTH (nm)
1587
1750
2120
2270 2320
1210 nm
1720 nm
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011

FIG. 10

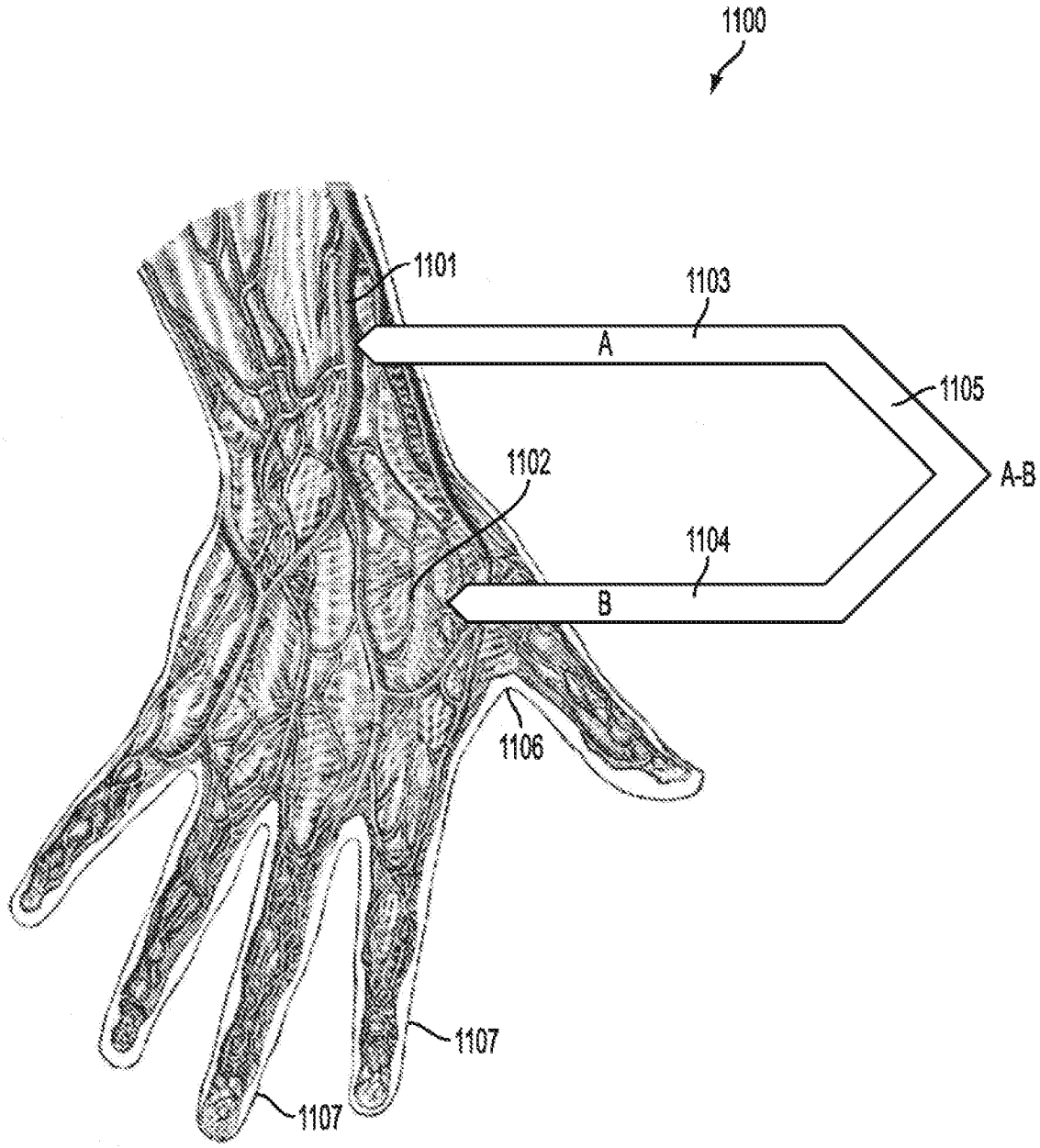

FIG. 11

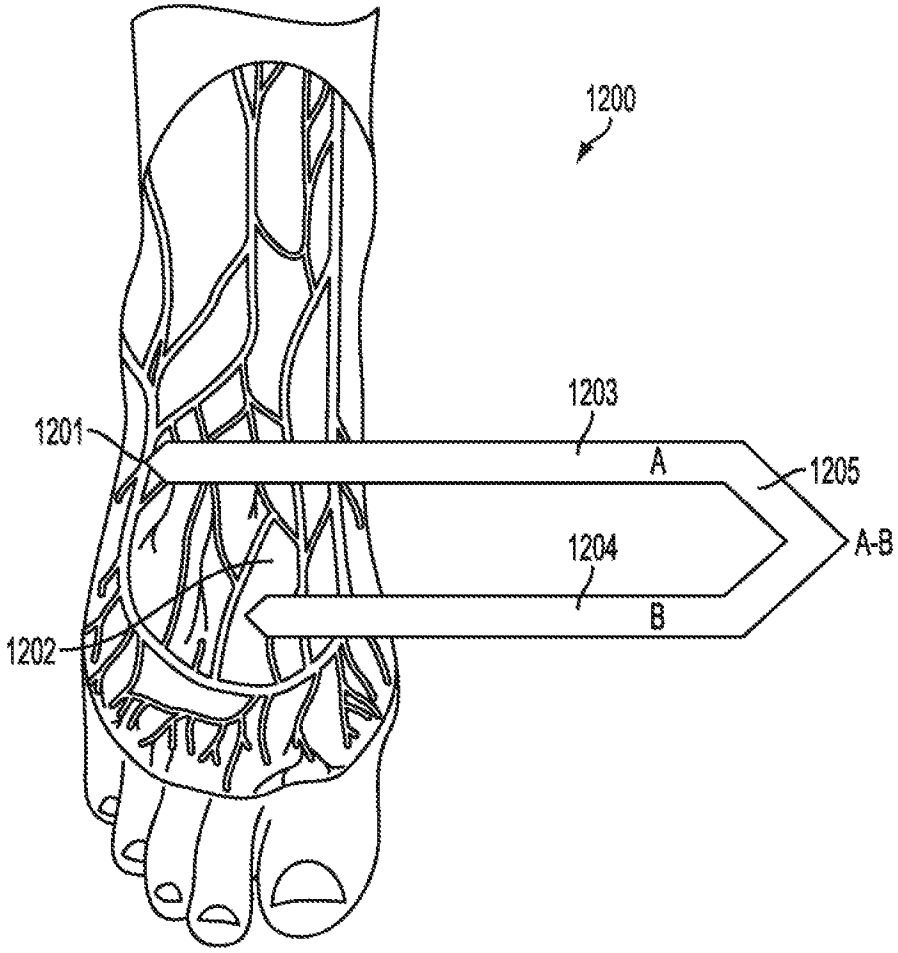

FIG. 12

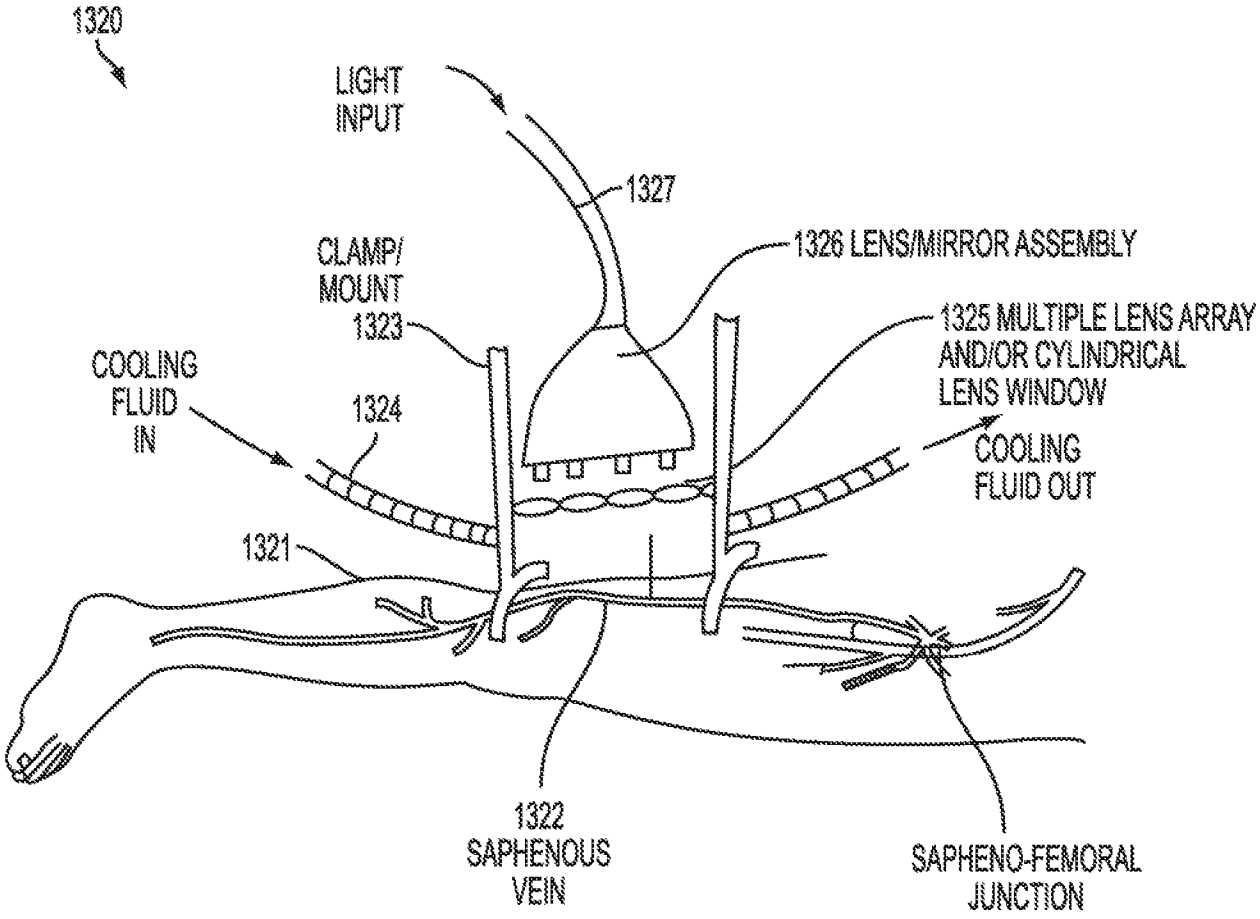
1320
LIGHT INPUT
1327
1326 LENS/MIRROR ASSEMBLY
CLAMP/ MOUNT
1323
1325 MULTIPLE LENS ARRAY AND/OR CYLINDRICAL LENS WINDOW
COOLING FLUID IN
1324
COOLING FLUID OUT
1321
1322 SAPHENOUS VEIN
SAPHENO-FEMORAL JUNCTION

FIG. 13A

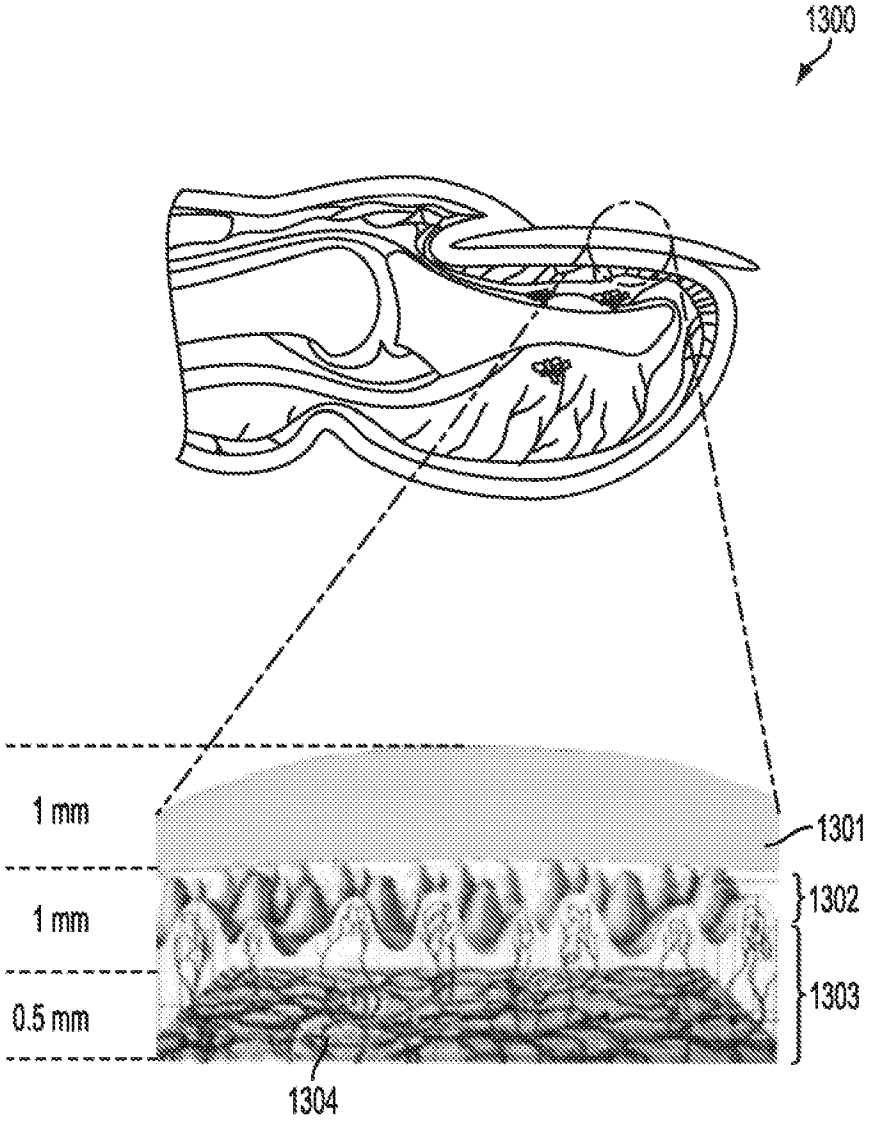

FIG. 13B

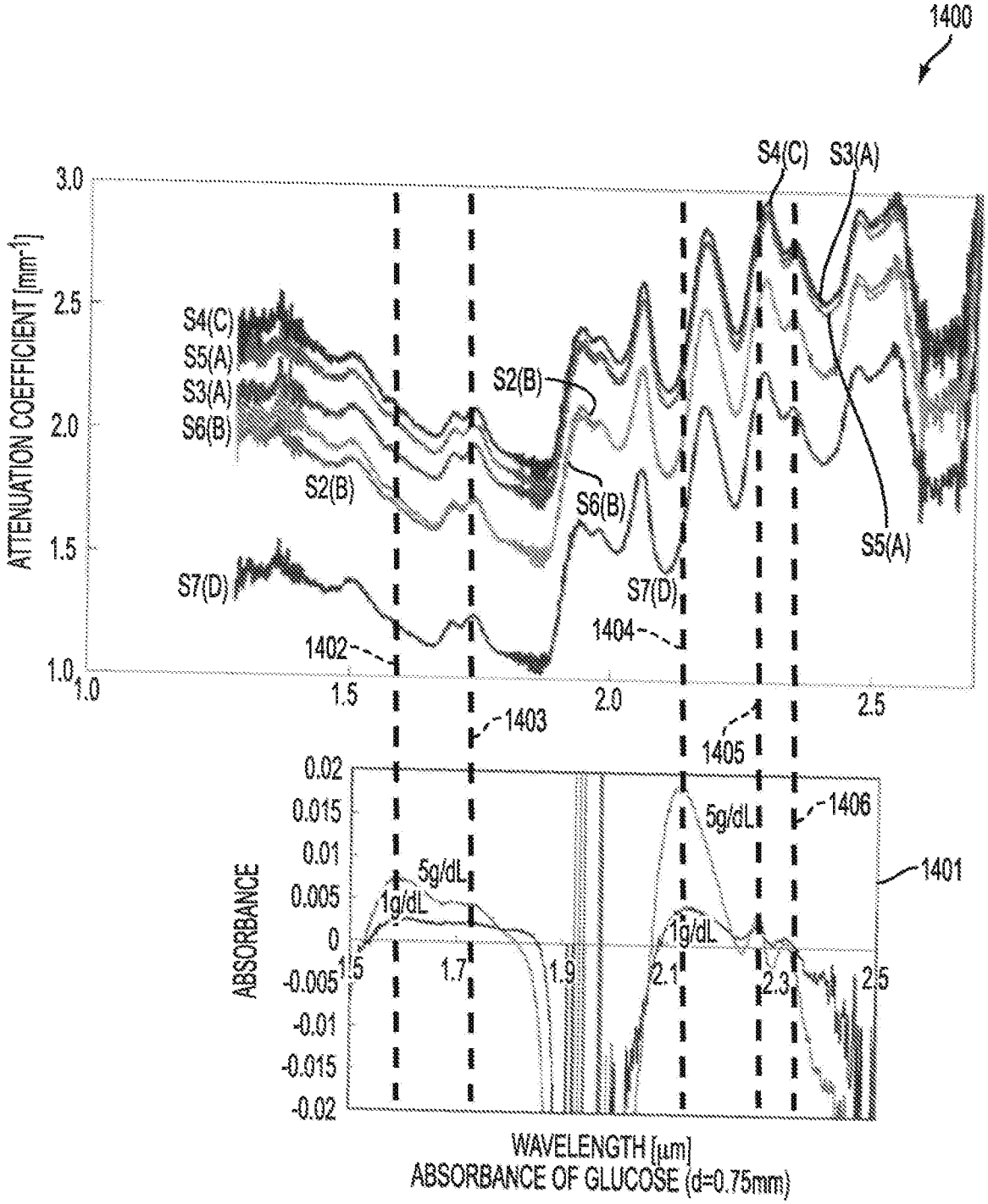
1400
ATTENUATION COEFFICIENT [mm-1]
3.0
2.5
2.0
1.5
1.0
1.0
1.5
2.0
2.5
S4(C)
S3(A)
S5(A)
S2(B)
S6(B)
S7(D)
1402
1403
1404
1405
1406
1401
ABSORBANCE
0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
5g/dL
1g/dL
1.5
1.7
1.9
2.1
2.3
2.5
WAVELENGTH [μm]
ABSORBANCE OF GLUCOSE (d=0.75mm)

FIG. 14

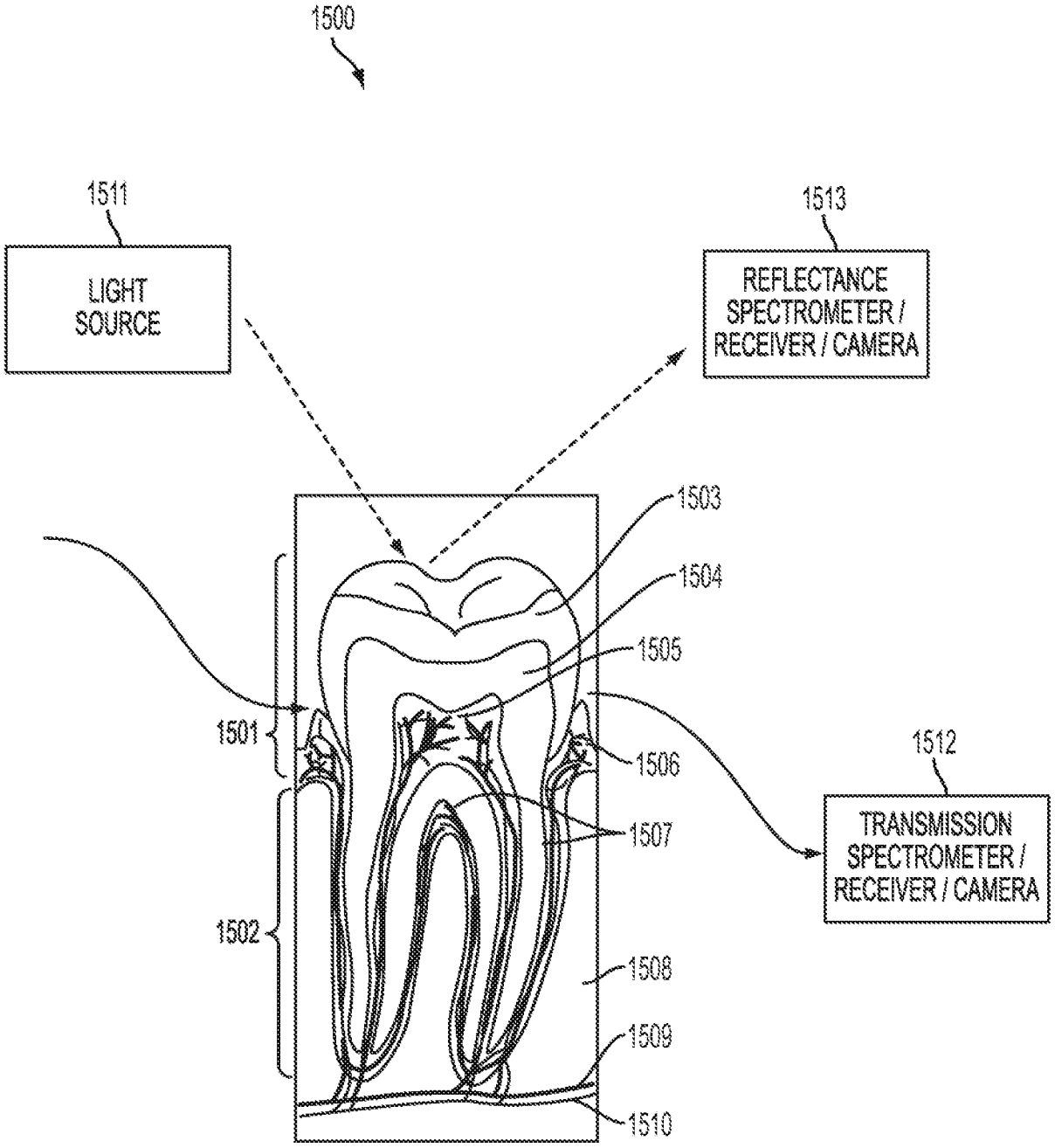
1500
1511
LIGHT SOURCE
1513
REFLECTANCE SPECTROMETER / RECEIVER / CAMERA
1503
1504
1505
1501
1506
1512
TRANSMISSION SPECTROMETER / RECEIVER / CAMERA
1507
1502
1508
1509
1510

FIG. 15

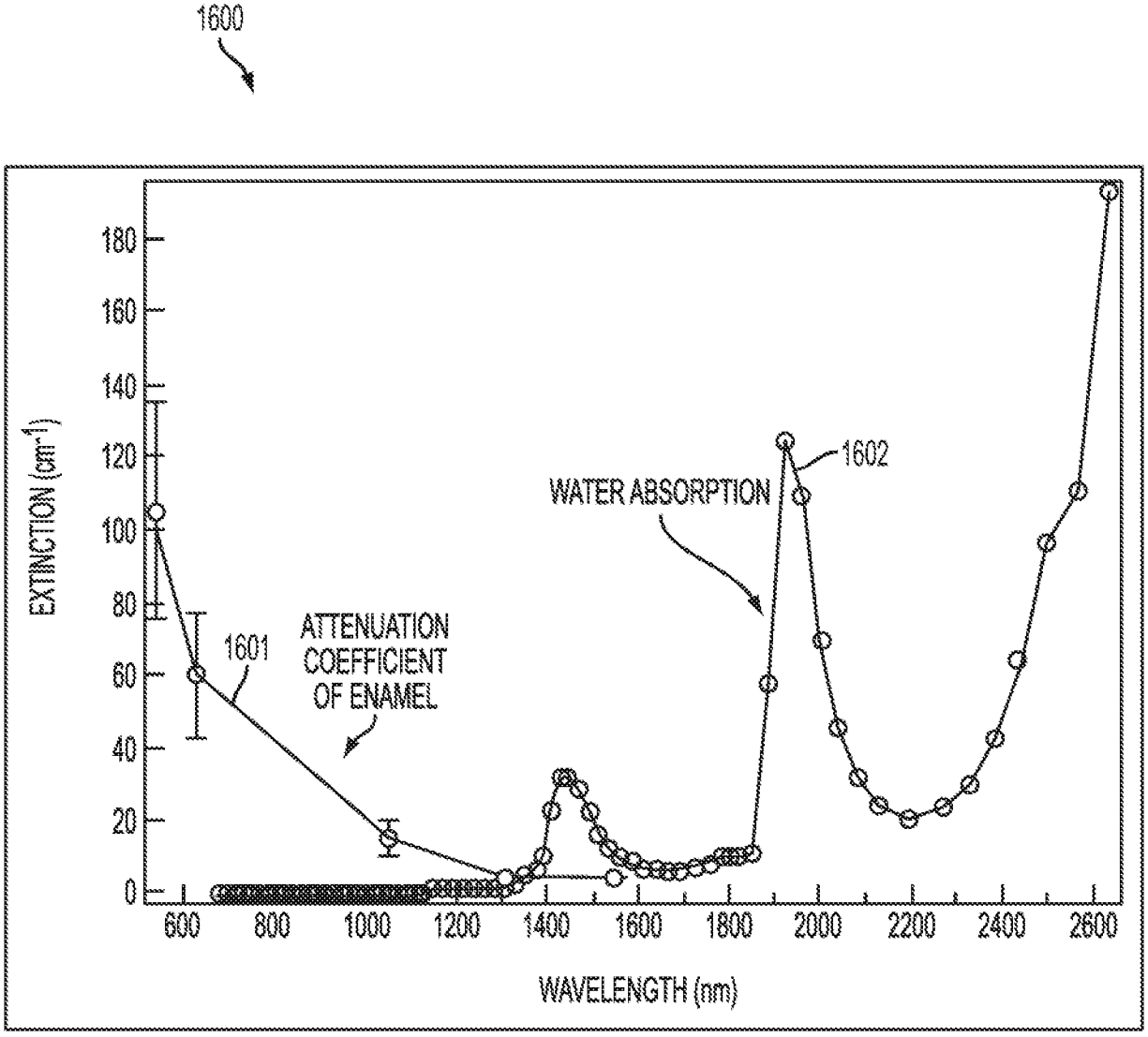
1600
EXTINCTION (cm-1)
180
160
140
120
100
80
60
40
20
0
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
WAVELENGTH (nm)
1601
ATTENUATION COEFFICIENT OF ENAMEL
WATER ABSORPTION
1602

FIG. 16A

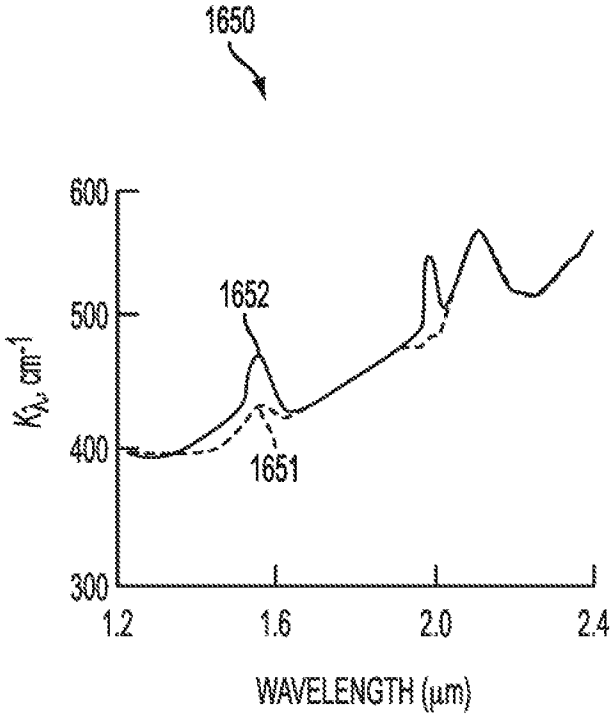
1650
600
500
400
300
1652
1651
K_{λ_N}, cm^{-1}
1.2
1.6
2.0
2.4
WAVELENGTH (μm)

FIG. 16B

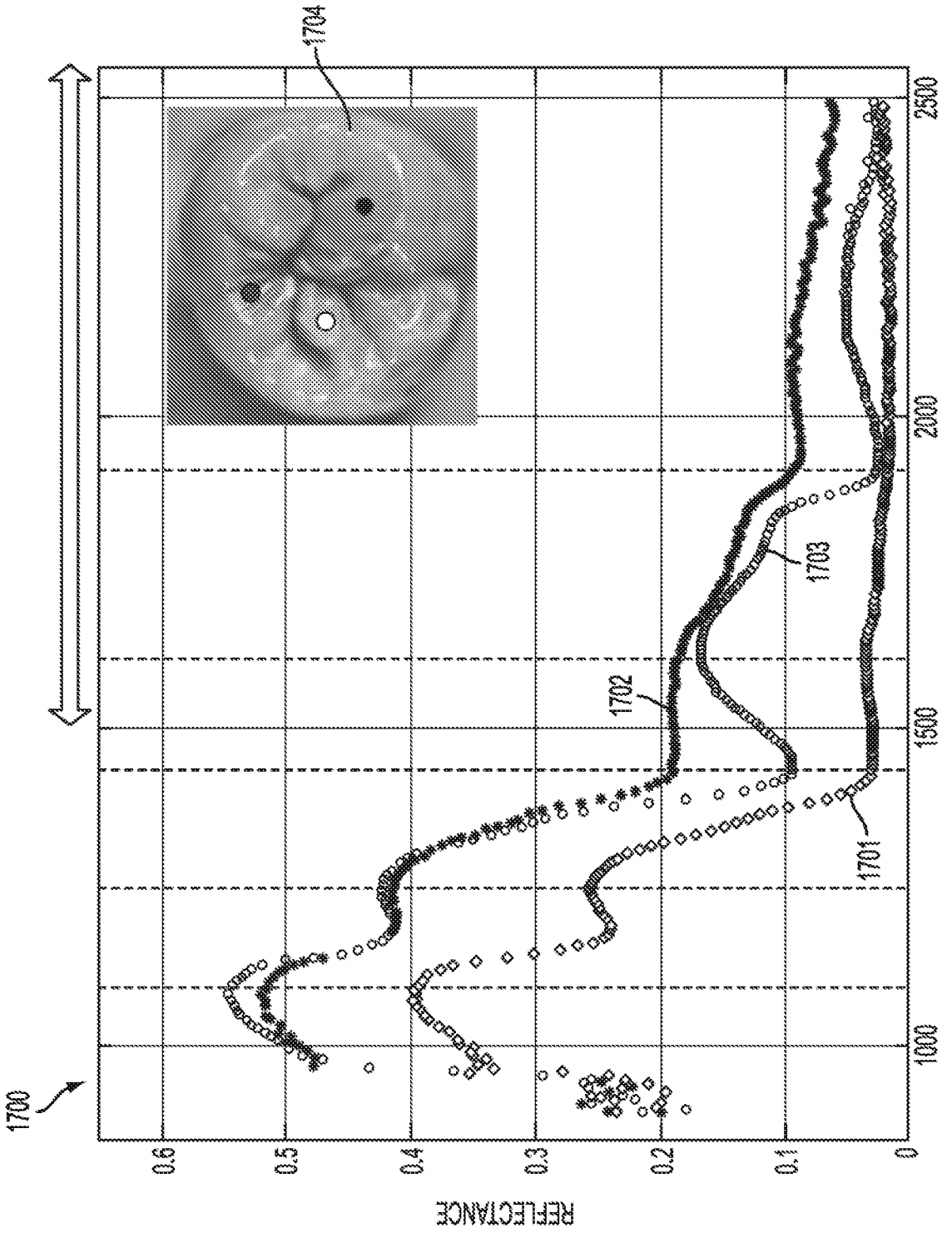
1700
1704
1703
1702
1701
REFLECTANCE
0
0.1
0.2
0.3
0.4
0.5
0.6
1000
1500
2000
2500
WAVELENGTH (nm)

FIG. 17

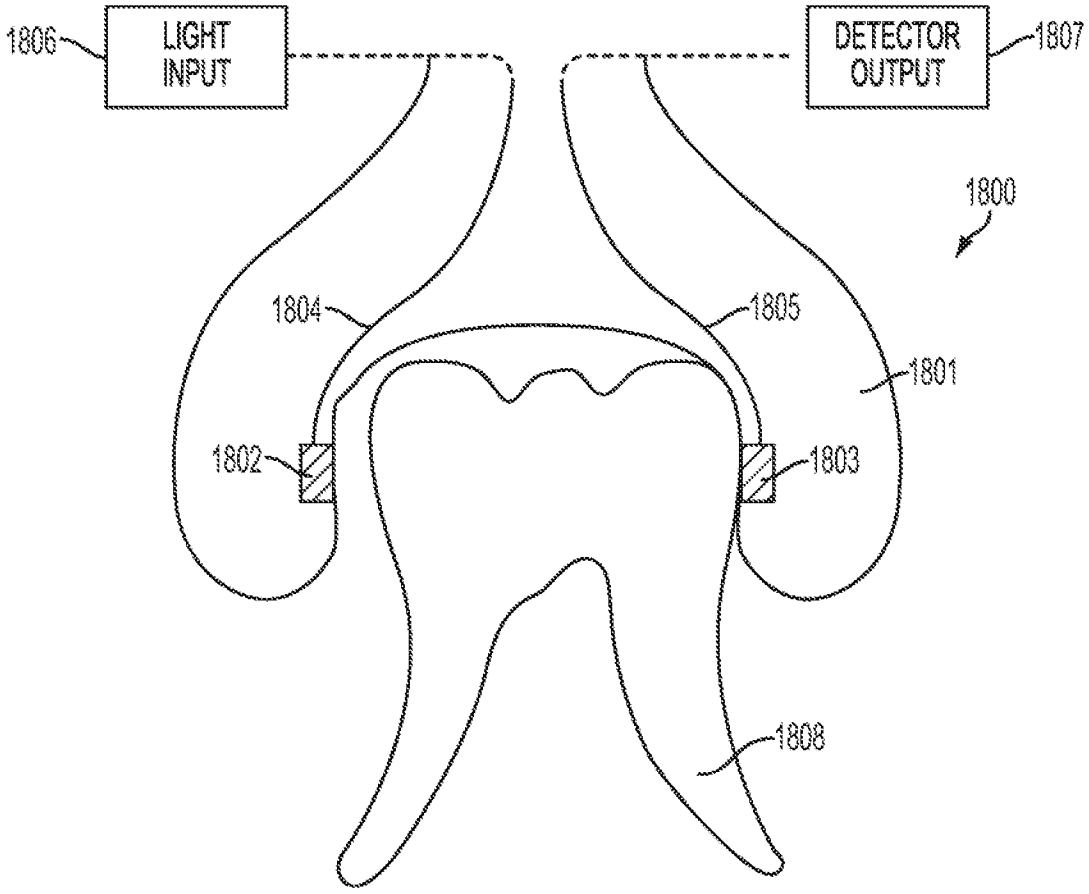
1806
LIGHT INPUT
DETECTOR OUTPUT
1807
1800
1804
1805
1801
1802
1803
1808

FIG. 18A

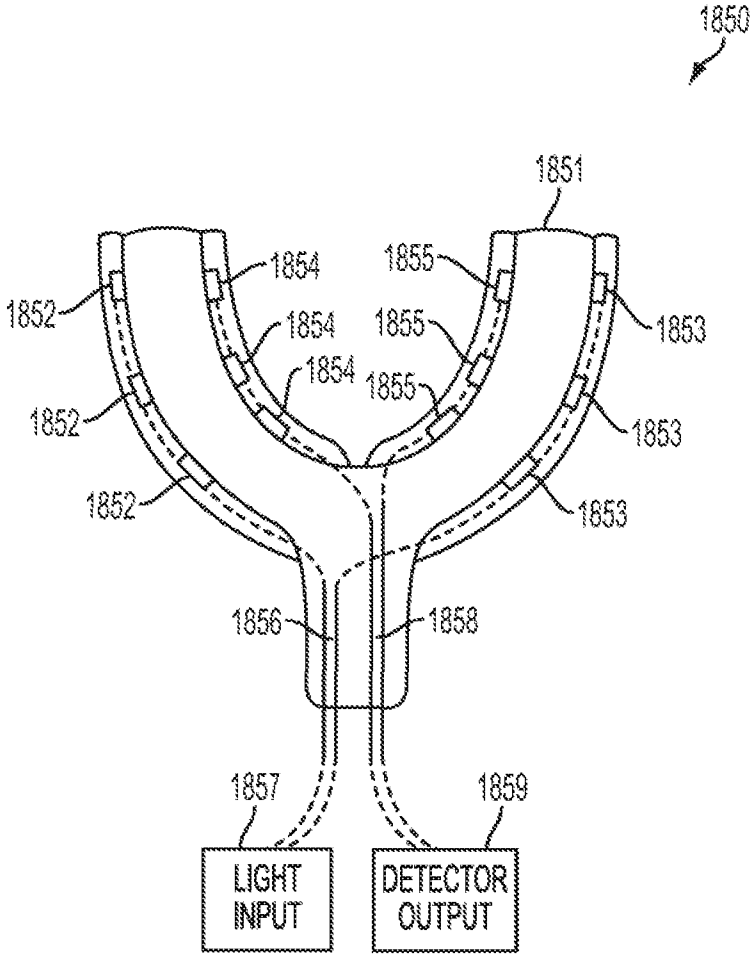
1850
1851
1852
1852
1852
1853
1853
1853
1854
1854
1854
1855
1855
1855
1856
1858
1857
1859
LIGHT INPUT
DETECTOR OUTPUT

FIG. 18B

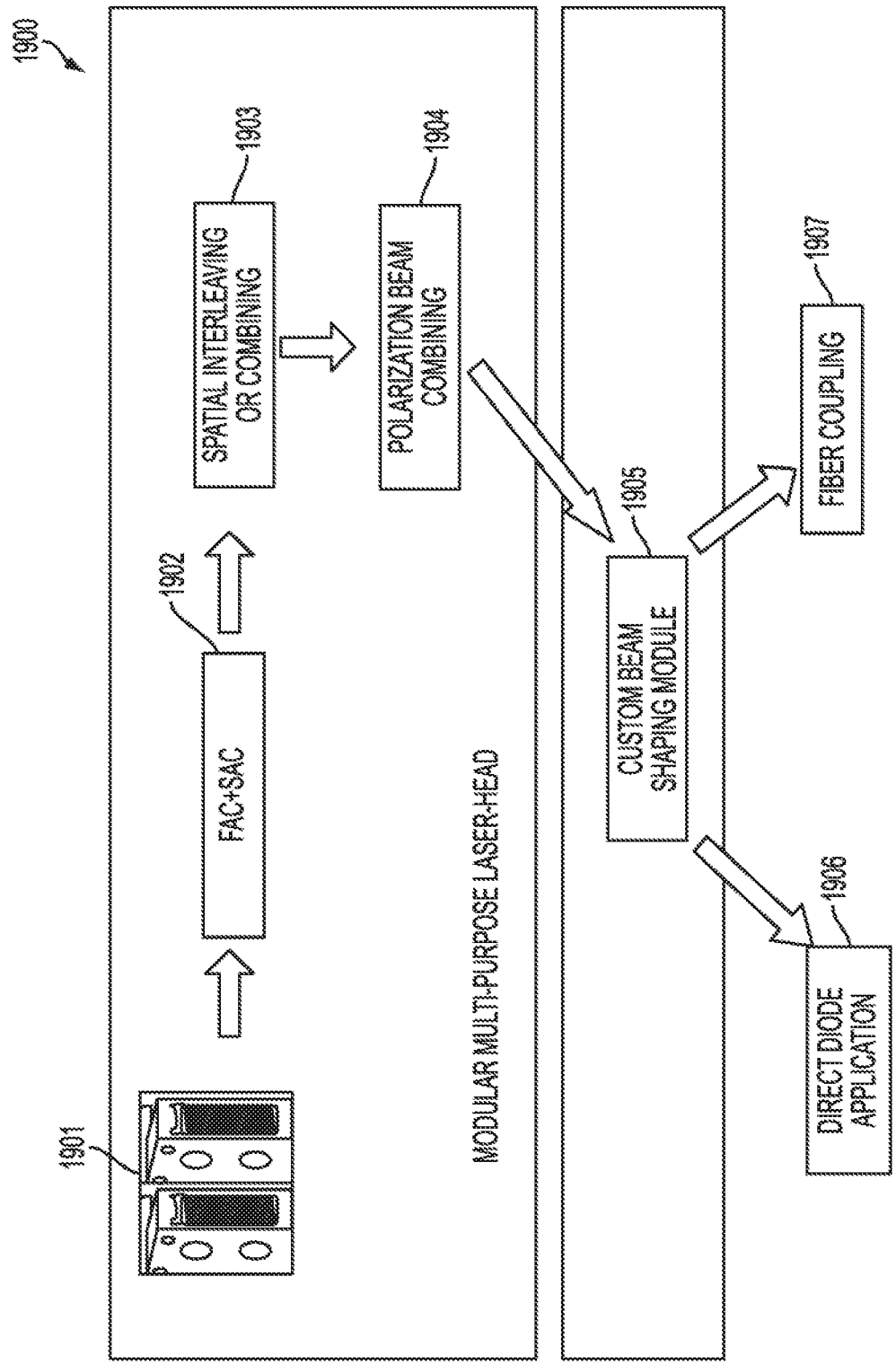
1900
1901
1902
FAC+SAC
1903
SPATIAL INTERLEAVING OR COMBINING
1904
POLARIZATION BEAM COMBINING
MODULAR MULTI-PURPOSE LASER-HEAD
1905
CUSTOM BEAM SHAPING MODULE
1906
DIRECT DIODE APPLICATION
1907
FIBER COUPLING

FIG. 19

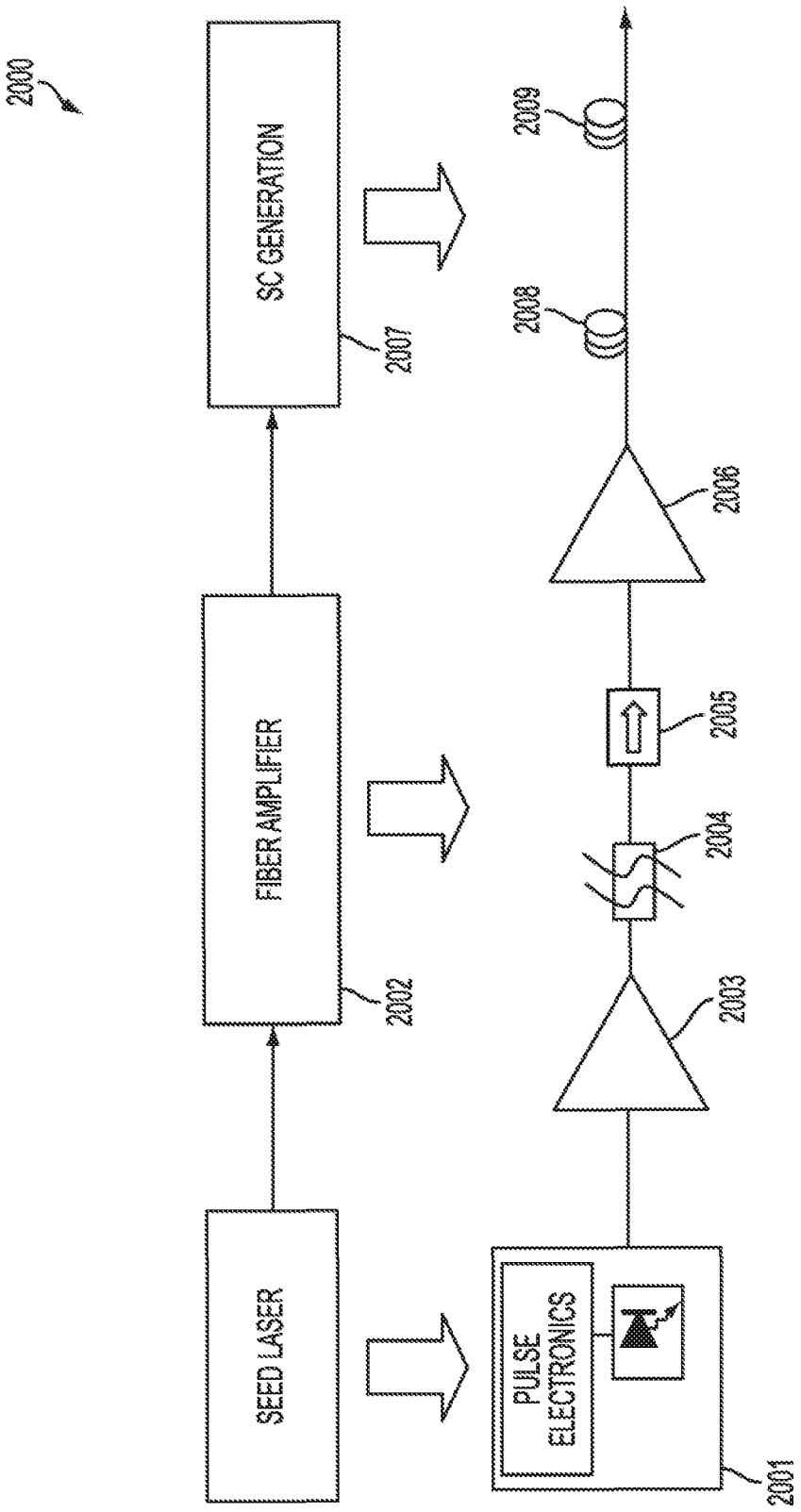
2000
SEED LASER
FIBER AMPLIFIER
SC GENERATION
2001
2002
2007
PULSE ELECTRONICS
2003
2004
2005
2006
2008
2009

FIG. 20

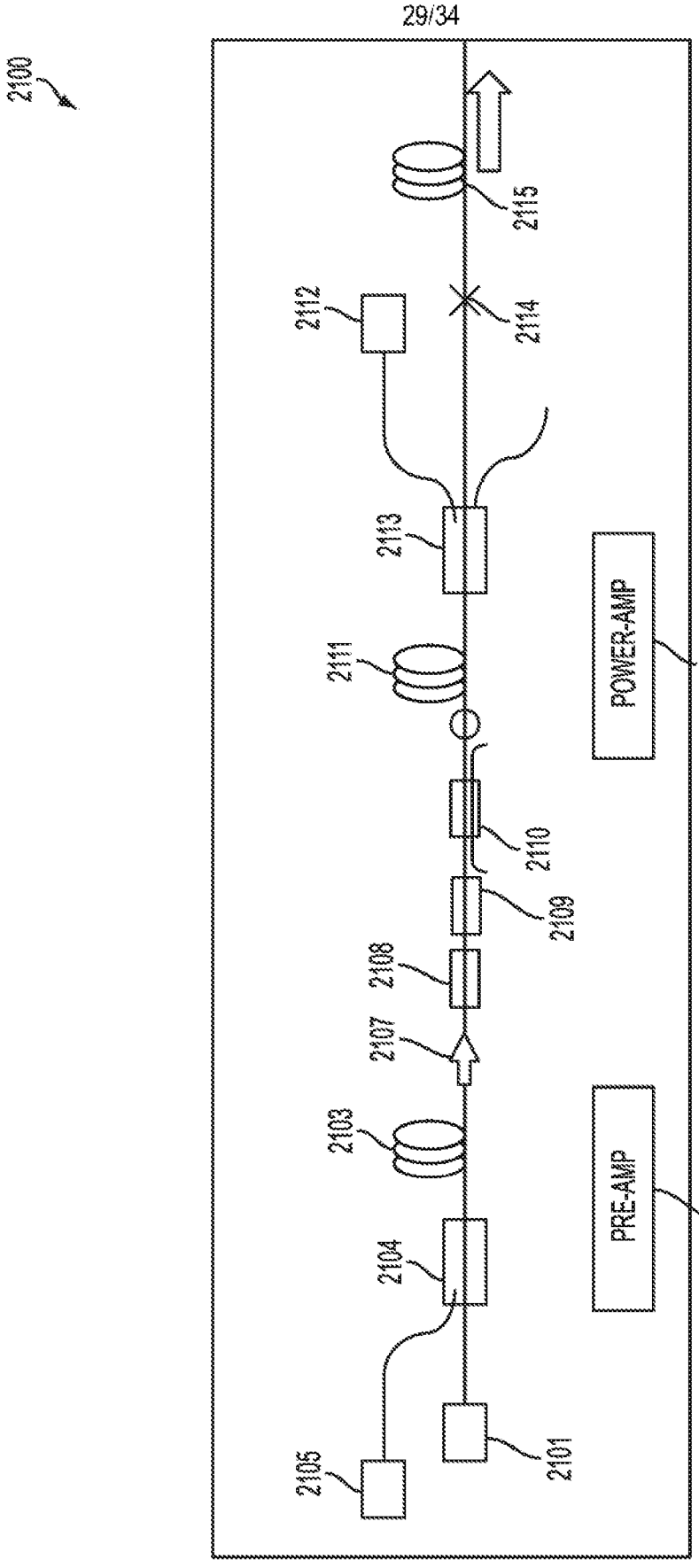
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
PRE-AMP
POWER-AMP

FIG. 21

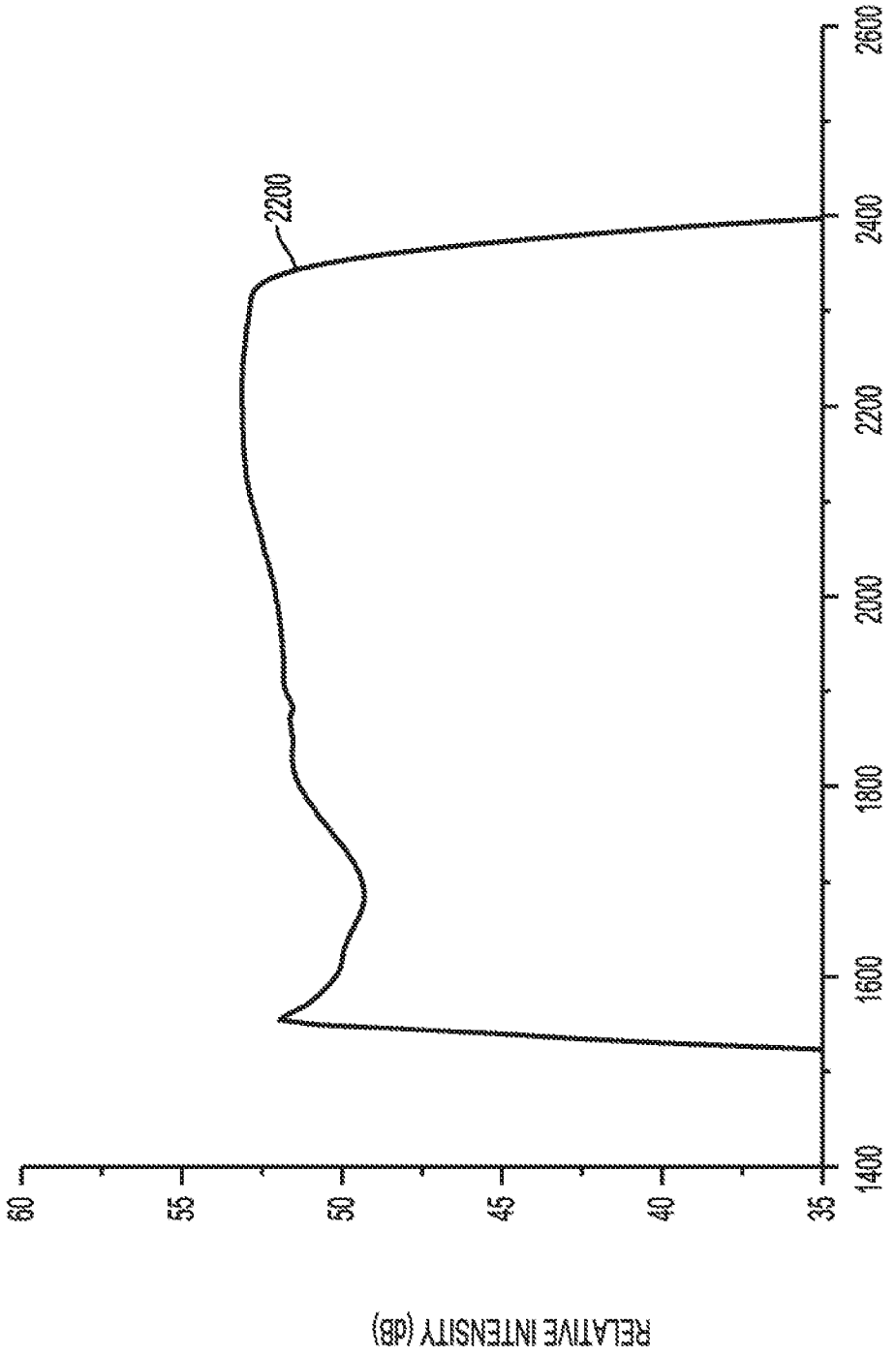
RELATIVE INTENSITY (dB)
60
55
50
45
40
35
1400
1600
1800
2000
2200
2400
2600
WAVELENGTH (nm)
2200

FIG. 22

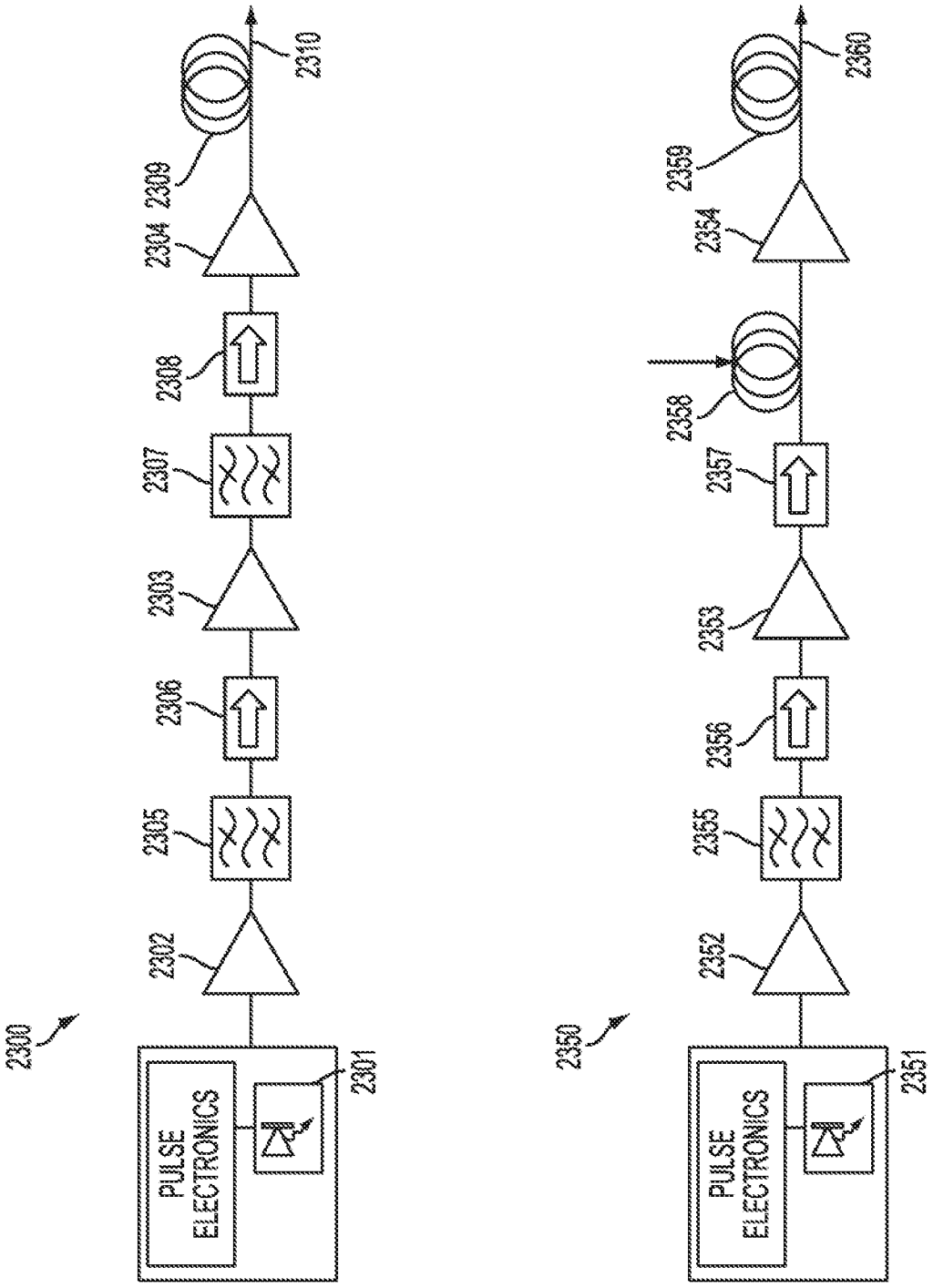
2300
PULSE ELECTRONICS
2301
2302
2305
2306
2303
2307
2308
2304
2309
2310
2350
PULSE ELECTRONICS
2351
2352
2355
2356
2353
2357
2358
2354
2359
2360

FIG. 23

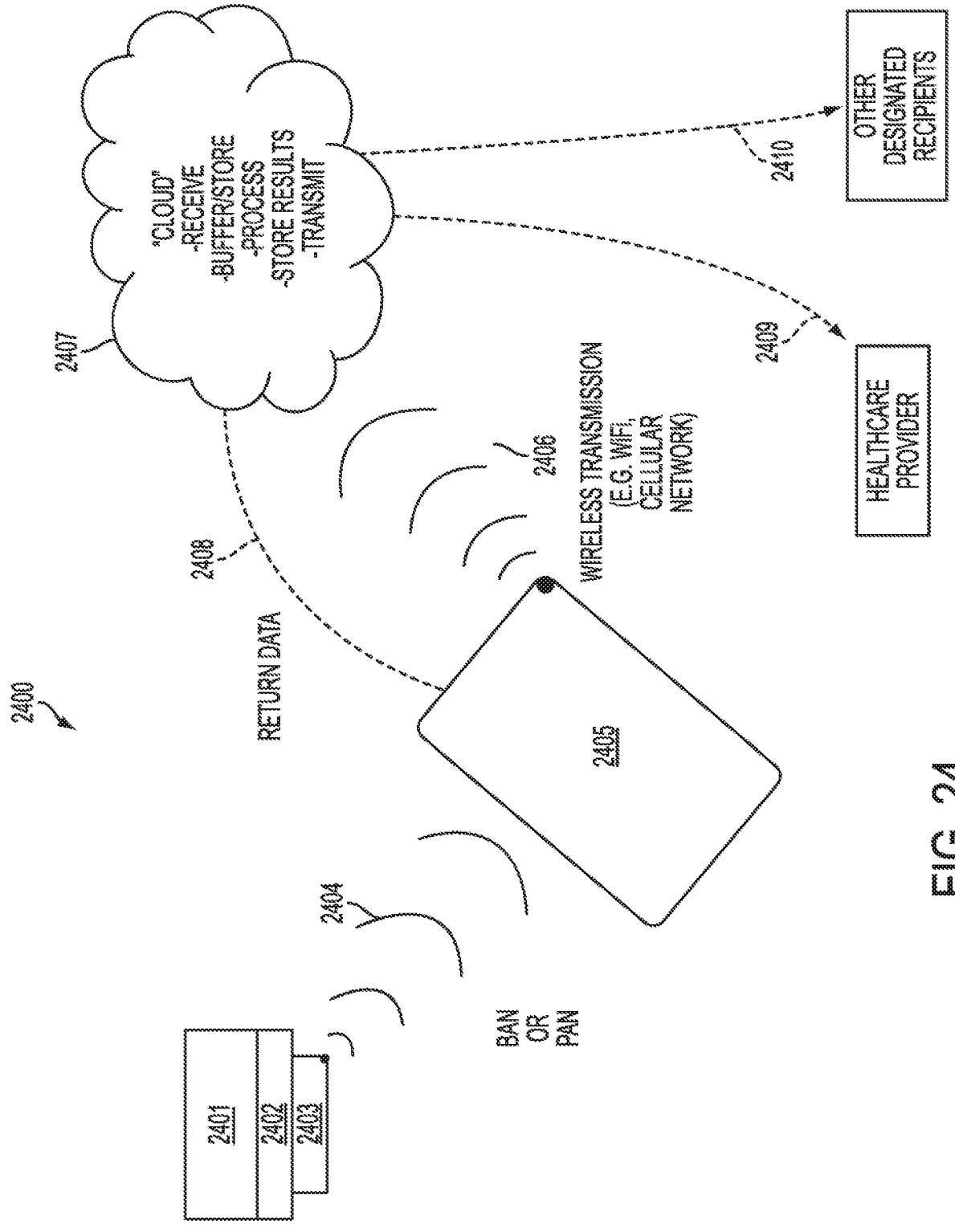
2400
2401
2402
2403
2404
BAN OR PAN
2405
RETURN DATA
2408
2406
WIRELESS TRANSMISSION (E.G. WIFI, CELLULAR NETWORK)
2407
"CLOUD"
-RECEIVE
-BUFFER/STORE
-PROCESS
-STORE RESULTS
-TRANSMIT
2409
HEALTHCARE PROVIDER
2410
OTHER DESIGNATED RECIPIENTS

FIG. 24

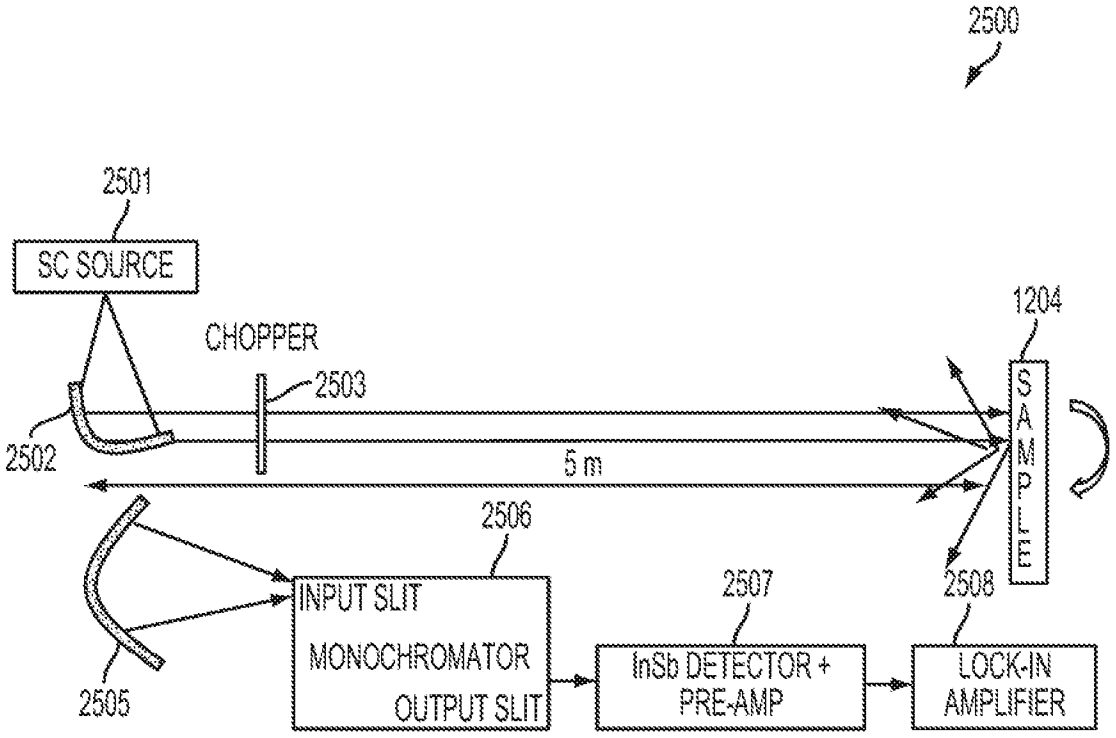
2500
2501
SC SOURCE
CHOPPER
2503
2502
5 m
1204
SAMPLE
2506
INPUT SLIT
MONOCHROMATOR
OUTPUT SLIT
2505
2507
InSb DETECTOR +
PRE-AMP
2508
LOCK-IN
AMPLIFIER

FIG. 25

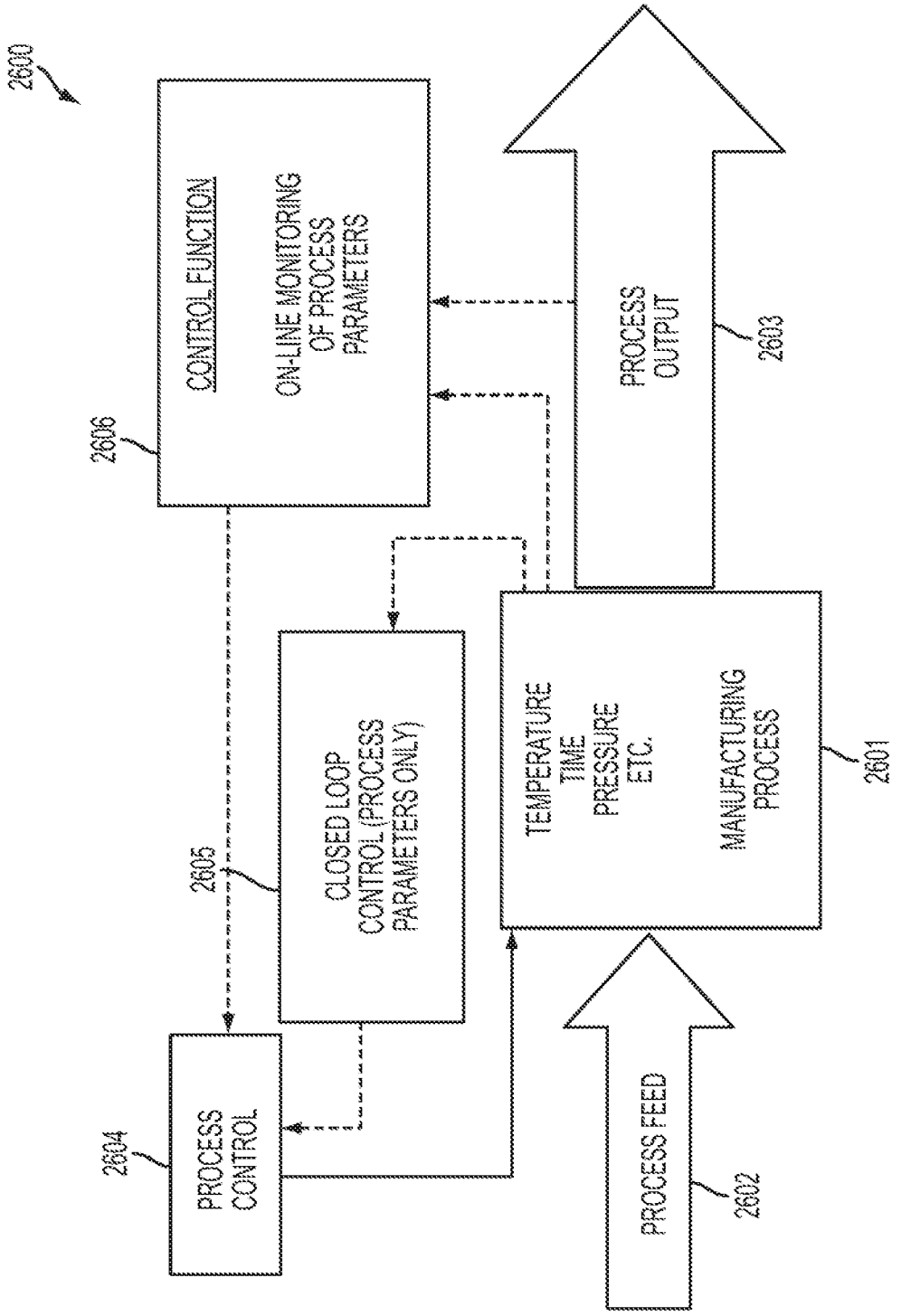
2600
CONTROL FUNCTION
ON-LINE MONITORING OF PROCESS PARAMETERS
2606
PROCESS OUTPUT
2603
CLOSED LOOP CONTROL (PROCESS PARAMETERS ONLY)
2605
TEMPERATURE
TIME
PRESSURE
ETC.
MANUFACTURING PROCESS
2601
PROCESS CONTROL
2604
PROCESS FEED
2602

FIG. 26

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

Mohammed N. ISLAM

Serial No.:

Filed:

Group Art Unit:

Examiner:

For: SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

Attorney Docket No.: OMNI 0101 PUSA5

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. § 1.97(b)(1)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Commissioner:

In compliance with the duty of disclosure under 37 C.F.R. § 1.56 and §§ 1.97-1.98, the references listed and identified on the attached Form PTO/SB/08a are being submitted herewith for consideration by the Examiner. This Statement is being filed in accordance with 37 C.F.R. § 1.97(b)(1).

While this Statement is being filed in compliance with the duty of disclosure, citation of the listed references is not to be construed as an admission that any of the references are "material" as defined under 37 C.F.R. § 1.56(b).

In accordance with 37 C.F.R. § 1.98(d), copies of the listed references are not being provided since the references were previously cited by or submitted to the Patent and Trademark

Office in prior applications Serial No. 16/272,069, filed February 11, 2019 (pending), Serial No. 16/004,359 filed June 9, 2018 (pending), Serial No. 16/188,194 filed November 12, 2018 (pending), Serial No. 16/241,628 filed January 7, 2019 (pending), and Serial No. 16/284,514 filed February 25, 2019 (pending), of which the present application is a continuation.

Please charge any fees or credit any overpayments as a result of the filing of this paper to our Deposit Account No. 02-3978.

Respectfully submitted,

Mohammed N. ISLAM

By: /David S. Bir/
David S. Bir
Reg. No. 38,383
Attorney/Agent for Applicant

Date: July 8, 2019

BROOKS KUSHMAN P.C.
1000 Town Center, 22nd Floor
Southfield, MI 48075-1238
Phone: 248-358-4400
Fax: 248-358-3351

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B or equivalent) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5. If the Power of Attorney by Applicant form is not accompanied by this transmittal form or an equivalent, the Power of Attorney will not be recognized in the application.

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Title	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

SIGNATURE of Applicant or Patent Practitioner

Signature	/David S. Bir/	Date (Optional)	2018-07-08
Name	David S. Bir	Registration Number	38,383
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☒ * Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/82B(07-12)
Approved for use through 11/30/2014. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in the attached transmittal letter.

☒ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A or equivalent):

109543

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A or equivalent):

Name	Registration Number	Name	Registration Number

Please recognize or change the correspondence address for the application identified in the attached transmittal letter to:

☒ The address associated with the above-mentioned Customer Number.

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant:

☐ Inventor or Joint Inventor

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor

☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (*e.g.*, a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document)

SIGNATURE of Applicant for Patent

Signature		Date	October 10, 2012
Name	Mohammed N. Islam	Telephone	734-647-6941
Title and Company	President - OMNI MEDSCI, INC.		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms for more than one signature, see below *.

☒ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI 0101 PUSA5
	Application Number	
Title of Invention	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Mohammed	N.	ISLAM	

Residence Information (Select One) ● US Residency ○ Non US Residency ○ Active US Military Service

City	State/Province	Country of Residence
Ann Arbor	MI	US

Mailing Address of Inventor:

Address 1	1718 Newport Creek
Address 2	

City	State/Province	Postal Code	Country
Ann Arbor	MI	48103	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	109543	
Email Address		Add Email / Remove Email

Application Information:

Title of the Invention	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO		
Attorney Docket Number	OMNI 0101 PUSA5	Small Entity Status Claimed	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	34	Suggested Figure for Publication (if any)	24

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI 0101 PUSA5
	Application Number	
Title of Invention	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	109543		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	16/272069	2019-02-11

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI 0101 PUSA5
	Application Number	
Title of Invention	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO	

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/272069	Continuation of	16/029611	2018-07-08	10201283	2019-02-12

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/029611	Continuation of	15/888052	2018-02-04	10136819	2018-11-27

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/888052	Continuation of	15/212549	2016-07-18	9885698	2018-02-06

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/212549	Continuation of	14/650897	2015-06-10	9494567	2016-11-15

Prior Application Status	Expired	Remove

Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14/650897	a 371 of international	PCT/US2013/075700	2013-12-17

Prior Application Status	Expired	Remove

Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/2013/075700	Claims benefit of provisional	61/747472	2012-12-31

Prior Application Status	Pending	Remove

Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	16/004359	2018-06-09

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/004359	Continuation of	14/109007	2013-12-17	9993159	2018-06-12

Prior Application Status	Expired	Remove

Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14/109007	Claims benefit of provisional	61/747553	2012-12-31

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI 0101 PUSA5
	Application Number	
Title of Invention	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO	

Prior Application Status	Pending	Remove

Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	16/188194	2018-11-12

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/188194	Continuation of	16/004154	2018-06-08	10126283	2018-11-13

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/004154	Continuation of	15/855201	2017-12-27	9995722	2018-06-12

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/855201	Continuation of	15/711907	2017-09-21	9897584	2018-02-20

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/711907	Division of	15/357225	2016-11-21	9797876	2017-10-24

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/357225	Continuation of	14/650981	2015-06-10	9500634	2016-11-22

Prior Application Status	Expired	Remove

Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14/650981	a 371 of international	PCT/US2013/075767	2013-12-17

Prior Application Status	Expired	Remove

Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2013/075767	Claims benefit of provisional	61/747485	2012-12-31

Prior Application Status	Pending	Remove

Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	16/241628	2019-01-07

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/241628	Continuation of	16/015737	2018-06-22	10172523	2019-01-08

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI 0101 PUSA5
	Application Number	
Title of Invention	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO	

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/015737	Continuation of	15/594053	2017-05-12	10188299	2019-01-29

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/594053	Continuation of	14/875709	2015-10-06	9651533	2017-05-16

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14/875709	Continuation of	14/108986	2013-12-17	9164032	2015-10-20

Prior Application Status	Expired	Remove

Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14/108986	Claims benefit of provisional	61/747487	2012-12-31

Prior Application Status	Pending	Remove

Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	16/284514	2019-02-25

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/284514	Continuation of	16/016649	2018-06-24	10213113	2019-02-26

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/016649	Continuation of	15/860065	2018-01-02	10098546	2018-10-16

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/860065	Continuation of	15/686198	2017-08-25	9861286	2018-01-09

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/686198	Continuation of	15/357136	2016-11-21	9757040	2017-09-12

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/357136	Continuation of	14/651367	2015-06-11	9500635	2016-11-22

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI 0101 PUSA5
	Application Number	
Title of Invention	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO	

Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
14/651367	a 371 of international	PCT/US2013/075736	2013-12-17
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2013/075736	Claims benefit of provisional	61/747477	2012-12-31
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2013/075736	Claims benefit of provisional	61/754698	2013-01-21

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☒ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI 0101 PUSA5
	Application Number	
Title of Invention	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI 0101 PUSA5
	Application Number	
Title of Invention	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 — Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Omni Medsci, Inc.		
Mailing Address Information For Applicant:			
Address 1	1718 Newport Creek Drive		
Address 2			
City	Ann Arbor	**State/Province**	MI
Country	US	Postal Code	48103
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI 0101 PUSA5
	Application Number	
Title of Invention	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

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Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

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NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/David S. Bir/			Date (YYYY-MM-DD)	2019-07-09
First Name	David S.	Last Name	Bir	Registration Number	38383

Additional Signature may be generated within this form by selecting the Add button. Add

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI 0101 PUSA5
	Application Number	
Title of Invention	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO
First Named Inventor/Applicant Name:	Mohammed N. ISLAM
Filer:	David S. Bir
Attorney Docket Number:	OMNI 0101 PUSA5

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY FILING FEE (ELECTRONIC FILING)	4011	1	75	75
UTILITY SEARCH FEE	2111	1	330	330
UTILITY EXAMINATION FEE	2311	1	380	380
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	2202	3	50	150
Miscellaneous-Filing:				
LATE FILING FEE FOR OATH OR DECLARATION	2051	1	80	80

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1015**

Electronic Acknowledgement Receipt

EFS ID:	36479783
Application Number:	16506885
International Application Number:	
Confirmation Number:	7781
Title of Invention:	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO
First Named Inventor/Applicant Name:	Mohammed N. ISLAM
Customer Number:	109543
Filer:	David S. Bir
Filer Authorized By:	
Attorney Docket Number:	OMNI 0101 PUSA5
Receipt Date:	09-JUL-2019
Filing Date:	
Time Stamp:	19:37:40
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1015
RAM confirmation Number	071019INTEFSW00006002023978
Deposit Account	023978
Authorized User	David Bir

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37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_IDS_1.PDF	809893 3d1d461db8211c18b8adb57ebf6cf808ef318847	no	17
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Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_IDS_2.PDF	817460 5c72adaae1e29b03d0498202e2cdfed917846e26	no	19
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Information:					
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Information:					
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4	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_IDS_4.PDF	729660 cb826f788a5383784ce030654fa4bab174ea67e3	no	7
Warnings:					
Information:					
5	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_IDS_5.PDF	686443 9b0159d6d923146c2da734f71b64413ea3c25fd4	no	5
Warnings:					
Information:					

6	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_IDS_6.PDF	700743 d98a6314e8723760a3141667fc017a6f425315db	no	5
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7	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_IDS_7.PDF	676367 f1865e47d63235527d14f1b2ed494e503de212ad2	no	4
Warnings:					
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8	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_IDS_8.PDF	676440 da9fb2fa729be8bff05e2f2cce1e7e14004991ad	no	4
Warnings:					
Information:					
9	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_IDS_9.PDF	674692 a204cd27617eb4f2c250807ca5059790ed546775	no	4
Warnings:					
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10	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_IDS_10.PDF	678594 e646a2d547be05f203579dd8ddbdc31599a94b0d	no	4
Warnings:					
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11	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_IDS_11.PDF	674472 a7a01729c2f02654a2bed3257d1fb1b5d435af7e	no	4
Warnings:					
Information:					
A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					

12	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_IDS_12.PDF	1259320 8c63b12b73ee0a72b450b4cb811fe589a54030cc	no	5
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Information:					
13	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_IDS_13.PDF	1455935 ccc360ad285f4a215560e05da1f71ff3e18a20f8	no	12
Warnings:					
Information:					
14	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_IDS_14.PDF	1347746 5c377567d977c39053ff3bb517ca40e66f0e822a	no	4
Warnings:					
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15	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_updated_IDS_15.PDF	1137584 471d0aec9c2f2771206da40268d6f8fd139a5a80	no	5
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17	Information Disclosure Statement (IDS) Form (SB08)	OMNI0101PUSA5_updated_IDS_17.PDF	1122320 c93940ad5576a13487b06256aaf1d3e22182d2a4	no	4
Warnings:					
Information:					
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18	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA5_IDS_1.PDF	747184 b8ef8f897af6f381642797b1aec1c7c14c43014d	no	11
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Warnings:					
Information:					
20	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA5_IDS_3.PDF	745102 066e8b9ecc926aadf8942011f76fd5448f4994e1	no	8
Warnings:					
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21	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA5_IDS_4.PDF	724132 27aca1719417be077ec5fbc76211c72c0f7fa4c0	no	7
Warnings:					
Information:					
A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
22	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA5_IDS_5.PDF	713758 71a6e5ec5cf72ed088ce5202533a60aecb0455c8	no	6
Warnings:					
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23	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA5_IDS_6.PDF	679503 d250cf8d7eea93ef1b15215400ff1dd3009702c7	no	4
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25	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA5_updated_IDS_8.PDF	1259568 e3195bfa645b03109c2407a59309b72b0b29c66c	no	5
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26	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA5_updated_IDS_9.PDF	1370669 51be626b881d1f026c519763ab355fd51fcbebb8	no	12
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27	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA5_updated_IDS_10.PDF	1303287 8896c27a226438f8e70f6eae62127343de9afd9d	no	4
Warnings:					
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28	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA5_updated_IDS_11.PDF	1228993 4b44001304784b78c9556f15e4c989613981eb6e	no	8
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Information:					
31	Information Disclosure Statement (IDS) Form (SB08)	OMNI0104PUSA5_IDS_3.PDF	760544 12492d904c6d447f4a1ba967b643054a84aa962d	no	8
Warnings:					
Information:					
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32	Information Disclosure Statement (IDS) Form (SB08)	OMNI0104PUSA5_IDS_4.PDF	737190 00b20b2ba2fa4b48258afae2e670043bc01c4daa	no	7
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A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
33	Information Disclosure Statement (IDS) Form (SB08)	OMNI0104PUSA5_IDS_5.PDF	725682 db04b935ebca9bf6d418eb18802599c460735a67	no	6
Warnings:					
Information:					
A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
34	Information Disclosure Statement (IDS) Form (SB08)	OMNI0104PUSA5_IDS_6.PDF	720045 e9ccb5103b98386efc770194812c96b3e9d49a6f	no	5
Warnings:					
Information:					

35	Information Disclosure Statement (IDS) Form (SB08)	OMNI0104PUSA5_IDS_7.PDF	742993 acf08c57e06a55adb9e68625dd27c8569ee6ceda	no	11
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Warnings:					
Information:					
37	Information Disclosure Statement (IDS) Form (SB08)	OMNI0104PUSA5_IDS_9.PDF	1176116 d34907ffb0ef5c46a17da7cade3217d990b3b1f2	no	6
Warnings:					
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38	Information Disclosure Statement (IDS) Form (SB08)	OMNI0105PUSP4_IDS_1.PDF	666045 f2345d76a97b4f3e22540cfc967511c514a0eeff	no	4
Warnings:					
Information:					
39	Information Disclosure Statement (IDS) Form (SB08)	OMNI0105PUSP4_IDS_2.PDF	680376 80af0fad02abb6ba9b7c804898e9397330072f79	no	9
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Warnings:					
Information:					
41	Information Disclosure Statement (IDS) Form (SB08)	OMNI0105PUSP4_IDS_4.PDF	670978 e6072da5e8e63d30cdb47e57469343dd69834c93	no	5
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Claims	54	60
Specification	1	53

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16506885
Filing Date	2019-07-09
First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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	1	5747806		1998-05-05	Khalil	
	2	6115673		2000-09-05	Malin	
	3	6512936	B1	2003-01-28	MONFRE	
	4	6534012	B1	2003-04-01	VISWANATHAN	
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	9	6587702	B1	2003-07-01	RUCHTI	
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	14	7233816	B2	2007-06-19	BLANK	
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	20	7697966	B2	2010-04-13	MONFRE	
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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	38383

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16506885
	Filing Date	2019-07-09
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1636
	Examiner Name	
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	1	International Search Report and Written Opinion for International Application No. PCT/US2013/075767 dated October 14, 2014	
	2	International Preliminary Report on Patentability for International Application No. PCT/US2013/07567 dated July 9, 2015	

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	38383

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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Art Unit	1636
Examiner Name	
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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7771320	B2	2010-08-10	Riley, et al.	
	2	6619835	B2	2003-09-16	Kita	
	3	9326712	B1	2016-05-03	Kiani	
	4	5267152	A	1993-11-30	Yang et al.	
	5	7356364	B1	2008-04-08	Bullock et al.	
	6	5246004		1993-09-21	Clarke, et al.	
	7	8472108		2013-06-25	Islam	

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	1	20100217102	A1	2010-08-26	LeBoeuf, et al.	
	2	20120310062	A1	2012-12-06	Li, et al.	
	3	20120316455	A1	2012-12-13	Rahman, et al.	
	4	20140275854	A1	2014-09-18	Venkatraman, et al.	
	5	20140275852	A1	2014-09-18	Hong, et al.	
	6	20160045118	A1	2016-02-18	Kiani	
	7	20110208015	A1	2011-08-25	Welch, et al.	
	8	20110040197	A1	2011-02-17	Welch et al.	
	9	20070021670	A1	2007-01-25	Mandelis et al.	
	10	20110282167	A1	2011-11-17	Ridder et al.	

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	11	20130274569	2013-10-17	Islam	

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	1	U.S. Provisional Application No. 61/350,673; titled: OPTICOUSTIC SENSOR; Inventor: Massi Joe E. Kiani; filed on June 2, 2010.	
	2	International Search Report and Written Opinion for International Application No. PCT/US2013/075700 dated April 24, 2014	
	3	International Preliminary Report on Patentability for International Application No. PCT/US2013/075700 dated July 9, 2015	
	4	Ooi ET, Zhang XQ, Chen JH, Soh PH, Ng K, Yeo JH, "Non-invasive glucose measurement using multiple laser diodes," Optical Diagnostic and Sensing VII, edited by Gerard L. Cote, Alexander V. Priezzhev, Proc. of SPIE Vol. 6445, 64450K , (2007).	
	5	Schulz, I., J. Putzger, A. Niklas, M. Brandt, A. Jager, A. Hardt, S. Knorzer, K.A. Hiller, S. Loffler, G. Schmalz, S.N. Danilov, S. Giglberger, M. Hirmer, S.D. Ganichev, G. Monkman, "PPG signal acquisition and analysis on in vitro tooth model for dental pulp vitality assessment," ARC Submission 16, (2012).	

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	6	Drexler, C., Hirmer, M., Danilov, S., Giglberger, S., Putzger, J., Niklas, A., Jager, A., Hiller, K., Loffler, S., Schmalz, G., Redlich, B., Schulz, I., Monkman, G., Ganichev, S. "Infrared spectroscopy for clinical diagnosis of dental pulp vitality." Infrared, Millimeter, and Terahertz Waves (IRMMW-THz), 2012 37th International Conference on. IEEE (2012).
	7	Hirmer, Marion, Danilov, Sergey, Giglberger, Stephan, Putzger, Jurgen, Niklas, Andreas, Jager, Andreas, Hiller, Karl-Anton, Loffler, Susanne, Schmalz, Gottfried, Redlich, Britta, Schulz, Irene, Monkman, Gareth, Ganichev, Sergey. "Spectroscopic Study of Human Teeth and Blood from Visible to Terahertz Frequencies for Clinical Diagnosis of Dental Pulp Vitality." Journal of Infrared, Millimeter, and Terahertz Waves 33.3 (2012): 366-375.
	8	Na, J, J.H. Baek, S.Y. Ryu, C. Lee, B.H. Lee, "Tomographic imaging of incipient dental-caries using optical coherence tomography and comparison with various modalities," Optical Review, vol. 16, no. 4, pp. 426-431 (2009).

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	1	20050133691	A1	2005-06-23	Doppke et al.	
	2	20090244288	A1	2009-10-01	FUJIMOTO et al.	
	3	20110267688	A1	2011-11-03	Kleppe et al.	
	4	20130327966	A1	2013-12-12	Fidler et al.	
	5	20140078510	A1	2014-03-20	Rubio Guivernau et al.	

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	6	20140249427	A1	2014-09-04	Liu

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	1	102010012987	DE	A1	2010-10-07	FRAUNHOFER GES FORSCHUNG		
	2	2005013843	WO	A2	2005-02-17	The Regents of the University of California		
	3	2007061772	WO	A2	2007-05-31	OMNI SCIENCES, INC.		
	4	2009130464	WO	A1	2009-10-29	UNIVERSITY OF MANCHESTER		

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	1	VINAY V. ALEXANDER ET AL.; Modulation Instability High Power All-Fiber Supercontinuum Lasers And Their Applications; Optical Fiber Technology 18; 2012; pages 349-374.	
	2	ROBERT S. JONES ET AL.; Near-Infrared Transillumination At 1310-nm For The Imaging Of Early Dental Decay; Volume 11, No. 18; Optics Express 2259; September 8, 2003	

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	3	Extended European Search Report for European Application No. 13867874.3 dated July 15, 2016
	4	Extended European Search Report for European Application No. 13867892.5 dated July 22, 2016

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16506885
Filing Date	2019-07-09
First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	8158175	B2	2012-04-17	Bourg, Jr.	

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	1	20180231373	A1	2018-08-16	Pesach et al.	
	2	20080240502	A1	2008-10-02	Freedman et al.	
	3	20090185274	A1	2009-07-23	Shpunt	
	4	20100284082	A1	2010-11-11	Shpunt et al.	
	5	20110188054	A1	2011-08-04	Petronius et al.	

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	6	20100118123	A1	2010-05-13	Freedman et al.	
	7	20100007717	A1	2010-01-14	Spektor et al.	

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	1	2008120217	WO	A2	2008-10-09	Freedman et al.		

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Segtnan, Vegard H., et al. "Screening of acrylamide contents in potato crisps using process variable settings and near-infrared spectroscopy." Molecular nutrition & food research 50.9 (2006): 811-817.	
	2	Shiroma, Cecilia, and Luis Rodriguez-Saona. "Application of NIR and MIR spectroscopy in quality control of potato chips." Journal of Food Composition and Analysis 22.6 (2009): 596-605.	
	3	Pedreschi, F., V. H. Segtnan, and S. H. Knutsen. "On-line monitoring of fat, dry matter and acrylamide contents in potato chips using near infrared interactance and visual reflectance imaging." Food Chemistry 121.2 (2010): 616-620.	
	4	Kays, Sandra E., William R. Windham, and Franklin E. Barton. "Prediction of total dietary fiber in cereal products using near-infrared reflectance spectroscopy." Journal of Agricultural and food chemistry 44.8 (1996): 2266-2271.	

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	5	Williams, Phil. "Near-Infrared Spectroscopy of Cereals." Handbook of vibrational spectroscopy (2006).
	6	Ng, Choo Lum, Randy L. Wehling, and Susan L. Cuppett. "Method for determining frying oil degradation by near-infrared spectroscopy." Journal of agricultural and food chemistry 55.3 (2007): 593-597.
	7	"Analysis of Edible Oils Using FT–NIR Spectroscopy." Bruker Optics, www.azom.com/article.aspx?ArticleID=5981, Mar 10, 2012.
	8	Shiroma, Cecilia. "Rapid quality control of potato chips using near and mid-infrared spectroscopy." (2007).
	9	Shiroma, Cecilia, and Luis Rodriguez-Saona. "Application of NIR and MIR spectroscopy in quality control of potato chips." Journal of Food Composition and Analysis 22.6 (2009): 596-605.
	10	Ni, Yongnian, Minghua Mei, and Serge Kokot. "Analysis of complex, processed substances with the use of NIR spectroscopy and chemometrics: Classification and prediction of properties—The potato crisps example." Chemometrics and Intelligent Laboratory Systems 105.2 (2011): 147-156.
	11	Hartmann, R., and H. Büning-Pfaue. "NIR determination of potato constituents." Potato research 41.4 (1998): 327-334.
	12	Thybo, Anette Kistrup, et al. "Prediction of sensory texture of cooked potatoes using uniaxial compression, near infrared spectroscopy and low field1H NMR spectroscopy." LWT-Food Science and Technology 33.2 (2000): 103-111.
	13	Büning-Pfaue, Hans. "Analysis of water in food by near infrared spectroscopy." Food Chemistry 82.1 (2003): 107-115.
	14	Haase, Norbert U. "Prediction of potato processing quality by near infrared reflectance spectroscopy of ground raw tubers." Journal of Near Infrared Spectroscopy 19.1 (2011): 37-45.
	15	September, Danwille Jacqwin Franco. Detection and quantification of spice adulteration by near infrared hyperspectral imaging. Diss. Stellenbosch: University of Stellenbosch, 2011.

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	16	Galvis-Sánchez, Andrea C., et al. "Fourier transform near-infrared spectroscopy application for sea salt quality evaluation." Journal of agricultural and food chemistry 59.20 (2011): 11109-11116.
	17	Rein, Alan, and Luis Rodriguez-Saona. "Measurement of Acrylamide in Potato Chips by Portable FTIR Analyzers." (2013)
	18	Ayvaz, Huseyin, et al. "Application of infrared microspectroscopy and chemometric analysis for screening the acrylamide content in potato chips." Analytical Methods 5.8 (2013): 2020-2027.

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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CERTIFICATION STATEMENT

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	38383

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5746206	A	1998-05-05	Mannheimer	
	2	6505133	B1	2003-01-07	Hanna et al.	
	3	8172761	B1	2012-05-08	Rulkov et al.	
	4	9241676	B2	2016-01-26	Lisogurski et al.	
	5	9596990	B2	2017-03-21	Park et al.	

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	1	20050049468	A1	2005-03-03	Carlson et al.	

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	2	20100217099	A1	2010-08-26	LeBoeuf et al.		
	3	20120197093	A1	2012-08-02	LeBoeuf et al.		

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	1	Inter Partes Review No. IPR2019-00910; Petition for Inter Partes Review of U.S. Patent No. 9,757,040; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-96; dated April 10, 2019	
	2	Inter Partes Review No. IPR2019-00911; Petition for Inter Partes Review of U.S. Patent No. 9,861,286; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-83; dated April 10, 2019	
	3	Inter Partes Review No. IPR2019-00912; Petition for Inter Partes Review of U.S. Patent No. 9,885,698; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-94; dated April 10, 2019	
	4	Inter Partes Review No. IPR2019-00913; Petition for Inter Partes Review of U.S. Patent No. 9,651,533; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-96; dated April 10, 2019	

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	5	Inter Partes Review No. IPR2019-00914; Petition for Inter Partes Review of U.S. Patent No. 9,861,286; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-90; dated April 10, 2019	
	6	Inter Partes Review No. IPR2019-00915; Petition for Inter Partes Review of U.S. Patent No. 9,885,698; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-91; dated April 10, 2019	
	7	Inter Partes Review No. IPR2019-00916; Petition for Inter Partes Review of U.S. Patent No. 9,651,533; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-90; dated April 10, 2019	
	8	Inter Partes Review No. IPR2019-00917; Petition for Inter Partes Review of U.S. Patent No. 9,757,040; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-93; dated April 10, 2019	

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Name/Print	David S. Bir	Registration Number	38383

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	1	4972331		1990-11-20	Chance	
	2	5774213	A	1998-06-30	Trebino et al.	
	3	5855550	A	1999-01-05	Lai et al.	
	4	6044283	A	2000-03-28	Fein et al.	
	5	6898451	B2	2005-05-24	Wuori	
	6	7278966	B2	2007-10-09	Hjelt et al.	
	7	9651533	B2	2017-05-16	Islam	
	8	9757040	B2	2017-09-12	Islam	

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	9	9861286	B1	2018-01-09	Islam	
	10	9885698	B2	2018-02-06	Islam	

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	1	20120041767	A1	2012-02-16	Hoffman et al.	

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	1	Declaration of Brian W. Anthony, PhD regarding USPN 9,651,533 filed in IPR2019-00913 & IPR2019-00916 (April 10, 2019)	
	2	Declaration of Brian W. Anthony, PhD regarding USPN 9,757,040 filed in IPR2019-00910 & IPR2019-00917 (April 10, 2019)	

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	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1636
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	3	Declaration of Brian W. Anthony, PhD regarding USPN 9,861,286 filed in IPR2019-00911 & IPR2019-00914 (April 10, 2019)
	4	Declaration of Brian W. Anthony, PhD regarding USPN 9,885,698 filed in IPR2019-00912 & IPR2019-00915 (April 10, 2019)
	5	Proof of Service of Summons in Omni MedSci, Inc. v. Apple Inc., No. 2:18-cv-134 (E.D. Tex.) (Dkt. #12) (April 13, 2018)
	6	U.S. Provisional Application No. 61/747,487 filed December 31, 2012
	7	U.S. Provisional Application No. 61/747,472 filed December 31, 2012
	8	U.S. Provisional Application No. 61/747,477 filed December 31, 2012
	9	U.S. Provisional Application No. 61/754,698 filed January 21, 2013
	10	JOSEPH D. BRONZINO; "The Biomedical Engineering Handbook", (1995)
	11	M. KRANTZ, ET AL., The mobile fitness coach: Towards individualized skill assessment using personalized mobile devices, Pervasive and Mobile Computing (June 2012)
	12	S. PATEL, ET AL., A review of wearable sensors and systems with application rehabilitation, Journal of Neuroengineering & Rehabilitation 2012 9:21
	13	ScienceDirect Report on M. KRANTZ, ET AL., The mobile fitness coach: Towards individualized skill assessment using personalized mobile devices, Pervasive and Mobile Computing (2012), available at https://www.sciencedirect.com/science/article/pii/S1574119212000673?via%3Dihub (2018 Elsevier B.V.)

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	14	RAUF ADIL, "The Usage of Tablets in the HealthCare Industry," available at https://www.healthcareitnews.com/blog/usage-tablets-healthcare-industry (Aug. 2, 2012)
	15	A. OMRE, Bluetooth Low Energy: Wireless Connectivity for Medical Monitoring, Journal of Diabetes Science & Technology , Vol. 4, Issue 2 (March 2010)
	16	"Absorption Coefficient and Penetration Depth," The Science of Solar, available at https://photon.libretexts.org/The_Science_of_Solar/Solar_Basics/C._Semiconductors_and_Solar_Interactions/III._Absorption_of_Light_and_Generation/1._Absorption_Coefficient_and_Penetration_Depth (Last Updated Nov. 3, 2018)
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	26	Omni MedSci Inc.'s Opening Claim Construction Brief filed in Case No. 2:18-cv-134-RWS (Dkt. #85) (Dec. 20, 2018)
	27	Apple Inc.'s Preliminary Claim Constructions and Extrinsic Evidence Pursuant to Patent Local Rule 4-2 served in Case No. 2:18-cv-134-RWS (Nov. 1, 2018)
	28	Excerpts from the American Heritage Dictionary, 5th Edition (July 2012)
	29	Curriculum Vitae of Brian W. Anthony, PhD (Nov. 18, 2018)
	30	Amended Joint Claim Construction and Prehearing Statement filed in Case No. 2:18-cv-134-RWS (Dkt. #102) (Jan. 11, 2019)
	31	Excerpt from Claim Construction Markman Hearing Transcript filed in Case No. 2:18-cv-134-RWS (Feb. 6, 2019) Vol. 1, pgs. 1, 2, 21, 22
	32	Dr. MOHAMMED ISLAM, Faculty Profile, University of Michigan, College of Engineering (available at https://islam.engin.umich.edu) (2019 The Regents of the University of Michigan)
	33	Technology Transfer Policy, Office of Technology Transfer - University of Michigan (available at https://techtransfer.umich.edu/for-inventors/policies/technology-transfer-policy/) (revision effective June 1, 2009)
	34	The Bylaws of the University of Michigan Board of Regents, (available at http://www.regents.umich.edu/bylaws/bylawsrevised_09-18.pdf) (last updated Sept. 20, 2018)
	35	District Court Preliminary Claim Constructions in Case No. 2:18-cv-134-RWS (received February 6, 2019) from Court at Markman hearing

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	36	File History for U.S. Patent No. 9,651,533 issued May 16, 2017
	37	File History for U.S. Patent No. 9,757,040 issued September 12, 2017
	38	File History for U.S. Patent No. 9,861,286 issued January 9, 2018
	39	File History for U.S. Patent No. 9,885,698 issued February 6, 2018

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Name/Print	David S. Bir	Registration Number	38383

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	1	NELLCOR; Charts 1-3: NELLCOR-533; U.S. Patent No. 9,651,533 vs. Nellcor; Omni MedSci, Inc. v. Apple Inc., pps. 1-155; May 22, 2019
	2	LISOGURSKI; Charts 1-3: LISOGURSKI-533; U.S. Patent No. 9,651,533 vs. Lisogurski; Omni MedSci, Inc. v. Apple Inc., pps. 1-84; May 22, 2019
	3	ASADA; Charts 1-3: ASADA-533; U.S. Patent No. 9,651,533 vs. Asada; Omni MedSci, Inc. v. Apple Inc., pps. 1-188; May 22, 2019
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	5	VALENCELL; Charts 1-3: Valencell-533; U.S. Patent No. 9,651,533 vs. Valencell; Omni MedSci, Inc. v. Apple Inc., pps. 1-122; May 22, 2019

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	1	Pan, Yingtian, et al., "Hand-held arthroscopic optical coherence tomography for in vivo high-resolution imaging of articular cartilage", Journal of Biomedical Optics 8(4), October 2003, pages 648-654.
	2	Xie, Tuqiang, et al., "Endoscopic optical coherence tomography with a modified microelectromechanical systems mirror for detection of bladder cancers", APPLIED OPTICS, Vol. 42, No. 31, November1, 2003, pages 6422-6426.
	3	Dubois, A., et al., "Three-dimensional cellular-level imaging using full-field optical coherence tomography", Physics in Medicine and Biology, Phys. Med. Biol. 49, 2004, pages 1227-1234.
	4	Park, Jesung, et al., "Analysis of birefringent image in the retinal nerve fiber layer by polarization sensitive optical coherence tomography", Ophthalmic Technologies XIV, Proceedings of SPIE, Vol. 5314, 2004, pages 188-194.
	5	Unterhuber, A., et al., "Advances in broad bandwidth light sources for ultrahigh resolution optical coherence tomography", Physics in Medicine and Biology, Phys. Med. Biol. 49, 2004, pages 1235-1246.
	6	Drexler, Wolfgang, "Ultrahigh-resolution optical coherence tomography", Journal of Biomedical Optics, Vol. 9, No. 1, January/February 2004, pages 47-74.
	7	Schmitt, Joseph, et al., "Intravascular Optical Coherence Tomography Opens a Window Onto Coronary Artery Disease", Optics & Photonics News, February 2004, pages 20-25.
	8	Nassif, N.A., et al., "In vivo high-resolution video-rate spectral-domain optical coherence tomography of the human retina and optic nerve", OPTICS EXPRESS, Vol. 12, No. 3, February 9, 2004, pages 367-376.
	9	Choi, Seung-Ho, et al., "Observation of Optical Precursors in Water", Physical Review Letters, Volume 92, Number 19, May 14, 2004, pages 193903-1-193903-.3.
	10	Pierce, Mark C., et al., "Advances in Optical Coherence Tomography imaging for Dermatology", Optical Coherence Tomography Advances, The Journal of Investigative Dermatology, September 3, 2004, pages 458-463.
	11	"State-Specific Trends in Chronic Kidney Failure - United States, 1990-2001", Morbidity and Mortality Weekly Report, Department of Health and Human Services Centers for Disease Control and Prevention, Vol. 53, No. 39, copied from internet: file://C:\Documents and Settings\eturlo\Desktop\State-Specific Trends in Chronic Kidney ... 2/12/10, October 8, 2004, pages 918-920.

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Name/Print	David S. Bir	Registration Number	38383

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	2	6281471	B1	2001-08-28	SMART	
	3	6340806		2002-01-22	SMART ET AL.	
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	20	6289238		2001-09-11	Besson, et al.	
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	4	20020082612		2002-06-27	Moll, Frederic H. ; et al.	
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	6	20020115914		2002-08-22	Russ, Tomas	
	7	20020178003		2002-11-28	Gehrke, James K. ; et al.	
	8	20040174914		2004-09-09	Fukatsu, Susumu	
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	13	20070078348		2007-04-05	Holman; Hoi-Ying N.	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16506885
	Filing Date	2019-07-09
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1636
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1636
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

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See attached certification statement.

Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	38383

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	4063106		1977-12-13	Ashkin, et al.	
	2	4158750		1979-06-19	Sakoe, et al.	
	3	4221997		1980-09-09	Flemming	
	4	4275266		1981-06-23	Lasar	
	5	4374618		1983-02-22	Howard	
	6	4403605		1983-09-13	Tanikawa	
	7	4462080		1984-07-24	Johnstone, et al.	
	8	4516207		1985-05-07	Moriyama, et al.	

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	9	4523884		1985-06-18	Clement, et al.	
	10	4605080		1986-08-12	Lemelson	
	11	4641292		1987-02-03	Tunnell, et al.	
	12	4704696		1987-11-03	Reimer, et al.	
	13	4728974		1988-03-01	Nio, et al.	
	14	4762455		1988-08-09	Coughlan, et al.	
	15	4776016		1988-10-04	Hansen	
	16	4958910		1990-09-25	Taylor, et al.	
	17	4989253		1991-01-29	Liang, et al.	
	18	5078140		1992-01-07	Kwoh	
	19	5084880		1992-01-28	Esterowitz, et al.	

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	20	5086401		1992-02-04	Glassman, et al.	
	21	5134620		1992-07-28	Huber	
	22	5142930		1992-09-01	Allen, et al.	
	23	5180378		1993-01-19	Kung, et al.	
	24	5191628		1993-03-02	Byron	
	25	5218655		1993-06-08	Mizrahi	
	26	5230023		1993-07-20	Nakano	
	27	5267256		1993-11-30	Saruwatari, et al.	
	28	5267323		1993-11-30	Kimura	
	29	5300097		1994-04-05	Lerner, et al.	
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	31	5305427		1994-04-19	Nagata	
	32	5313306		1994-05-17	Kuban, et al.	
	33	5323404		1994-06-21	Grubb	
	34	5345538		1994-09-06	Narayannan, et al.	
	35	5408409		1995-04-18	Glassman, et al.	
	36	5544654		1996-08-13	Murphy, et al.	
	37	5572999		1996-11-12	Funda, et al.	
	38	5695493		1997-12-09	Nakajima, et al.	
	39	5696778		1997-12-09	MacPherson	
	40	5792204		1998-08-11	Snell	
	41	5812978		1998-09-22	Nolan	

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	42	5950629		1999-09-14	Taylor, et al.	
	43	5970457		1999-10-19	Brant, et al.	
	44	6014249		2000-01-11	Fermann, et al.	
	45	6185535		2001-02-06	Hedin, et al.	
	46	6200309		2001-03-13	Rice, et al.	
	47	6224542		2001-05-01	Chang, et al.	
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	49	6273858		2001-08-14	Fox, et al.	
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	51	6301273		2001-10-09	Sanders, et al.	
	52	6337462		2002-01-08	Smart	

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	53	6340806		2002-01-22	Smart, et al.	
	54	6350261		2002-02-26	Domankevitz, et al.	
	55	6374006		2002-04-16	Islam, et al.	
	56	6407853		2002-06-18	Samson, et al.	
	57	6436107		2002-08-20	Wang, et al.	
	58	6442430		2002-08-27	Ferek-Petric	
	59	6450172		2002-09-17	Hartlaub, et al.	
	60	6453201		2002-09-17	Daum, et al.	
	61	6458120		2002-10-01	Shen, et al.	
	62	6462500		2002-10-08	L'Hegarat, et al.	
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	64	6567431		2003-05-20	Tabirian, et al.	
	65	6605080		2003-08-12	Altshuler, et al.	
	66	6625180		2003-09-23	Bufetov, et al.	
	67	6631025		2003-10-07	Islam, et al.	
	68	6659999		2003-12-09	Anderson, et al.	
	69	6760148		2004-07-06	Islam	
	70	6885498		2005-04-26	Islam	
	71	6885683		2005-04-26	Fermann, et al.	
	72	6943936		2005-09-13	Islam, et al.	
	73	7027467		2006-04-11	Baev, et al.	
	74	7060061		2006-06-13	Altshuler, et al.	

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	75	7167300		2007-01-23	Fermann, et al.	
	76	7259906		2007-08-21	Islam	
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	1	20020032468		2002-03-14	Hill, Michael R.S. ; et al.	
	2	20020082612		2002-06-27	Moll, Frederic H. ; et al.	
	3	20020128846		2002-09-12	Miller, Steven C.	
	4	20020178003		2002-11-28	Gehrke, James K. ; et al.	
	5	20040174914		2004-09-09	Fukatsu, Susumu	

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	1	EP1148666	EP		2001-10-24	Grant Andrew R et al.		
	2	WO01150959	WO		2001-07-19	SUHM		
	3	WO09715240	WO		1997-05-01	BRANT		
	4	WO97049340	WO		1997-12-31	WANG		

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	1	7787503	B2	2010-08-31	WADSWORTH	
	2	7800818	B2	2010-09-21	MATTSSON	
	3	8000574	B2	2011-08-16	BUCHTER	
	4	6611643	B2	2003-08-26	BIRK	

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	1	SUN, Y., C.F. Booker, S. Kumari, R.N. Day, M. Davidson, A. Periasamy, "Characterization of an orange acceptor fluorescent protein for sensitized spectral fluorescence resonant energy transfer microscopy using a white-light laser," Journal of Biomedical Optics, Vol. 14, no. 5, paper 054009 (2009).	
	2	BORLINGHAUS, R., "Colours Count: how the challenge of fluorescence was solved in confocal microscopy," in Modern Research and Educational Topics in Microscopy, A. Mendez-Vilas and J. Diaz, eds, pp. 890-899, Formatex (2007)	
	3	BORLINGHAUS, R., "The White Confocal: Continuous Spectral Tuning in Excitation and Emission," in Optical Fluorescence Microscopy, A. Diaspro (Ed), Chapter 2, pp. 37-54, ISBN 978-3-642-15174-3, Springer-Verlag, Berlin (2011).	
	4	BORLINGHAUS, R.T., L. Kuschel, "White Light Laser: The Ultimate Source for Confocal Microscopy," http://www.leica-microsystems.com/science-lab/white-light-laser (June 27, 2012).	
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	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16506885
	Filing Date	2019-07-09
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1636
	Examiner Name	
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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	38383

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16506885
	Filing Date	2019-07-09
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1636
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

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☒ A certification statement is not submitted herewith.

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	38383

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16506885
	Filing Date	2019-07-09
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1636
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Signature		Date Considered	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16506885
	Filing Date	2019-07-09
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1636
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

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That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	38383

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Electronic Acknowledgement Receipt

EFS ID:	36540738
Application Number:	16506885
International Application Number:	
Confirmation Number:	7781
Title of Invention:	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO
First Named Inventor/Applicant Name:	Mohammed N. ISLAM
Customer Number:	109543
Filer:	David S. Bir/Pamela Demos
Filer Authorized By:	David S. Bir
Attorney Docket Number:	OMNI 0101 PUSA5
Receipt Date:	12-JUL-2019
Filing Date:	
Time Stamp:	09:33:55
Application Type:	Utility under 35 USC 111(a)

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Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	OMNI017PUSP1_updated_IDS_9.PDF	710696 1f7a1dcba5dc070e9720ba1d35c1c30c746551a3	no	9

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2	Information Disclosure Statement (IDS) Form (SB08)	OMNI0104PUSA5_IDS_1.PDF	702013 ae3a92f8c8852c2f79ae1e63d72a8c4e0ce3945f	no	4
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5	Information Disclosure Statement (IDS) Form (SB08)	OMNI0105PUSP4_IDS_15.PDF	1212242 2f0903977b0f8c3ef045a97d5dfc3f0407eed895	no	6
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8	Information Disclosure Statement (IDS) Form (SB08)	OMNI0105PUSP4_updated_IDS_18.PDF	1136123 7d1833557220d07482b2072f6f44d107c3946fe6	no	4
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11	Information Disclosure Statement (IDS) Form (SB08)	OMNI0107PUSP1_updated_IDS_2.PDF	670383 a1a6a69208c57927476f9ae3f78d218a714372ac	no	9
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12	Information Disclosure Statement (IDS) Form (SB08)	OMNI0107PUSP1_updated_IDS_3.PDF	678734 af8d587a057fd30213841b2bda0bb18bf26d05b8	no	11
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13	Information Disclosure Statement (IDS) Form (SB08)	OMNI0107PUSP1_updated_IDS_4.PDF	662703 b6491b617a30d610ee596e3c863d8a50635e7dac	no	5
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14	Information Disclosure Statement (IDS) Form (SB08)	OMNI0107PUSP1_updated_IDS_5.PDF	654496 aab82be2a40a9e506a8ae2b1c4b3bbb516c3bb7a	no	4
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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/506,885	07/09/2019	1636	1015	OMNI 0101 PUSA5	23	3

CONFIRMATION NO. 7781

FILING RECEIPT

109543
Brooks, Kushman P.C./Cheetah Omni MedSci
1000 Town Center
Twenty Second Floor
Southfield, MI 48075

Date Mailed: 07/24/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Inventor(s)

Mohammed N. ISLAM, Ann Arbor, MI;

Applicant(s)

Omni Medsci, Inc., Ann Arbor, MI;

Power of Attorney: The patent practitioners associated with Customer Number 109543

Domestic Priority data as claimed by applicant

This application is a CON of 16/272,069 02/11/2019
which is a CON of 16/029,611 07/08/2018 PAT 10201283
which is a CON of 15/888,052 02/04/2018 PAT 10136819
which is a CON of 15/212,549 07/18/2016 PAT 9885698
which is a CON of 14/650,897 06/10/2015 PAT 9494567
which is a 371 of PCT/US2013/075700 12/17/2013
which claims benefit of 61/747,472 12/31/2012
This application 16/506,885
is a CON of 16/004,359 06/09/2018
which is a CON of 14/109,007 12/17/2013 PAT 9993159
which claims benefit of 61/747,553 12/31/2012
This application 16/506,885
is a CON of 16/188,194 11/12/2018
which is a CON of 16/004,154 06/08/2018 PAT 10126283
which is a CON of 15/855,201 12/27/2017 PAT 9995722
which is a CON of 15/711,907 09/21/2017 PAT 9897584

which is a DIV of 15/357,225 11/21/2016 PAT 9797876
which is a CON of 14/650,981 06/10/2015 PAT 9500634
which is a 371 of PCT/US2013/075767 12/17/2013
which claims benefit of 61/747,485 12/31/2012
This application 16/506,885
is a CON of 16/241,628 01/07/2019
which is a CON of 16/015,737 06/22/2018 PAT 10172523
which is a CON of 15/594,053 05/12/2017 PAT 10188299
which is a CON of 14/875,709 10/06/2015 PAT 9651533
which is a CON of 14/108,986 12/17/2013 PAT 9164032
which claims benefit of 61/747,487 12/31/2012
This application 16/506,885
is a CON of 16/284,514 02/25/2019
which is a CON of 16/016,649 06/24/2018 PAT 10213113
which is a CON of 15/860,065 01/02/2018 PAT 10098546
which is a CON of 15/686,198 08/25/2017 PAT 9861286
which is a CON of 15/357,136 11/21/2016 PAT 9757040
which is a CON of 14/651,367 06/11/2015 PAT 9500635
which is a 371 of PCT/US2013/075736 12/17/2013
which claims benefit of 61/747,477 12/31/2012
and claims benefit of 61/754,698 01/21/2013

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/506,885**

Projected Publication Date: 10/31/2019

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****
Title

SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

Preliminary Class

435

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: Yes

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NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

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Petitioner Apple Inc. – Ex. 1002, p. 603

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/506,885	07/09/2019	Mohammed N. ISLAM	OMNI 0101 PUSA5

CONFIRMATION NO. 7781

109543
Brooks, Kushman P.C./Cheetah Omni MedSci
1000 Town Center
Twenty Second Floor
Southfield, MI 48075

INFORMAL NOTICE

OC00000109847467

Date Mailed: 07/24/2019

INFORMATIONAL NOTICE TO APPLICANT

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

The item(s) indicated below are also required and should be submitted with any reply to this notice to avoid further processing delays.

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
  Mohammed N. ISLAM

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/ldvan/

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/506,885

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	75		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	330		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	380		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	23 minus 20 =	* 3	x 50 =	150	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*	x 230 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	935		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

MOHAMMED N. ISLAM

Group Art Unit: 2886

Examiner: RAHMAN, MD M

Serial No.: 16/506885

Filed: 7/9/2019

For: SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

Attorney Docket No.: OMNI0101PUSA5

PRELIMINARY AMENDMENT UNDER 37 C.F.R. § 1.115

Commissioner for Patents
U.S. Patent & Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

Commissioner:

Please amend the above-identified application as follows:

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) A system for measuring one or more physiological parameters and for use with a smart phone or tablet, the system comprising:

a wearable device adapted to be placed on a wrist or an ear of a user, including a light source comprising a plurality of semiconductor sources that are light emitting diodes, each of the light emitting diodes configured to generate an output optical light having one or more optical wavelengths;

the wearable device ~~comprising one or more lenses~~ configured to receive a portion of at least one of the output optical lights and to direct an output ~~a lens output light~~ to tissue;

the wearable device further comprising a detection system configured to receive at least a portion of the ~~lens output light~~ output reflected from the tissue and to generate an output signal having a signal-to-noise ratio, wherein the detection system is configured to be synchronized to the light source;

wherein the detection system comprises a plurality of spatially separated detectors, and wherein at least one analog to digital converter is coupled to at least one of the spatially separated detectors;

wherein a detector output from the at least one of the plurality of spatially separated detectors is coupled to an amplifier having a gain configured to improve detection sensitivity;

the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a speaker, a voice input module, one or more buttons or knobs, a microprocessor and a touch screen, the smart phone or tablet configured to receive and process at least a portion of the output signal, wherein the smart phone or tablet is configured to store and display the processed output signal, and wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link;

a cloud configured to receive over the wireless transmission link an output status comprising the at least a portion of the processed output signal, to process the received output status to generate processed data, and to store the processed data;

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wherein the output signal is indicative of one or more of the physiological parameters, and the cloud is configured to store a history of at least a portion of the one or more physiological parameters over a specified period of time;

the wearable device configured to increase the signal-to-noise ratio by increasing light intensity of at least one of the plurality of semiconductor sources from an initial light intensity and by increasing a pulse rate of at least one of the plurality of semiconductor sources from an initial pulse rate; and

the detection system further configured to:

generate a first signal responsive to light received while the light emitting diodes are off,

generate a second signal responsive to light received while at least one of the light emitting diodes is on, and

increase the signal-to-noise ratio by comparing the first signal and the second signal.

2. (Original) The system of Claim 1, wherein the wearable device is configured to use artificial intelligence in making decisions associated with at least a portion of the output signal.

3. (Original) The system of Claim 2, wherein the wearable device is at least in part configured to identify an object, and to compare a property of at least some of the output signal to a threshold.

4. (Currently Amended) The system of Claim 3, wherein the wearable device is configured to perform pattern identification or classification based on at least a part of the output signal, or the wearable device is configured to apply regression signal processing methodologies to at least a part of the output signal.

5. (Original) The system of Claim 4, wherein at least one of the spatially separated detectors is located at a first distance from at least one of the light emitting diodes and at least another of the spatially separated detectors is located at a second distance from the at least one of the light emitting diodes, and the at least one of the spatially separated detectors is configured to generate a third signal responsive to light from the at least one light emitting diode and the at least another of the spatially separated detectors is configured to generate a fourth signal responsive to the light from the at least one of the light emitting diodes; and

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wherein at least one of the spatially separated detectors is located at a third distance from a first one of the light emitting diodes and at a fourth distance from a second one of the light emitting diodes, and is configured to generate a fifth signal responsive to light from the first light emitting diode and a sixth signal responsive to light from the second light emitting diode, and wherein the first distance is different from the second distance, and the third distance is different from the fourth distance.

6. (Currently Amended) The system of Claim 5, wherein the wearable device further comprises a reflective surface positioned to reflect at least a portion of the ~~lens output light~~ output reflected from the tissue.

7. (Currently Amended) A system for measuring one or more physiological parameters and for use with a smart phone or tablet, the system comprising:

a wearable device adapted to be placed on a wrist or an ear of a user, and including a light source comprising a plurality of semiconductor sources, each of the semiconductor sources configured to generate an output light having one or more optical wavelengths;

the wearable device ~~comprising one or more lenses~~ configured to receive a portion of at least one of the output lights and to deliver ~~a lens output light~~ an output to tissue;

the wearable device further comprising a detection system configured to receive at least a portion of the ~~lens output light~~ output reflected from the tissue and to generate an output signal having a signal-to-noise ratio, wherein the detection system is configured to be synchronized to the light source;

wherein the detection system comprises a plurality of spatially separated detectors, and wherein at least one analog to digital converter is coupled to at least one of the spatially separated detectors;

the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a speaker, a voice input module, one or more buttons or knobs, a microprocessor and a touch screen, the smart phone or tablet configured to receive and process at least a portion of the output signal, wherein the smart phone or tablet is configured to store and display the processed output signal, and wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link;

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a cloud configured to receive over the wireless transmission link an output status comprising the at least a portion of the processed output signal, to process the received output status to generate processed data, and to store the processed data;

wherein the output signal is indicative of one or more of the physiological parameters;

the wearable device configured to increase the signal-to-noise ratio by increasing light intensity of at least one of the semiconductor sources from an initial light intensity and by increasing a pulse rate of at least one of the semiconductor sources from an initial pulse rate; and

the detection system further configured to:

generate a first signal responsive to light received while the semiconductor sources are off,

generate a second signal responsive to light received while at least one of the semiconductor sources is on, and

increase the signal-to-noise ratio by comparing the first signal and the second signal.

8. (Original) The system of Claim 7, wherein the wearable device is at least in part configured to identify an object, and a property of at least some of the output signal is compared by at least one of the wearable device, the smart phone or tablet to a threshold.

9. (Original) The system of Claim 8, wherein a detector output from at least one of the plurality of spatially separated detectors is coupled to an amplifier having a gain configured to improve detection sensitivity.

10. (Original) The system of Claim 9, wherein the wearable device is configured to use artificial intelligence to process at least a portion of the output signal.

11. (Currently Amended) The system of Claim 10, wherein the artificial intelligence comprises pattern identification or classification or regression signal processing methodologies.

12. (Currently Amended) The system of Claim 10, wherein the wearable device is configured to perform pattern identification or classification based on at least a part of the output signal, or the wearable device is configured to apply regression signal processing methodologies to at least a part of the output signal.

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13. (Original) The system of Claim 12, wherein at least one of the spatially separated detectors is located at a first distance from at least one of the light emitting diodes and at least another of the spatially separated detectors is located at a second distance from the at least one of the light emitting diodes, and the at least one of the spatially separated detectors is configured to generate a third signal responsive to light from the at least one light emitting diode and the at least another of the spatially separated detectors is configured to generate a fourth signal responsive to the light from the at least one of the light emitting diodes; and

wherein at least one of the spatially separated detectors is located at a third distance from a first one of the light emitting diodes and at a fourth distance from a second one of the light emitting diodes, and is configured to generate a fifth signal responsive to light from the first light emitting diode and a sixth signal responsive to light from the second light emitting diode, and wherein the first distance is different from the second distance, and the third distance is different from the fourth distance.

14. (Currently Amended) The system of Claim 13, wherein the wearable device further comprises a reflective surface positioned to reflect at least a portion of the ~~lens output light~~ output reflected from the tissue.

15. (Currently Amended) A system for measuring one or more physiological parameters and for use with a smart phone or tablet, the system comprising:

a wearable device adapted to be placed on a wrist or an ear of a user, including a light source comprising a plurality of semiconductor sources that are light emitting diodes, each of the light emitting diodes configured to generate an output optical light having one or more optical wavelengths;

the wearable device ~~comprising one or more lenses~~ configured to receive a portion of at least some of the output optical light and to deliver ~~a lens output light~~ an output to tissue;

the wearable device further comprising a detection system configured to receive at least a portion of the ~~lens output light~~ output reflected from the tissue and to generate an output signal having a signal-to-noise ratio, wherein the detection system is configured to be synchronized to the light source;

wherein the detection system comprises a plurality of spatially separated detectors, and wherein at least one analog to digital converter is coupled to at least one of the spatially separated detectors;

the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a microphone, a speaker, one or more buttons or knobs, a microprocessor and a touch screen, the smart phone or tablet configured to receive and process at least a portion of the output signal, wherein the smart phone or tablet is configured to store and display the processed output signal, and wherein at least a portion of the processed output signal is configured to be transmitted over a wireless transmission link;

a cloud configured to receive over the wireless transmission link an output status comprising the at least a portion of the processed output signal, to process the received output status to generate processed data, and to store the processed data;

wherein the output signal is indicative of one or more of the physiological parameters;

the wearable device configured to increase the signal-to-noise ratio by increasing light intensity of at least one of the plurality of semiconductor sources from an initial light intensity; and

the detection system further configured to:

generate a first signal responsive to light received while the light emitting diodes are off,

generate a second signal responsive to light received while at least one of the light emitting diodes is on, and

increase the signal-to-noise ratio by comparing the first signal and the second signal.

16. (Original) The system of Claim 15, wherein the wearable device is at least in part configured to detect an object, and a property of at least some of the output signal is compared to a threshold.

17. (Original) The system of Claim 15, wherein a detector output from at least one of the plurality of spatially separated detectors is coupled to an amplifier having a gain configured to be adjusted to improve detection sensitivity.

18. (Original) The system of Claim 15, wherein the wearable device is configured to use artificial intelligence in making decisions associated with at least a portion of the output signal.

19. (Original) The system of claim 18 wherein the artificial intelligence comprises a pattern matching algorithm.

20. (Original) The system of claim 18 wherein the artificial intelligence comprises spectral fingerprinting.

21. (Currently Amended) The system of Claim 15, wherein the wearable device is configured to perform pattern identification or classification based on at least a part of the output signal, or the wearable device is configured to apply regression signal processing methodologies to at least a part of the output signal.

22. (Original) The system of Claim 21, wherein the pattern identification or classification comprises a pattern matching algorithm or spectral fingerprinting.

23. (Currently Amended) The system of Claim 15, wherein the wearable device further comprises a reflective surface positioned to reflect at least a portion of ~~light~~ the output reflected from the tissue.

Remarks

Applicant has amended various claims to more particularly point out the claimed subject matter. Applicant respectfully requests entry of this amendment prior to substantive examination.

No additional fee is believed to be due. However, please charge any fees or credit any overpayments as a result of the filing of this paper to our Deposit Account No. 02-3978.

Respectfully submitted,

MOHAMMED N. ISLAM

By: /Andrew B. Turner/
Andrew B. Turner
Reg. No. 63,121
Attorney for Applicant

Date: August 6, 2019

BROOKS KUSHMAN P.C.
1000 Town Center, 22nd Floor
Southfield, MI 48075-1238
Phone: 248-358-4400
Fax: 248-358-3351

Electronic Acknowledgement Receipt

EFS ID:	36798714
Application Number:	16506885
International Application Number:	
Confirmation Number:	7781
Title of Invention:	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO
First Named Inventor/Applicant Name:	Mohammed N. ISLAM
Customer Number:	109543
Filer:	Andrew B. Turner/Amy Tanner
Filer Authorized By:	Andrew B. Turner
Attorney Docket Number:	OMNI 0101 PUSA5
Receipt Date:	06-AUG-2019
Filing Date:	09-JUL-2019
Time Stamp:	16:43:07
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		OMNI0101PUSA5_preliminary_amendment.pdf	54185 22b081825aa6bf47e81fc1427383d4be649b1da1	yes	9

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Preliminary Amendment	1	1
	Claims	2	8
	Applicant Arguments/Remarks Made in an Amendment	9	9
Warnings:			
Information:			
	Total Files Size (in bytes):	54185	

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney Docket Number	OMNI0101PUSA5

ASSIGNMENT AND DECLARATION (37 C.F.R. 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 C.F.R. 1.76)

Title of Invention	**SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO**

As a below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 16/506,885 filed on July 9, 2019. (I hereby authorize the insertion of the application filing date and number when they become known.)

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I am aware of the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in 37 C.F.R. § 1.56.

NOW, THEREFORE, for good and valuable consideration, receipt of which is hereby acknowledged, I do hereby assign, sell and set over to Omni Medsci, Inc., a corporation organized and existing under the laws of the state or country of Michigan, and having a place of business at 1718 Newport Creek Drive, Ann Arbor, Michigan 48103, hereinafter referred to as the ASSIGNEE, its successors, assigns or other legal representatives, my entire right, title and interest, domestic and foreign, in and to the inventions and discoveries in the above-identified application including the right of said ASSIGNEE, its successors, assigns or other legal representatives to make applications and to receive Letters Patent for said inventions and discoveries in any and all foreign countries in its or their own name or names, or in my name, at its or their election, and I hereby assign, sell and set over to said ASSIGNEE, its successors, assigns or other legal representatives, all rights of priority, including any provisional applications, in and to said inventions and discoveries in all countries, including all applications claiming benefit of the filing date hereof, continuations, continuations-in-part, divisionals, reexaminations and reissue applications.

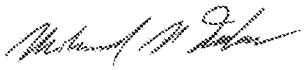
And I hereby agree for myself, my heirs, successors, assigns or other legal representatives to execute any and all papers, including applications for Letters Patent of any and all kinds and in any and all countries and to perform any and all acts which said ASSIGNEE, its successors, assigns or other legal representatives may deem necessary to secure thereto the rights herein assigned, sold and set over.

And I hereby represent and warrant that I have not granted any rights inconsistent with the rights granted herein.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years or both.

LEGAL NAME OF INVENTOR

Inventor: Mohammed N. ISLAM Date: August 1, 2019

Signature: 

Page 1 (Supplemental Sheet with Additional Joint Inventors is attached if necessary)

Note: An Application Data Sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form.

Electronic Acknowledgement Receipt

EFS ID:	36799654
Application Number:	16506885
International Application Number:	
Confirmation Number:	7781
Title of Invention:	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO
First Named Inventor/Applicant Name:	Mohammed N. ISLAM
Customer Number:	109543
Filer:	Andrew B. Turner/Amy Tanner
Filer Authorized By:	Andrew B. Turner
Attorney Docket Number:	OMNI 0101 PUSA5
Receipt Date:	06-AUG-2019
Filing Date:	09-JUL-2019
Time Stamp:	16:54:42
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	OMNI0101PUSA5_Signed_Declaration_Assignment.pdf	264646 97d96363ac9113d68914ea2be3aeb7dd42f57834	no	1

Warnings:

Information:	
Total Files Size (in bytes):	264646

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/506,885	Filing Date 07/09/2019	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $50 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $230 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	08/06/2019	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 23	Minus	** 23	= 0		x $50 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $230 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/VERONICA EVERETTE/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	PTO/SB/25 PTO/SB/26 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A PROVISIONAL DOUBLE PATENTING REJECTION OVER A PENDING "REFERENCE" APPLICATION AND TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT**
Application Number	16506885
Filing Date	09-Jul-2019
First Named Inventor	Mohammed ISLAM
Attorney Docket Number	OMNI 0101 PUSA5
Title of Invention	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
OMNI MEDSCI, INC.	100 %

The owner(s) of percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of any patent granted on pending reference Application Number(s)

16272069 filed on 02/11/2019

as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and any patent granted on the reference application are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of any patent granted on the instant application that would extend to the expiration date of the full statutory term of any patent granted on said reference application, "as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application," in the event that any such patent granted on the pending reference application: expires for failure to pay a maintenance fee, is held unenforceable, is found invalid by a court of competent jurisdiction, is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321, has all claims canceled by a reexamination certificate, is reissued, or is in any manner terminated prior to the expiration of its full statutory term as shortened by any terminal disclaimer filed prior to its grant.

The owner(s) with percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s)

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10136819

10201283

as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:
- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

◉ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

○ I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.

Applicants claims the following fee status:

◉ Small Entity

○ Micro Entity

○ Regular Undiscounted

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

◉ An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application

Registration Number 63121

○ A sole inventor

○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application

○ A joint inventor; all of whom are signing this request

Signature	/Andrew B. Turner/
Name	Andrew B. Turner

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	16506885
Filing Date:	09-Jul-2019
Title of Invention:	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO
First Named Inventor/Applicant Name:	Mohammed N. ISLAM
Filer:	Andrew B. Turner/Amy Tanner
Attorney Docket Number:	OMNI 0101 PUSA5

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
STATUTORY OR TERMINAL DISCLAIMER	2814	1	160	160
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**160**

Doc Code: DISQ.E.FILE
Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 16506885

Filing Date: 09-Jul-2019

Applicant/Patent under Reexamination: ISLAM

Electronic Terminal Disclaimer filed on August 12, 2019

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt

EFS ID:	36831701
Application Number:	16506885
International Application Number:	
Confirmation Number:	7781
Title of Invention:	SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO
First Named Inventor/Applicant Name:	Mohammed N. ISLAM
Customer Number:	109543
Filer:	Andrew B. Turner/Amy Tanner
Filer Authorized By:	Andrew B. Turner
Attorney Docket Number:	OMNI 0101 PUSA5
Receipt Date:	12-AUG-2019
Filing Date:	09-JUL-2019
Time Stamp:	13:42:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$160
RAM confirmation Number	E20198BD42315924
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	37271 ea42f653525a058fe82b6bb4592fceacee1e1b91	no	3
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30548 f724ab344ed54cc59396354a213ca7ee1253fedf	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	67819		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

109543 7590 08/19/2019

Brooks, Kushman P.C./Cheetah Omni MedSci
1000 Town Center
Twenty Second Floor
Southfield, MI 48075

EXAMINER	
RAHMAN, MD M	
ART UNIT	PAPER NUMBER
2886	

DATE MAILED: 08/19/2019

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/506,885	07/09/2019	Mohammed N. ISLAM	OMNI 0101 PUSA5	7781

TITLE OF INVENTION: SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	11/19/2019

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

109543 7590 08/19/2019

Brooks, Kushman P.C./Cheetah Omni MedSci
1000 Town Center
Twenty Second Floor
Southfield, MI 48075

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/506,885	07/09/2019	Mohammed N. ISLAM	OMNI 0101 PUSA5	7781

TITLE OF INVENTION: SEMICONDUCTOR DIODES-BASED PHYSIOLOGICAL MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	11/19/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
RAHMAN, MD M	2886	250-341800

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

Petitioner Apple Inc. – Ex. 1002, p. 630

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/506,885	07/09/2019	Mohammed N. ISLAM	OMNI 0101 PUSA5	7781

109543 7590 08/19/2019

Brooks, Kushman P.C./Cheetah Omni MedSci
1000 Town Center
Twenty Second Floor
Southfield, MI 48075

EXAMINER	
RAHMAN, MD M	
ART UNIT	PAPER NUMBER
2886	

DATE MAILED: 08/19/2019

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 16/506,885	Applicant(s) ISLAM, Mohammed N.	
	Examiner MD M RAHMAN	Art Unit 2886	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 7/9/19.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1-23 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/MD M RAHMAN/
Primary Examiner, Art Unit 2886

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Information Disclosure Statement

Acknowledgment is made of Applicant's Information Disclosure Statement (IDS) form PTO 1449.These IDS has been considered.

Terminal Disclaimer

The terminal disclaimer filed on 8/12/19 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of (US application no 16272069) and US patent (9494567, 9885698, 10136819 and 10201283) has been reviewed and is accepted. The terminal disclaimer has been recorded.

Allowable Subject Matter

Claims 1-23 are allowed.

The following is an examiner's statement of reasons for allowance:

As to claim 1, 7 and 15, the prior arts alone or in combination fail to disclose the claimed limitations such as, "the wearable device further comprising a detection system configured to receive at least a portion of the lens output light output reflected from the tissue and to generate an output signal having a signal-to-noise ratio, wherein the detection system is configured to be synchronized to the light source;

a cloud configured to receive over the wireless transmission link an output status comprising the at least a portion of the processed output signal, to process the received output status to generate processed data, and to store the processed data;

wherein the output signal is indicative of one or more of the physiological parameters, and the cloud is configured to store a history of at least a portion of the one or more physiological parameters over a specified period of time;

the wearable device configured to increase the signal-to-noise ratio by increasing light intensity of at least one of the plurality of semiconductor sources from an initial light intensity and by increasing a pulse rate of at least one of the plurality of semiconductor sources from an initial pulse rate; and

the detection system further configured to:

generate a first signal responsive to light received while the light emitting diodes are off, generate a second signal responsive to light received while at least one of the light emitting diodes is on, and increase the signal-to-noise ratio by comparing the first signal and the second signal" along with all other limitations of the claim.

Claims 2-6, 8-14 and 16-23 are allowable due to their dependencies.

The closest references, Islam (US PG Pub 2009/0204110) (cited in the IDS filed by the applicant), Islam et al. (US 6381391) (cited in the IDS filed by the applicant), Holman (US PG Pub 2007/0078348) (cited in the IDS filed by the applicant) and Waarts et al. (US 6212310 B1) (cited in the IDS filed by the applicant) alone or in combination disclose some features of the claimed invention but do not disclose the claimed invention.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MD M RAHMAN whose telephone number is (571)272-9175. The examiner can normally be reached on Mon-Thur.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, TARIFUR CHOWDHURY can be reached on 571-272-2287. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/MD M RAHMAN/
Primary Examiner, Art Unit 2886

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/506,885	ISLAM, Mohammed N.
	Examiner	Art Unit
	MD M RAHMAN	2886

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	08/13/2019								
1	1	=								
2	2	=								
3	3	=								
4	4	=								
5	5	=								
6	6	=								
7	7	=								
8	8	=								
9	9	=								
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21	21	=								
22	22	=								
23	23	=								

Petitioner Apple Inc. – Ex. 1002, p. 637

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/506,885	ISLAM, Mohammed N.
	Examiner	Art Unit
	MD M RAHMAN	2886

CPC - Searched*		
Symbol	Date	Examiner
G 01N 21/3581 G 01N 21/3563 G 01N 21/35 , G 01N 21/4738, G 01N 21/55	08/13/2019	MR
G01J3/02 G01J3/28 G01J3/42, G01N21/31, G01N21/552	08/13/2019	MR

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
356	300	08/13/2019	MR

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
INVENTOR SEARCH, US PG PUB AND PAT	08/13/2019	MR

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
G 01N 21/3581	G 01N 21/3563 G 01N 21/35 , G 01N 21/4738, G 01N 21/55	08/13/2019	MR

/MD M RAHMAN/ Primary Examiner, Art Unit 2886	

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/506,885	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

CPC						
Symbol					**Type**	**Version**
A61B	/	5	/	0088	F	2013-01-01
G01N	/	21	/	3563	I	2013-01-01
G01N	/	33	/	025	I	2013-01-01
G01N	/	33	/	15	I	2013-01-01
G01N	/	33	/	442	I	2013-01-01
G01N	/	33	/	49	I	2013-01-01
A61B	/	5	/	14532	I	2013-01-01
A61B	/	5	/	1455	I	2013-01-01
A61B	/	5	/	742	I	2013-01-01
G01J	/	3	/	0218	I	2013-01-01
G01J	/	3	/	108	I	2013-01-01
G01J	/	3	/	14	I	2013-01-01
G01J	/	3	/	28	I	2013-01-01
G01J	/	3	/	2823	I	2013-01-01
G01J	/	3	/	42	I	2013-01-01
G01J	/	3	/	453	I	2013-01-01
G01N	/	21	/	35	I	2013-01-01
G01N	/	33	/	02	I	2013-01-01
G01N	/	21	/	359	I	2013-01-01
G01N	/	21	/	39	I	2013-01-01
G01N	/	21	/	88	I	2013-01-01
A61B	/	5	/	0013	I	2013-01-01
A61B	/	5	/	0075	I	2013-01-01
A61B	/	5	/	7405	I	2013-01-01
A61B	/	5	/	7257	I	2013-01-01
A61B	/	5	/	6801	I	2013-01-01
A61B	/	5	/	4547	I	2013-01-01
A61B	/	5	/	14546	I	2013-01-01
A61B	/	5	/	0086	I	2013-01-01
A61B	/	5	/	0022	I	2013-01-01
A61B	/	2562	/	146	A	2013-01-01

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	23	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	13 August 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	21

U.S. Patent and Trademark Office

Part of Paper No.: 20190813

Petitioner Apple Inc. – Ex. 1002, p. 639

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/506,885	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

CPC							
Symbol						**Type**	**Version**
G01N	/	21	/	85		A	2013-01-01
H01S	/	3	/	06758		A	2013-01-01
G01N	/	21	/	9508		A	2013-01-01
G01N	/	2021	/	3595		A	2013-01-01
G01N	/	2021	/	399		A	2013-01-01
G01N	/	2201	/	061		A	2013-01-01
G01N	/	2201	/	06113		A	2013-01-01
G01N	/	2201	/	062		A	2013-01-01
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G01N	/	2201	/	12		A	2013-01-01
G01J	/	2003	/	104		A	2013-01-01
H01S	/	3	/	302		A	2013-01-01
G01J	/	2003	/	1208		A	2013-01-01
G01J	/	2003	/	2826		A	2013-01-01
G01M	/	3	/	38		A	2013-01-01
G01J	/	3	/	1838		A	2013-01-01
A61B	/	2576	/	02		A	2013-01-01
A61B	/	2562	/	0233		A	2013-01-01
A61B	/	2562	/	0238		A	2013-01-01
G01N	/	2201	/	129		A	2013-01-01
H01S	/	3	/	0092		A	2013-01-01

CPC Combination Sets								
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	23	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	13 August 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	21

U.S. Patent and Trademark Office — Part of Paper No.: 20190813

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/506,885	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

INTERNATIONAL CLASSIFICATION				
CLAIMED				
G01J	/	5	/	02

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**
356	300

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	23	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	13 August 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	21

U.S. Patent and Trademark Office — Part of Paper No.: 20190813

Petitioner Apple Inc. – Ex. 1002, p. 641

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/506,885	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	10	10	19	19										
2	2	11	11	20	20										
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7	7	16	16												
8	8	17	17												
9	9	18	18												

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	23	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	13 August 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	21

U.S. Patent and Trademark Office

Part of Paper No.: 20190813

Petitioner Apple Inc. – Ex. 1002, p. 642

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7771320	B2	2010-08-10	Riley, et al.	
	2	6619835	B2	2003-09-16	Kita	
	3	9326712	B1	2016-05-03	Kiani	
	4	9164032	B2	2015-10-20	Islam	

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U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20100217102	A1	2010-08-26	LeBoeuf, et al.	
	2	20120310062	A1	2012-12-06	Li, et al.	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.M.R/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	3	20120316455	A1	2012-12-13	Rahman, et al.	
	4	20140275854	A1	2014-09-18	Venkatraman, et al.	
	5	20140275852	A1	2014-09-18	Hong, et al.	
	6	20160045118	A1	2016-02-18	Kiani	
	7	20110208015	A1	2011-08-25	Welch, et al.	
	8	20110040197	A1	2011-02-11	Welch et al.	
	9	20060283931	A1	2006-12-21	Polli et al.	
	10	20090244288	A1	2009-10-01	FUJIMOTO et al.	
	11	20100160798	A1	2010-06-24	BANET et al.	
	12	20140249427	A1	2014-09-04	Liu	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	U.S. Provisional Application No. 61/350,673; titled: OPTICOUSTIC SENSOR; Inventor: Massi Joe E. Kiani; filed on June 2, 2010.	
	2	Non-Final Office Action for U.S. Application No. 14/875,709 dated May 26, 2016	

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EXAMINER SIGNATURE

Examiner Signature	/MD M RAHMAN/	Date Considered	08/13/2019

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.M.R/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.M.R/

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.M.R/

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7,969,558	B2	2011-06-28	Hall	
	2	8158175	B2	2012-04-17	Bourg, Jr.	
	3	8767190	B2	2014-07-01	Hall	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.M.R/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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	1	Segtnan, Vegard H., et al. "Screening of acrylamide contents in potato crisps using process variable settings and near-infrared spectroscopy." Molecular nutrition & food research 50.9 (2006): 811-817.	
	2	Shiroma, Cecilia, and Luis Rodriguez-Saona. "Application of NIR and MIR spectroscopy in quality control of potato chips." Journal of Food Composition and Analysis 22.6 (2009): 596-605.	
	3	Pedreschi, F., V. H. Segtnan, and S. H. Knutsen. "On-line monitoring of fat, dry matter and acrylamide contents in potato chips using near infrared interactance and visual reflectance imaging." Food Chemistry 121.2 (2010): 616-620.	
	4	Kays, Sandra E., William R. Windham, and Franklin E. Barton. "Prediction of total dietary fiber in cereal products using near-infrared reflectance spectroscopy." Journal of Agricultural and food chemistry 44.8 (1996): 2266-2271.	
	5	Williams, Phil. "Near-Infrared Spectroscopy of Cereals." Handbook of vibrational spectroscopy (2006).	
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	7	"Analysis of Edible Oils Using FT–NIR Spectroscopy." Bruker Optics, www.azom.com/article.aspx?ArticleID=5981, Mar 10, 2012.	
	8	Shiroma, Cecilia. "Rapid quality control of potato chips using near and mid-infrared spectroscopy." (2007).	
	9	Shiroma, Cecilia, and Luis Rodriguez-Saona. "Application of NIR and MIR spectroscopy in quality control of potato chips." Journal of Food Composition and Analysis 22.6 (2009): 596-605.	

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	10	Ni, Yongnian, Minghua Mei, and Serge Kokot. "Analysis of complex, processed substances with the use of NIR spectroscopy and chemometrics: Classification and prediction of properties—The potato crisps example." Chemometrics and Intelligent Laboratory Systems 105.2 (2011): 147-156.
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	18	Ayvaz, Huseyin, et al. "Application of infrared microspectroscopy and chemometric analysis for screening the acrylamide content in potato chips." Analytical Methods 5.8 (2013): 2020-2027.

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	/MD M RAHMAN/
Attorney Docket Number	OMNI 0101 PUSA5

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	25	STANINEC, M., S.M. Douglas, C.L. Darling, K. Chan, H. Kang, R. C. Lee, D. Fried, "Nondestructive clinical assessment of occlusal caries lesions using near-IR imaging methods," Lasers in Surgery and Medicine, Vol. 43, No. 10, pp. 951-959 (2011).	
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Application Number	16/506,885 - GAU: 2886
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First Named Inventor	Mohammed N. ISLAM
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Examiner Signature	/MD M RAHMAN/	Date Considered	08/13/2019

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

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See attached certification statement.

Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
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(Not for submission under 37 CFR 1.99)

Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5795300	A	1998-08-18	Bryars	
	2	6731967	B1	2004-05-04	Turcott	
	3	7648463	B1	2010-01-19	Elhag et al.	
	4	8172761	B1	2012-05-08	Rulkov et al.	
	5	8315682	B2	2012-11-20	Such et al.	
	6	8954135	B2	2015-02-10	Yuen et al.	
	7	9241676	B2	2016-01-26	Lisogurski et al.	

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First Named Inventor	Mohammed N. ISLAM
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Attorney Docket Number	OMNI 0101 PUSA5

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	1	20050049468	A1	2005-03-03	Carlson et al.	

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	J.G. WEBSTER; Design Of Pulse Oximeters; Medical Science Series; Taylor & Francis Group; CRC Press; October 23, 1997; 260 pps	
	2	H. HARRY ASADA ET AL.; Mobile Monitoring With Wearable Photoplethysmographic Biosensors; IEEE Engineering In Medicine And Biology Magazine, June 2003; 13 pps	
	3	UNITED STATES DISTRICT COURT EASTERN DISTRICT OF TEXAS MARSHALL DIVISION; Defendant And Counter Claimant Apple Inc.'s Amended Answer, Affirmative Defenses, And Counterclaims To Complaint Of Plaintiff And Counter Defendant Omni Medsci, Inc.; Document 38; July 19, 2018; 32 pps	

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16506885
Filing Date	2019-07-09
First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5084880		1992-01-28	Esterowitz, et al.	
	2	5180378		1993-01-19	Kung, et al.	
	3	5400165		1995-03-21	Gnauck, et al.	
	4	5458122		1995-10-17	Hethuin	
	5	5617871		1997-04-08	Burrows	
	6	5631758		1997-05-20	Knox, et al.	
	7	5687734		1997-11-18	Dempsey, et al.	
	8	5696778		1997-12-09	MacPherson	

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	9	5704351		1998-01-06	Mortara, et al.	
	10	5718234		1998-02-17	Warden, et al.	
	11	5748103		1998-05-05	Flach, et al.	
	12	5855550		1999-01-05	Lai, et al.	
	13	5862803		1999-01-26	Besson, et al.	
	14	5867305		1999-02-02	Waarts, et al.	
	15	5912749		1999-06-15	Harstead, et al.	
	16	5944659		1999-08-31	Flach, et al.	
	17	5957854		1999-09-28	Besson, et al.	
	18	6014249		2000-01-11	Fermann, et al.	
	19	6043927		2000-03-28	Islam	

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	20	6289238		2001-09-11	Besson, et al.	
	21	6333803		2001-12-25	Kurotori, et al.	
	22	6364834		2002-04-02	Reuss, et al.	
	23	6381391		2002-04-30	Islam, et al.	
	24	6402691		2002-06-11	Peddicord, et al.	
	25	6407853		2002-06-18	Samson, et al.	
	26	6441747		2002-08-27	Khair, et al.	
	27	6443890		2002-09-03	Schulze, et al.	
	28	6454705		2002-09-24	Cosentino, et al.	
	29	6480656		2002-11-12	Islam, et al.	
	30	6549702		2003-04-15	Islam, et al.	

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	31	6603910		2003-08-05	Islam, et al.	
	32	6659947		2003-12-09	Carter, et al.	
	33	6802811		2004-10-12	Slepian	
	34	7167300		2007-01-23	Fermann, et al.	
	35	7209657		2007-04-24	Islam	
	36	7263288		2007-08-28	Islam	
	37	7519253		2009-04-14	Islam	

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	1	20020013518		2002-01-31	West, Kenneth G. ; et al.	
	2	20020019584		2002-02-14	Schulze, Arthur E. ; et al.	

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Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

	3	20020032468		2002-03-14	Hill, Michael R.S. ; et al.	
	4	20020082612		2002-06-27	Moll, Frederic H. ; et al.	
	5	20020109621		2002-08-15	Khair, Mohammad ; et al.	
	6	20020115914		2002-08-22	Russ, Tomas	
	7	20020178003		2002-11-28	Gehrke, James K. ; et al.	
	8	20040174914		2004-09-09	Fukatsu, Susumu	
	9	20040240037		2004-12-02	Harter, Donald J.	
	10	20050111500		2005-05-26	Harter, Donald J. ; et al.	
	11	20060245461		2006-11-02	Islam; Mohammed N.	
	12	20060268393		2006-11-30	Islam; Mohammed N.	
	13	20070078348		2007-04-05	Holman; Hoi-Ying N.	

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	14	20090028193		2009-01-29	Islam; Mohammed N.	
	15	20090204110		2009-08-13	Islam; Mohammed N.	

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	1	200189362	WO		2001-11-29	West Kenneth G et al.		
	2	200227640	WO		2002-04-04	Whittington Charles Lynn et al.		
	3	200228123	WO		2002-04-04	Whittington Charles Lynn		

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	38383

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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(Not for submission under 37 CFR 1.99)

Application Number	16506885
Filing Date	2019-07-09
First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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	1	7771320	B2	2010-08-10	Riley, et al.	
	2	6619835	B2	2003-09-16	Kita	
	3	9326712	B1	2016-05-03	Kiani	
	4	5267152	A	1993-11-30	Yang et al.	
	5	7356364	B1	2008-04-08	Bullock et al.	
	6	5246004		1993-09-21	Clarke, et al.	
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	1	20100217102	A1	2010-08-26	LeBoeuf, et al.	
	2	20120310062	A1	2012-12-06	Li, et al.	
	3	20120316455	A1	2012-12-13	Rahman, et al.	
	4	20140275854	A1	2014-09-18	Venkatraman, et al.	
	5	20140275852	A1	2014-09-18	Hong, et al.	
	6	20160045118	A1	2016-02-18	Kiani	
	7	20110208015	A1	2011-08-25	Welch, et al.	
	8	20110040197	A1	2011-02-17	Welch et al.	
	9	20070021670	A1	2007-01-25	Mandelis et al.	
	10	20110282167	A1	2011-11-17	Ridder et al.	

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	11	20130274569	2013-10-17	Islam	

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	1	U.S. Provisional Application No. 61/350,673; titled: OPTICOUSTIC SENSOR; Inventor: Massi Joe E. Kiani; filed on June 2, 2010.	
	2	International Search Report and Written Opinion for International Application No. PCT/US2013/075700 dated April 24, 2014	
	3	International Preliminary Report on Patentability for International Application No. PCT/US2013/075700 dated July 9, 2015	
	4	Ooi ET, Zhang XQ, Chen JH, Soh PH, Ng K, Yeo JH, "Non-invasive glucose measurement using multiple laser diodes," Optical Diagnostic and Sensing VII, edited by Gerard L. Cote, Alexander V. Priezzhev, Proc. of SPIE Vol. 6445, 64450K , (2007).	
	5	Schulz, I., J. Putzger, A. Niklas, M. Brandt, A. Jager, A. Hardt, S. Knorzer, K.A. Hiller, S. Loffler, G. Schmalz, S.N. Danilov, S. Giglberger, M. Hirmer, S.D. Ganichev, G. Monkman, "PPG signal acquisition and analysis on in vitro tooth model for dental pulp vitality assessment," ARC Submission 16, (2012).	

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Filing Date	2019-07-09
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	6	Drexler, C., Hirmer, M., Danilov, S., Giglberger, S., Putzger, J., Niklas, A., Jager, A., Hiller, K., Loffler, S., Schmalz, G., Redlich, B., Schulz, I., Monkman, G., Ganichev, S. "Infrared spectroscopy for clinical diagnosis of dental pulp vitality." Infrared, Millimeter, and Terahertz Waves (IRMMW-THz), 2012 37th International Conference on. IEEE (2012).
	7	Hirmer, Marion, Danilov, Sergey, Giglberger, Stephan, Putzger, Jurgen, Niklas, Andreas, Jager, Andreas, Hiller, Karl-Anton, Loffler, Susanne, Schmalz, Gottfried, Redlich, Britta, Schulz, Irene, Monkman, Gareth, Ganichev, Sergey. "Spectroscopic Study of Human Teeth and Blood from Visible to Terahertz Frequencies for Clinical Diagnosis of Dental Pulp Vitality." Journal of Infrared, Millimeter, and Terahertz Waves 33.3 (2012): 366-375.
	8	Na, J, J.H. Baek, S.Y. Ryu, C. Lee, B.H. Lee, "Tomographic imaging of incipient dental-caries using optical coherence tomography and comparison with various modalities," Optical Review, vol. 16, no. 4, pp. 426-431 (2009).

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Attorney Docket Number	OMNI 0101 PUSA5

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	38383

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Application Number	
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First Named Inventor	Mohammed N. ISLAM
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Attorney Docket Number	OMNI 0101 PUSA5

	1	Lee, Ju Han, et al., "Continuous-wave supercontinuum laser based on an erbium-doped fiber ring cavity incorporating a highly nonlinear optical fiber", OPTICS LETTERS, Vol. 30, No. 19, October 1, 2005, pages 2599-2601.	
	2	Genty, G., et al., "Supercontinuum generation in large mode-area microstructured fibers", OPTICS EXPRESS, Vol. 13, No. 21, October 17, 2005, pages 8625-8633.	
	3	Schreiber, T., et al., "Supercontinuum generation by femtosecond single and dual wavelength pumping in photonic crystal fibers with two zero dispersion wavelengths", OPTICS EXPRESS, Vol. 13, No. 23, November 14, 2005, pages 9556-9569.	
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	12	Tearney, Guillermo J., et al., "In vivo Endoscopic Optical Biopsy with Optical Coherence Tomography", Science, New Series, Volume 276, June 27, 1997, pages 2037-2039.
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	15	de Boer, Johannes F., et al., "Determination of the depth-resolved Stokes parameters of light backscattered from turbid media by use of polarization-sensitive optical coherence tomography", OPTICS LETTERS, Vol. 24, No. 5; March 1, 1999, pages 300-302.
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	20	Kowalevicz, Andrew M., et al., "Ultrahigh resolution optical coherence tomography using a superluminescent light source" OPTICS EXPRESS 349, Vol. 10, No. 7, April 8, 2002, pages 349-353.
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	23	Seefeldt, Michael, et al., "Compact white-light source with an average output power of 2.4 Wand 900 nm spectral bandwidth", Optics Communications 216, pages 199-202.
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	25	Bizheva, K, et al., "Compact, broad-bandwidth fiberlaserforsub-2-pm axial resolution optical coherence tomography in the 1300-nm wavelength region," OPTICS LETTERS, Vol. 28, No. 9, May 1, 2003, pages 707-709.

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☒ None

SIGNATURE

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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(Not for submission under 37 CFR 1.99)

Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6212310	B1	2001-04-03	Waarts, et al.	
	2	7890158	B2	2011-02-15	Rowe, et al.	
	3	8213007	B2	2012-07-03	Wang, et al.	
	4	7848605	B2	2010-12-07	Ridder, et al.	
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	1	20060198397	A1	2006-09-07	Korolev, et al.	

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	2	20090105605	A1	2009-04-23	Abreu	
	3	20100160794	A1	2010-06-24	Banet, et al.	
	4	20110292376	A1	2011-12-01	Kukushkin, et al.	

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5267152	A	1993-11-30	Yang et al.	
	2	7356364	B1	2008-04-08	Bullock et al.	

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	1	20070021670	A1	2007-01-25	Mandelis et al.	
	2	20110282167	A1	2011-11-17	Ridder et al.	
	3	20120239013	A1	2012-09-20	Islam	

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	1	Pan, Yingtian, et al., "Hand-held arthroscopic optical coherence tomography for in vivo high-resolution imaging of articular cartilage", Journal of Biomedical Optics 8(4), October 2003, pages 648-654.	
	2	Xie, Tuqiang, et al., "Endoscopic optical coherence tomography with a modified microelectromechanical systems mirror for detection of bladder cancers", APPLIED OPTICS, Vol. 42, No. 31, November1, 2003, pages 6422-6426.	
	3	Dubois, A., et al., "Three-dimensional cellular-level imaging using full-field optical coherence tomography", Physics in Medicine and Biology, Phys. Med. Biol. 49, 2004, pages 1227-1234.	
	4	Park, Jesung, et al., "Analysis of birefringent image in the retinal nerve fiber layer by polarization sensitive optical coherence tomography", Ophthalmic Technologies XIV, Proceedings of SPIE, Vol. 5314, 2004, pages 188-194.	
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	7	Schmitt, Joseph, et al., "Intravascular Optical Coherence Tomography Opens a Window Onto Coronary Artery Disease", Optics & Photonics News, February 2004, pages 20-25.	
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	9	Choi, Seung-Ho, et al., "Observation of Optical Precursors in Water", Physical Review Letters, Volume 92, Number 19, May 14, 2004, pages 193903-1-193903-.3.
	10	Pierce, Mark C., et al., "Advances in Optical Coherence Tomography imaging for Dermatology", Optical Coherence Tomography Advances, The Journal of Investigative Dermatology, September 3, 2004, pages 458-463.
	11	"State-Specific Trends in Chronic Kidney Failure - United States, 1990-2001", Morbidity and Mortality Weekly Report, Department of Health and Human Services Centers for Disease Control and Prevention, Vol. 53, No. 39, copied from internet: file://C:\Documents and Settings\eturlo\Desktop\State-Specific Trends in Chronic Kidney ... 2/12/10, October 8, 2004, pages 918-920.
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	17	Computer Motion, Inc., "501(k) Summary -ZEUS® MicroWrist™ Surgical System and Accessories," September 24, 2002, 6 pages
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	20	J. Sanghera, I. Aggarwal, "IR Fiber Optics at NRL," undated, 10 pages	
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	22	B. Rigas, P.T.T. Wong, "Human Colon Adenocarcinoma Cell Lines Display Infrared Spectroscopic Features," Cancer Research, January 1, 1992, pp. 84-88	
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	25	PASSAT, "Solid-State Lasers and Optical Components," July 14, 2003, 5 pages	
	26	P.A. Thielen and L.B. Shaw, et al., "Small-core As-Se fiber for Raman amplification," OPTICS LETI-ERS, Vol. 28, No. 16, August 15, 2003, 3 pages	
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	28	U.S. Appln. Serial No. 10/652,276, "System and Method for Voice Control of Medical devices," by Mohammed N. Islam, abandoned (074036.0129) Date filed: August 29, 2003	
	29	U.S. Appln. Serial No. 10/757,341, "System and Method for Voice Control of Medical devices," by Mohammed N. Islam, issued (074036.0132) Date filed: January 13, 2004	
	30	U.S. Appln. Serial No. 12/206432, "System and Method for Voice Control of Medical Devices," by Mohammed N. Islam, pending (074036.0154) Date filed: September 8, 2008	

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	31	U.S. Patent and Trademark Office, Office Action for USSN 12/206,432, filed 09/08/2008, Mohammed N, Islam, Attorney Docket No. 074036.0154, Date filed: March 12, 2009
	32	U.S. Patent and Trademark Office, Notice of Allowance and Fee(s) Due for USSN 12/206,432, filed 09/08/2008, Mohammed N. Islam, Attorney Docket No. 074036.0154, Date filed: August 28, 2009
	33	International Search Report and Written Opinion for International Application No. PCT/US2013/075700 dated April 24, 2014
	34	International Preliminary Report on Patentability for International Application No. PCT/US2013/075700 dated July 9, 2015

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Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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See attached certification statement.

Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
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Attorney Docket Number	OMNI 0101 PUSA5

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	2	5774213	A	1998-06-30	Trebino et al.	
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Attorney Docket Number	OMNI 0101 PUSA5

	9	9861286	B1	2018-01-09	Islam	
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	1	Declaration of Brian W. Anthony, PhD regarding USPN 9,651,533 filed in IPR2019-00913 & IPR2019-00916 (April 10, 2019)	
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	3	Declaration of Brian W. Anthony, PhD regarding USPN 9,861,286 filed in IPR2019-00911 & IPR2019-00914 (April 10, 2019)	
	4	Declaration of Brian W. Anthony, PhD regarding USPN 9,885,698 filed in IPR2019-00912 & IPR2019-00915 (April 10, 2019)	
	5	Proof of Service of Summons in Omni MedSci, Inc. v. Apple Inc., No. 2:18-cv-134 (E.D. Tex.) (Dkt. #12) (April 13, 2018)	
	6	U.S. Provisional Application No. 61/747,487 filed December 31, 2012	
	7	U.S. Provisional Application No. 61/747,472 filed December 31, 2012	
	8	U.S. Provisional Application No. 61/747,477 filed December 31, 2012	
	9	U.S. Provisional Application No. 61/754,698 filed January 21, 2013	
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	25	BAROLET, DANIEL, Light-Emitting Diodes (LEDs) in Dermatology, Seminars in Cutaneous Medicine and Surgery 27:227-238 (2008)	
	26	Omni MedSci Inc.'s Opening Claim Construction Brief filed in Case No. 2:18-cv-134-RWS (Dkt. #85) (Dec. 20, 2018)	
	27	Apple Inc.'s Preliminary Claim Constructions and Extrinsic Evidence Pursuant to Patent Local Rule 4-2 served in Case No. 2:18-cv-134-RWS (Nov. 1, 2018)	
	28	Excerpts from the American Heritage Dictionary, 5th Edition (July 2012)	
	29	Curriculum Vitae of Brian W. Anthony, PhD (Nov. 18, 2018)	
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	31	Excerpt from Claim Construction Markman Hearing Transcript filed in Case No. 2:18-cv-134-RWS (Feb. 6, 2019) Vol. 1, pgs. 1, 2, 21, 22	
	32	Dr. MOHAMMED ISLAM, Faculty Profile, University of Michigan, College of Engineering (available at https://islam.engin.umich.edu) (2019 The Regents of the University of Michigan)	
	33	Technology Transfer Policy, Office of Technology Transfer - University of Michigan (available at https://techtransfer.umich.edu/for-inventors/policies/technology-transfer-policy/) (revision effective June 1, 2009)	
	34	The Bylaws of the University of Michigan Board of Regents, (available at http://www.regents.umich.edu/bylaws/bylawsrevised_09-18.pdf) (last updated Sept. 20, 2018)	
	35	District Court Preliminary Claim Constructions in Case No. 2:18-cv-134-RWS (received February 6, 2019) from Court at Markman hearing	

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	37	File History for U.S. Patent No. 9,757,040 issued September 12, 2017	
	38	File History for U.S. Patent No. 9,861,286 issued January 9, 2018	
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Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Attorney Docket Number	OMNI 0101 PUSA5

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	2	20090287067	A1	2009-11-19	Dorogusker, et al.	
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Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Name/Print	David S. Bir	Registration Number	38383

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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.M.R/

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7318909	B2	2008-01-15	Lehmann et al.	
	2	8180422	B2	2012-05-15	Rebec	
	3	9207121	B2	2015-12-08	Adler	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20030107739	A1	2003-06-12	Lehmann et al.	
	2	20030109055	A1	2003-06-12	Lehmann et al.	
	3	20030152307	A1	2003-08-14	Drasek et al.	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	4	20050133691	A1	2005-06-23	Doppke et al.	
	5	20060283931	A1	2006-12-21	Polli et al.	
	6	20110267688	A1	2011-11-03	Kleppe et al.	
	7	20130327966	A1	2013-12-12	Fidler et al.	
	8	20140078510	A1	2014-03-20	Rubio Guivernau et al.	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2005013843	WO	A2	2005-02-17	The Regents of the University of California		
	2	2007061772	WO	A2	2007-05-31	OMNI SCIENCES, INC.		
	3	2009130464	WO	A1	2009-10-29	UNIVERSITY OF MANCHESTER		
	4	102010012987	DE	A1	2010-10-07	FRAUNHOFER GES FORSCHUNG		

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	ROBERT S. JONES ET AL.; Near-Infrared Transillumination At 1310-nm For The Imaging Of Early Dental Decay; Volume 11, No. 18; Optics Express 2259; September 8, 2003	
	2	Extended European Search Report for European Application No. 13867892.5 dated July 22, 2016	
	3	Extended European Search Report for European Application No. 13867874.3 dated July 15, 2016	
	4	VINAY V. ALEXANDER ET AL.; Modulation Instability High Power All-Fiber Supercontinuum Lasers And Their Applications; Optical Fiber Technology 18; 2012; pages 349-374	
	5	Final Office Action dated October 21, 2016 for U.S. Application No. 14/875,709	

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EXAMINER SIGNATURE

Examiner Signature	/MD M RAHMAN/	Date Considered	08/14/2019

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16506885
Filing Date	2019-07-09
First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5746206	A	1998-05-05	Mannheimer	
	2	6505133	B1	2003-01-07	Hanna et al.	
	3	8172761	B1	2012-05-08	Rulkov et al.	
	4	9241676	B2	2016-01-26	Lisogurski et al.	
	5	9596990	B2	2017-03-21	Park et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20050049468	A1	2005-03-03	Carlson et al.	

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Application Number	16506885
Filing Date	2019-07-09
First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

	2	20100217099	A1	2010-08-26	LeBoeuf et al.	
	3	20120197093	A1	2012-08-02	LeBoeuf et al.	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Inter Partes Review No. IPR2019-00910; Petition for Inter Partes Review of U.S. Patent No. 9,757,040; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-96; dated April 10, 2019	
	2	Inter Partes Review No. IPR2019-00911; Petition for Inter Partes Review of U.S. Patent No. 9,861,286; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-83; dated April 10, 2019	
	3	Inter Partes Review No. IPR2019-00912; Petition for Inter Partes Review of U.S. Patent No. 9,885,698; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-94; dated April 10, 2019	
	4	Inter Partes Review No. IPR2019-00913; Petition for Inter Partes Review of U.S. Patent No. 9,651,533; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-96; dated April 10, 2019	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16506885
	Filing Date	2019-07-09
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1636
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	5	Inter Partes Review No. IPR2019-00914; Petition for Inter Partes Review of U.S. Patent No. 9,861,286; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-90; dated April 10, 2019	
	6	Inter Partes Review No. IPR2019-00915; Petition for Inter Partes Review of U.S. Patent No. 9,885,698; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-91; dated April 10, 2019	
	7	Inter Partes Review No. IPR2019-00916; Petition for Inter Partes Review of U.S. Patent No. 9,651,533; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-90; dated April 10, 2019	
	8	Inter Partes Review No. IPR2019-00917; Petition for Inter Partes Review of U.S. Patent No. 9,757,040; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-93; dated April 10, 2019	

If you wish to add additional non-patent literature document citation information please click the Add button [Add]

EXAMINER SIGNATURE

Examiner Signature	/MD M RAHMAN/	Date Considered	08/13/2019

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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CERTIFICATION STATEMENT

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OR

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	38383

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5746206	A	1998-05-05	Mannheimer	
	2	6505133	B1	2003-01-07	Hanna et al.	
	3	8172761	B1	2012-05-08	Rulkov et al.	
	4	9241676	B2	2016-01-26	Lisogurski et al.	
	5	9596990	B2	2017-03-21	Park et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20050049468	A1	2005-03-03	Carlson et al.	

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	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	2	20100217099	A1	2010-08-26	LeBoeuf et al.	
	3	20120197093	A1	2012-08-02	LeBoeuf et al.	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
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	1	Inter Partes Review No. IPR2019-00910; Petition for Inter Partes Review of U.S. Patent No. 9,757,040; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-96; dated April 10, 2019	
	2	Inter Partes Review No. IPR2019-00911; Petition for Inter Partes Review of U.S. Patent No. 9,861,286; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-83; dated April 10, 2019	
	3	Inter Partes Review No. IPR2019-00912; Petition for Inter Partes Review of U.S. Patent No. 9,885,698; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-94; dated April 10, 2019	
	4	Inter Partes Review No. IPR2019-00913; Petition for Inter Partes Review of U.S. Patent No. 9,651,533; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-96; dated April 10, 2019	

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	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	5	Inter Partes Review No. IPR2019-00914; Petition for Inter Partes Review of U.S. Patent No. 9,861,286; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-90; dated April 10, 2019	
	6	Inter Partes Review No. IPR2019-00915; Petition for Inter Partes Review of U.S. Patent No. 9,885,698; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-91; dated April 10, 2019	
	7	Inter Partes Review No. IPR2019-00916; Petition for Inter Partes Review of U.S. Patent No. 9,651,533; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-90; dated April 10, 2019	
	8	Inter Partes Review No. IPR2019-00917; Petition for Inter Partes Review of U.S. Patent No. 9,757,040; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-93; dated April 10, 2019	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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Filing Date	2019-07-09
First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Attorney Docket Number	OMNI 0101 PUSA5

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	1	7787503	B2	2010-08-31	WADSWORTH	
	2	7800818	B2	2010-09-21	MATTSSON	
	3	8000574	B2	2011-08-16	BUCHTER	
	4	6611643	B2	2003-08-26	BIRK	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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	1	SUN, Y., C.F. Booker, S. Kumari, R.N. Day, M. Davidson, A. Periasamy, "Characterization of an orange acceptor fluorescent protein for sensitized spectral fluorescence resonant energy transfer microscopy using a white-light laser," Journal of Biomedical Optics, Vol. 14, no. 5, paper 054009 (2009).	
	2	BORLINGHAUS, R., "Colours Count: how the challenge of fluorescence was solved in confocal microscopy," in Modern Research and Educational Topics in Microscopy, A. Mendez-Vilas and J. Diaz, eds, pp. 890-899, Formatex (2007)	
	3	BORLINGHAUS, R., "The White Confocal: Continuous Spectral Tuning in Excitation and Emission," in Optical Fluorescence Microscopy, A. Diaspro (Ed), Chapter 2, pp. 37-54, ISBN 978-3-642-15174-3, Springer-Verlag, Berlin (2011).	
	4	BORLINGHAUS, R.T., L. Kuschel, "White Light Laser: The Ultimate Source for Confocal Microscopy," http://www.leica-microsystems.com/science-lab/white-light-laser (June 27, 2012).	
	5	ZIEGLER, U., A.G. Bittermann, M. Hoechli, "Introduction to Confocal Laser Scanning Microscopy (LEICA)," www.zmb.unizh.ch, May 29, 2013.	
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	First Named Inventor	Mohammed N. ISLAM
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	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

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Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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	1	4063106		1977-12-13	Ashkin, et al.	
	2	4158750		1979-06-19	Sakoe, et al.	
	3	4221997		1980-09-09	Flemming	
	4	4275266		1981-06-23	Lasar	
	5	4374618		1983-02-22	Howard	
	6	4403605		1983-09-13	Tanikawa	
	7	4462080		1984-07-24	Johnstone, et al.	
	8	4516207		1985-05-07	Moriyama, et al.	

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First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

	9	4523884		1985-06-18	Clement, et al.	
	10	4605080		1986-08-12	Lemelson	
	11	4641292		1987-02-03	Tunnell, et al.	
	12	4704696		1987-11-03	Reimer, et al.	
	13	4728974		1988-03-01	Nio, et al.	
	14	4762455		1988-08-09	Coughlan, et al.	
	15	4776016		1988-10-04	Hansen	
	16	4958910		1990-09-25	Taylor, et al.	
	17	4989253		1991-01-29	Liang, et al.	
	18	5078140		1992-01-07	Kwoh	
	19	5084880		1992-01-28	Esterowitz, et al.	

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	20	5086401		1992-02-04	Glassman, et al.	
	21	5134620		1992-07-28	Huber	
	22	5142930		1992-09-01	Allen, et al.	
	23	5180378		1993-01-19	Kung, et al.	
	24	5191628		1993-03-02	Byron	
	25	5218655		1993-06-08	Mizrahi	
	26	5230023		1993-07-20	Nakano	
	27	5267256		1993-11-30	Saruwatari, et al.	
	28	5267323		1993-11-30	Kimura	
	29	5300097		1994-04-05	Lerner, et al.	
	30	5303148		1994-04-12	Mattson, et al.	

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	31	5305427		1994-04-19	Nagata	
	32	5313306		1994-05-17	Kuban, et al.	
	33	5323404		1994-06-21	Grubb	
	34	5345538		1994-09-06	Narayannan, et al.	
	35	5408409		1995-04-18	Glassman, et al.	
	36	5544654		1996-08-13	Murphy, et al.	
	37	5572999		1996-11-12	Funda, et al.	
	38	5695493		1997-12-09	Nakajima, et al.	
	39	5696778		1997-12-09	MacPherson	
	40	5792204		1998-08-11	Snell	
	41	5812978		1998-09-22	Nolan	

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	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	42	5950629		1999-09-14	Taylor, et al.	
	43	5970457		1999-10-19	Brant, et al.	
	44	6014249		2000-01-11	Fermann, et al.	
	45	6185535		2001-02-06	Hedin, et al.	
	46	6200309		2001-03-13	Rice, et al.	
	47	6224542		2001-05-01	Chang, et al.	
	48	6246707		2001-06-12	Yin, et al.	
	49	6273858		2001-08-14	Fox, et al.	
	50	6278975		2001-08-21	Brant, et al.	
	51	6301273		2001-10-09	Sanders, et al.	
	52	6337462		2002-01-08	Smart	

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	53	6340806		2002-01-22	Smart, et al.	
	54	6350261		2002-02-26	Domankevitz, et al.	
	55	6374006		2002-04-16	Islam, et al.	
	56	6407853		2002-06-18	Samson, et al.	
	57	6436107		2002-08-20	Wang, et al.	
	58	6442430		2002-08-27	Ferek-Petric	
	59	6450172		2002-09-17	Hartlaub, et al.	
	60	6453201		2002-09-17	Daum, et al.	
	61	6458120		2002-10-01	Shen, et al.	
	62	6462500		2002-10-08	L'Hegarat, et al.	
	63	6463361		2002-10-08	Wang, et al.	

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Attorney Docket Number	OMNI 0101 PUSA5

	64	6567431		2003-05-20	Tabirian, et al.	
	65	6605080		2003-08-12	Altshuler, et al.	
	66	6625180		2003-09-23	Bufetov, et al.	
	67	6631025		2003-10-07	Islam, et al.	
	68	6659999		2003-12-09	Anderson, et al.	
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	71	6885683		2005-04-26	Fermann, et al.	
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	74	7060061		2006-06-13	Altshuler, et al.	

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	75	7167300		2007-01-23	Fermann, et al.	
	76	7259906		2007-08-21	Islam	
	77	7433116		2008-10-07	Islam	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20020032468		2002-03-14	Hill, Michael R.S. ; et al.	
	2	20020082612		2002-06-27	Moll, Frederic H. ; et al.	
	3	20020128846		2002-09-12	Miller, Steven C.	
	4	20020178003		2002-11-28	Gehrke, James K. ; et al.	
	5	20040174914		2004-09-09	Fukatsu, Susumu	

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	1	EP1148666	EP		2001-10-24	Grant Andrew R et al.		
	2	WO01150959	WO		2001-07-19	SUHM		
	3	WO09715240	WO		1997-05-01	BRANT		
	4	WO97049340	WO		1997-12-31	WANG		

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Doc description: Information Disclosure Statement (IDS) Filed

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(Not for submission under 37 CFR 1.99)

Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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	1	Islam, M. N., et al., "Broad bandwidths from frequency-shifting solitons in fibers", OPTICS LETTERS, Vol. 14, No. 7, April 1, 1989, pages 370-372.	
	2	Islam, M. N., et al., "Femtosecond distributed soliton spectrum in fibers", J. Opt. Soc. Am. B, Vol. 6, No. 6, June 1989, pages 1149-1158.	
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Attorney Docket Number	OMNI 0101 PUSA5

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

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(Not for submission under 37 CFR 1.99)

Application Number	16506885
Filing Date	2019-07-09
First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6246896	B1	2001-06-12	DUMOULIN	
	2	6285897	B1	2001-09-04	KILCOYNE	
	3	6847336	B1	2005-01-25	LEMELSON	

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Examiner Signature	/MD M RAHMAN/	Date Considered	08/13/2019

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Application Number	16506885
Filing Date	2019-07-09
First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	38383

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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Doc description: Information Disclosure Statement (IDS) Filed

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(Not for submission under 37 CFR 1.99)

Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5368224	A	1994-11-29	Richardson et al.	
	2	5746206	A	1998-05-05	Mannheimer	
	3	5795300	A	1998-08-18	Bryars	
	4	5919134	A	1999-07-06	Diab	
	5	6031603	A	2000-02-29	Fine et al	
	6	6325978	B1	2001-12-04	Labuda et al.	
	7	6701170	B2	2004-03-02	Stetson	
	8	6708048	B1	2004-03-16	Chance	

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Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

	9	6731967	B1	2004-05-04	Turcott	
	10	6916096	B2	2005-07-12	Eberl et al.	
	11	7184148	B2	2007-02-27	Alphonse	
	12	7332784	B2	2008-02-19	Mills et al.	
	13	7468036	B1	2008-12-23	Rulkov et al.	
	14	7648463	B1	2010-01-19	Elhag et al.	
	15	8172761	B1	2012-05-08	Rulkov et al.	
	16	8180591	B2	2012-05-15	Yuen et al.	
	17	8310336	B2	2012-11-13	Muhsin et al.	
	18	8315682	B2	2012-11-20	Such et al.	
	19	8463576	B2	2013-06-11	Yuen et al.	

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	Application Number	
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	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	20	8475367	B1	2013-07-02	Yuen et al.	
	21	8755871	B2	2014-06-17	Weng et al.	
	22	8945017	B2	2015-02-03	Venkatraman et al.	
	23	8954135	B2	2015-02-10	Yuen et al.	
	24	9142117	B2	2015-09-22	Muhsin et al.	
	25	9179876	B2	2015-11-10	Ochs et al.	
	26	9192329	B2	2015-11-24	Al-Ali	
	27	9241676	B2	2016-01-26	Lisogurski et al.	
	28	9596990	B2	2017-03-21	Park et al.	
	29	9651533	B2	2017-05-16	Islam	
	30	9675250	B2	2017-06-13	Tverskoy	

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	Filing Date	
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	31	9757040	B2	2017-09-12	Islam	
	32	9820658	B2	2017-11-21	Tran	
	33	9861286	B1	2018-01-09	Islam	
	34	9885698	B2	2018-02-06	Islam	
	35	RE44875	E	2014-04-29	Kiani et al.	

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	1	20050049468	A1	2005-03-03	Carlson et al.	
	2	20050209516	A1	2005-09-22	Fraden	
	3	20110237911	A1	2011-09-29	Lamego et al.	
	4	20120203077	A1	2012-08-09	He et al.	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

	5	20120310062	A1	2012-12-06	Li et al.	
	6	20130303921	A1	2013-11-14	CHU et al.	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2005270544	JP	A	2005-10-06	Seiko Instruments Inc.		

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit A), 66 pps	
	2	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit B), 73 pps	
	3	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit C), 85 pps	
	4	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit D), 38 pps	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
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Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

	5	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit E), 120 pps	
	6	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit F), 40 pps	
	7	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit G), 66 pps	
	8	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit H), 74 pps	
	9	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit I), 102 pps	
	10	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit J), 64 pps	
	11	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit K), 77 pps	
	12	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit L), 64 pps	
	13	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit M), 119 pps	
	14	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit N), 50 pps	
	15	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit O), 63 pps	

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Attorney Docket Number	OMNI 0101 PUSA5

	16	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit P), 78 pps	
	17	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit Q), 69 pps	
	18	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit R), 61 pps	
	19	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit S), 50 pps	
	20	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit T), 174 pps	
	21	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit U), 334 pps	
	22	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit V), 137 pps	
	23	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit W), 384 pps	
	24	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit X), 291 pps	
	25	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit Y), 120 pps	
	26	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit Z), 53 pps	

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	Application Number	
	Filing Date	
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	27	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit AA), 75 pps
	28	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit BB), 65 pps
	29	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit CC), 320 pps
	30	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit DD), 240 pps
	31	RHEE et al., Artifact-Resistant Power-Efficient Design of Finger-Ring Plethysmographic Sensors, IEEE Transactions on Biomedical Engineering (July 2001), Vol. 48, No. 7, Cambridge, MA, 11 pages.
	32	BRANCHE et al., Signal Quality and Power Consumption of a New Prototype Reflectance Pulse Oximeter Sensor, Proceedings of the IEEE 31st Annual Northeast Bioengineering Conference (2005), Hoboken, NJ, 2 pages.
	33	PELÁEZ, LED Power Reduction Trade-Offs for Ambulatory Pulse Oximetry, Conference Proceedings of the 29th Annual International Conference of the IEEE EMBS (August 2007) Lyon, France, 4 pages.
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	35	ASADA et al., The MIT Ring: History, Technology, and Challenges of Wearable Health Monitoring, MIT Industrial Liaison Program (2010) R&D Conference, MA, 72 pages.
	36	ASADA et al., Mobile Monitoring with Wearable Photoplethysmographic Biosensors, Technical and Clinical Aspects of a Ring Sensor for Ambulatory, Telemetric, Continuous Health Monitoring in the Field, in the Hospital, and in the Home, IEEE Engineering in Medicine and Biology Magazine, (May/June 2003) 13 pages.
	37	SCHREINER et al., Blood Oxygen Level Measurement with a Chest-Based Pulse Oximetry Prototype System, Computing in Cardiology (2010) NIBEC, University of Ulster, Newtownabbey, Northern Ireland, 4 pages.

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	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	38	GE HEALTHCARE, TuffSat User's Guide and Service Manual Electromagnetic Compatibility (EMC), (March 2005) Helsinki, Finland, 43 pages.	
	39	KURYLYAK et al., Smartphone-Based Photoplethysmogram Measurement, Department of Electronics, Computer and System Sciences, (2012) River Publishers, University of Calabria, Italy, 30 pages.	
	40	PATTERSON et al., Ratiometric Artifact Reduction in Low Power Reflective Photoplethysmography, (August 2011) IEEE Transactions on Biomedical Circuits and Systems, Vol. 5, No. 4, 9 pages.	
	41	CAI et al., Implementation of a Wireless Pulse Oximeter Based on Wrist Band Sensor, College of Biological Science and Medical Engineering Southeast University, (2010) 3rd International Conference on Biomedical Engineering and Informatics, Nanjing, China, 4 pages.	
	42	YAMAHA, BODiBEAT, Body, Music, In Sync., BF-1 Quick Guide, Player/Heart Rate Monitor: Quick Manual, 120 pages.	
	43	GE HEALTHCARE, GE Ohmeda TufSat Oximeter for Clinicians on the go, (2012), A General Electric Co., www.gehealthcare.com, GE, Finland, 4 pages.	
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	45	WEBSTER, Design of Pulse Oximeters, Medical Science Series (1997), Department of Electrical and Computer Engineering, University of Wisconsin- Madison, Institute of Physics Publishing, Bristol and Philadelphia, 267 pages.	
	46	TAOS, INC., Infrared Light-to-Voltage Optical Sensors, (2006) Texas Advanced Optoelectronic Solutions Inc., The Lumenology Company, TX, 14 pages.	
	47	JUNG et al., Design of A Low-Power Consumption Wearable Reflectance Pulse Oximetry for Ubiquitous Healthcare System, International Conference on Control, Automation and Systems (October 2008), in COEX, Seoul, Korea, 4 pages.	
	48	EMBEDDED-LAB, Introducing Easy Pulse: A DIY Photoplethysmographic Sensor for Measuring Hearth Rate, posted on www.Embedded-Lab.com September 12, 2012, by R-B, 10 pages.	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	OMNI 0101 PUSA5

	49	ASARE et al., Analysis of Multi-Spectral Photoplethysmograph Biosensors, Proc. SPIE 8801, Novel Biophotonic Techniques and Applications II, 880106 (June 2013), European Conferences on Biomedical Optics, Munich, Germany, 7 pages.
	50	MORÓN et al, A Wireless Monitoring System for Pulse-Oximetry Sensors, (2005) Electronic Technology Department, University of Málaga, Spain, 6 pages.

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Examiner Signature	/MD M RAHMAN/	Date Considered	08/14/2019

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Application Number	16506885
Filing Date	2019-07-09
First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	4063106		1977-12-13	Ashkin, et al.	
	2	4158750		1979-06-19	Sakoe, et al.	
	3	4221997		1980-09-09	Flemming	
	4	4275266		1981-06-23	Lasar	
	5	4374618		1983-02-22	Howard	
	6	4403605		1983-09-13	Tanikawa	
	7	4462080		1984-07-24	Johnstone, et al.	
	8	4516207		1985-05-07	Moriyama, et al.	

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	9	4523884		1985-06-18	Clement, et al.	
	10	4605080		1986-08-12	Lemelson	
	11	4641292		1987-02-03	Tunnell, et al.	
	12	4704696		1987-11-03	Reimer, et al.	
	13	4728974		1988-03-01	Nio, et al.	
	14	4762455		1988-08-09	Coughlan, et al.	
	15	4776016		1988-10-04	Hansen	
	16	4958910		1990-09-25	Taylor, et al.	
	17	4989253		1991-01-29	Liang, et al.	
	18	5078140		1992-01-07	Kwoh	
	19	5084880		1992-01-28	Esterowitz, et al.	

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	20	5086401		1992-02-04	Glassman, et al.	
	21	5134620		1992-07-28	Huber	
	22	5142930		1992-09-01	Allen, et al.	
	23	5180378		1993-01-19	Kung, et al.	
	24	5191628		1993-03-02	Byron	
	25	5218655		1993-06-08	Mizrahi	
	26	5230023		1993-07-20	Nakano	
	27	5267256		1993-11-30	Saruwatari, et al.	
	28	5267323		1993-11-30	Kimura	
	29	5300097		1994-04-05	Lerner, et al.	
	30	5303148		1994-04-12	Mattson, et al.	

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	31	5305427		1994-04-19	Nagata	
	32	5313306		1994-05-17	Kuban, et al.	
	33	5323404		1994-06-21	Grubb	
	34	5345538		1994-09-06	Narayannan, et al.	
	35	5408409		1995-04-18	Glassman, et al.	
	36	5544654		1996-08-13	Murphy, et al.	
	37	5572999		1996-11-12	Funda, et al.	
	38	5695493		1997-12-09	Nakajima, et al.	
	39	5696778		1997-12-09	MacPherson	
	40	5792204		1998-08-11	Snell	
	41	5812978		1998-09-22	Nolan	

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	42	5950629		1999-09-14	Taylor, et al.	
	43	5970457		1999-10-19	Brant, et al.	
	44	6014249		2000-01-11	Fermann, et al.	
	45	6185535		2001-02-06	Hedin, et al.	
	46	6200309		2001-03-13	Rice, et al.	
	47	6224542		2001-05-01	Chang, et al.	
	48	6246707		2001-06-12	Yin, et al.	
	49	6273858		2001-08-14	Fox, et al.	
	50	6278975		2001-08-21	Brant, et al.	
	51	6301273		2001-10-09	Sanders, et al.	
	52	6337462		2002-01-08	Smart	

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	53	6340806		2002-01-22	Smart, et al.	
	54	6350261		2002-02-26	Domankevitz, et al.	
	55	6374006		2002-04-16	Islam, et al.	
	56	6407853		2002-06-18	Samson, et al.	
	57	6436107		2002-08-20	Wang, et al.	
	58	6442430		2002-08-27	Ferek-Petric	
	59	6450172		2002-09-17	Hartlaub, et al.	
	60	6453201		2002-09-17	Daum, et al.	
	61	6458120		2002-10-01	Shen, et al.	
	62	6462500		2002-10-08	L'Hegarat, et al.	
	63	6463361		2002-10-08	Wang, et al.	

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	64	6567431		2003-05-20	Tabirian, et al.	
	65	6605080		2003-08-12	Altshuler, et al.	
	66	6625180		2003-09-23	Bufetov, et al.	
	67	6631025		2003-10-07	Islam, et al.	
	68	6659999		2003-12-09	Anderson, et al.	
	69	6760148		2004-07-06	Islam	
	70	6885498		2005-04-26	Islam	
	71	6885683		2005-04-26	Fermann, et al.	
	72	6943936		2005-09-13	Islam, et al.	
	73	7027467		2006-04-11	Baev, et al.	
	74	7060061		2006-06-13	Altshuler, et al.	

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	75	7167300		2007-01-23	Fermann, et al.	
	76	7259906		2007-08-21	Islam	
	77	7433116		2008-10-07	Islam	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20020032468		2002-03-14	Hill, Michael R.S. ; et al.	
	2	20020082612		2002-06-27	Moll, Frederic H. ; et al.	
	3	20020128846		2002-09-12	Miller, Steven C.	
	4	20020178003		2002-11-28	Gehrke, James K. ; et al.	
	5	20040174914		2004-09-09	Fukatsu, Susumu	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	EP1148666	EP		2001-10-24	Grant Andrew R et al.		
	2	WO01150959	WO		2001-07-19	SUHM		
	3	WO09715240	WO		1997-05-01	BRANT		
	4	WO97049340	WO		1997-12-31	WANG		

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See attached certification statement.

Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

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Attorney Docket Number	OMNI 0101 PUSA5

	1	NELLCOR; Charts 1-3: NELLCOR-533; U.S. Patent No. 9,651,533 vs. Nellcor; Omni MedSci, Inc. v. Apple Inc., pps. 1-155; May 22, 2019	
	2	LISOGURSKI; Charts 1-3: LISOGURSKI-533; U.S. Patent No. 9,651,533 vs. Lisogurski; Omni MedSci, Inc. v. Apple Inc., pps. 1-84; May 22, 2019	
	3	ASADA; Charts 1-3: ASADA-533; U.S. Patent No. 9,651,533 vs. Asada; Omni MedSci, Inc. v. Apple Inc., pps. 1-188; May 22, 2019	
	4	PARK; Charts 1-3: Park-533; U.S. Patent No. 9,651,533 vs. Park; Omni MedSci, Inc. v. Apple Inc., pps. 1-171; May 22, 2019	
	5	VALENCELL; Charts 1-3: Valencell-533; U.S. Patent No. 9,651,533 vs. Valencell; Omni MedSci, Inc. v. Apple Inc., pps. 1-122; May 22, 2019	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16506885
Filing Date	2019-07-09
First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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☒ A certification statement is not submitted herewith.

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	63108

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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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	1	8180422	B2	2012-05-15	Rebec	

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	1	20050133691	A1	2005-06-23	Doppke et al.	
	2	20090244288	A1	2009-10-01	FUJIMOTO et al.	
	3	20110267688	A1	2011-11-03	Kleppe et al.	
	4	20130327966	A1	2013-12-12	Fidler et al.	
	5	20140078510	A1	2014-03-20	Rubio Guivernau et al.	

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	6	20140249427	A1	2014-09-04	Liu			

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	1	102010012987	DE	A1	2010-10-07	FRAUNHOFER GES FORSCHUNG		
	2	2005013843	WO	A2	2005-02-17	The Regents of the University of California		
	3	2007061772	WO	A2	2007-05-31	OMNI SCIENCES, INC.		
	4	2009130464	WO	A1	2009-10-29	UNIVERSITY OF MANCHESTER		

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	1	VINAY V. ALEXANDER ET AL.; Modulation Instability High Power All-Fiber Supercontinuum Lasers And Their Applications; Optical Fiber Technology 18; 2012; pages 349-374.	
	2	ROBERT S. JONES ET AL.; Near-Infrared Transillumination At 1310-nm For The Imaging Of Early Dental Decay; Volume 11, No. 18; Optics Express 2259; September 8, 2003	

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	3	Extended European Search Report for European Application No. 13867874.3 dated July 15, 2016
	4	Extended European Search Report for European Application No. 13867892.5 dated July 22, 2016

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Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	38383

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Doc code: IDS
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	1	Pan, Yingtian, et al., "Hand-held arthroscopic optical coherence tomography for in vivo high-resolution imaging of articular cartilage", Journal of Biomedical Optics 8(4), October 2003, pages 648-654.
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	30	U.S. Appln. Serial No. 12/206432, "System and Method for Voice Control of Medical Devices," by Mohammed N. Islam, pending (074036.0154) Date filed: September 8, 2008
	31	U.S. Patent and Trademark Office, Office Action for USSN 12/206,432, filed 09/08/2008, Mohammed N, Islam, Attorney Docket No. 074036.0154, Date filed: March 12, 2009
	32	U.S. Patent and Trademark Office, Notice of Allowance and Fee(s) Due for USSN 12/206,432, filed 09/08/2008, Mohammed N. Islam, Attorney Docket No. 074036.0154, Date filed: August 28, 2009

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Examiner Signature	/MD M RAHMAN/	Date Considered	08/13/2019

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[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16506885
Filing Date	2019-07-09
First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-10
Name/Print	David S. Bir	Registration Number	38383

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16506885
Filing Date	2019-07-09
First Named Inventor	Mohammed N. ISLAM
Art Unit	1636
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5267152	A	1993-11-30	Yang et al.	
	2	7356364	B1	2008-04-08	Bullock et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20070021670	A1	2007-01-25	Mandelis et al.	
	2	20110282167	A1	2011-11-17	Ridder et al.	
	3	20120239013	A1	2012-09-20	Islam	

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Attorney Docket Number	OMNI 0101 PUSA5

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	International Search Report and Written Opinion for International Application No. PCT/US2013/075767 dated October 14, 2014	
	2	International Preliminary Report on Patentability for International Application No. PCT/US2013/07567 dated July 9, 2015	

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EXAMINER SIGNATURE

Examiner Signature	/MD M RAHMAN/	Date Considered	08/13/2019

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Name/Print	David S. Bir	Registration Number	38383

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16/506,885 - GAU: 2886
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5368224	A	1994-11-29	Richardson et al.	
	2	5746206	A	1998-05-05	Mannheimer	
	3	5795300	A	1998-08-18	Bryars	
	4	5919134	A	1999-07-06	Diab	
	5	6031603	A	2000-02-29	Fine et al	
	6	6325978	B1	2001-12-04	Labuda et al.	
	7	6701170	B2	2004-03-02	Stetson	
	8	6708048	B1	2004-03-16	Chance	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Mohammed N. ISLAM
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

	9	6731967	B1	2004-05-04	Turcott	
	10	6916096	B2	2005-07-12	Eberl et al.	
	11	7184148	B2	2007-02-27	Alphonse	
	12	7332784	B2	2008-02-19	Mills et al.	
	13	7468036	B1	2008-12-23	Rulkov et al.	
	14	7648463	B1	2010-01-19	Elhag et al.	
	15	8172761	B1	2012-05-08	Rulkov et al.	
	16	8180591	B2	2012-05-15	Yuen et al.	
	17	8310336	B2	2012-11-13	Muhsin et al.	
	18	8315682	B2	2012-11-20	Such et al.	
	19	8463576	B2	2013-06-11	Yuen et al.	

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Attorney Docket Number	OMNI 0101 PUSA5

	20	8475367	B1	2013-07-02	Yuen et al.	
	21	8755871	B2	2014-06-17	Weng et al.	
	22	8945017	B2	2015-02-03	Venkatraman et al.	
	23	8954135	B2	2015-02-10	Yuen et al.	
	24	9142117	B2	2015-09-22	Muhsin et al.	
	25	9179876	B2	2015-11-10	Ochs et al.	
	26	9192329	B2	2015-11-24	Al-Ali	
	27	9241676	B2	2016-01-26	Lisogurski et al.	
	28	9596990	B2	2017-03-21	Park et al.	
	29	9651533	B2	2017-05-16	Islam	
	30	9675250	B2	2017-06-13	Tverskoy	

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Art Unit	
Examiner Name	
Attorney Docket Number	OMNI 0101 PUSA5

	31	9757040	B2	2017-09-12	Islam	
	32	9820658	B2	2017-11-21	Tran	
	33	9861286	B1	2018-01-09	Islam	
	34	9885698	B2	2018-02-06	Islam	
	35	RE44875	E	2014-04-29	Kiani et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20050049468	A1	2005-03-03	Carlson et al.	
	2	20050209516	A1	2005-09-22	Fraden	
	3	20110237911	A1	2011-09-29	Lamego et al.	
	4	20120203077	A1	2012-08-09	He et al.	

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	Art Unit	
	Examiner Name	
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	5	20120310062	A1	2012-12-06	Li et al.	
	6	20130303921	A1	2013-11-14	CHU et al.	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2005270544	JP	A	2005-10-06	Seiko Instruments Inc.		

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit A), 66 pps	
	2	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit B), 73 pps	
	3	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit C), 85 pps	
	4	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit D), 38 pps	

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Attorney Docket Number	OMNI 0101 PUSA5

	5	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit E), 120 pps	
	6	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit F), 40 pps	
	7	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit G), 66 pps	
	8	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit H), 74 pps	
	9	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit I), 102 pps	
	10	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit J), 64 pps	
	11	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit K), 77 pps	
	12	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit L), 64 pps	
	13	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit M), 119 pps	
	14	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit N), 50 pps	
	15	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit O), 63 pps	

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	16	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit P), 78 pps	
	17	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit Q), 69 pps	
	18	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit R), 61 pps	
	19	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit S), 50 pps	
	20	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit T), 174 pps	
	21	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit U), 334 pps	
	22	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit V), 137 pps	
	23	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit W), 384 pps	
	24	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit X), 291 pps	
	25	OMNI MEDSCI, INC. V. APPLE INC.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, August 28, 2018 (Exhibit Y), 120 pps	
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Art Unit	
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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David S. Bir/	Date (YYYY-MM-DD)	2019-07-08
Name/Print	David S. Bir	Registration Number	38383

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Application Number	16/506,885 - GAU: 2886
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First Named Inventor	Mohammed N. ISLAM
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