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### Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

#### Inventor(s)

Inventor 1

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**Title of Invention** SHORT-WAVE INFRARED SUPER-CONTINUUM LASERS FOR EARLY DETECTION OF DENTAL CARIES

**Attorney Docket Number (if applicable)** OMNI0102PRV

#### Correspondence Address

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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

No.

Yes, the name of the U.S. Government agency and the Government contract number are:

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### Entity Status

Applicant claims small entity status under 37 CFR 1.27

- Yes, applicant qualifies for small entity status under 37 CFR 1.27  
 No

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Signature	/David S. Bir/			Date (YYYY-MM-DD)	2012-12-31
First Name	David	Last Name	Bir	Registration Number (If appropriate)	38383

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## SHORT-WAVE INFRARED SUPER-CONTINUUM LASERS FOR EARLY DETECTION OF DENTAL CARIES

### TECHNICAL FIELD

[0001] This disclosure relates to lasers and light sources for healthcare, medical, dental, or bio-technology applications, including systems and methods for using near-infrared or short-wave infrared light sources for early detection of dental caries, often called cavities.

### BACKGROUND AND SUMMARY

[0002] Dental care and the prevention of dental decay or dental caries has changed in the United States over the past several decades, due to the introduction of fluoride to drinking water, the use of fluoride dentifrices and rinses, application of topical fluoride in the dental office, and improved dental hygiene. Despite these advances, dental decay continues to be the leading cause of tooth loss. With the improvements over the past several decades, the majority of newly discovered carious lesions tend to be localized to the occlusal pits and fissures of the posterior dentition and the proximal contact sites. These early carious lesions may be often obscured in the complex and convoluted topography of the pits and fissures or may be concealed by debris that frequently accumulates in those regions of the posterior teeth. Moreover, such lesions are difficult to detect in the early stages of development.

[0003] Dental caries may be a dynamic disease that is characterized by tooth demineralization leading to an increase in the porosity of the enamel surface. Leaving these lesions untreated may potentially lead to cavities reaching the dentine and pulp and perhaps eventually causing tooth loss. Occlusal surfaces (bite surfaces) and approximal surfaces (between the teeth) are among the most susceptible sites of demineralization due to acid attack from bacterial by-products in the biofilm. Therefore, there is a need for detection of lesions at an early stage, so that preventive agents may be used to inhibit or reverse the demineralization.

[0004] Traditional methods for caries detection include visual examination and tactile probing with a sharp dental exploration tool, often assisted by radiographic (x-ray) imaging. However, detection using these methods may be somewhat subjective; and, by the time that caries are evident under visual and tactile examination, the disease may have already progressed to an advanced stage. Also, because of the ionizing nature of x-rays, they are dangerous to use (limited use with adults, and even less used with children). Although x-ray methods are suitable for approximal surface lesion detection, they offer reduced utility for screening early caries in occlusal surfaces due to their lack of sensitivity at very early stages of the disease.

[0005] Some of the current imaging methods are based on the observation of the changes of the light transport within the tooth, namely absorption, scattering, transmission, reflection and/or fluorescence of light. Porous media may scatter light more than uniform media. Taking advantage of this effect, the Fiber-optic trans-illumination is a qualitative method used to highlight the lesions within teeth by observing the patterns formed when white light, pumped from one side of the tooth, is scattered away and/or absorbed by the lesion. This technique may be difficult to quantify due to an uneven light distribution inside the tooth.

[0006] Another method called quantitative light-induced fluorescence – QLF – relies on different fluorescence from solid teeth and caries regions when excited with bright light in the visible. For example, when excited by relatively high intensity blue light, healthy tooth enamel yields a higher intensity of fluorescence than does demineralized enamel that has been damaged by caries infection or any other cause. On the other hand, for excitation by relatively high intensity of red light, the opposite magnitude change occurs, since this is the region of the spectrum for which bacteria and bacterial by-products in carious regions absorb and fluoresce more pronouncedly than do healthy areas. However, the image provided by QLF may be difficult to assess due to relatively poor contrast between healthy and infected areas. Moreover, QLF may have difficulty discriminating between white spots and stains because both produce similar effects. Stains on teeth are commonly observed in the occlusal sites of teeth, and this obscures the detection of caries using visible light.

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