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Ju et al.

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(54) **MASSIVE PARALLEL METHOD FOR DECODING DNA AND RNA**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

4,711,955 A 12/1987 Ward et al.
4,772,691 A 9/1988 Herman
(Continued)

FOREIGN PATENT DOCUMENTS

CA 2425112 4/2002
CA 2408143 11/2002
(Continued)

OTHER PUBLICATIONS

Non-Final Office Action issued by the U.S. Patent and Trademark Office dated Feb. 8, 2017 in connection with U.S. Appl. No. 15/380,284.

(Continued)

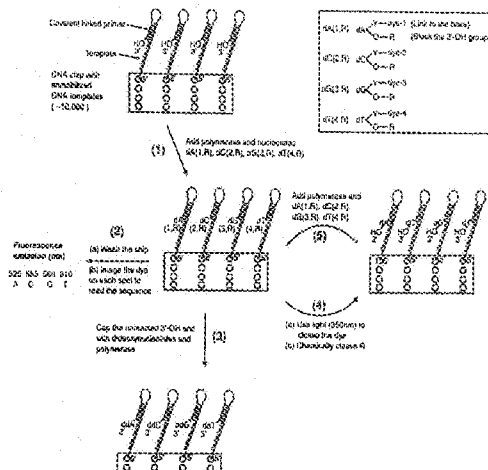
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(57) **ABSTRACT**

This invention provides methods for attaching a nucleic acid to a solid surface and for sequencing nucleic acid by detecting the identity of each nucleotide analog after the nucleotide analog is incorporated into a growing strand of DNA in a polymerase reaction. The invention also provides nucleotide analogs which comprise unique labels attached to the nucleotide analog through a cleavable linker, and a cleavable chemical group to cap the —OH group at the 3'-position of the deoxyribose.

2 Claims, 28 Drawing Sheets



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(56) **References Cited**

U.S. PATENT DOCUMENTS

4,804,748	A	2/1989	Seela	5,728,528	A	3/1998	Mathies et al.
4,824,775	A	4/1989	Dattagupta et al.	5,763,594	A	6/1998	Hiatt et al.
4,863,849	A	9/1989	Melamede	5,770,365	A	6/1998	Lane et al.
5,043,272	A	8/1991	Hartley	5,770,367	A	6/1998	Southern et al.
5,047,519	A	9/1991	Hobbs, Jr. et al.	5,789,167	A	8/1998	Konrad
5,118,605	A	6/1992	Urdea	5,798,210	A	8/1998	Canard et al.
5,151,507	A	9/1992	Hobbs, Jr. et al.	5,804,386	A	9/1998	Ju
5,174,962	A	12/1992	Brennan	5,808,045	A	9/1998	Hiatt et al.
5,175,269	A	12/1992	Stavrianopoulos	5,814,454	A	9/1998	Ju
5,242,796	A	9/1993	Prober et al.	5,821,356	A	10/1998	Khan et al.
5,302,509	A	4/1994	Cheeseman	5,834,203	A	11/1998	Katzir et al.
5,308,990	A	5/1994	Takahashi et al.	5,844,106	A	12/1998	Seela et al.
5,328,824	A	7/1994	Ward et al.	5,849,542	A	12/1998	Reeve et al.
5,332,666	A	7/1994	Prober et al.	5,853,992	A	12/1998	Glazer et al.
5,383,858	A	1/1995	Reilly et al.	5,856,104	A	1/1999	Chee et al.
5,436,143	A	7/1995	Hyman	5,869,255	A	2/1999	Mathies et al.
5,437,975	A	8/1995	McClelland et al.	5,872,244	A	2/1999	Hiatt et al.
5,449,767	A	9/1995	Ward et al.	5,876,936	A	3/1999	Ju
5,476,928	A	12/1995	Ward et al.	5,885,775	A	3/1999	Haff et al.
5,516,664	A	5/1996	Hyman	5,908,755	A	6/1999	Kumar et al.
5,534,424	A	7/1996	Uhlen et al.	5,945,283	A	8/1999	Kwok et al.
5,547,839	A	8/1996	Dower et al.	5,948,648	A	9/1999	Khan et al.
5,547,859	A	8/1996	Goodman et al.	5,952,180	A	9/1999	Ju
5,556,748	A	9/1996	Douglas	5,959,089	A	9/1999	Hannessian
5,599,675	A	2/1997	Brenner	5,962,228	A	10/1999	Brenner
5,602,000	A	2/1997	Hyman	6,001,566	A	12/1999	Canard et al.
5,637,469	A	6/1997	Wilding et al.	6,001,611	A	12/1999	Will
5,654,419	A	8/1997	Mathies et al.	6,008,379	A	12/1999	Benson et al.
5,658,736	A	8/1997	Wong	6,013,445	A	1/2000	Albrecht et al.
				6,028,190	A	2/2000	Mathies et al.
				6,046,005	A	4/2000	Ju et al.
				6,074,823	A	6/2000	Koster
				6,087,095	A	7/2000	Rosenthal et al.
				6,136,543	A	10/2000	Anazawa et al.
				6,175,107	B1	1/2001	Juvinall
				6,197,557	B1	3/2001	Makarov et al.
				6,207,831	B1	3/2001	Auer et al.
				6,210,891	B1	4/2001	Nyren et al.
				6,214,987	B1	4/2001	Hiatt et al.
				6,218,118	B1	4/2001	Sampson et al.
				6,218,530	B1	4/2001	Rothschild et al.
				6,221,592	B1	4/2001	Schwartz et al.
				6,232,465	B1	5/2001	Hiatt et al.
				6,242,193	B1	6/2001	Anazawa et al.
				6,245,507	B1	6/2001	Bogdanov
				6,255,083	B1	7/2001	Williams
				6,255,475	B1	7/2001	Kwiatkowski
				6,274,320	B1	8/2001	Rothberg et al.
				6,277,607	B1	8/2001	Tyagi et al.
				6,287,821	B1	9/2001	Shi et al.
				6,294,324	B1	9/2001	Bensimon et al.
				6,309,829	B1	10/2001	Livak et al.
				6,309,836	B1	10/2001	Kwiatkowski
				6,312,893	B1	11/2001	Van Ness et al.
				6,316,230	B1	11/2001	Egholm et al.
				6,335,155	B1	1/2002	Wells et al.
				6,361,940	B1	3/2002	Van Ness et al.
				6,380,378	B1	4/2002	Kitamura et al.
				6,495,680	B1	12/2002	Gong
				6,524,829	B1	2/2003	Seeger
				6,555,349	B1	4/2003	O'Donnell
				6,613,508	B1	9/2003	Ness et al.
				6,613,513	B1	9/2003	Parce et al.
				6,627,748	B1	9/2003	Ju et al.
				6,632,655	B1	10/2003	Mehta et al.
				6,639,088	B2	10/2003	Kwiatkowski
				6,664,079	B2	12/2003	Ju et al.
				6,664,399	B1	12/2003	Sabesan
				6,713,255	B1	3/2004	Makino et al.
				6,780,591	B2	8/2004	Williams et al.
				6,787,308	B2	9/2004	Balasubramanian et al.
				6,818,395	B1	11/2004	Quake et al.
				6,833,246	B2	12/2004	Balasubramanian
				6,858,393	B1	2/2005	Anderson et al.
				6,864,052	B1	3/2005	Drmanac et al.
				6,911,345	B2	6/2005	Quake et al.
				6,934,636	B1	8/2005	Skierczynski et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

7,056,661 B2 6/2006 Korlach et al.
 7,056,666 B2 6/2006 Dower et al.
 7,057,026 B2 6/2006 Barnes et al.
 7,057,031 B2 6/2006 Olejnik et al.
 7,074,597 B2 7/2006 Ju
 7,078,499 B2 7/2006 Odedra et al.
 7,105,300 B2 9/2006 Parce et al.
 7,270,951 B1 9/2007 Stemple et al.
 7,279,563 B2 10/2007 Kwiatkowski
 7,329,496 B2 2/2008 Dower et al.
 7,345,159 B2 3/2008 Ju et al.
 7,414,116 B2 8/2008 Milton et al.
 7,427,673 B2 9/2008 Balasubramanian et al.
 7,459,275 B2 12/2008 Dower et al.
 7,566,537 B2 7/2009 Balasubramanian et al.
 7,622,279 B2 11/2009 Ju
 7,635,578 B2 12/2009 Ju et al.
 7,713,698 B2 5/2010 Ju et al.
 7,790,869 B2 9/2010 Ju et al.
 7,883,869 B2 2/2011 Ju et al.
 7,982,029 B2 7/2011 Ju et al.
 8,088,575 B2 1/2012 Ju et al.
 8,158,346 B2 4/2012 Balasubramanian et al.
 8,298,792 B2 10/2012 Ju et al.
 8,399,188 B2 3/2013 Zhao et al.
 8,796,432 B2 8/2014 Ju et al.
 8,889,348 B2 11/2014 Ju
 9,115,163 B2 8/2015 Ju et al.
 9,133,511 B2 9/2015 Ju et al.
 9,159,610 B2 10/2015 Zhang et al.
 9,175,342 B2 11/2015 Ju et al.
 9,255,292 B2 2/2016 Ju et al.
 9,297,042 B2 3/2016 Ju et al.
 9,708,358 B2 7/2017 Ju et al.
 9,718,852 B2 8/2017 Ju et al.
 9,719,139 B2 8/2017 Ju et al.
 9,725,480 B2 8/2017 Ju et al.
 2002/0012966 A1 1/2002 Shi et al.
 2002/0168642 A1 11/2002 Drukier
 2003/0008285 A1 1/2003 Fischer
 2003/0022225 A1 1/2003 Monforte et al.
 2003/0027140 A1 2/2003 Ju et al.
 2003/0044871 A1 3/2003 Cutsforth et al.
 2003/0054360 A1 3/2003 Gold et al.
 2003/0099972 A1 5/2003 Olejnik et al.
 2003/0166282 A1 9/2003 Brown et al.
 2003/0180769 A1 9/2003 Metzker
 2003/0186256 A1 10/2003 Fischer
 2003/0190680 A1 10/2003 Rothschild et al.
 2003/0198982 A1 10/2003 Seela et al.
 2004/0014096 A1 1/2004 Anderson et al.
 2004/0096825 A1 5/2004 Chenna et al.
 2005/0032081 A1 2/2005 Ju et al.
 2005/0170367 A1 8/2005 Quake et al.
 2005/0239134 A1 10/2005 Gorenstein et al.
 2006/0003352 A1 1/2006 Lipkin et al.
 2006/0057565 A1 3/2006 Ju et al.
 2006/0105461 A1 5/2006 Tom-Moy et al.
 2006/0160081 A1 7/2006 Milton et al.
 2006/0160113 A1 7/2006 Korlach et al.
 2006/0240439 A1 10/2006 Smith et al.
 2006/0252038 A1 11/2006 Ju
 2007/0166705 A1 7/2007 Milton et al.
 2009/0088332 A1 4/2009 Ju et al.
 2009/0240030 A1 9/2009 Ju et al.
 2010/0159531 A1 6/2010 Gordon et al.
 2011/0014611 A1 1/2011 Ju et al.
 2011/0124054 A1 5/2011 Olejnik et al.
 2012/0052489 A1 3/2012 Gordon et al.
 2012/0142006 A1 6/2012 Ju et al.
 2013/0264207 A1 10/2013 Ju et al.
 2014/0315191 A1 10/2014 Ju et al.
 2015/0037788 A1 2/2015 Ju

2015/0119259 A1 4/2015 Ju et al.
 2015/0197800 A1 7/2015 Ju et al.
 2015/0368710 A1 12/2015 Fuller et al.
 2016/0024570 A1 1/2016 Ju et al.
 2016/0024574 A1 1/2016 Ju et al.
 2016/0041179 A1 2/2016 Ju et al.
 2016/0090621 A1 3/2016 Ju et al.

FOREIGN PATENT DOCUMENTS

DE 4141178 6/1993
 DE 20122767 9/2007
 DE 112007002932.3 8/2015
 EP 0251786 B1 11/1994
 EP 0995804 4/2000
 EP 1182267 2/2002
 EP 1291354 3/2003
 EP 0808320 4/2003
 EP 1337541 B1 3/2007
 EP 1218391 4/2007
 EP 0992511 3/2009
 EP 2209911 B1 10/2013
 GB 2000 0013276 6/2000
 GB 2001 0029012 12/2001
 GB 2446083 3/2011
 GB 2446084 3/2011
 GB 2457402 9/2011
 WO WO 1989/09282 10/1989
 WO WO 1989/11548 11/1989
 WO WO 1990/13666 11/1990
 WO WO 1991/06678 5/1991
 WO WO 1992/10587 6/1992
 WO WO 1993/05183 3/1993
 WO WO 93/12340 10/1993
 WO WO 1993/21340 10/1993
 WO WO 1994/14972 7/1994
 WO WO 1996/07669 3/1996
 WO WO 96/23807 8/1996
 WO WO 1996/23807 8/1996
 WO WO 1996/27025 9/1996
 WO WO 1997/08183 3/1997
 WO WO 1997/27317 7/1997
 WO WO 1997/35033 9/1997
 WO WO 1998/30720 7/1998
 WO WO 1998/33939 8/1998
 WO WO 1998/44151 10/1998
 WO WO 1999/05315 2/1999
 WO WO 1999/49082 9/1999
 WO WO 1999/57321 11/1999
 WO WO 2000/02895 1/2000
 WO WO 2000/06770 2/2000
 WO WO 2000/09753 2/2000
 WO WO 2000/15844 3/2000
 WO WO 2000/18956 4/2000
 WO WO 2000/21974 4/2000
 WO WO 2000/50172 8/2000
 WO WO 2000/50642 8/2000
 WO WO 2000/53805 9/2000
 WO WO 2000/53812 9/2000
 WO WO 2000/70073 11/2000
 WO WO 2001/16375 3/2001
 WO WO 2001/23610 4/2001
 WO WO 2001/25247 4/2001
 WO WO 2001/27625 4/2001
 WO WO 2001/32930 5/2001
 WO WO 2001/57248 8/2001
 WO WO 2001/57249 8/2001
 WO WO 2001/92284 12/2001
 WO WO 2002/02813 1/2002
 WO WO 02/21098 3/2002
 WO WO 2002/22883 3/2002
 WO WO 2002/29003 4/2002
 WO WO 2002/72892 9/2002
 WO WO 2002/079519 10/2002
 WO WO 2002/88381 11/2002
 WO WO 2002/88382 11/2002
 WO WO 2003/02767 1/2003

(56)

References Cited

FOREIGN PATENT DOCUMENTS

WO	WO 2003/48387	6/2003
WO	WO 2003/85135	10/2003
WO	WO 04/18493	3/2004
WO	WO 04/18497	3/2004
WO	WO 2004/18493	3/2004
WO	WO 2004/18497	3/2004
WO	WO 2004/055160	7/2004
WO	WO 2005/084367	9/2005
WO	WO 2006/73436	7/2006
WO	WO 2007/002204	1/2007
WO	WO 2007/62105	5/2007
WO	WO 2008/069973	6/2008
WO	WO 2012/083249	6/2012
WO	WO 2012/162429	11/2012
WO	WO 2013/154999	10/2013
WO	WO 2013/191793	12/2013
WO	WO 2014/144883	9/2014
WO	WO 2014/144898	9/2014
WO	WO 2015/123430	8/2015
WO	WO 2015/148402	10/2015
WO	WO 2015/179284	11/2015

OTHER PUBLICATIONS

Non-Final Office Action issued by the U.S. Patent and Trademark Office dated Feb. 9, 2017 in connection with U.S. Appl. No. 15/380,270.

Non-Final Office Action issued by the U.S. Patent and Trademark Office dated Feb. 10, 2017 in connection with U.S. Appl. No. 15/380,311.

Communication Pursuant to Article 94(3) EPC dated Nov. 10, 2016 in connection with European Patent Application No. 15195765.1. Response to Nov. 10, 2016 Communication Pursuant to Article 94(3) EPC, filed with the European Patent Office dated Mar. 20, 2017 in connection with European Patent Application No. 15195765.1.

Notice of Allowance issued by the U.S. Patent and Trademark Office dated May 26, 2017 in connection with U.S. Appl. No. 15/380,270.

Notice of Allowance issued by the U.S. Patent and Trademark Office dated May 26, 2017 in connection with U.S. Appl. No. 15/380,284.

Notice of Allowance issued by the U.S. Patent and Trademark Office dated May 26, 2017 in connection with U.S. Appl. No. 15/380,311.

Exhibit 2025, filed Jun. 24, 2013 in connection with IPR2012-00006: Sanger et al. (1977) DNA sequencing with chain-terminating inhibitors, Proc. Natl. Acad. Sci. USA. 74:5463-5467.

Exhibit 2026, filed Jun. 24, 2013 in connection with IPR2012-00006: Pennisi (2000) DOE Team Sequences Three Chromosomes, Science. 288:417-419.

Exhibit 2027, filed Jun. 24, 2013 in connection with IPR2012-00006: Welch and Burgess (1999) Synthesis of Fluorescent, Photolabile 3'-O-Protected nucleoside Triphosphates for the Base Addition Sequencing Scheme, nucleosides & Nucleotides. 18:197-201.

Exhibit 2028, filed Jun. 24, 2013 in connection with IPR2012-00006: Hyman (1998) A New Method of Sequencing DNA, Analytical Biochemistry 174:423-436.

Exhibit 2030, filed Jun. 24, 2013 in connection with IPR2012-00006: Canard and Sarfati (1994) DNA polymerase fluorescent substrates with reversible 3'-tags, Gene. 1481-6.

Exhibit 2032, filed Jun. 24, 2013 in connection with IPR2012-00006: Sarfati et al. (1987) Synthesis of Fluorescent or Biotinylated Nucleoside Compounds, Tetrahedron Letters. 43:3491-3497.

Exhibit 2033, filed Aug. 30, 2013 in connection with IPR2012-00006: Jun. 25, 2013 Substitute Declaration of Dr. George L. Trainor [redacted].

Exhibit 2034, filed Jun. 25, 2013 in connection with IPR2012-00006: Jingyue Ju et. al. (2006) Four-color DNA sequencing by synthesis using cleavable fluorescent nucleotide reversible termi-

Exhibit 2035, filed Jun. 25, 2013 in connection with IPR2012-00006: Batista et al. (2008) PRG-1 and 21U-RNAs Interact to Form the piRNA Complex Required for Fertility in *C. elegans*. Molecular Cell 31:1-12.

Exhibit 2036, filed Jun. 25, 2013 in connection with IPR2012-00006: Form 7 Review Context and Analysis, Biomedical Engineering and Research to Aid Persons with Disabilities Programs Dec. 19-20, 2000 Panel Review, Fluorescence Imaging Chip System for Massive Parallel DNA Sequencing. Proposal No. BES-0097793.

Exhibit 2037, filed Jun. 25, 2013 in connection with IPR2012-00006: Oct. 1, 2006 Request for opinion on manuscript by J. Ju et. al., Proceedings of National Academy of Sciences, U.S.A.

Exhibit 2038, filed Jun. 25, 2013 in connection with IPR2012-00006: Correspondence between George Rupp, Chancellor, Columbia University and Richard T. Schlossberg, President, The David and Lucile Packard Foundation (2001).

Exhibit 2039, filed Jun. 25, 2013 in connection with IPR2012-00006: The David and Lucile Packard Foundation, Packard Fellowships for Science and Engineering, <http://www.packard.org/what-wefund/conservation-and-science/packard-fellowships-for-science-and-engineering/> (last visited Jun. 25, 2013).

Exhibit 2040, filed Jun. 25, 2013 in connection with IPR2012-00006: "Chemistry for Next-Generation Sequencing." http://www.illumina.com/technology/sequencing_technology.ilmn.

Exhibit 2041, filed Jun. 25, 2013 in connection with IPR2012-00006: Chiang et al. (2010) Mammalian microRNAs: experimental evaluation of novel and previously annotated genes, Genes & Dev. 24:992, 993.

Exhibit 2042, filed Jun. 25, 2013 in connection with IPR2012-00006: Seo et al. (2004) Photocleavable fluorescent nucleotides for DNA sequencing on a chip constructed by site-specific coupling chemistry, Proc. Natl. Acad. Sci. 101(15):5488-5493.

Exhibit 2043, filed Jun. 25, 2013 in connection with IPR2012-00006: Curriculum vitae of Mr. Raymond S. Sims.

Exhibit 2044, filed Jun. 25, 2013 in connection with IPR2012-00006: Prior Testimony of Mr. Raymond S. Sims.

Exhibit 2045, filed Jun. 25, 2013 in connection with IPR2012-00006: Documents reviewed by Mr. Raymond S. Sims in this Proceeding.

Exhibit 2052, filed Jun. 25, 2013 in connection with IPR2012-00006: Gary Schroth Proof of Chiang Paper.

Exhibit 2074, filed Jun. 25, 2013 in connection with IPR2012-00006: Information about Dr. Ju's intellectual property sent to Illumina.

Exhibit 2090, filed Jun. 26, 2013 in connection with IPR2012-00006: IPR Default Protective Order.

Exhibit 2091, filed Jun. 26, 2013 in connection with IPR2012-00006: Declaration of Raymond S. Sims.

Exhibit 2092, filed Oct. 10, 2013 in connection with IPR2012-00006: Rough Transcript of the Sep. 4, 2013 deposition of Dr. George L. Trainor.

Exhibit 2093, filed Oct. 1, 2013 in connection with IPR2012-00006: Excerpt from Protective Groups in Organic Synthesis, 3rd Ed. (Theodora W. Greene and Peter G.M. Wuts ed., John Wiley & Sons, Inc. 1999).

Exhibit 2094, filed Oct. 1, 2013 in connection with IPR2012-00006: Final transcript of the Sep. 4-6, 2013 deposition of Dr. George L. Trainor.

Exhibit 2095, filed Oct. 1, 2013 in connection with IPR2012-00006: Final transcript of the Sep. 3, 2013 deposition of Raymond S. Sims. Nov. 12, 2013 Petitioner Motion to Exclude Evidence in connection with IPR2012-00006.

Exhibit 1056, filed Nov. 19, 2013 in connection with IPR2012-00006: Videotaped Deposition Transcript of Kevin Burgess, Ph.D., Oct. 28, 2013, signed with errata.

Nov. 12, 2013 Patent Owner Motion for Observations on the Cross-Examination Testimony of Kevin Burgess, Ph.D. in connection with IPR2012-00006.

Nov. 12, 2013 Patent Owner Motion to Exclude Evidence in connection with IPR2012-00006.

(56)

References Cited

OTHER PUBLICATIONS

Nucleosides Designed for Combinatorial DNA Sequencing Chem. Eur.J., 1999, 951-960. Published in Chem. Eur. J, 2005, 11, 7136-7145.

Exhibit 2100, filed Nov. 12, 2013 in connection with IPR2012-00006: Welch, M (1999) "Base Additions Sequencing Scheme (BASS) and Studies Toward New Sequencing Methodologies." Ph.D. Dissertation, Texas A&M University.

Exhibit 2101, filed Nov. 12, 2013 in connection with IPR2012-00006: Lu and Burgess (2006) "A Diversity Oriented Synthesis of 3'-O-modified nucleoside triphosphates for DNA 'Sequencing by Synthesis'." Bioorganic & Medicinal Chemistry Letters, 16, 3902-3905.

Exhibit 2102, filed Nov. 12, 2013 in connection with IPR2012-00006: Advanced Sequencing Technology Awards 2004. <http://www.genome.gov/12513162> (accessed Oct. 14, 2013).

Exhibit 2103, filed Nov. 12, 2013 in connection with IPR2012-00006: Welch and Burgess (2006) Erratum to Synthesis of Fluorescent, Photolabile 3'-O-Protected Nucleoside Triphosphates for the Base Addition Sequencing Scheme, Nucleosides & Nucleotides, 18:197-201. Published in Nucleosides, Nucleotides and Nucleic Acids, 25:1, 119.

Nov. 26, 2013 Petitioner Response to Motion for Observations in connection with IPR2012-00006.

Nov. 26, 2013 Patent Owner Opposition to Petitioner's Motion to Exclude in connection with IPR2012-00006.

Nov. 26, 2013 Petitioner Opposition to Motion to Exclude in connection with IPR2012-00006.

Dec. 3, 2013 Petitioner Reply to Patent Owner's Opposition to Motion to Exclude in connection with IPR2012-00006.

Dec. 3, 2013 Patent Owner Reply on Motion to Exclude in connection with IPR2012-00006.

Exhibit 2105, filed Dec. 15, 2013 in connection with IPR2012-00006: Columbia's Demonstratives Under 42.70(b) for Dec. 17, 2013 Oral Hearing in connection with IPR2012-00006, IPR2012-00007, and IPR2013-00011.

Exhibit 1057, filed Dec. 16, 2013 in connection with IPR2012-00006: Illumina's Invalidity Demonstratives for Final Hearing Dec. 17, 2013 in connection with IPR2012-00006, IPR2012-00007, and IPR2013-00011.

Feb. 10, 2014 Record of Dec. 17, 2013 Oral Hearing in connection with IPR2012-00006, IPR2012-00007, and IPR2013-00011.

Mar. 6, 2014 Final Written Decision in connection with IPR2012-00006.

Aug. 19, 2013 Petition 2 of 2 for Inter Partes Review of U.S. Pat. No. 7,566,537, issued Aug. 19, 2013.

Exhibit 1015, filed Aug. 19, 2013 in connection with IPR2013-00518: Aug. 16, 2013 Declaration of Dr. Bruce Branchaud.

Exhibit 1016, filed Aug. 19, 2013 in connection with IPR2013-00518: Excerpts from the '537 Patent File History.

Exhibit 1017, filed Aug. 19, 2013 in connection with IPR2013-00518: Excerpts from the file history of European Patent Application No. 02781434.2.

Feb. 13, 2014 Decision of Institution of Inter Partes Review IPR2013-00518.

2014 Patentee Request for Adverse Judgment in IPR2013-00518.

2014 Decision of Adverse Judgment in IPR2013-00518.

U.S. Application for a Method for Direct Nucleic Acid Sequencing; U.S. Appl. No. 09/266,187, filed Mar. 10, 1999.

U.S. Appl. No. 90/008,149, filed Aug. 4, 2006, Gitten.

U.S. Appl. No. 90/008,152, filed Aug. 3, 2006, Gitten.

International Search Report dated Sep. 26, 2003 in connection with PCT/US03/21818.

International Preliminary Examination Report dated Mar. 18, 2005 in connection with PCT/US03/21818.

Notification of Transmittal of International Search Report and Written Opinion, dated May 22, 2008 in connection with International Application No. PCT/US06/45180.

International Search Report dated Oct. 29, 2007 in connection with PCT International Application No. PCT/US07/13559.

Supplementary European Search Report dated Feb. 9, 2007 in connection with European Patent Application No. 03764568.6.

Supplementary European Search Report dated Sep. 9, 2008 in connection with PCT International Application No. PCT/US05/06960.

International Search Report dated Jan. 23, 2002 in connection with PCT/US01/28967.

International Search Report dated Sep. 18, 2002 in connection with PCT/US02/09752.

International Preliminary Examination Report dated Mar. 17, 2003 in connection with PCT/US02/09752.

Supplementary European Search Report dated May 25, 2005 in connection with European Patent Application No. 02728606.1.

Written Opinion of the International Searching Authority dated Oct. 27, 2005 in connection with PCT/US05/06960.

Written Opinion of the International Searching Authority dated Dec. 15, 2006 in connection with PCT/US05/13883.

International Search Report dated Jun. 8, 2004 in connection with PCT/US03/39354.

International Search Report dated Nov. 4, 2005 in connection with PCT/US05/06960.

International Search Report dated Dec. 15, 2006 in connection with PCT/US05/13883.

Sep. 16, 2012 Petition for Inter Partes Review of U.S. Pat. No. 7,790,869.

Sep. 17, 2012 Motion to Waive Page Limit and Proposed Petition in connection with Petition for Inter Partes Review of U.S. Pat. No. 7,790,869.

Dec. 21, 2012 Preliminary Response under 37 C.F.R. 42.107 in connection with IPR2012-00007.

Mar. 12, 2013 Decision on Petition for Inter Partes Review in connection with IPR2012-00007.

Mar. 26, 2013 Request for Reconsideration in connection with IPR2012-00007.

Mar. 26, 2013 Request for Rehearing. under 37 C.F.R. 42.71 of Decision to Institute Inter Partes Review in connection with IPR2012-00007.

Apr. 26, 2013 Opposition to Request for Reconsideration (Rehearing) Under 37 C.F.R. 42.71.(C) in connection with IPR2012-00007.

May 10, 2013 Decision on Request for Rehearing in connection with IPR2012-00007.

Aug. 30, 2013 Substitute Patent Owner Response Under 37 C.F.R. 42.120 in connection with IPR2012-00007.

Aug. 30, 2013 Substitute Patent Owner Motion to Amend Under 37 C.F.R. 42.121 in connection with IPR2012-00007.

Sep. 27, 2013 Petitioner Opposition to Motion to Amend in connection with IPR2012-00007.

Sep. 27, 2013 Petitioner Reply to Response to Petition in connection with IPR2012-00007.

Nov. 18, 2013 Substitute Patent Owner Reply on Motion to Amend in connection with IPR2012-00007.

Exhibit 1022, filed Sep. 16, 2012 in connection with IPR2012-00007: Excerpts of File History of U.S. Pat. No. 7,790,869.

Exhibit 1053, filed Sep. 27, 2013 in connection with IPR2012-00007: Sep. 27, 2013 Declaration of Kevin Burgess.

Exhibit 2001, filed Dec. 21, 2012 in connection with IPR2012-00007: Composition of a Nucleotide.

Exhibit 2033, filed Aug. 30, 2013 in connection with IPR2012-00007: Jun. 25, 2013 Substitute Declaration of Dr. George L. Trainor [redacted].

Nov. 12, 2013 Petitioner Motion to Exclude Evidence in connection with IPR2012-00007.

Nov. 12, 2013 Patent Owner Motion for Observations on the Cross-Examination Testimony of Kevin Burgess, Ph.D. in connection with IPR2012-00007.

Nov. 12, 2013 Patent Owner Motion to Exclude Evidence in connection with IPR2012-00007.

Nov. 26, 2013 Petitioner's Response to Motion for Observations in connection with IPR2012-00007.

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