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Application Number	
Filing Date	Herewith
First Named Inventor	MOHAMMED N. ISLAM
Title	SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO
Art Unit	
Examiner Name	
Attorney Docket Number	OMNI0102PUSA6

SIGNATURE of Applicant or Patent Practitioner

Signature	/Andrew B. Turner/	Date (Optional)	October 31, 2019
Name	Andrew B. Turner	Registration Number	63,121
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

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SIGNATURE of Applicant for Patent

Signature		Date	October 10, 2012
Name	Mohammed N. Islam	Telephone	734-647-8941
Title and Company	President - OMNI MEDSCI, INC.		

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SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is 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 which are hereby incorporated by reference in their entirety.

[0002] This application is also a continuation of U.S. application Serial No. 16/506,885 filed July 9, 2019, which is a continuation of U.S. Application 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.

[0003] U.S. application Serial No. 16/506,885 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.

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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.

[0004] U.S. application Serial No. 16/506,885 is also a continuation of U.S. application Serial No.16/188,194 filed November 12, 2018 (now U.S. Patent No. 10,386,230), 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 application Ser. No. 61/747,485 filed Dec. 31, 2012, the disclosures of all of which are hereby incorporated by reference in their entirety.

[0005] U.S. application Serial No. 16/506,885 is also a continuation of U.S. application Serial No. 16/241,628 filed January 7, 2019 (now U.S. Patent No. 10,441,176), 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.

[0006] U.S. application Serial No. 16/506,885 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

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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.

[0007] This application is related to U.S. provisional application Ser. No. 61/747,472 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; and Ser. No. 61/747,553 filed Dec. 31, 2012, the disclosures of which are hereby incorporated by reference in their entirety herein.

[0008] This application has a common priority date with commonly owned U.S. Application Ser. No. 14/650,897 filed June 10, 2015 (now U.S. Patent No. 9,494,567), which is the U.S. national phase of International Application PCT/US2013/075700 entitled Near-Infrared Lasers For Non-Invasive Monitoring Of Glucose, Ketones, HBA1C, And Other Blood Constituents (Attorney Docket No. OMNI0101PCT); U.S. application Ser. No. 14/108,995 filed December 17, 2013 (published as US 2014/0188092) entitled Focused Near-Infrared Lasers For Non-Invasive Vasectomy And Other Thermal Coagulation Or Occlusion Procedures (Attorney Docket No. OMNI0103PUSP); U.S. Application Ser. No. 14/650,981 filed June 10, 2015 (now U.S. Patent No. 9,500,634), which is the U.S. national phase of International Application PCT/US2013/075767 entitled Short-Wave Infrared Super-Continuum Lasers For Natural Gas Leak Detection, Exploration, And Other Active Remote Sensing Applications (Attorney Docket No. OMNI0104PCT); U.S. Application 14/108,986 filed December 17, 2013 (now U.S. Patent No. 9,164,032) entitled Short-Wave Infrared Super-Continuum Lasers For Detecting Counterfeit Or Illicit Drugs And Pharmaceutical Process Control (Attorney Docket No. OMNI0105PUSP); U.S. application Ser. No. 14/108,974 filed December 17, 2013 (Published as US2014/0188094) entitled Non-Invasive Treatment Of Varicose Veins (Attorney Docket No. OMNI0106PUSP); and U.S. Application 14/109,007 filed December 17, 2013 (Published as US2014/0236021) entitled Near-Infrared Super-Continuum Lasers For Early Detection Of Breast And Other Cancers (Attorney Docket No. OMNI0107PUSP), the disclosures of all of which are hereby incorporated in their entirety by reference herein.

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TECHNICAL FIELD

[0009] 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

[0010] 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.

[0011] 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.

[0012] 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

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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.

[0013] 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.

[0014] 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.

[0015] As described in this disclosure, the near-infrared region of the spectrum offers a novel approach to imaging carious regions because scattering is reduced and absorption by stains is low. For example, it has been demonstrated that the scattering by enamel tissues reduces in the form of $1/(\text{wavelength})^3$, e.g., inversely as the cube of wavelength. By using a broadband light source in the short-wave infrared (SWIR) part of the spectrum, which corresponds approximately to 1400nm to 2500nm, lesions in the enamel and dentine may be observed. In one embodiment, intact teeth have low reflection over the SWIR wavelength range. In the presence of caries, the scattering increases, and the scattering is a function of wavelength; hence, the reflected signal decreases with increasing wavelength. Moreover, particularly when caries exist in the dentine region, water build up may occur,

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and dips in the SWIR spectrum corresponding to the water absorption lines may be observed. The scattering and water absorption as a function of wavelength may thus be used for early detection of caries and for quantifying the degree of demineralization.

[0016] SWIR light may be generated by light sources such as lamps, light emitting diodes, one or more laser diodes, super-luminescent laser diodes, and fiber-based super-continuum sources. The SWIR super-continuum light sources advantageously may produce high intensity and power, as well as being a nearly transform-limited beam that may also be modulated. Also, apparatuses for caries detection may include C-clamps over teeth, a handheld device with light input and light detection, which may also be attached to other dental equipment such as drills. Alternatively, a mouth-guard type apparatus may be used to simultaneously illuminate one or more teeth. Fiber optics may be conveniently used to guide the light to the patient as well as to transport the signal back to one or more detectors and receivers.

[0017] 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.

[0018] In one embodiment, a wearable device includes a measurement device including a light source comprising a plurality of light emitting diodes (LEDs) for measuring one or more physiological parameters, the measurement device configured to generate, by modulating at least one of the LEDs having an initial light intensity, an optical beam having a plurality of optical wavelengths, wherein at least a portion of the plurality of optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers. The measurement device comprises one or more lenses configured

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to receive and to deliver a portion of the optical beam to tissue, wherein the tissue reflects at least a portion of the optical beam delivered to the tissue, and wherein the measurement device is adapted to be placed on a wrist or an ear of a user. The measurement device further comprises a receiver, the receiver having a plurality of spatially separated detectors and one or more analog to digital converters coupled to the spatially separated detectors, the one or more analog to digital converters configured to generate at least two receiver outputs. The measurement device is configured to improve a signal-to-noise ratio of the optical beam reflected from the tissue by comparing the at least two receiver outputs. The measurement device is also configured to further improve the signal-to-noise ratio of the optical beam reflected from the tissue by increasing the light intensity relative to the initial light intensity from at least one of the LEDs. The measurement device is further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue. The receiver further comprises one or more spectral filters positioned in front of at least some of the plurality of spatially separated detectors, wherein the receiver is configured to be synchronized to the modulation of the at least one of the LED, and wherein the modulating at least one of the LEDs has a modulation frequency, and wherein the receiver is configured to use a lock-in technique that detects the modulation frequency.

[0019] In one or more embodiments, a wearable device comprises a measurement device including a light source comprising a plurality of light emitting diodes (LEDs) for measuring one or more physiological parameters, the measurement device configured to generate, by modulating at least one of the LEDs having an initial light intensity, an optical beam having a plurality of optical wavelengths, wherein at least a portion of the plurality of optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers. The measurement device comprises one or more lenses configured to receive and to deliver a portion of the optical beam to tissue, wherein the tissue reflects at least a portion of the optical beam delivered to the tissue, and wherein the measurement device is adapted to be placed on a wrist or an ear of a user. The measurement device is configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue. The measurement device is configured to improve a signal-to-noise ratio of the optical beam reflected from the tissue by increasing the light intensity relative to the initial light intensity from at least one of the LEDs. The measurement device further comprises a receiver having one or more detectors, wherein one of the one or more detectors is located a first distance from

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a first one of the LEDs and a different distance from a second one of the LEDs such that the receiver can compare light received from the first LED and light received from the second LED, and wherein the output signal is generated in part by comparing signals associated with the light received from the first and second LEDs. The receiver is configured to be synchronized to the modulation of the at least one of the LEDs, wherein the modulating at least one of the LEDs has a modulation frequency, and wherein the receiver is configured to use a lock-in technique that detects the modulation frequency.

[0020] In at least one embodiment, a wearable device comprises a measurement device including a light source comprising a plurality of light emitting diodes (LEDs) for measuring one or more physiological parameters, the measurement device configured to generate, by modulating at least one of the LEDs having an initial light intensity, an optical beam having a plurality of optical wavelengths, wherein at least a portion of the plurality of optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers. The measurement device comprises one or more lenses configured to receive and to deliver a portion of the optical beam to tissue, wherein the tissue reflects at least a portion of the optical beam delivered to the tissue, and wherein the measurement device is adapted to be placed on a wrist or an ear of a user. The measurement device is further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue. The measurement device is configured to improve a signal-to-noise ratio of the optical beam reflected from the tissue by increasing the light intensity relative to the initial light intensity from at least one of the LEDs. The measurement device further comprises a receiver, the receiver having a plurality of spatially separated detectors configured to generate at least two receiver outputs, and the measurement device configured to further improve the signal-to-noise ratio of the optical beam reflected from the tissue by comparing the at least two receiver outputs. One of the plurality of detectors is located a first distance from a first one of the LEDs and a different distance from a second one of the LEDs such that the receiver can generate a third signal responsive to light received from the first LED and a fourth signal responsive to light received from the second LED, and wherein the output signal is generated in part by comparing the third and fourth signals, wherein the receiver is configured to be synchronized to the modulation of the at least one of the LEDs, and wherein the modulating at least one of the LEDs has a modulation frequency, and wherein the receiver is configured to use a lock-in technique that detects the modulation frequency.

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[0021] In one or more embodiments, a wearable device includes a measurement device having a light source comprising a plurality of light emitting diodes (LEDs) for measuring one or more physiological parameters. The measurement device is configured to generate, by modulating at least one of the LEDs having an initial light intensity, an optical beam having a plurality of optical wavelengths, wherein at least a portion of the optical beam includes a near-infrared wavelength between 700 nanometers and 2500 nanometers. The measurement device comprises one or more lenses configured to receive and to deliver at least a portion of the optical beam to tissue, wherein the tissue reflects at least a portion of the optical beam delivered to the tissue. The measurement device further comprises a receiver having a plurality of spatially separated detectors and one or more analog to digital converters coupled to the spatially separated detectors, the one or more analog to digital converters being configured to generate at least two receiver outputs. The receiver is configured to capture light while the LEDs are off and convert the captured light into a first signal, and to capture light while at least one of the LEDs is on and to convert the captured light into a second signal, the captured light including at least a portion of the optical beam reflected from the tissue. The measurement device is configured to improve a signal-to-noise ratio of the optical beam reflected from the tissue by differencing the first signal and the second signal and by differencing the two receiver outputs. The measurement device is configured to further improve the signal-to-noise ratio of the optical beam reflected from the tissue by increasing the light intensity relative to the initial light intensity from at least one of the LEDs. The measurement device is further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue.

[0022] Embodiments may include a wearable device comprising a measurement device including a light source comprising a plurality of light emitting diodes (LEDs) for measuring one or more physiological parameters. The measurement device is configured to generate, by modulating at least one of the LEDs having an initial light intensity, an optical beam having a plurality of optical wavelengths, wherein at least a portion of the plurality of optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers. The measurement device comprises one or more lenses configured to receive and to deliver a portion of the optical beam to tissue, wherein the tissue reflects at least a portion of the optical beam delivered to the tissue, and wherein the measurement device is adapted to be placed on a wrist or an ear of a user. The measurement device

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further comprises a receiver having a plurality of spatially separated detectors and one or more analog to digital converters coupled to the spatially separated detectors. The one or more analog to digital converters is configured to generate at least two receiver outputs. The receiver is configured to capture light while the LEDs are off and convert the captured light into a first signal, and to capture light while at least one of the LEDs is on and convert the captured light into a second signal, the captured light including at least a portion of the optical beam reflected from the tissue. The measurement device is configured to improve a signal-to-noise ratio of the optical beam reflected from the tissue by differencing the first signal and the second signal and by differencing the two receiver outputs. The measurement device is also configured to further improve the signal-to-noise ratio of the optical beam reflected from the tissue by increasing the light intensity relative to the initial light intensity from at least one of the LEDs. The measurement device is further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue.

[0023] In one or more embodiments, a wearable device comprises a measurement device including a light source comprising a plurality of light emitting diodes (LEDs) for measuring one or more physiological parameters. The measurement device is configured to generate, by modulating at least one of the LEDs having an initial light intensity, an optical beam having a plurality of optical wavelengths, wherein at least a portion of the plurality of optical wavelengths is a near-infrared wavelength between 700 nanometers and 2500 nanometers. The measurement device comprises one or more lenses configured to receive and to deliver a portion of the optical beam to tissue, wherein the tissue reflects at least a portion of the optical beam delivered to the tissue, and wherein the measurement device is adapted to be placed on a wrist or an ear of a user. The measurement device further comprises a receiver having a plurality of spatially separated detectors and one or more analog to digital converters coupled to the spatially separated detectors, the one or more analog to digital converters configured to generate at least two receiver outputs. The receiver is configured to capture light while the LEDs are off and convert the captured light into a first signal, and to capture light while at least one of the LEDs is on and convert the captured light into a second signal, the captured light including at least a portion of the optical beam reflected from the tissue. The measurement device is configured to improve a signal-to-noise ratio of the optical beam reflected from the tissue by differencing the first signal and the second signal and by differencing the two receiver outputs. The measurement device is configured to further improve the signal-to-noise ratio of the optical beam

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reflected from the tissue by increasing the light intensity relative to the initial light intensity from at least one of the LEDs. The measurement device is further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue, wherein the output signal is generated at least in part by using a Fourier transform and mathematical manipulation of a signal resulting from the captured light. The receiver further comprises one or more spectral filters positioned in front of at least some of the plurality of spatially separated detectors.

[0024] In one embodiment a measurement system is provided with a light source, an apparatus, a receiver, a smart phone or tablet, and a remote device. The light source comprises a plurality of semiconductor sources that are configured to generate an output optical beam with one or more optical wavelengths, the light source is configured to increase signal-to-noise ratio by increasing a light intensity from at least one of the plurality of semiconductor sources. The apparatus is configured to: receive a portion of the output optical beam, and deliver an analysis output beam to a sample. The receiver is configured to: receive and process at least a portion of the analysis output beam reflected or transmitted from the sample, generate an output signal, and synchronize to the light source. The smart phone or tablet comprises 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 is configured to: receive and process at least a portion of the output signal, store and display the processed output signal, and transmit at least a portion of the processed output signal over a wireless transmission link. The remote device is configured to: receive, over the wireless transmission link, an output status comprising the at least a portion of the processed output signal, process the received output status to generate processed data, and store the processed data.

[0025] In another embodiment a measurement system is provided with a wearable measurement device for measuring one or more physiological parameters, including a light source comprising a plurality of semiconductor sources that are configured to generate an output optical beam with one or more optical wavelengths. The light source is configured to increase signal-to-noise ratio by increasing a light intensity from at least one of the plurality of semiconductor sources. The wearable measurement device is configured to receive a portion of the output optical beam and to deliver an analysis output beam to a sample. The wearable measurement device further comprises a receiver configured to receive and process at least a portion of the analysis output beam reflected or transmitted from the sample and to generate an output signal, wherein the wearable measurement device receiver

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is configured to be synchronized to pulses of the light source. The measurement system is also provided with a smart phone or tablet and a remote device. The smart phone or tablet comprises 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 is configured to receive and process at least a portion of the output signal, to store and display the processed output signal, and to transmit a portion of the processed output signal over a wireless transmission link. The remote device is 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. The remote device is capable of storing a history of at least a portion of the received output status over a specified period of time.

[0026] In yet another embodiment a wearable device for use with a smart phone or tablet is provided with a measurement device including a light source comprising a plurality of semiconductor sources for measuring one or more physiological parameters. The measurement device is configured to: generate, by modulating at least one of the semiconductor sources having an initial light intensity, an input optical beam having one or more optical wavelengths, and receive and to deliver a portion of the input optical beam to tissue, wherein the tissue reflects at least a portion of the input optical beam delivered to the tissue. The measurement device further comprises a receiver that is configured to: capture light while the semiconductor sources are off and convert the captured light into a first signal, and capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a portion of the input optical beam reflected from the tissue; synchronize to the modulation of the at least one of the semiconductor sources. The measurement device is further configured to improve a signal-to-noise ratio of the input optical beam reflected from the tissue by: differencing the first signal and the second signal, and increasing the light intensity relative to the initial light intensity from at least one of the semiconductor sources. The measurement device is further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue. The wearable device is configured to communicate with the smart phone or tablet. The smart phone or tablet comprises a wireless receiver, a wireless transmitter, a display, a voice input module, a speaker, and a touch screen. The smart phone or tablet is configured to: receive and to process at least a portion of the output signal, store and display

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the processed output signal, and transmit at least a portion of the processed output signal over a wireless transmission link.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] 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:

[0028] FIGURE 1 illustrates the structure of a tooth.

[0029] FIGURE 2A shows the attenuation coefficient for dental enamel and water versus wavelength from approximately 600nm to 2600nm.

[0030] FIGURE 2B illustrates the absorption spectrum of intact enamel and dentine in the wavelength range of approximately 1.2 to 2.4 microns.

[0031] FIGURE 3 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.

[0032] FIGURE 4 illustrates a hand-held dental tool design of a human interface that may also be coupled with other dental tools.

[0033] FIGURE 5A illustrates a clamp design of a human interface to cap over one or more teeth and perform a non-invasive measurement for dental caries.

[0034] FIGURE 5B shows a mouth guard design of a human interface to perform a non-invasive measurement for dental caries.

[0035] FIGURE 6A illustrates the dorsal of a hand for performing a differential measurement for measuring blood constituents or analytes.

[0036] FIGURE 6B illustrates the dorsal of a foot for performing a differential measurement for measuring blood constituents or analytes.

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[0037] FIGURE 7 illustrates a block diagram or building blocks for constructing high power laser diode assemblies.

[0038] FIGURE 8 shows a platform architecture for different wavelength ranges for an all-fiber-integrated, high powered, super-continuum light source.

[0039] FIGURE 9 illustrates one embodiment for a short-wave infrared super-continuum light source.

[0040] FIGURE 10 shows the output spectrum from the SWIR SC laser of FIGURE 9 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 1550nm.

[0041] FIGURE 11A illustrates a schematic of the experimental set-up for measuring the diffuse reflectance spectroscopy using the SWIR-SC light source of FIGURES 9 and 10.

[0042] FIGURE 11B shows exemplary reflectance from a sound enamel region, an enamel lesion region, and a dentine lesion region. The spectra are normalized to have equal value near 2050nm.

[0043] FIGURES 12A-B illustrate high power SWIR-SC lasers that may generate light between approximately 1.4-1.8 microns (FIG. 12A) or approximately 2-2.5 microns (FIG. 12B).

[0044] FIGURE 12C shows a reflection-spectroscopy based stand-off detection system having an SC laser source.

[0045] FIGURE 12D shows one example of a dual-beam experimental set-up that may be used to subtract out (or at least minimize the adverse effects of) light source fluctuations.

[0046] FIGURE 13 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, dental or healthcare providers, or other designated recipients.

[0047] FIGURE 14A is a schematic diagram of the basic elements of an imaging spectrometer.

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[0048] FIGURE 14B illustrates one example of a typical imaging spectrometer used in hyper-spectral imaging systems.

[0049] FIGURE 15 illustrates a flowchart of a smart manufacturing process.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

[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] Near-infrared (NIR) and SWIR light may be preferred for caries detection compared to visible light imaging because the NIR/SWIR wavelengths generally have lower absorption by stains and deeper penetration into teeth. Hence, NIR/SWIR light may provide a caries detection method that can be non-invasive, non-contact and relatively stain insensitive. Broadband light may provide further advantages because carious regions may demonstrate spectral signatures from water absorption and the wavelength dependence of porosity in the scattering of light.

[0052] The wavelength of light should be selected appropriately to achieve a non-invasive procedure. For example, the light should be able to penetrate deep enough to reach through the dermis and subcutaneous fat layers to reach varicose veins. For example, the penetration depth may be defined as the inverse of the absorption coefficient, although it may also be necessary to include the scattering for the calculation. To achieve penetration deep enough to reach the varicose veins, wavelengths may correspond to local minima in water 501 and adipose 502 absorption, as well as potentially local minima in collagen 503 and elastin 504 absorption. For example, wavelengths near approximately 1100nm, 1310nm, or 1650nm may be advantageous for non-invasive procedures. More generally, wavelength ranges of approximately 900nm to 1150nm, 1280nm to 1340nm, or 1550nm to 1680nm may be advantageous for non-invasive procedures.

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[0053] In general, the near-infrared region of the electromagnetic spectrum covers between approximately 0.7 microns (700nm) to about 2.5 microns (2500nm). However, it may also be advantageous to use just the short-wave infrared between approximately 1.4 microns (1400nm) and about 2.5 microns (2500nm). 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 1400nm. 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.

[0054] In particular, wavelengths in the eye 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 from inadvertent exposure. 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 1400nm 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 1400nm, in general only the cornea of the eye may receive or absorb the light radiation.

[0055] FIGURE 1 illustrates the structure of an exemplary cross-section of a tooth 100. The tooth 100 has a top layer called the crown 101 and below that a root 102 that reaches well into the gum 106 and bone 108 of the mouth. The exterior of the crown 101 is an enamel layer 103, and below the enamel is a layer of dentine 104 that sits atop a layer of cementum 107. Below the dentine 104 is a pulp region 105, which comprises within it blood vessels 109 and nerves 110. If the light can penetrate the enamel 103 and dentine 104, then the blood flow and blood constituents may be measured through the blood vessels in the dental pulp 105. While the amount of blood flow in the capillaries of the dental pulp 105 may be less than an artery or vein, the smaller blood flow could still be advantageous for detecting or measuring blood constituents as compared to detection through the skin if there is less interfering spectral features from the tooth. Although the structure of a molar tooth is illustrated in FIGURE 1, other types of teeth also have similar structure. For example, different types of teeth include molars, pre-molars, canine and incisor teeth.

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[0056] 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.

[0057] As used throughout this disclosure, 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, for example. 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.

[0058] 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, and/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

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"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.

[0059] 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 or at least 10nm. 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.

[0060] 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, which also means that they may or may not contain information. 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.

TRANSMISSION OR REFLECTION THROUGH TEETH

[0061] 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 SWIR wavelengths between about 1400 and 2500nm). For example, the absorption or extinction ratio for light transmission has been studied. FIGURE 2A illustrates the attenuation coefficient 200 for dental enamel 201 (filled circles) and the absorption coefficient of water 202 (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 $1/(\text{wavelength})^3$ [i.e., inverse of the cube of the wavelength] with increasing wavelength to a value of only 2-3 cm-1 at 1310nm and 1550nm in the near infrared. Therefore, enamel may be virtually

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transparent in the near infrared with optical attenuation 1-2 orders of magnitude less than in the visible range.

[0062] As another example, FIGURE 2B illustrates the absorption spectrum 250 of intact enamel 251 (dashed line) and dentine 252 (solid line) in the wavelength range of approximately 1.2 to 2.4 microns. In the near infrared there are two absorption bands in the areas of about 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).

[0063] 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, FIGURE 3 shows the near infrared spectral reflectance 300 over the wavelength range of approximately 800nm to 2500nm from an occlusal (e.g., top) tooth surface 304. The curve with black diamonds 301 corresponds to the reflectance from a sound, intact tooth section. The curve with asterisks (*) 302 corresponds to a tooth section with an enamel lesion. The curve with circles 303 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.

[0064] For wavelengths shorter than approximately 1400nm, the shapes of the spectra remain similar, but the amplitude of the reflection changes with lesions. Between approximately 1400nm and 2500nm, an intact tooth 301 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 302 and 303, there is increased scattering, and the scattering loss may be wavelength dependent. For example, the scattering loss may decrease as the inverse of some power of wavelength, such as $1/(\text{wavelength})^3$ -- so, the scattering loss decreases with longer wavelengths. When there is a lesion in the dentine 303, more water can accumulate in the area, so there is also increased water absorption. For example,

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the dips near 1450nm and 1900nm may correspond to water absorption, and the reflectance dips are particularly pronounced in the dentine lesion 303.

[0065] FIGURE 3 may point to several novel techniques for early detection and quantification of carious regions. One method may be to use a relatively narrow wavelength range (for example, from a laser diode or super-luminescent laser diode) in the wavelength window below 1400nm. In one embodiment, wavelengths in the vicinity of 1310nm may be used, which is a standard telecommunications wavelength where appropriate light sources are available. Also, it may be advantageous to use a super-luminescent laser diode rather than a laser diode, because the broader bandwidth may avoid the production of laser speckle that can produce interference patterns due to light's scattering after striking irregular surfaces. As FIGURE 3 shows, the amplitude of the reflected light (which may also be proportional to the inverse of the transmission) may increase with dental caries. Hence, comparing the reflected light from a known intact region with a suspect region may help identify carious regions. However, one difficulty with using a relatively narrow wavelength range and relying on amplitude changes may be the calibration of the measurement. For example, the amplitude of the reflected light may depend on many factors, such as irregularities in the dental surface, placement of the light source and detector, distance of the measurement instrument from the tooth, etc.

[0066] In one embodiment, use of a plurality of wavelengths can help to better calibrate the dental caries measurement. For example, a plurality of laser diodes or super-luminescent laser diodes may be used at different center wavelengths. Alternately, a lamp or alternate broadband light source may be used followed by appropriate filters, which may be placed after the light source or before the detectors. In one example, wavelengths near 1090nm, 1440nm and 1610nm may be employed. The reflection from the tooth 305 appears to reach a local maximum near 1090nm in the representative embodiment illustrated. Also, the reflectance near 1440nm 306 is higher for dental caries, with a distinct dip particularly for dentine caries 303. Near 1610nm 307, the reflection is also higher for carious regions. By using a plurality of wavelengths, the values at different wavelengths may help quantify a caries score. In one embodiment, the degree of enamel lesions may be proportional to the ratio of the reflectance near 1610nm divided by the reflectance near 1090nm. Also, the degree of dentine lesion may be proportional to the difference between the reflectance near 1610nm and 1440nm, with the difference then divided by the reflectance near 1090nm. Although one set of

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wavelengths has been described, other wavelengths may also be used and are intended to be covered by this disclosure.

[0067] In yet another embodiment, it may be further advantageous to use all of some fraction of the SWIR between approximately 1400 and 2500nm. For example, a SWIR super-continuum light source could be used, or a lamp source could be used. On the receiver side, a spectrometer and/or dispersive element could be used to discriminate the various wavelengths. As FIGURE 3 shows, an intact tooth 301 has a relatively low and featureless reflectance over the SWIR. On the other hand, with a carious region there is more scattering, so the reflectance 302,303 increases in amplitude. Since the scattering is inversely proportional to wavelength or some power of wavelength, the carious region reflectance 302, 303 also decreases with increasing wavelength. Moreover, the carious region may contain more water, so there are dips in the reflectance near the water absorption lines 306 and 308. The degree of caries or caries score may be quantified by the shape of the spectrum over the SWIR, taking ratios of different parts of the spectrum, or some combination of this and other spectral processing methods.

[0068] Although several methods of early caries detection using spectral reflectance have been described, other techniques could also be used and are intended to be covered by this disclosure. For example, transmittance may be used rather than reflectance, or a combination of the two could be used. Moreover, the transmittance, reflectance and/or absorbance could also be combined with other techniques, such as quantitative light-induced fluorescence or fiber-optic trans-illumination. Also, the SWIR could be advantageous, but other parts of the infrared, near-infrared or visible wavelengths may also be used consistent with this disclosure.

[0069] One other benefit of the absorption, transmission or reflectance in the near infrared and SWIR may be that stains and non-calcified plaque are not visible in this wavelength range, enabling better discrimination of defects, cracks, and demineralized areas. For example, dental calculus, accumulated plaque, and organic stains and debris may interfere significantly with visual diagnosis and fluorescence-based caries detection schemes in occlusal surfaces. In the case of using quantitative light-induced fluorescence, such confounding factors typically may need to be removed by prophylaxis (abrasive cleaning) before reliable measurements can be taken. Surface staining at visible wavelengths may further complicate the problem, and it may be difficult to determine whether pits

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and fissures are simply stained or demineralized. On the other hand, staining and pigmentation generally interfere less with NIR or SWIR imaging. For example, NIR and SWIR light may not be absorbed by melanin and porphyrins produced by bacteria and those found in food dyes that accumulate in dental plaque and are responsible for the pigmentation.

HUMAN INTERFACE FOR MEASUREMENT SYSTEM

[0070] A number of different types of measurements may be used to image for dental caries, particularly early detection of dental caries. A basic feature of the measurements may 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 one embodiment, the light source may cover some or all of the wavelength range between approximately 1400nm and 2500nm. 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 one 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.

[0071] Referring to FIGURE 1, one or more light sources 111 may be used for illumination. In one embodiment, a transmission measurement may be performed by directing the light source output 111 to the region near the interface between the gum 106 and dentine 104. 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 105 to the other side, where the light may be incident on one or more detectors or another light guide to transport the signal to 112 a spectrometer, receiver, and/or camera, for example. In one embodiment, the light source may be directed to one or more locations near the interface between the gum 106 and dentine 104 (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 112 spectrometer, receiver, or camera, for example. In another embodiment, a reflectance measurement may be conducted by directing the light source output 111 to, for example, the occlusal surface of the tooth, and then detecting the reflectance at a 113 spectrometer, receiver or camera. Although a few

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embodiments for imaging the tooth are described, other embodiments and techniques may also be used and are intended to be covered by this disclosure. These optical techniques may measure optical properties such as reflectance, transmittance, absorption, or luminescence.

[0072] In one embodiment, FIGURE 4 shows that the light source and/or detection system may be integrated with a dental hand-piece 400. The hand-piece 400 may also include other dental equipment, such as a drill, pick, air spray or water cooling stream. The dental hand-piece 400 may include a housing 401 and a motor housing 402 (in some embodiments such as with a drill, a motor may be placed in this section). The end of hand-piece 403 that interfaces with the tooth may be detachable, and it may also have the light input and output end. The dental hand-piece 400 may also have an umbilical cord 404 for connecting to power supplies, diagnostics, or other equipment, for example.

[0073] A light guide 405 may be integrated with the hand-piece 400, either inside the housing 401, 402 or adjacent to the housing. In one embodiment, a light source 410 may be contained within the housing 401, 402. In an alternative embodiment, the hand-piece 400 may have a coupler 410 to couple to an external light source 411 and/or detection system or receiver 412. The light source 411 may be coupled to the hand-piece 400 using a light guide or fiber optic cable 406. In addition, the detection system or receiver 412 may be coupled to the hand-piece 400 using one or more light guides, fiber optic cable or a bundle of fibers 407.

[0074] The light incident on the tooth may exit the hand-piece 400 through the end 403. The end 403 may also have a lens system or curved mirror system to collimate or focus the light. In one embodiment, if the light source is integrated with a tool such as a drill, then the light may reach the tooth at the same point as the tip of the drill. The reflected or transmitted light from the tooth may then be observed externally and/or guided back through the light guide 405 in the hand-piece 400. If observed externally, there may be a lens system 408 for collecting the light and a detection system 409 that may have one or more detectors and electronics. If the light is to be guided back through the hand-piece 400, then the reflected light may transmit through the light guide 405 back to the detection system or receiver 412. In one embodiment, the incident light may be guided by a fiber optic through the light guide 405, and the reflected light may be captured by a series of fibers forming a bundle adjacent to or surrounding the incident light fiber.

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[0075] In another embodiment, a "clamp" design 500 may be used as a cap over one or more teeth, as illustrated in FIGURE 5A. 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 FIGURE 5A for a molar tooth 508. The C-clamp 501 may be made of a plastic or rubber material, and it may comprise a light source input 502 and a detector output 503 on the front or back of the tooth, for example.

[0076] The light source input 502 may comprise a light source directly, or it may have light guided to it from an external light source. Also, the light source input 502 may comprise a lens system to collimate or focus the light across the tooth. The detector output 503 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 502 may be coupled electrically or optically through 504 to a light input 506. For example, if the light source is external in 506, then the coupling element 504 may be a light guide, such as a fiber optic. Alternately, if the light source is contained in 502, then the coupling element 504 may be electrical wires connecting to a power supply in 506. Similarly, the detector output 503 may be coupled to a detector output unit 507 with a coupling element 505, 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. For example, if reflectance from the teeth is to be used in the measurement, then the light input 502 and detected light input 503 may be on the same side of the tooth.

[0077] 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 550 is illustrated in FIGURE 5B. The structure of the mouth guard 551 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, rubber, or any other suitable materials. As an example, the mouth guard may have one or more light source input ports 552, 553 and one or more detector output ports 554, 555. Although six input and output ports are illustrated, any number of ports may be used.

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[0078] Similar to the clamp design described above, the light source inputs 552, 553 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 552, 553 may comprise lens systems to collimate or focus the light across the teeth. The detector outputs 554, 555 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 552, 553 may be coupled electrically or optically through 556 to a light input 557. For example, if the light source is external in 557, then the one or more coupling elements 556 may be one or more light guides, such as a fiber optic. Alternately, if the light sources are contained in 552, 553, then the coupling element 556 may be one or more electrical wires connecting to a power supply in 557. Similarly, the detector outputs 554, 555 may be coupled to a detector output unit 559 with one or more coupling elements 558, 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. 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.

[0079] Other elements may be added to the human interface designs of FIGURES 4-6 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 dentist's or 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 FIGURE 5A or mouth guard design of FIGURE 5B. The coating material may be inserted before each use, and then after the measurement is exercised the coating material may be peeled off and

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replaced. The coating or covering material may be selected based on suitable optical properties that do not affect the measurement, or known optical properties that can be calibrated or compensated for during measurement. Such a design may save the dentist or physician or user considerable time, while at the same time provide the business venture with a recurring cost revenue source.

[0080] Thus, beyond the problem of other blood constituents or analytes having overlapping spectral features, 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.

[0081] Two representative embodiments for performing such a differential measurement are illustrated in FIGURE 6A and FIGURE 6B. In one embodiment shown in FIGURE 6A, the dorsal of the hand 600 may be used for measuring blood constituents or analytes. The dorsal of the hand 600 may have regions that have distinct veins 601 as well as regions where the veins are not as shallow or pronounced 602. By stretching the hand and leaning it backwards, the veins 601 may be accentuated in some cases. A near-infrared diffuse reflectance measurement may be performed by placing one probe 603 above the vein-rich region 601. To turn this into a differential measurement, a second probe 604 may be placed above a region without distinct veins 602. Then, the outputs from the two probes may be subtracted 605 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 600 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 606, or transmission or diffuse reflection through the tips of the fingers 607.

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[0082] In another embodiment, the dorsal of the foot 650 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 be easier to position the instrument using both hands. One probe 653 may be placed over regions where there are more distinct veins 651, and a near-infrared diffuse reflectance measurement may be made. For a differential measurement, a second probe 654 may be placed over a region with less prominent veins 652, 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.

[0083] 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 interference 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.

[0084] 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

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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). 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. These 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.

LIGHT SOURCES FOR NEAR INFRARED

[0085] 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 short wave infrared (SWIR), which may cover the wavelength range of approximately 1400nm to 2500nm. Other wavelength ranges may also be used for the applications described in this disclosure, so the discussion below is merely provided as 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. Second, the so-called "eye-safe" wavelengths are wavelengths longer than approximately 1400nm. 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.

[0086] 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

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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.

[0087] 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 500nm to 2500nm. 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 due to the low power levels. Also, the lamp based sources tend to be energy inefficient.

[0088] 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 20nm to 40nm. 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.

[0089] 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 10nm), in one embodiment a plurality of LDs may be used that are at different wavelengths in the SWIR. The various LDs may be spatially multiplexed, polarization

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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 (DBR) LDs, for example. 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.

[0090] 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 100nm wide, preferably in the 60 to 100nm range. Although currently SLDs are commercially available in the wavelength range of approximately 400nm to 1700nm, SLDs could and may in the future be made to cover a broader region of the SWIR.

[0091] 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. FIGURE 7 shows an example of a block diagram 700 or building blocks for constructing the high power LDs. In this embodiment, one or more diode bar stacks 701 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 702 may be used for the two axes.

[0092] Then, the brightness may be increased by spatially combining the beams from multiple stacks 703. 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 704 the two orthogonal polarizations, such as by using a polarization beam splitter. In a particular

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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 diameters of approximately 100 microns to 400 microns or more. Alternatively or in addition, a custom beam shaping module 705 may be used, depending on the particular application. For example, the output of the high power LD may be used directly 706, or it may be fiber coupled 707 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 FIGURE 7 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.

[0093] As described in greater detail in commonly owned US Pat. App. Pub. 2014/0188094, in some instances, it may be desirable to create multiple locations of focused light. For example, the speed of the treatment for varicose veins 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 such embodiments, 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.

[0094] 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

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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.

[0095] 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.

SWIR SUPER-CONTINUUM LASERS

[0096] 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

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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.

[0097] 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 recently, 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.

[0098] In one embodiment, an all-fiber-integrated, high-powered SC light source 800 may be elegant for its simplicity (FIGURE 8). The light may be first generated from a seed laser diode 801. For example, the seed LD 801 may be a distributed feedback (DFB) 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 about one kilohertz to about 100MHz or more. The output from the seed laser diode may then be amplified in a multiple-stage fiber amplifier 802 comprising one or more gain fiber segments. In one embodiment, the first stage pre-amplifier 803 may be designed for optimal noise performance. For example, the pre-amplifier 803 may be a standard erbium-doped fiber amplifier or an erbium/ytterbium doped cladding pumped fiber amplifier. Between amplifier stages 803 and 806, it may be advantageous to use band-pass filters 804 to block amplified spontaneous emission and isolators 805 to prevent spurious reflections. Then, the power amplifier stage 806 may use a cladding-pumped fiber amplifier that may be optimized to minimize nonlinear distortion. The power amplifier fiber 806 may also be an erbium-doped fiber amplifier, if only low or moderate power levels are to be generated.

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[0099] The SC generation 807 may occur in the relatively short lengths of fiber that follow the pump laser. The SC fiber length may range from around a few millimeters to 100m or more. In one embodiment, the SC generation may occur in a first fiber 808 where the modulational-instability initiated pulse break-up occurs primarily, followed by a second fiber 809 where the SC generation and spectral broadening occurs primarily.

[0100] 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 anomalous 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.

[0101] 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.

[0102] Mature fiber amplifiers for the power amplifier stage 806 include ytterbium-doped fibers (near 1060 nm), erbium-doped fibers (near 1550nm), erbium/ytterbium-doped fibers (near 1550

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nm), or thulium-doped fibers (near 2000nm). In various embodiments, candidates for SC fiber 809 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 806 and nonlinear fiber 809, SC may be generated in the visible, near-IR / SWIR, or mid-IR wavelength region.

[0103] The configuration 800 of FIGURE 8 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.

[0104] In one embodiment, one example of the SC laser that operates in the SWIR is illustrated in FIGURE 9. This SWIR SC source 900 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 901 is a distributed feedback (DFB) laser operating near 1542nm producing approximately 0.5nsec pulses at an about 8MHz repetition rate. The pre-amplifier 902 is forward pumped and uses about 2m length of erbium/ytterbium cladding pumped fiber 903 (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 903 is pumped using a 10W laser diode near 940nm 905 that is coupled in using a fiber combiner 904.

[0105] In this particular 5W unit, the mid-stage between amplifier stages 902 and 906 comprises an isolator 907, a band-pass filter 908, a polarizer 909 and a fiber tap 910. The power amplifier 906 uses an approximately 4m length of the 12/130 micron erbium/ytterbium doped fiber 911 that is counter-propagating pumped using one or more 30W laser diodes near 940nm 912 coupled in through a combiner 913. An approximately 1-2 meter length of the combiner pig-tail helps to

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initiate the SC process, and then a length of PM-1550 fiber 915 (polarization maintaining, single-mode, fused silica fiber optimized for 1550nm) is spliced 914 to the combiner output.

[0106] If an output fiber of about 10m in length is used, then the resulting output spectrum 1000 is shown in FIGURE 10. The details of the output spectrum 1000 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 about 2500nm). 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 spectra toward the shorter wavelengths, the pump wavelength (in this case ~1542nm) 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.

[0107] In one particular embodiment, the SWIR-SC light source of FIGURE 9 with output spectrum in FIGURE 10 was used in preliminary experiments for examining the reflectance from different dental samples. A schematic of the experimental set-up 1100 for measuring the diffuse reflectance spectroscopy is illustrated in FIGURE 11A. The SC source 1101 in this embodiment was based on the design of FIGURE 9 and delivered approximately 1.6W of light over the wavelength range from about 1500-2400nm. The output beam 1102 was collimated, and then passed through a chopper 1103 (for lock-in detection at the receiver after the spectrometer 1106) and an aperture 1104 for localizing the beam on the tooth location. Different teeth 1105 with different lesions and caries were placed in front of the aperture 1104, and the scattered light was passed through a spectrometer 1106 and collected on a detector, whose signal was sent to a receiver. The tooth samples 1105 were mounted in clay or putty for standing upright. Different types of teeth could be used, including molars, premolars, canine and incisor teeth.

[0108] FIGURE 11B shows exemplary reflectance spectra 1150 from a sound enamel region 1151 (e.g., without dental caries), an enamel lesion region 1152, and a dentine lesion region 1153 of various teeth. The spectra are normalized to have equal value near 2050nm. In this particular embodiment, the slope from the sound enamel 1151 is steepest between about 1500 and 1950nm, with a lesser slope in the presence of an enamel lesion 1152. When there is a sample with dentine lesion

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1153, more features appear in the spectrum from the presence of water absorption lines from water that collects in the dentine. For this experiment, the spectra 1151, 1152, and 1153 are flatter in the wavelength region between about 1950nm and 2350nm. These are preliminary results, but they show the benefit of using broadband sources such as the SWIR-SC source for diagnosing dental caries. Although the explanation behind the different spectra 1150 of FIGURE 11B may not be understood as yet, it is clear that the spectra 1151, 1152 and 1153 are distinguishable. Therefore, the broadband reflectance may be used for detection of dental caries and analyzing the region of the caries. Although diffuse reflectance has been used in this experiment, other signals, such as transmission, reflectance or a combination, may also be used and are covered by this disclosure.

[0109] Although one particular example of a 5W 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 900 in FIGURE 9 may be used to generate high powered SC between approximately 1060 and 1800nm. For this embodiment, the seed laser 901 may be a distributed feedback laser diode of about 1064nm, the pre-amplifier gain fiber 903 may be a ytterbium-doped fiber amplifier with 10/125 microns dimensions, and the pump laser 905 may be a 10W laser diode near 915nm. A mode field adapter may be including in the mid-stage, in addition to the isolator 907, band pass filter 908, polarizer 909 and tap 910. The gain fiber 911 in the power amplifier may be an about 20m length of ytterbium-doped fiber with 25/400 microns dimension. The pump 912 for the power amplifier may be up to six pump diodes providing 30W each near 915nm. For this much pump power, the output power in the SC may be as high as 50W or more.

[0110] In an alternate 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 SC source of FIGURE 12A can lead to bandwidths ranging from about 1400nm to 1800nm or broader, while the SC source of FIGURE 12B can lead to bandwidths ranging from about 1900nm to 2500nm or broader. Since these wavelength ranges are shorter than about 2500nm, 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.

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[0111] In one embodiment, FIGURE 12A illustrates a block diagram for an SC source 1200 capable of generating light between approximately 1400nm and 1800nm or broader. As an example, a pump fiber laser similar to FIGURE 9 can be used as the input to a SC fiber 1209. The seed laser diode 1201 can comprise a DFB laser that generates, for example, several milliwatts of power around 1542nm or 1553nm. The fiber pre-amplifier 1202 can comprise an erbium-doped fiber amplifier or an erbium/ytterbium doped double clad fiber. In this example, a mid-stage amplifier 1203 can be used, which can comprise an erbium/ytterbium doped double-clad fiber. A bandpass filter 1205 and isolator 1206 may be used between the pre-amplifier 1202 and mid-stage amplifier 1203. The power amplifier stage 1204 can comprise a larger core size erbium/ytterbium doped double-clad fiber, and another bandpass filter 1207 and isolator 1208 can be used before the power amplifier 1204. The output of the power amplifier can be coupled to the SC fiber 1209 to generate the SC output 1210. This is just one exemplary configuration for an SC source, and other configurations or elements may be used consistent with this disclosure.

[0112] In yet another embodiment, FIGURE 12B illustrates a block diagram for an SC source 1250 capable of generating light between approximately 1900 and 2500nm or broader. As an example, the seed laser diode 1251 can comprise a DFB or DBR laser that generates, for example, several milliwatts of power around 1542nm or 1553nm. The fiber pre-amplifier 1252 can comprise an erbium-doped fiber amplifier or an erbium/ytterbium doped double-clad fiber. In this example, a mid-stage amplifier 1253 can be used, which can comprise an erbium/ytterbium doped double-clad fiber. A bandpass filter 1255 and isolator 1256 may be used between the pre-amplifier 1252 and mid-stage amplifier 1253. The power amplifier stage 1254 can comprise a thulium doped double-clad fiber, and another isolator 1257 can be used before the power amplifier 1254. Note that the output of the mid-stage amplifier 1253 can be approximately near 1542nm, while the thulium-doped fiber amplifier 1254 can amplify wavelengths longer than approximately 1900nm and out to about 2100nm. Therefore, for this configuration wavelength shifting may be required between 1253 and 1254. In one embodiment, the wavelength shifting can be accomplished using a length of standard single-mode fiber 1258, which can have a length between approximately 5 and 50 meters, for example. The output of the power amplifier 1254 can be coupled to the SC fiber 1259 to generate the SC output 1260. 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,

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such as erbium doped fibers, ytterbium doped fibers, erbium/ytterbium co-doped fibers and thulium doped fibers.

[0113] FIGURE 12C illustrates a reflection-spectroscopy based stand-off detection system having an SC laser source. The set-up 1270 for the reflection-spectroscopy-based stand-off detection system includes an SC source 1271. 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 1272. 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 1274 is kept at a distance from the collimating mirror 1272, which provides a total round trip path length of twice the distance before reaching the collection optics 1275. A 12cm diameter silver coated concave mirror 1275 with a 75cm focal length is kept 20cm to the side of the collimation mirror 1272. The mirror 1275 is used to collect a fraction of the diffusely reflected light from the sample, and focus it into the input slit of a monochromator 1276. Thus, the beam is incident normally on the sample 1274, 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 1276 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 1277. The detected output is amplified using a trans-impedance pre-amplifier 1277 with a gain of about 105V/A and connected to a lock-in amplifier 1278 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.

[0114] While the above detection systems could be categorized as single path detection systems, it may be advantageous in some cases to use multi-path detection systems. In one embodiment, a detection system from a Fourier transform infrared spectrometer, FTIR, may be used. The received light may be incident on a particular configuration of mirrors, called a Michelson interferometer, that allows some wavelengths to pass through but blocks others due to wave interference. The beam may be modified for each new data point by moving one of the mirrors, which changes the set of wavelengths that pass through. This collected data is called an interferogram. The

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interferogram is then processed, typically on a computing system, using an algorithm called the Fourier transform. One advantageous feature of FTIR is that it may simultaneously collect spectral data in a wide spectral range.

[0115] Another advantage of using the near-infrared or SWIR is that most drug packaging materials are at least partially transparent in this wavelength range, so that drug compositions may be detected and identified through the packaging non-destructively. As an example, SWIR light could be used to see through plastics, since the signature for plastics can be subtracted off and there are large wavelength windows where the plastics are transparent. Because of the hydro-carbon bonds, there are absorption features near 1.7 microns and 2.2-2.5 microns. In general, the absorption bands in the near infrared are due to overtones and combination bands for various functional group vibrations, including signals from C-H, O-H, C=O, N-H, -COOH, and aromatic C-H groups. It may be difficult to assign an absorption band to a specific functional group due to overlapping of several combinations and overtones. However, with advancements in computational power and chemometrics or multivariate analysis methods, complex systems may be better analyzed. In one embodiment, using software analysis tools the absorption spectrum may be converted to its second derivative equivalent. The spectral differences may permit a fast, accurate, non-destructive and reliable identification of materials. Although particular derivatives are discussed, other mathematical manipulations may be used in the analysis, and these other techniques are also intended to be covered by this disclosure.

[0116] Described herein are just some examples of the beneficial use of near-infrared or SWIR lasers for spectroscopy, 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 near-infrared or SWIR spectroscopy, 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 near-infrared or

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SWIR spectroscopy, active remote sensing or hyper-spectral imagery would also have a location tag on the data. Moreover, the near-infrared or SWIR spectroscopy, 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 near-infrared or SWIR spectroscopy, 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.

[0117] In yet another example of multi-beam detection systems, a dual-beam set-up 1280 such as in FIGURE 12D may be used to subtract out (or at least minimize the adverse effects of) light source fluctuations. In one embodiment, the output from an SC source 1281 may be collimated using a CaF2 lens 1282 and then focused into the entrance slit of the monochromator 1283. At the exit slit, light at the selected wavelength is collimated again and may be passed through a polarizer 1284 before being incident on a calcium fluoride beam splitter 1285. After passing through the beam splitter 1285, the light is split into a sample 1286 and reference 1287 arm to enable ratiometric detection that may cancel out effects of intensity fluctuations in the SC source 1281. The light in the sample arm 1286 passes through the sample of interest and is then focused onto a HgCdTe detector 1288 connected to a pre-amp. A chopper 1282 and lock-in amplifier 1290 setup enable low noise detection of the sample arm signal. The light in the reference arm 1287 passes through an empty container (cuvette, gas cell etc.) of the same kind as used in the sample arm. A substantially identical detector 1289, pre-amp and lock-in amplifier 1290 is used for detection of the reference arm signal. The signal may then be analyzed using a computer system 1291. This is one particular example of a method to remove fluctuations from the light source, but other components may be added and other configurations may be used, and these are also intended to be covered by this disclosure.

[0118] Although particular examples of detection systems have been described, combinations of these systems or other systems may also be used, and these are also within the scope of this disclosure. As one example, environmental fluctuations (such as turbulence or winds) may lead to fluctuations in the beam for active remote sensing or hyper-spectral imaging. A configuration such as FIGURE 12D may be able to remove the effect of environmental fluctuations. Yet another technique may be to "wobble" the light beam after the light source using a vibrating mirror. The motion may

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lead to the beam moving enough to wash out spatial fluctuations within the beam waist at the sample or detection system. If the vibrating mirror is scanned faster than the integration time of the detectors, then the spatial fluctuations in the beam may be integrated out. Alternately, some sort of synchronous detection system may be used, where the detection is synchronized to the vibrating frequency.

[0119] By use of an active illuminator, a number of advantages may be achieved, such as higher signal-to-noise ratios. 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.

[0120] 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.

[0121] In another embodiment, an imaging spectrometer may be used to detect the light received from the sample. For example, FIGURE 14A shows a schematic diagram 1400 of the basic elements of an imaging spectrometer. The input light 1401 from the sample may first be directed by a scanning mirror and/or other optics 1402. An optical dispersing element 1403, such as a grating or prism, in the spectrometer may split the light into many narrow, adjacent wavelength bands, which

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may then be passed through imaging optics 1404 onto one or more detectors or detector arrays 1405. Some sensors may use multiple detector arrays to measure hundreds of narrow wavelength bands.

[0122] An example of a typical imaging spectrometer 1450 used in hyper-spectral imaging systems is illustrated in FIGURE 14B. In this particular embodiment, the input light may be directed first by a tunable mirror 1451. A front lens 1452 may be placed before the entrance slit 1453 and the collector lens 1454. In this embodiment, the dispersing element is a holographic grating with a prism 1455, which separates the different wavelength bands. Then, a camera lens 1456 may be used to image the wavelengths onto a detector or camera 1457.

[0123] Figures 14A and 14B provide particular examples, but some of the elements may not be used, or other elements may be added, and these are also intended to be covered by this disclosure. For instance, a scanning spectrometer may be used before the detector, where a grating or dispersive element is scanned to vary the wavelength being measured by the detector. In yet another embodiment, filters may be used before one or more detectors to select the wavelengths or wavelength bands to be measured. This may be particularly useful if only a few bands or wavelengths are to be measured. The filters may be dielectric filters, Fabry-Perot filters, absorption or reflection filters, fiber gratings, or any other wavelength selective filter. In one embodiment, a wavelength division multiplexer, WDM, may be used followed by one or more detectors or detector arrays. One example of a planar wavelength division multiplexer may be a waveguide grating router or an arrayed waveguide grating. The WDM may be fiber coupled, and detectors may be placed directly at the output or the detectors may be coupled through fibers to the WDM. Some of these components may also be combined with the configurations in Figures 14A and 14B.

[0124] One advantage of the SC lasers illustrated is 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.

[0125] The Figures provide examples of SC light sources that may advantageously be used for SWIR light generation in various medical and dental 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

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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.

[0126] Even within the all-fiber versions illustrated such as in FIGURE 9, 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 FIGURE 9. 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 902 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 902 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 906 that may preferentially reflect light near the wavelength of the seed laser 901. If the mirror or fiber grating reflector can transmit the pump light near 940nm, then this could also be used instead of the pump combiner 913 to bring in the pump light 912. The SC fiber 915 could be placed between the seed laser 901 and the power amplifier stage 906 (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 901 and the SC fiber, which now may be in front of the power amplifier 906. 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.

[0127] 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

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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.

[0128] 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.

[0129] FIGURE 15 illustrates what might be an eventual flow-chart 1500 of a smart manufacturing process. The manufacturing process 1501 may have as input the process feed 1502 and result in a process output 1503. A process controller 1504 may at least partially control the manufacturing process 1501, and the controller 1504 may receive inputs from the closed loop control (process parameters) 1505 as well as the on-line monitoring of process parameters 1506. The feedback loops in the process could refine the manufacturing process 1501 and improve the quality of the process output 1503. 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.

[0130] The discussion thus far has centered on 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-

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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.

WIRELESS LINK TO THE CLOUD

[0131] The non-invasive dental caries 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 wireless means. 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 optic 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 dentists, 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 and dentists can use to assess and manage disease, and that patients can use to help maintain their health and direct their own care.

[0132] In a particular embodiment 1300, the non-invasive measurement device 1301 may comprise a transmitter 1303 to communicate over a first communication link 1304 in the body area network or personal area network to a receiver in a smart phone, tablet, cell phone, PDA, and/or computer 1305, for example. For the measurement device 1301, it may also be advantageous to have a processor 1302 to process some of the measured data, since with processing the amount of data to transmit may be less (hence, more energy efficient). The first communication link 1304 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 1304 may occur in the wireless medical band between 2360MHz and 2390MHz, 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.

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[0133] The personal device 1305 may store, process, display, and transmit some of the data from the measurement device 1301. The device 1305 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 1305 include smart phones such as the Apple iPhones® or phones operating on the Android or Microsoft systems. In one embodiment, the device 1305 may have an application, software program, or firmware to receive and process the data from the measurement device 1301. The device 1305 may then transmit some or all of the data or the processed data over a second communication link 1306 to the internet or "cloud" 1307. The second communication link 1306 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 1306 may additionally comprise lengths of fiber optic and/or communication over copper wires or cables.

[0134] The internet or cloud 1307 may add value to the measurement device 1301 by providing services that augment the measured 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 1305; (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 1308 back to the originator (e.g., patient or user), it may be transmitted 1309 to a health care provider or doctor or dentist, or it may be transmitted 1310 to other designated recipients.

[0135] Service providers coupled to the cloud 1307 may provide a number of value-add services. For example, the cloud application may store and process the dental data for future reference or during a visit with the dentist or healthcare provider. If a patient has some sort of medical mishap or emergency, the physician can obtain the history of the dental or physiological parameters over a specified period of time. In another embodiment, alarms, warnings or reminders may be delivered to the user 1308, the healthcare provider 1309, or other designated recipients 1310. 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 1305 may also have a GPS sensor, so the cloud 1307 may be able to provide time, date, and position along with the dental or physiological parameters. Thus, if there is a medical or dental emergency, the cloud 1307 could provide the location of the patient to the dental or healthcare provider 1309 or other designated recipients 1310. Moreover, the digitized

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data in the cloud 1307 may help to move toward what is often called "personalized medicine." Based on the dental or physiological parameter data history, medication or medical/dental therapies may be prescribed that are customized to the particular patient. Another advantage for commercial entities may be that 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.

[0136] Beyond the above benefits, the cloud application 1307 and application on the device 1305 may also have financial value for companies developing devices 1301 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 1307. 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 1307. 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.

[0137] 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.

[0138] 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

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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, 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.

[0139] Described herein are just some examples of the beneficial use of near-infrared or SWIR lasers for non-invasive measurements of dental caries and early detection of carious regions. However, many other dental or medical procedures can use the near-infrared or SWIR light consistent with this disclosure and are intended to be covered by the disclosure.

[0140] 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.

[0141] 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

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characteristics are not outside the scope of the disclosure and may be desirable for particular applications.

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WHAT IS CLAIMED IS:

1. A measurement system comprising:

a light source comprising a plurality of semiconductor sources that are configured to generate an output optical beam with one or more optical wavelengths, the light source configured to increase signal-to-noise ratio by increasing a light intensity from at least one of the plurality of semiconductor sources;

an apparatus configured to:

receive a portion of the output optical beam, and

deliver an analysis output beam to a sample;

a receiver configured to:

receive and process at least a portion of the analysis output beam reflected or transmitted from the sample,

generate an output signal, and

synchronize to the light source;

a 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,

store and display the processed output signal, and

transmit at least a portion of the processed output signal over a wireless transmission link; and

a cloud configured to:

receive, over the wireless transmission link, an output status comprising the at least a portion of the processed output signal,

process the received output status to generate processed data, and

store the processed data.

2. The measurement system of claim 1, wherein the receiver is further configured to:

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capture light while the semiconductor sources are off and convert the captured light into a first signal;

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a part of the at least a portion of the analysis output beam reflected or transmitted from the sample; and

the measurement system further configured to improve the signal-to-noise ratio by differencing the first signal and the second signal.

3. The measurement system of claim 2 further comprising a reflective surface to receive and redirect at least some of the at least a portion of the analysis output beam reflected or transmitted from the sample.

4. The measurement system of claim 1, wherein the measurement system is configured to use artificial intelligence in making decisions;

wherein the measurement system is configured to perform pattern identification or classification, and wherein the measurement system is configured to apply a threshold function to a comparison with a stored data set; and

wherein the measurement system is at least in part configured for selection or identification of an object, and wherein the measurement system is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

5. The measurement system of claim 1, wherein the light source is configured to further increase signal-to-noise ratio by increasing a pulse rate of at least one of the plurality of semiconductor sources.

6. The measurement system of claim 1, wherein the plurality of semiconductor sources comprises at least one of: light emitting diodes (LEDs), laser diodes (LD's), tunable LD's, and super-luminescent laser diodes (SLDs).

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7. The measurement system of claim 1, wherein the light source is further configured to increase the light intensity from the plurality of semiconductor sources by spatially coupling the optical output beam from at least two of the plurality of semiconductor sources.

8. A measurement system comprising:

a wearable measurement device for measuring one or more physiological parameters, including a light source comprising a plurality of semiconductor sources that are configured to generate an output optical beam with one or more optical wavelengths;

the light source configured to increase signal-to-noise ratio by increasing a light intensity from at least one of the plurality of semiconductor sources;

the wearable measurement device configured to receive a portion of the output optical beam and to deliver an analysis output beam to a sample;

the wearable measurement device further comprising a receiver configured to receive and process at least a portion of the analysis output beam reflected or transmitted from the sample and to generate an output signal, wherein the wearable measurement device receiver is configured to be synchronized to pulses of the light source;

a 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, to store and display the processed output signal, and to transmit a portion of the processed output signal over a wireless transmission link; and

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, and wherein the cloud is capable of storing a history of at least a portion of the received output status over a specified period of time.

9. The measurement system of claim 8, wherein the receiver is further configured to:

capture light while the semiconductor sources are off and convert the captured light into a first signal;

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capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a part of the at least a portion of the analysis output beam reflected or transmitted from the sample; and

the measurement system further configured to improve the signal-to-noise ratio by differencing the first signal and the second signal.

10. The measurement system of claim 9 further comprising a reflective surface to receive and redirect at least some of the at least a portion of the analysis output beam reflected or transmitted from the sample.

11. The measurement system of claim 8, wherein the measurement system is configured to use artificial intelligence in making decisions;

wherein the measurement system is configured to perform pattern identification or classification, and wherein the measurement system is configured to apply a threshold function to a comparison with a stored data set; and

wherein the measurement system is at least in part configured for selection or identification of an object, and wherein the measurement system is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

12. The measurement system of claim 9, wherein the light source is configured to further increase signal-to-noise ratio by one of increasing a pulse rate of at least one of the plurality of semiconductor sources.

13. The measurement system of claim 8, wherein the plurality of semiconductor sources comprises at least one of: light emitting diodes (LEDs), laser diodes (LD's), tunable LD's, and super-luminescent laser diodes (SLDs).

14. A wearable device for use with a smart phone or tablet, the wearable device comprising:

a measurement device including a light source comprising a plurality of semiconductor sources for measuring one or more physiological parameters, the measurement device configured to:

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generate, by modulating at least one of the semiconductor sources having an initial light intensity, an input optical beam having one or more optical wavelengths, and

receive and to deliver a portion of the input optical beam to tissue, wherein the tissue reflects at least a portion of the input optical beam delivered to the tissue;

the measurement device further comprising a receiver configured to:

capture light while the semiconductor sources are off and convert the captured light into a first signal, and

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a portion of the input optical beam reflected from the tissue;

synchronize to the modulation of the at least one of the semiconductor sources;

the measurement device further configured to improve a signal-to-noise ratio of the input optical beam reflected from the tissue by:

differencing the first signal and the second signal, and

increasing the light intensity relative to the initial light intensity from at least one of the semiconductor sources;

the measurement device further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue;

the wearable device configured to communicate with the smart phone or tablet, the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a voice input module, a speaker, and a touch screen; and

the smart phone or tablet configured to:

receive and to process at least a portion of the output signal,

store and display the processed output signal, and

transmit at least a portion of the processed output signal over a wireless transmission link.

15. The wearable device of claim 14, wherein the light source is configured to further improve the signal-to-noise ratio of the input optical beam reflected from the tissue by increasing a pulse rate of at least one of the plurality of semiconductor sources.

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16. The wearable device of claim 15, further comprising a cloud configured to:

receive, over the wireless transmission link, an output status comprising the at least a portion of the processed output signal,

process the output status to generate processed data, and

store the processed data, and

wherein the cloud is capable of storing a history of at least a portion of the output status over a specified period of time.

17. The wearable device of claim 14, wherein the wearable device is configured to use artificial intelligence in making decisions;

wherein the wearable device is configured to perform pattern identification or classification, and wherein the wearable device is configured to apply a threshold function to a comparison with a stored data set; and

wherein the wearable device is at least in part configured for selection or identification of an object, and wherein the wearable device is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

18. The wearable device of claim 14, wherein the receiver is located a first distance from a first one of the semiconductor sources and a different distance from a second one of the semiconductor sources such that the receiver can capture a third signal from the first semiconductor source and a fourth signal from the second semiconductor source.

19. The wearable device of claim 14, wherein the measurement device further comprises a reflective surface configured to receive and redirect at least a portion of light reflected from the tissue.

20. The wearable device of claim 14, further comprising a cloud configured to:

receive, over the wireless transmission link, an output status comprising the at least a portion of the processed output signal,

process the output status to generate processed data, and

store the processed data, and

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wherein the cloud is capable of storing a history of at least a portion of the output status over a specified period of time.

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ABSTRACT

A measurement system is provided with a light source that is configured to increase signal-to-noise ratio by increasing a light intensity from at least one of a plurality of semiconductor sources. An apparatus to receive a portion of the output optical beam, and deliver an analysis output beam to a sample. A receiver to: receive and process at least a portion of the analysis output beam reflected or transmitted from the sample, generate an output signal, and synchronize to the light source. A smart phone or tablet to: receive and process at least a portion of the output signal, store and display the processed output signal, and transmit at least a portion of the processed output signal. A cloud to: receive an output status comprising the at least a portion of the processed output signal, process the received output status to generate processed data, and store the processed data.

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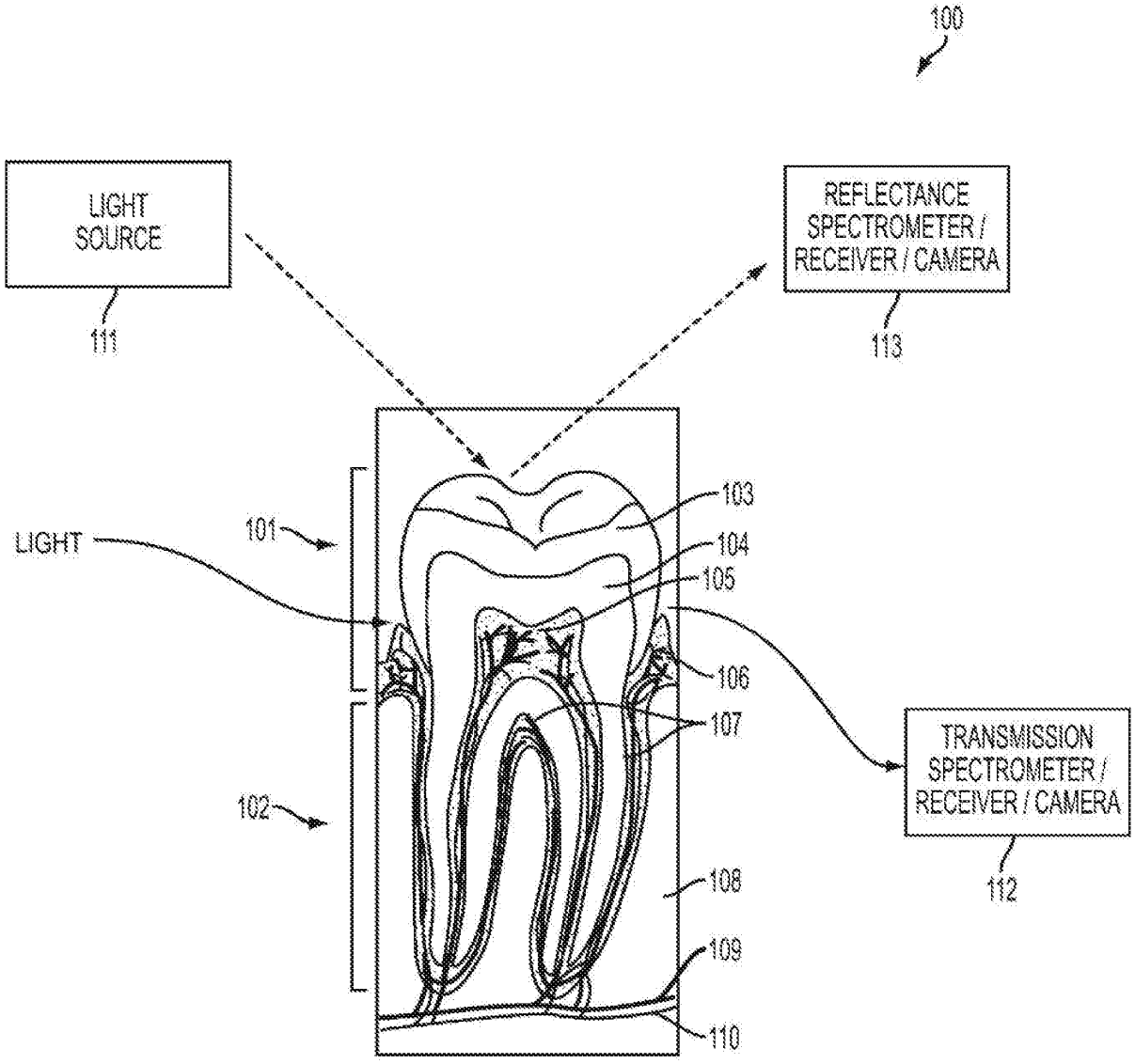

100
LIGHT SOURCE
111
REFLECTANCE SPECTROMETER / RECEIVER / CAMERA
113
LIGHT
101
102
103
104
105
106
107
108
109
110
TRANSMISSION SPECTROMETER / RECEIVER / CAMERA
112

FIG. 1

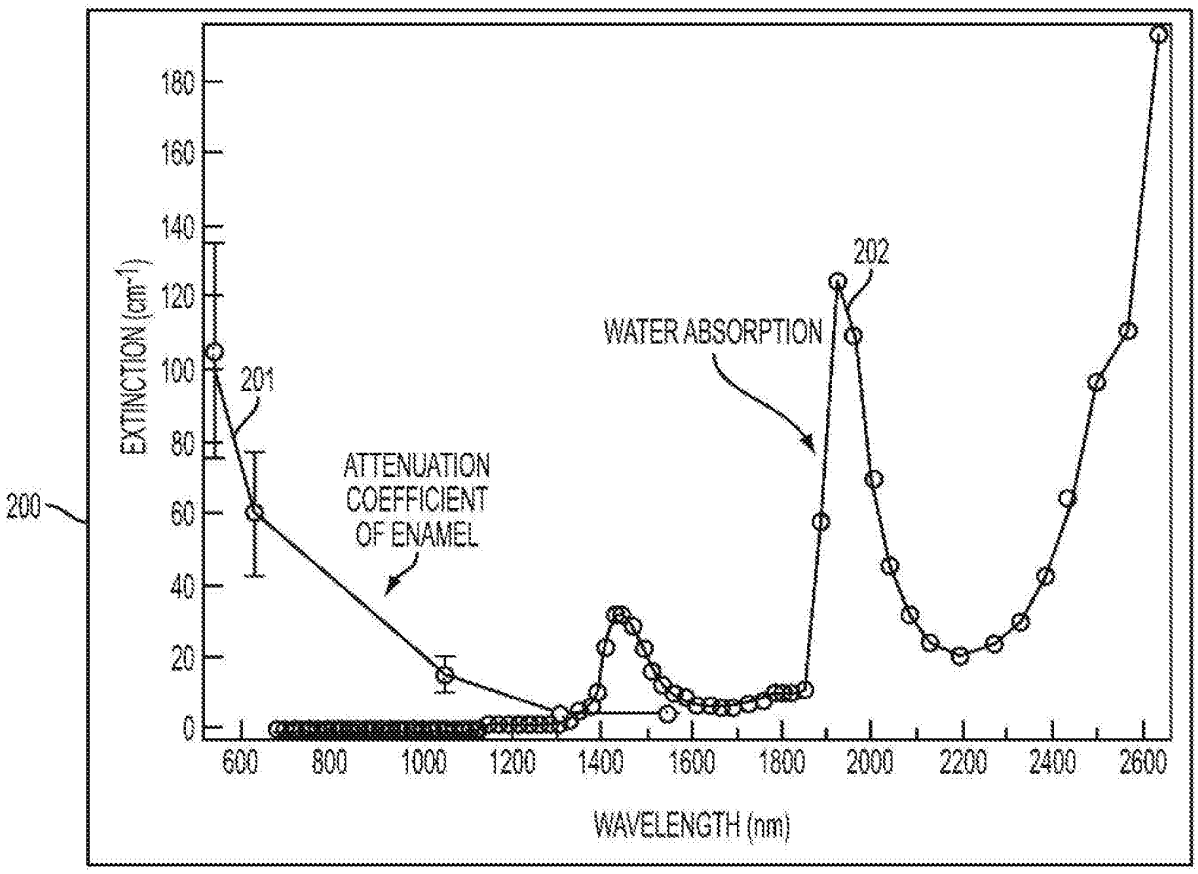

200
EXTINCTION (cm⁻¹)
180
160
140
120
100
80
60
40
20
0
201
202
ATTENUATION COEFFICIENT OF ENAMEL
WATER ABSORPTION
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
WAVELENGTH (nm)

FIG. 2A

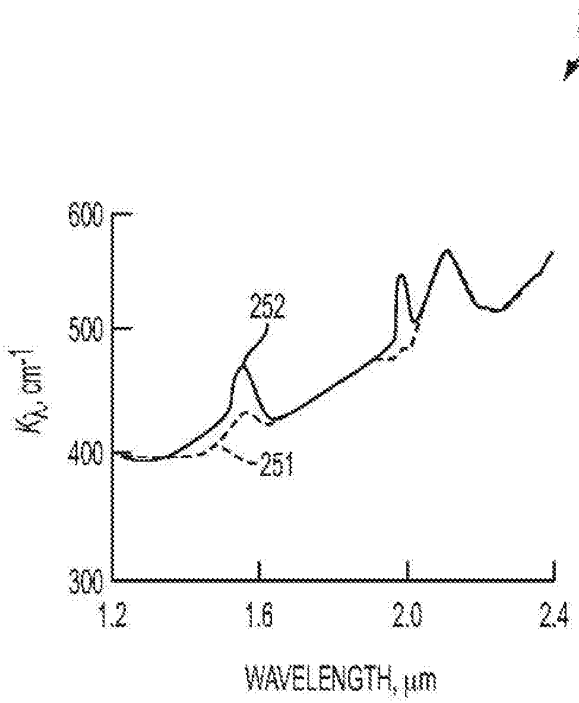

250
600
500
400
300
252
251
K_λ, cm^{-1}
1.2
1.6
2.0
2.4
WAVELENGTH, μm

FIG. 2B

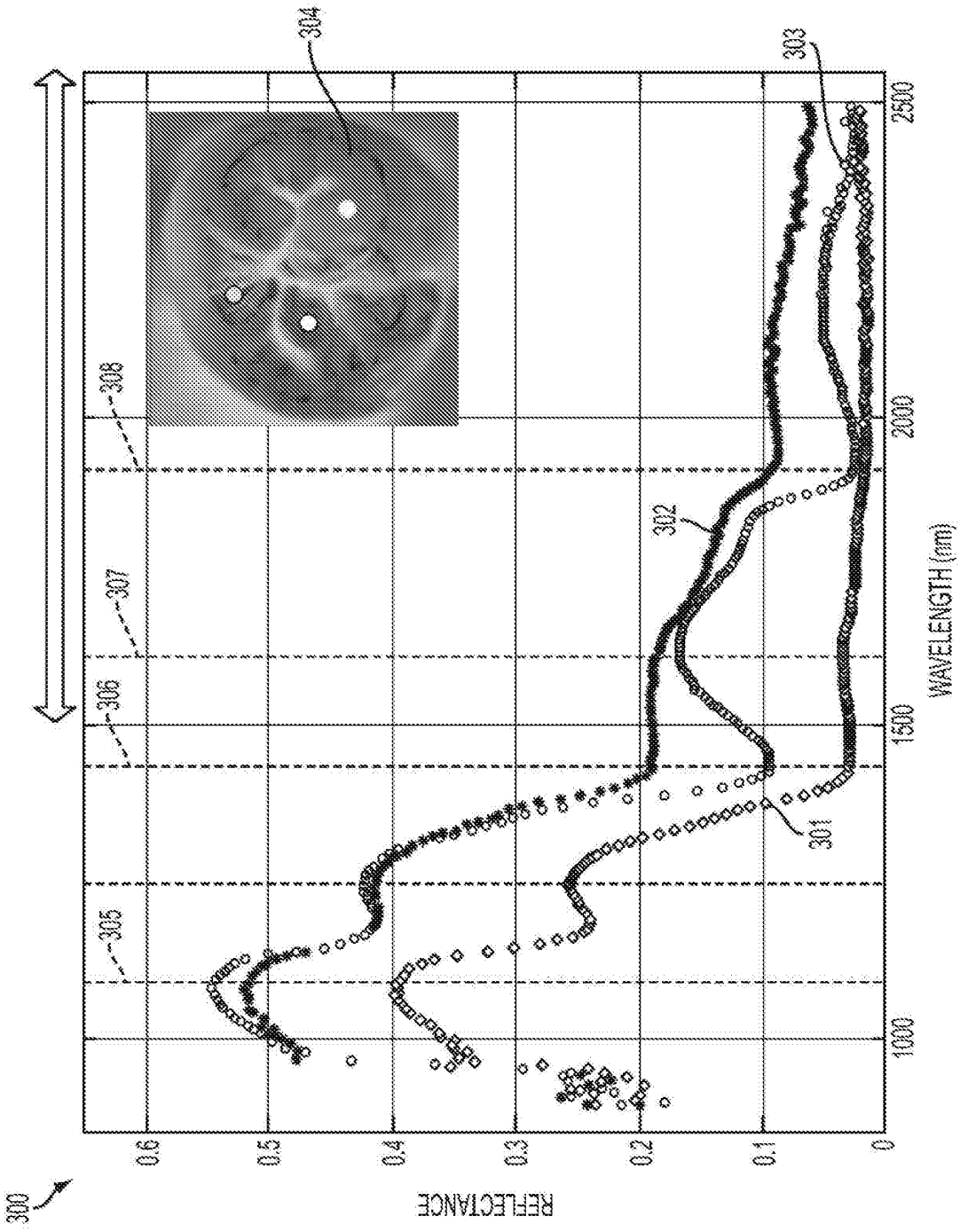

304
303
308
307
306
305
302
301
300
REFLECTANCE
0.6
0.5
0.4
0.3
0.2
0.1
0
1000
1500
2000
2500
WAVELENGTH (nm)

FIG. 3

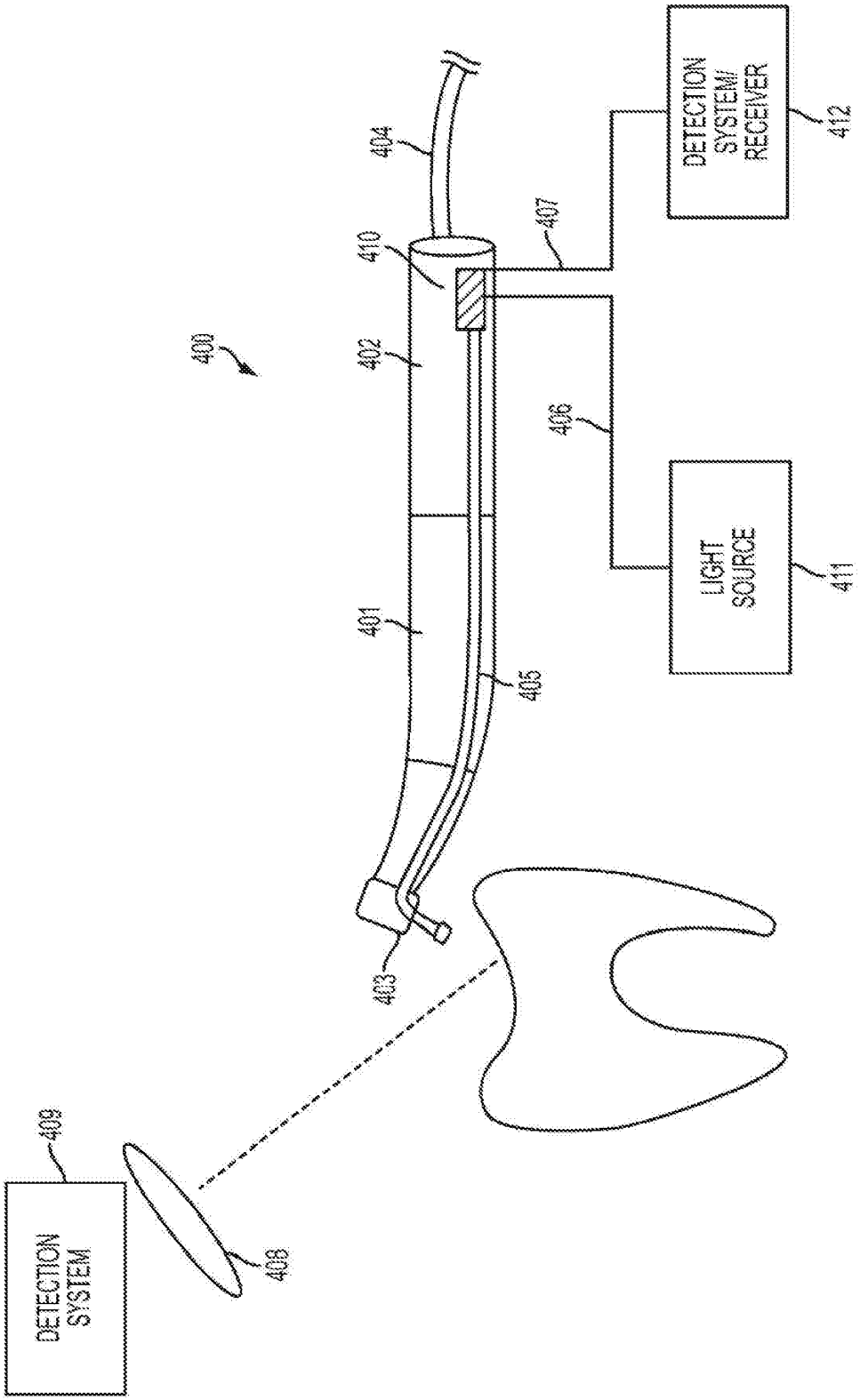

400
401
402
403
404
405
406
407
408
409
410
411
412
DETECTION SYSTEM
DETECTION SYSTEM/ RECEIVER
LIGHT SOURCE

FIG. 4

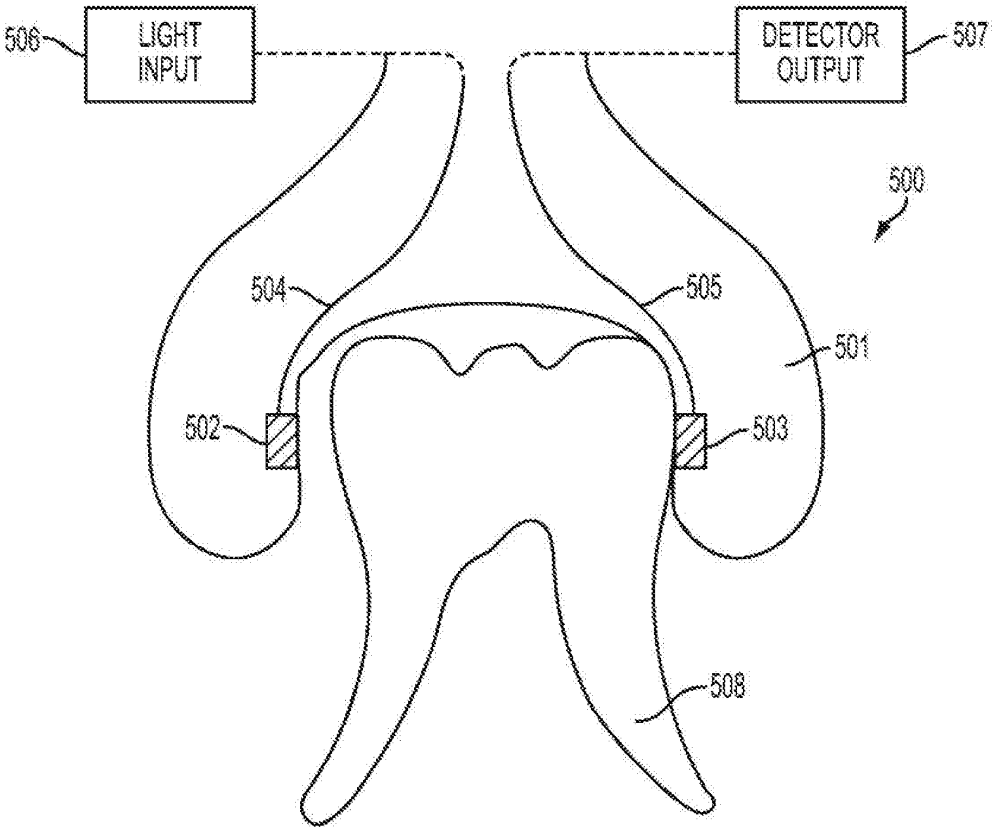

506
LIGHT INPUT
DETECTOR OUTPUT
507
500
504
505
501
502
503
508

FIG. 5A

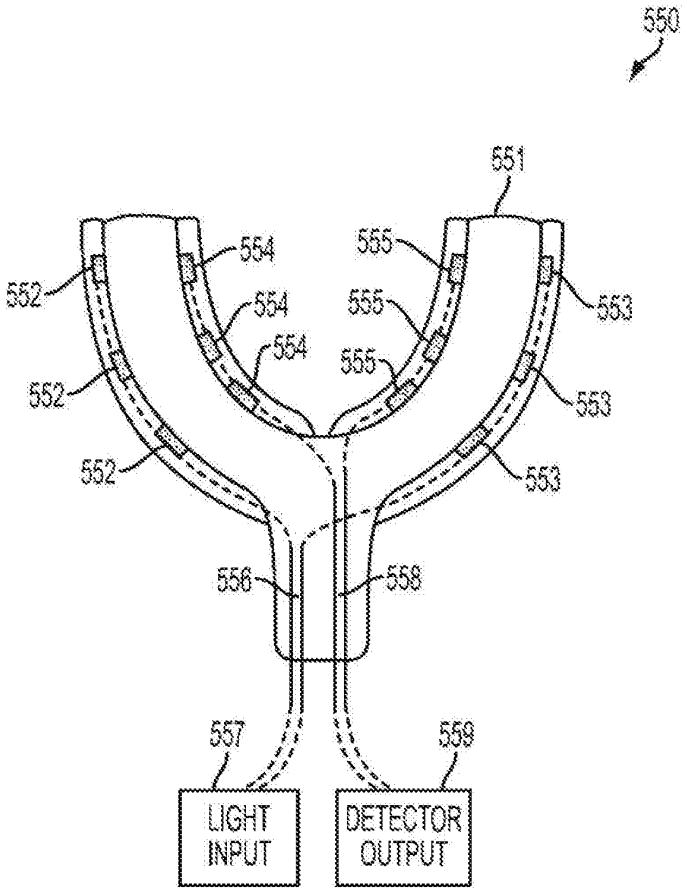

550
551
552
552
552
553
553
553
554
554
554
555
555
555
556
558
557
559
LIGHT INPUT
DETECTOR OUTPUT

FIG. 5B

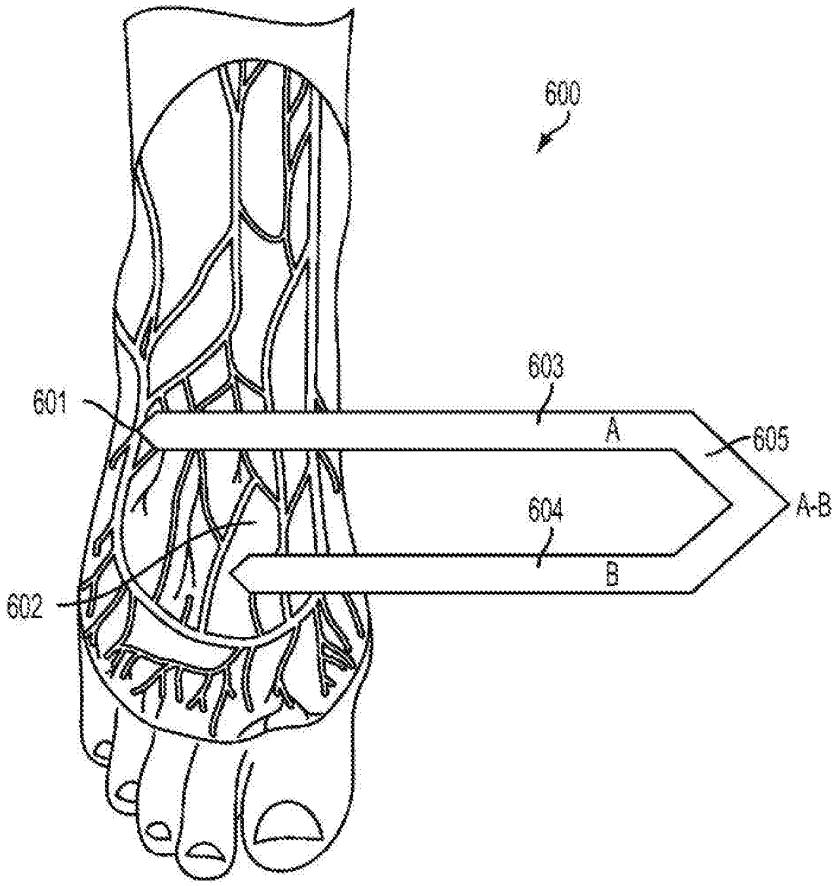


FIG. 6A

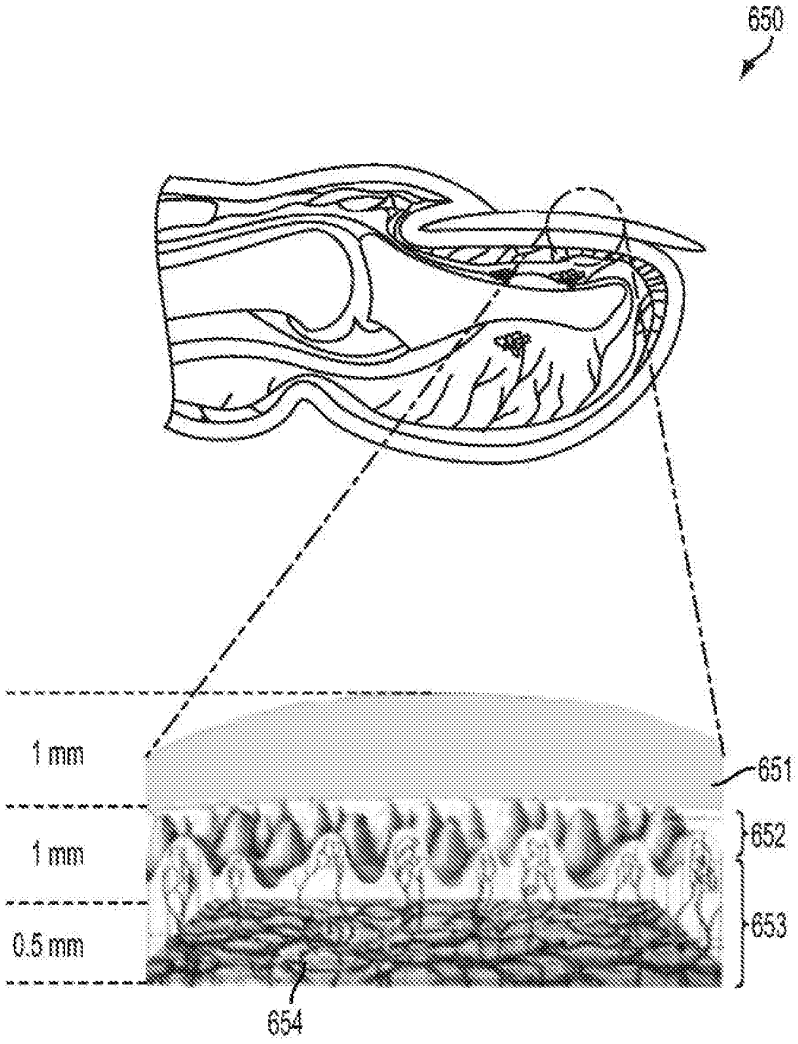


FIG. 6B

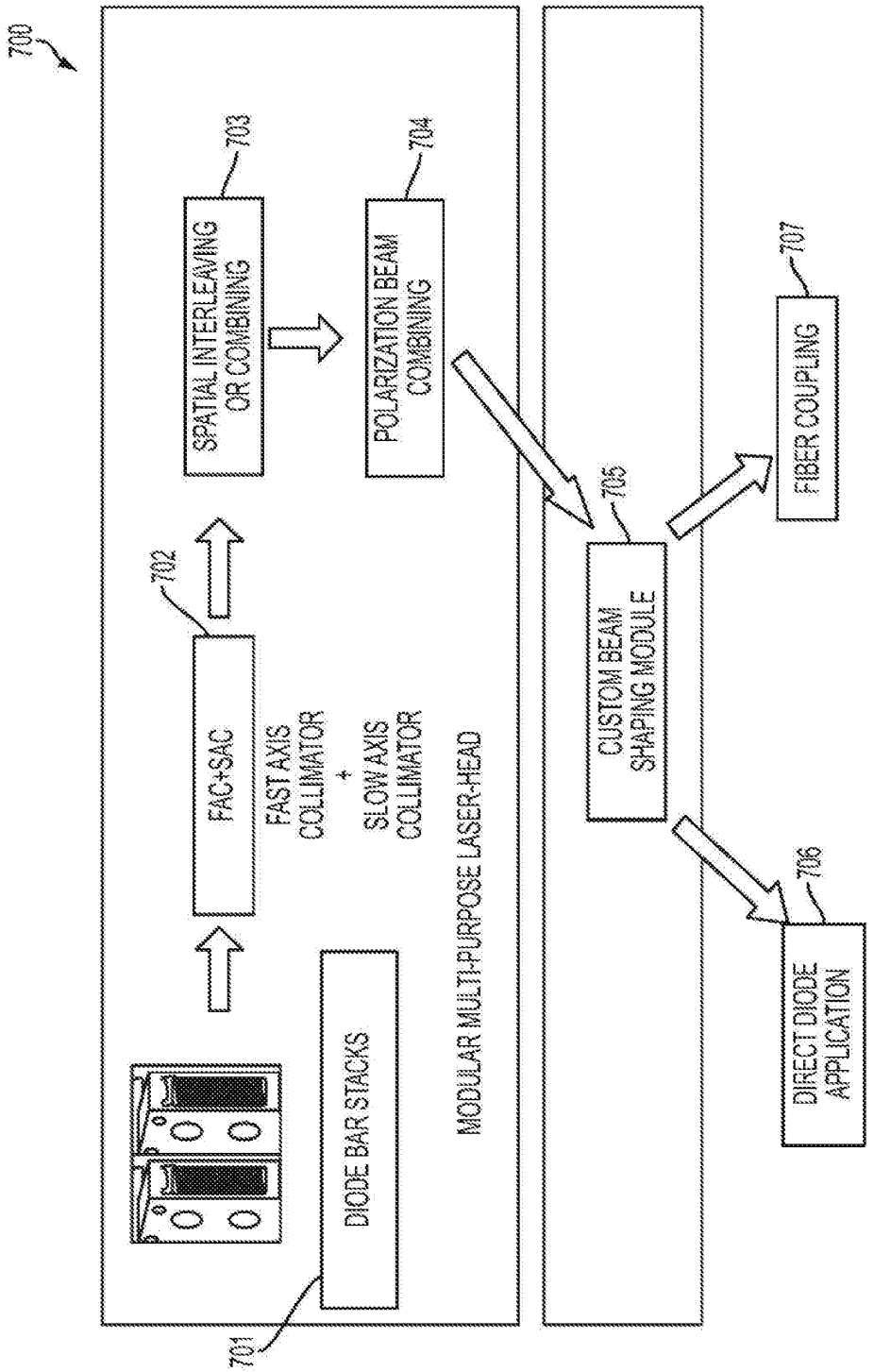

700
701
DIODE BAR STACKS
702
FAC+SAC
FAST AXIS COLLIMATOR
+
SLOW AXIS COLLIMATOR
MODULAR MULTI-PURPOSE LASER-HEAD
703
SPATIAL INTERLEAVING OR COMBINING
704
POLARIZATION BEAM COMBINING
705
CUSTOM BEAM SHAPING MODULE
706
DIRECT DIODE APPLICATION
707
FIBER COUPLING

FIG. 7

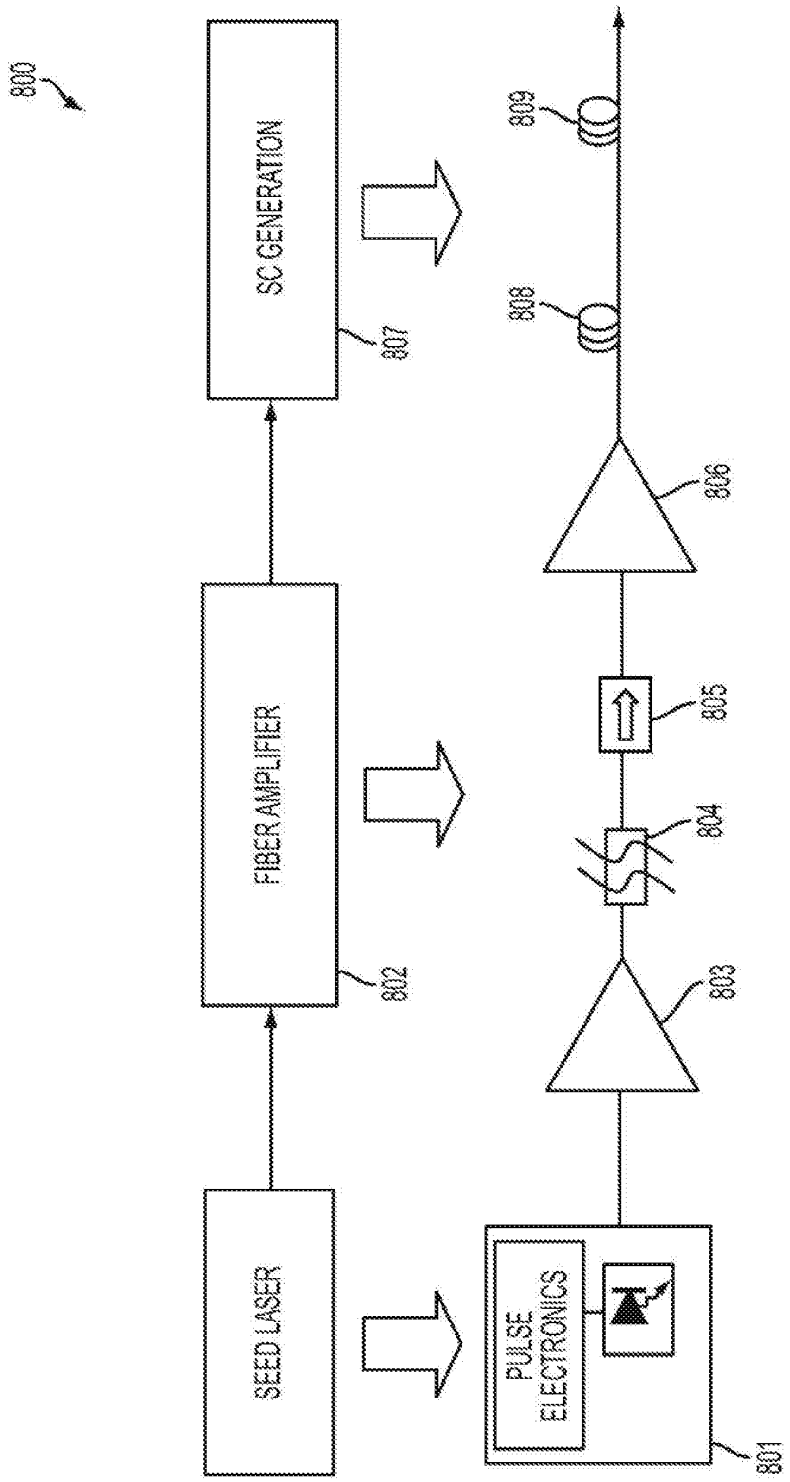

800
SEED LASER
FIBER AMPLIFIER
SC GENERATION
PULSE ELECTRONICS
801
802
803
804
805
806
807
808
809

FIG. 8

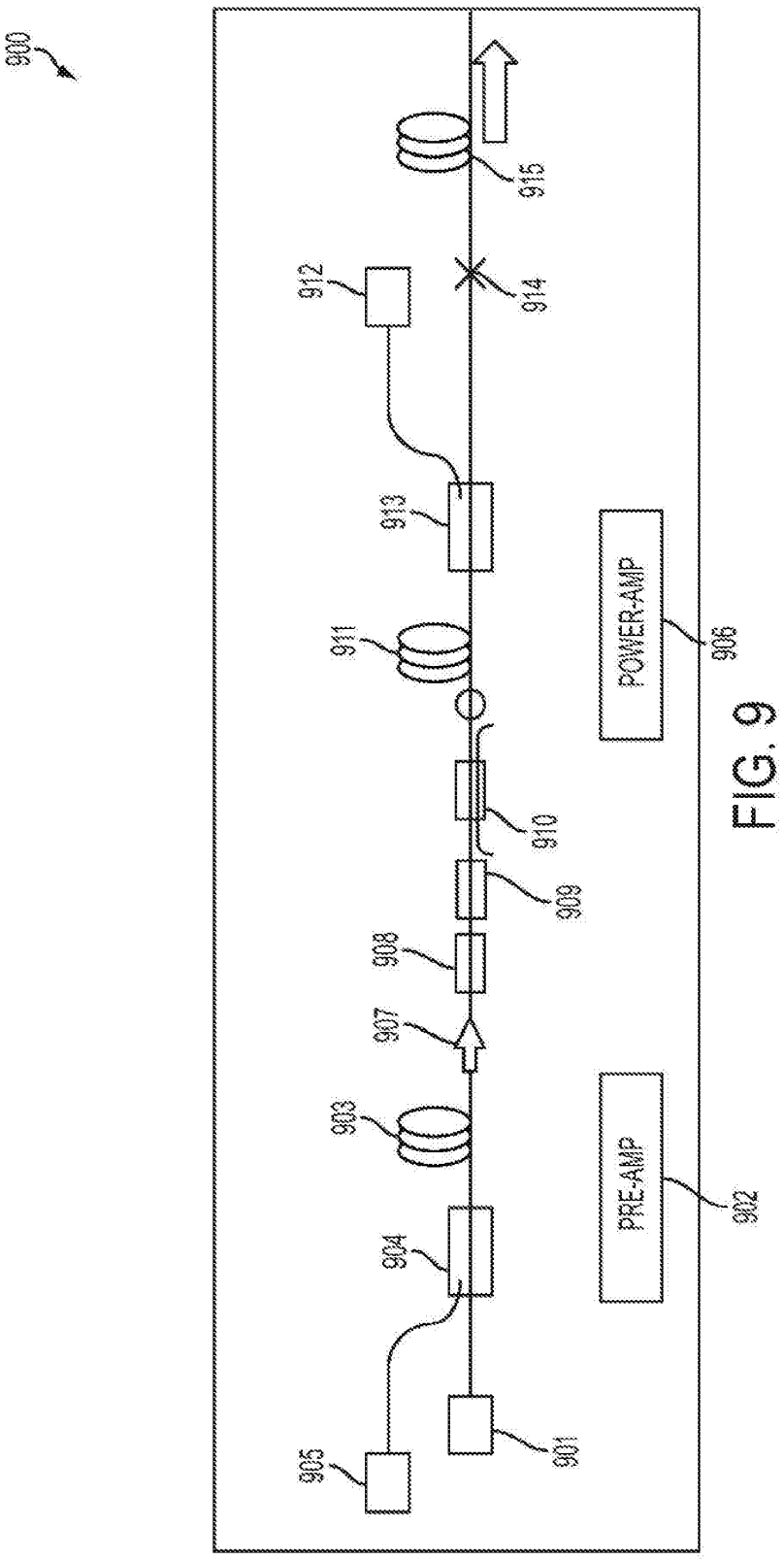

900
915
914
912
913
911
910
909
908
907
903
904
905
901
POWER-AMP
906
PRE-AMP
902

FIG. 9

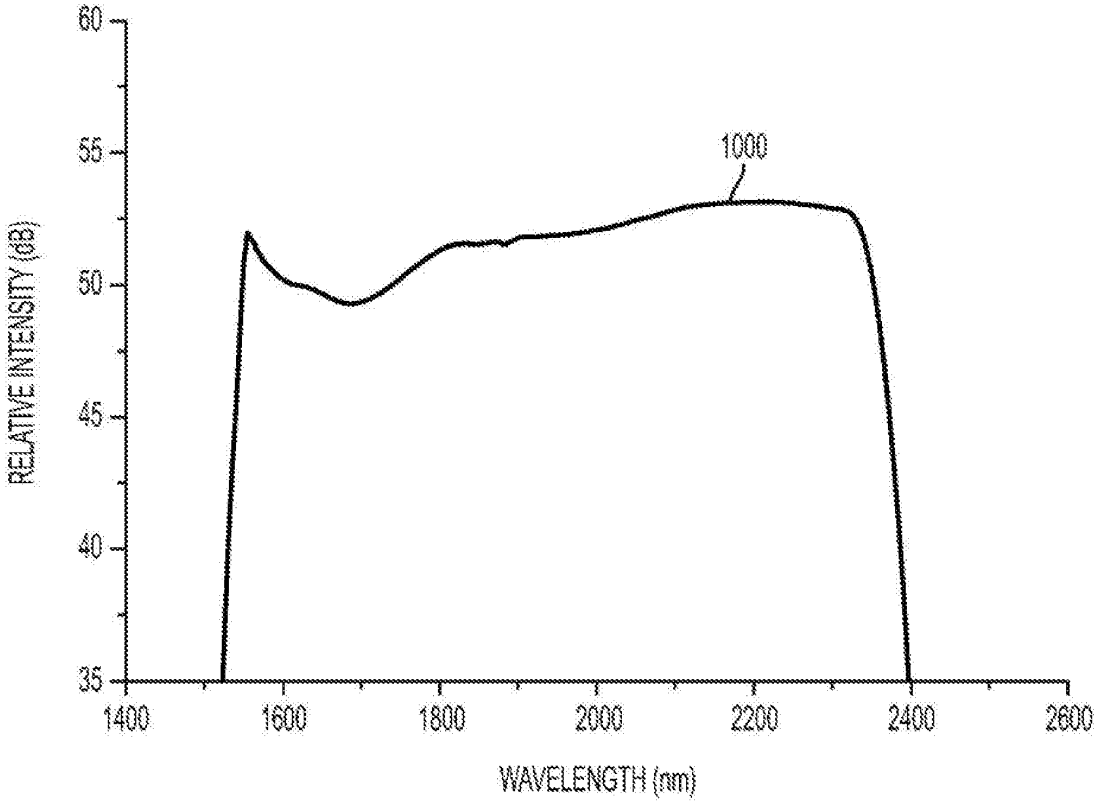

60
55
50
45
40
35
RELATIVE INTENSITY (dB)
1000
1400
1600
1800
2000
2200
2400
2600
WAVELENGTH (nm)

FIG. 10

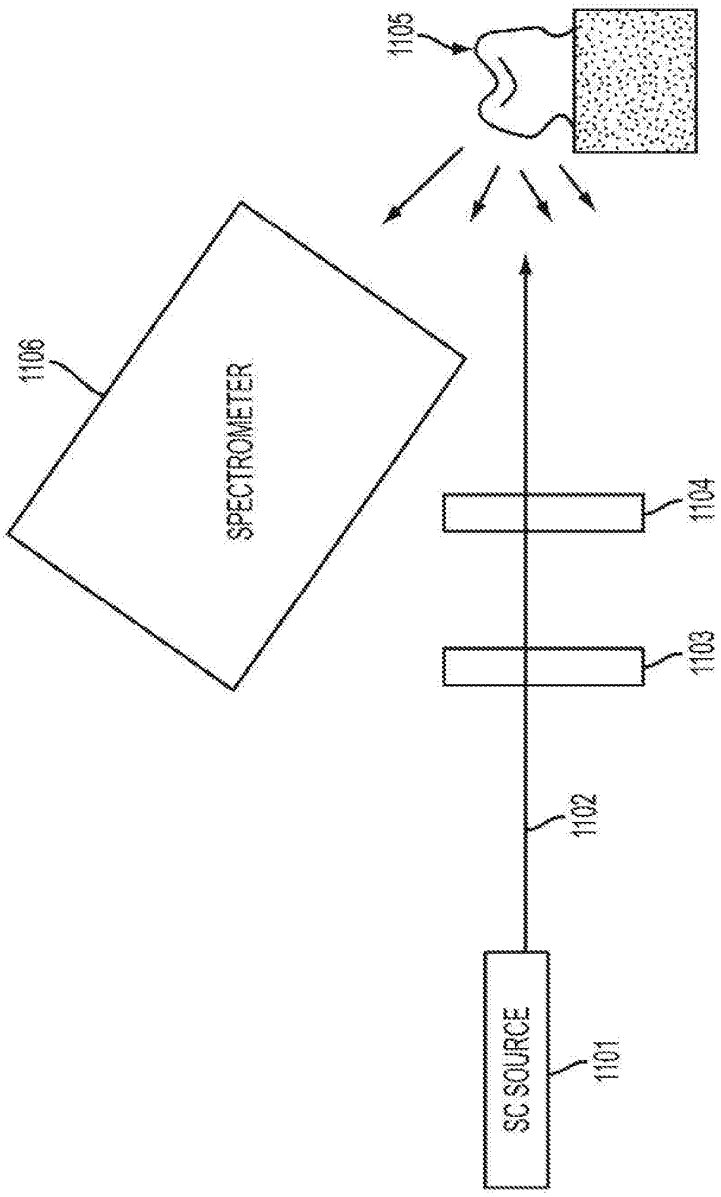


FIG. 11A

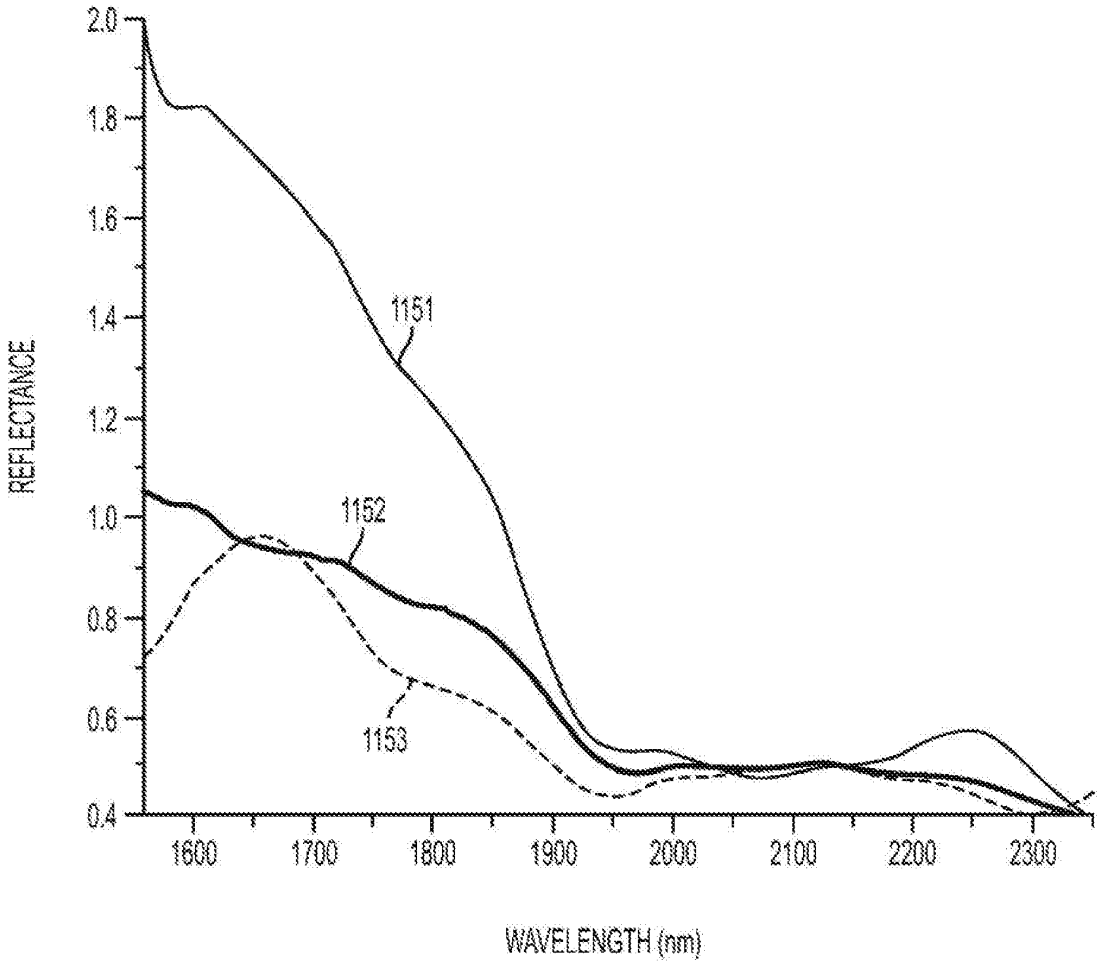

2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
REFLECTANCE
1151
1152
1153
1600
1700
1800
1900
2000
2100
2200
2300
WAVELENGTH (nm)

FIG. 11B

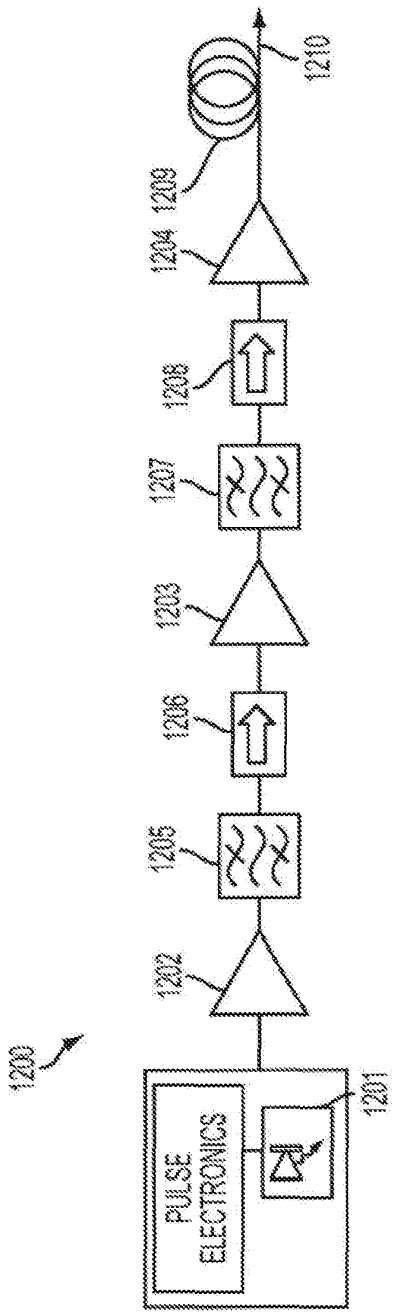


FIG. 12A

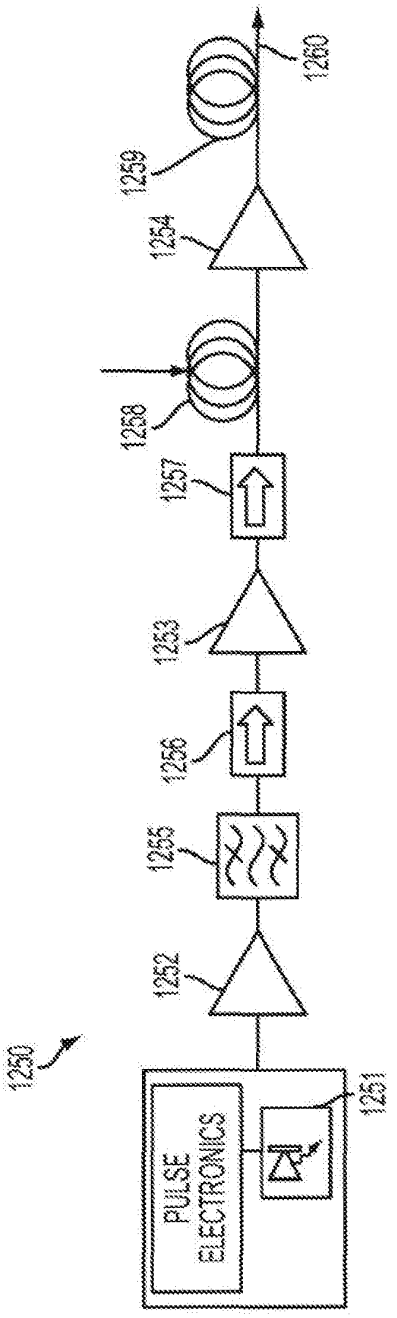


FIG. 12B

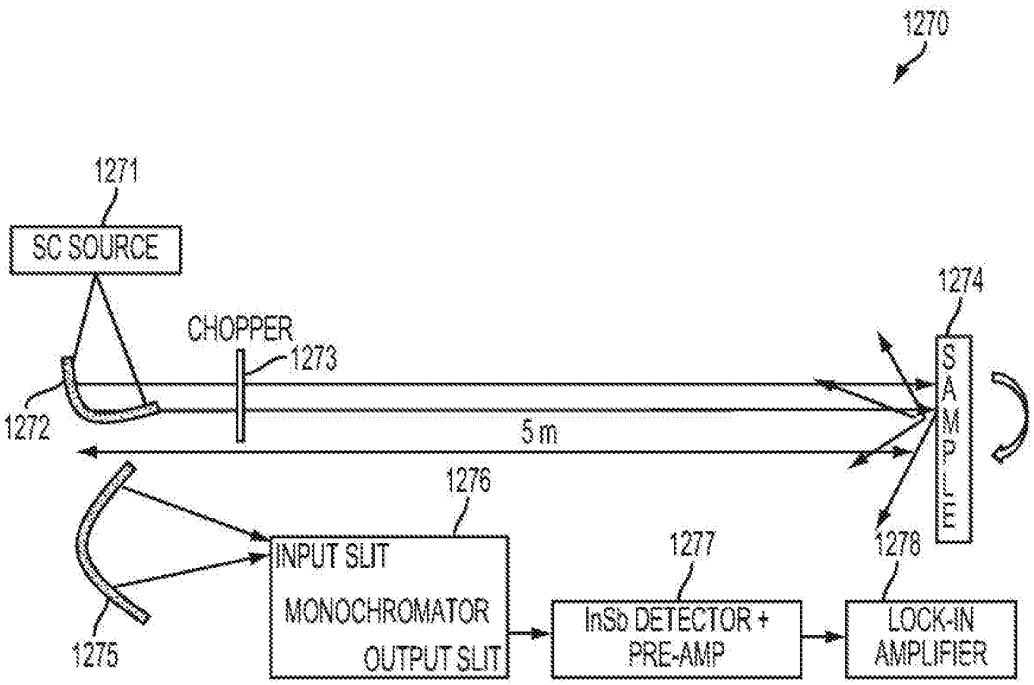

1270
1271
SC SOURCE
CHOPPER
1273
1272
5 m
1274
SAMPLE
1276
INPUT SLIT
MONOCHROMATOR
OUTPUT SLIT
1277
InSb DETECTOR + PRE-AMP
1278
LOCK-IN AMPLIFIER
1275

FIG. 12C

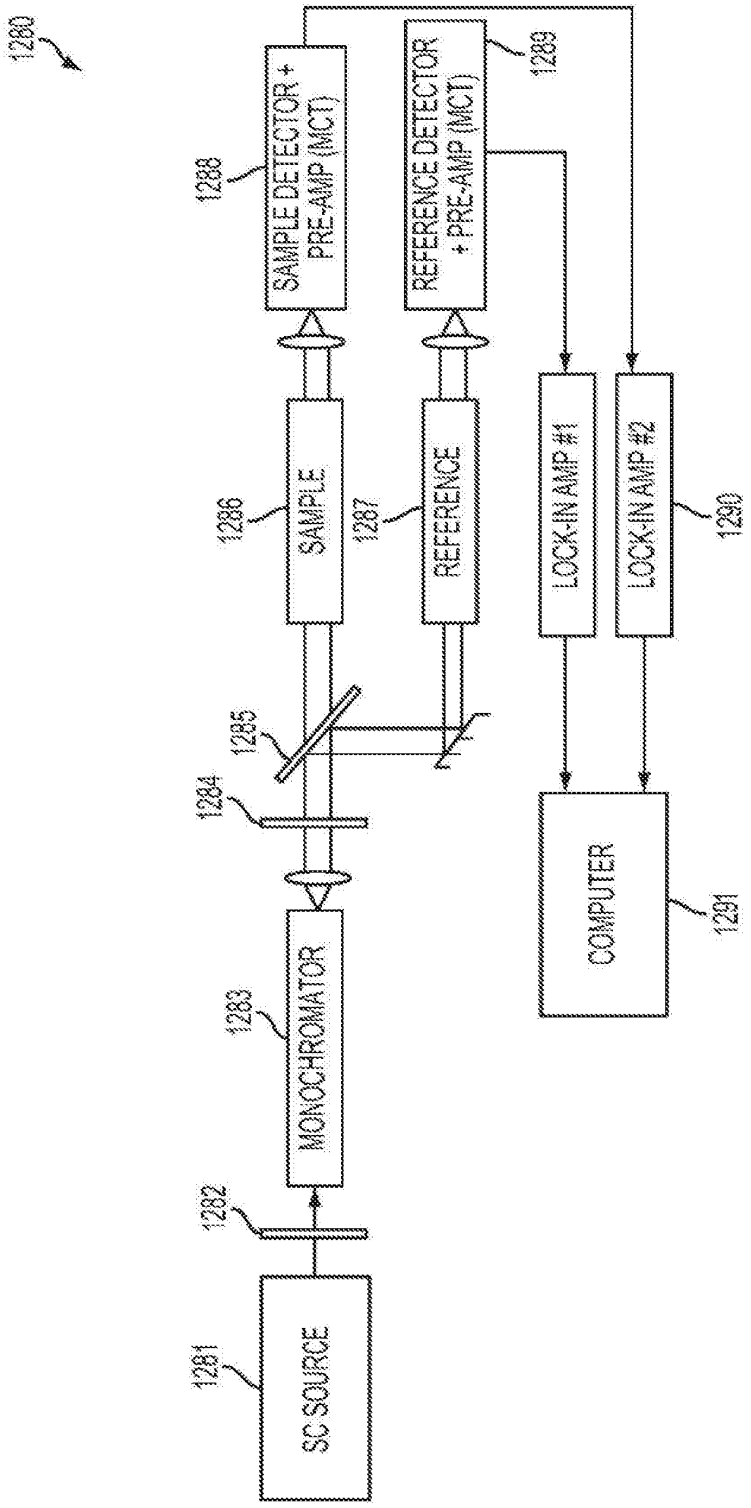

1280
1281
SC SOURCE
1282
1283
MONOCHROMATOR
1284
1285
1286
SAMPLE
1287
REFERENCE
1288
SAMPLE DETECTOR + PRE-AMP (MCT)
1289
REFERENCE DETECTOR + PRE-AMP (MCT)
1290
LOCK-IN AMP #1
LOCK-IN AMP #2
1291
COMPUTER

FIG. 12D

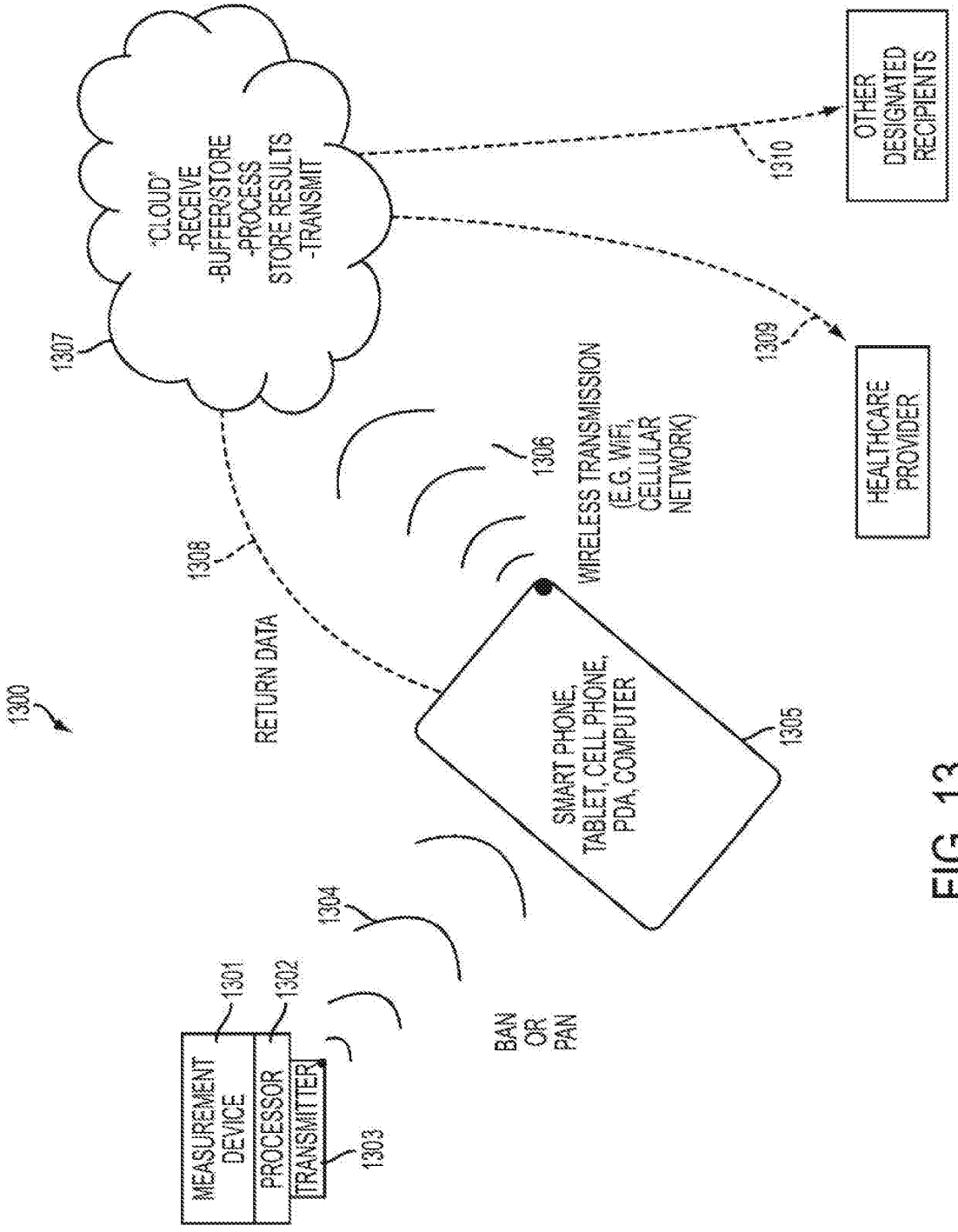

1300
MEASUREMENT DEVICE
PROCESSOR
TRANSMITTER
1301
1302
1303
1304
BAN OR PAN
SMART PHONE, TABLET, CELL PHONE, PDA, COMPUTER
1305
WIRELESS TRANSMISSION (E.G. WIFI, CELLULAR NETWORK)
1306
RETURN DATA
1308
'CLOUD' -RECEIVE -BUFFER/STORE -PROCESS STORE RESULTS -TRANSMIT
1307
HEALTHCARE PROVIDER
1309
OTHER DESIGNATED RECIPIENTS
1310

FIG. 13

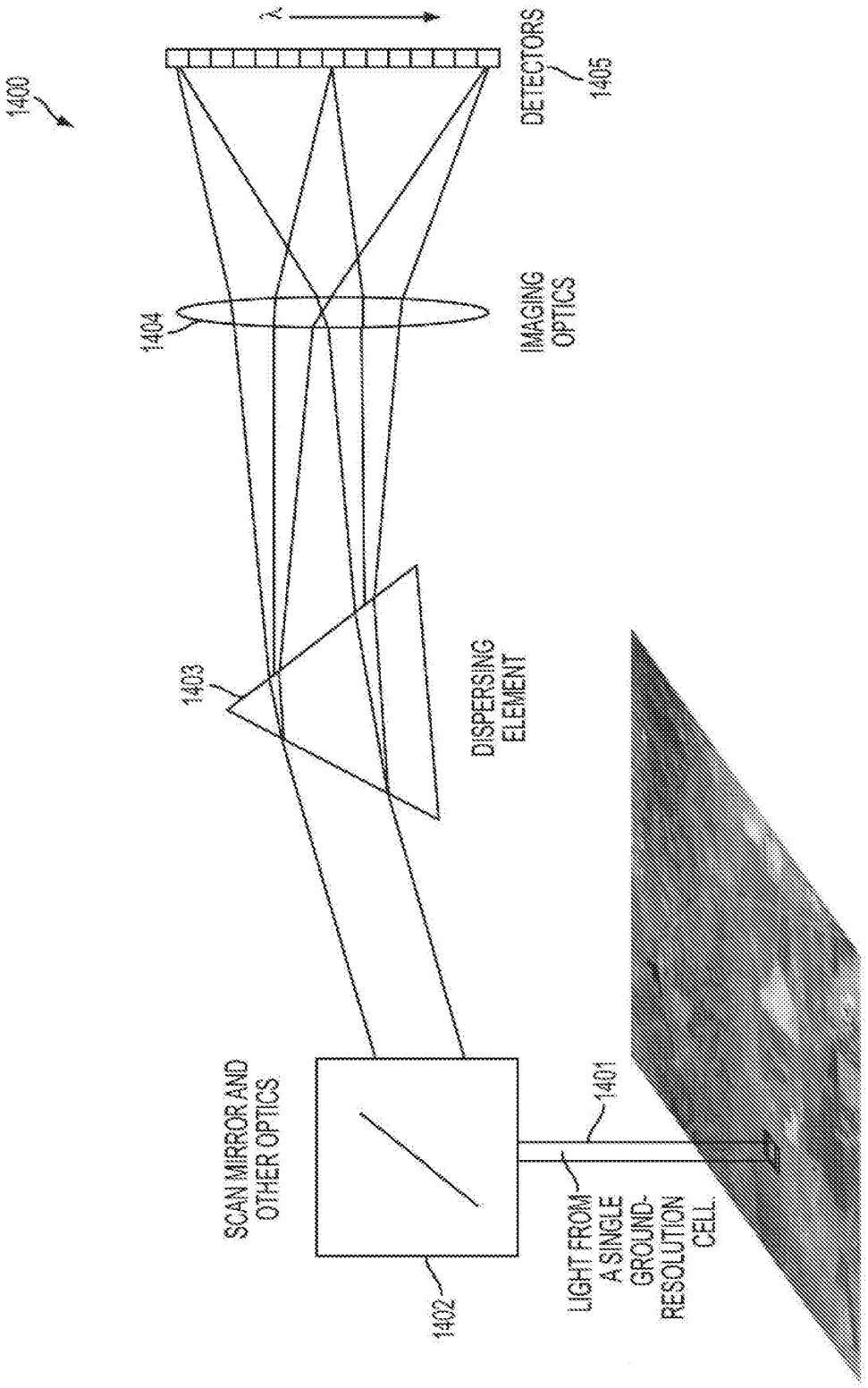

1400
λ
DETECTORS
1405
1404
IMAGING OPTICS
1403
DISPERSING ELEMENT
SCAN MIRROR AND OTHER OPTICS
1402
1401
LIGHT FROM A SINGLE GROUND-RESOLUTION CELL

FIG. 14A

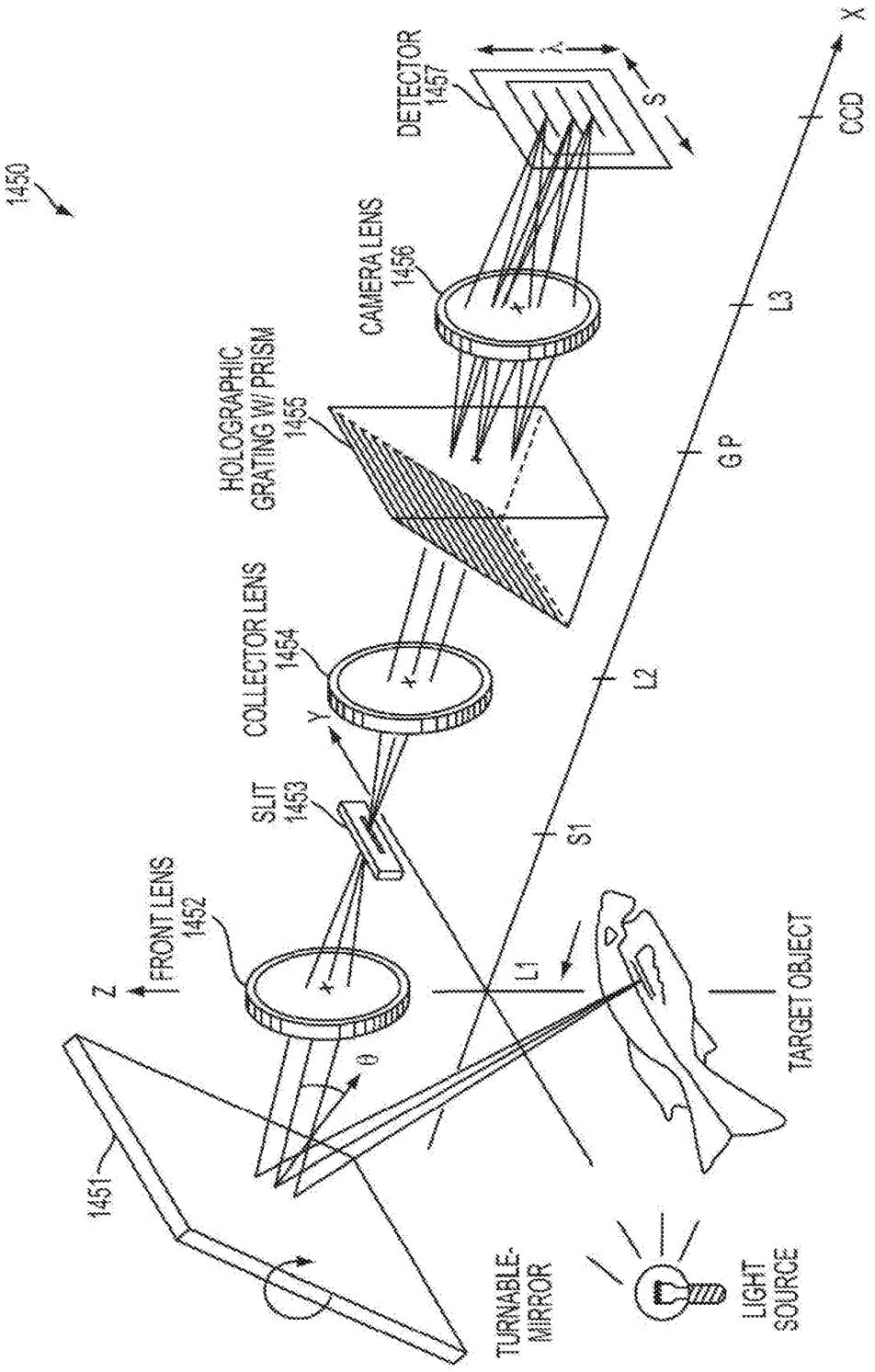

1450
1451
TURNABLE-MIRROR
LIGHT SOURCE
TARGET OBJECT
1452
FRONT LENS
Z
θ
L1
S1
1453
SLIT
1454
COLLECTOR LENS
Y
L2
1455
HOLOGRAPHIC GRATING W/ PRISM
GP
1456
CAMERA LENS
L3
1457
DETECTOR
λ
S
CCD
X

FIG. 14B

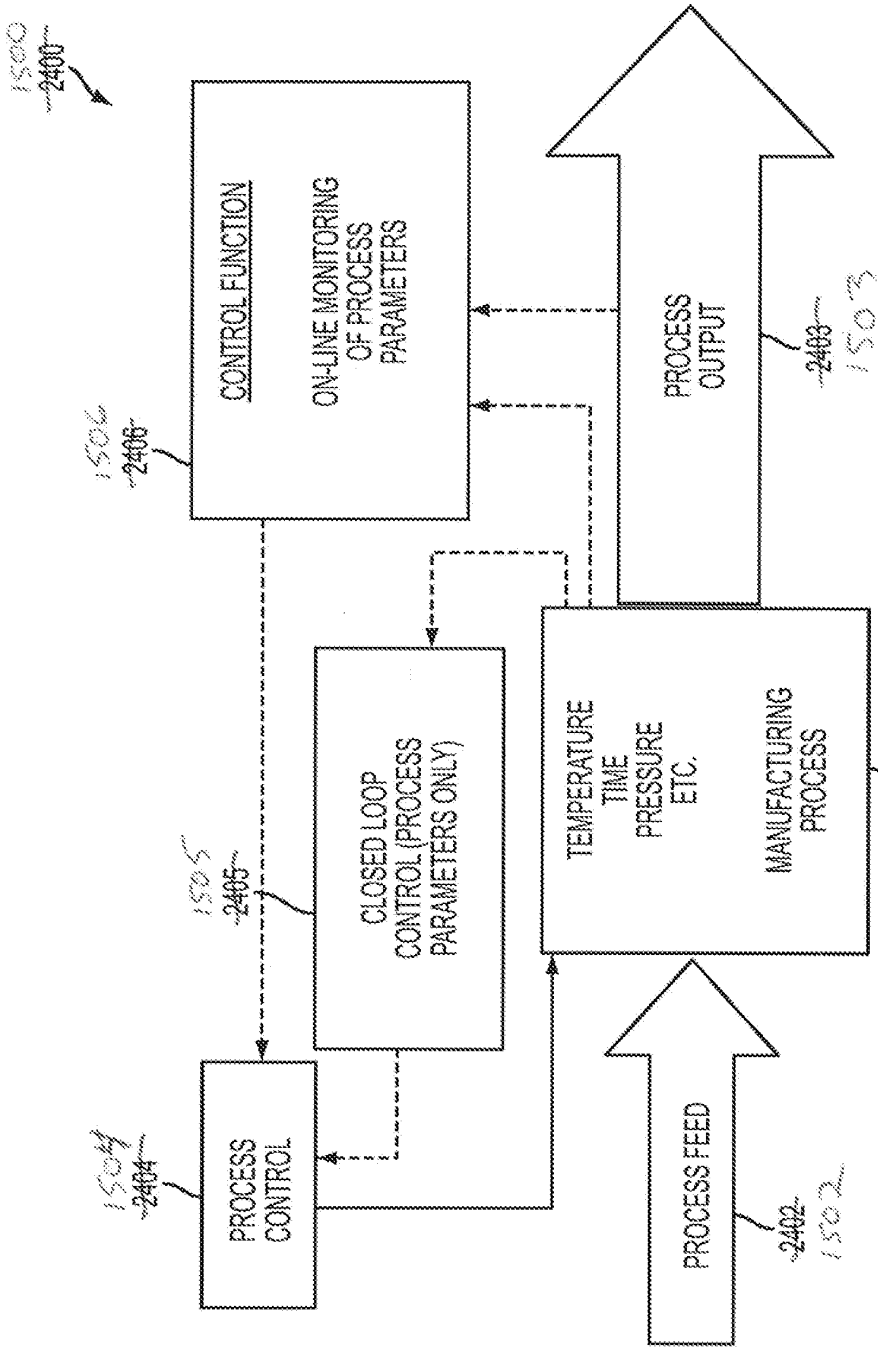

1500
2407
CONTROL FUNCTION
ON-LINE MONITORING OF PROCESS PARAMETERS
1506
2406
PROCESS OUTPUT
2403
1503
CLOSED LOOP CONTROL (PROCESS PARAMETERS ONLY)
1505
2405
TEMPERATURE TIME PRESSURE ETC.
MANUFACTURING PROCESS
2401
1501
PROCESS CONTROL
1504
2404
PROCESS FEED
2402
1502

FIG. 24

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
	Application Number	
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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 SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO		
Attorney Docket Number	OMNI0102PUSA6	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	22	**Suggested Figure for Publication (if any)**	1

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
	Application Number	
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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	16/284514	2019-02-25

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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	OMNI0102PUSA6
	Application Number	
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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)
16/284514	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
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		
Prior Application Status	Pending				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
	Continuation of	16/506885	2019-07-09		

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
	Application Number	
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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)
16/506885	Continuation of	16/272069	2019-02-11

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/US2013/075700	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)
16/506885	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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
	Application Number	
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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)
14/109007	Claims benefit of provisional	61/747553	2012-12-31

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16506885	Continuation of	16/188194	2018-11-12	10386230	2019-08-20

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
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	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/506885	Continuation of	16/241628	2019-01-07	10441176	2019-10-15

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
	Application Number	
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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)
16/241628	Continuation of	16/015737	2018-06-22	10172523	2019-01-08
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)		
16/506885	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

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
	Application Number	
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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)
15/357136	Continuation of	14/651367	2015-06-11	9500635	2016-11-22
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

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
	Application Number	
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO	

☒ 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.

Attorney Docket Number	OMNI0102PUSA6

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 SOURCE BASED NEAR INFRARED 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 _____ filed on _____. (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: October 30, 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 Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6

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:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**785**

Electronic Acknowledgement Receipt	
EFS ID:	37616267
Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6
Receipt Date:	31-OCT-2019
Filing Date:	
Time Stamp:	12:18:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$785
RAM confirmation Number	E20190UC18463155
Deposit Account	023978
Authorized User	Amy Tanner
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 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	Power of Attorney	OMNI0102PUSA6_POA.pdf	1120243 3b496e13070815263f47d65fff96ef76eb53bf52	no	2
Warnings:					
Information:					
2		OMNI0102PUSA6_Specification.pdf	495625 23edb9702b55c35418ee7c5a7baefa7fd5a1be94	yes	58

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	50
Claims	51	57
Abstract	58	58

Warnings:					
Information:					
3	Drawings-only black and white line drawings	OMNI0102PUSA6_Drawings_final.pdf	4398983 5ed9b2f84efe4d095b88006766d34c2dab1eced0	no	22
Warnings:					
Information:					
4	Application Data Sheet	OMNI0102PUSA6_ADS.PDF	1456835 91a4f20e066e3438cff56a3667ccb7fec399e5d8	no	8
Warnings:					
Information:					
5	Oath or Declaration filed	OMNI0102PUSA6_oath_assignment_v2.pdf	860708 77f7157c532a3ef3811b3bac7b1eb82b19c0d52d	no	1

Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	35223 cad5a69545cfc5e713fe7693a3d628725efba83d	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	8367617		

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/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
	Application Number	
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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	Ann Arbor	State/Province	MI	Country of Residence	US

Mailing Address of Inventor:

Address 1	1718 Newport Creek		
Address 2			
City	Ann Arbor	State/Province	MI
Postal Code	48103	Country	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 SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO		
Attorney Docket Number	OMNI0102PUSA6	Small Entity Status Claimed	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	22	Suggested Figure for Publication (if any)	1

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
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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		

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	
					Remove
Registration Number					
Prefix	**Given Name**	Middle Name	**Family Name**	Suffix	
					Remove
Registration Number					

Additional Representative Information blocks may be generated within this form by selecting the **Add** button.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
	Application Number	
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO	

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	16/284514	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

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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
	Application Number	
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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)
PCT/US2013/075736	Claims benefit of provisional	61/754698	2013-01-21
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	16/506885	2019-07-09
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
16/506885	Continuation of	16/272069	2019-02-11
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/US2013/075700	Claims benefit of provisional	61/747472	2012-12-31

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
	Application Number	
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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)
16/506885	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

Prior Application Status	Patented			Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16506885	Continuation of	16/188194	2018-11-12	10386230	2019-08-20

Prior Application Status	Patented			Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
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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	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/506885	Continuation of	16/241628	2019-01-07	10441176	2019-10-15

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

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)
16/506885	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

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063

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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
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.

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)

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063

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

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.

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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.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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

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. [x]

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.

Assignee Information including Non-Applicant Assignee 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.

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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.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

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		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.

Signature:

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	/Andrew B. Turner/			Date (YYYY-MM-DD)	2019-10-31
First Name	Andrew	Last Name	Turner	Registration Number	63121

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	OMNI0102PUSA6
	Application Number	
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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.**

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 records.

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 CooperationTreaty.

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.

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063

Electronic Acknowledgement Receipt	
EFS ID:	37618470
Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6
Receipt Date:	31-OCT-2019
Filing Date:	
Time Stamp:	13:17:19
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	Application Data Sheet	OMNI0102PUSA6_ADS_v2.pdf	9652875 0b034ef57beb67898dc51d750a953bde77d04d33	no	13

Warnings:

Information:	
This is not an USPTO supplied ADS fillable form	
Total Files Size (in bytes):	9652875

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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.

DocCode – SCORE

SCORE Placeholder Sheet for IFW Content

Application Number: 16669794 Document Date: 10/31/2019

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

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- Drawing

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Form Revision Date: March 1, 2019

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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
16/669,794	10/31/2019	1731	785	OMNI0102PUSA6	20	3

CONFIRMATION NO. 7663

FILING RECEIPT



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

Date Mailed: 11/20/2019

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.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

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 16/284,514 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
This application 16/669,794
is a CON of 16/506,885 07/09/2019
which 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
and said 16/506,885 07/09/2019
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
and said 16/506,885 07/09/2019
is a CON of 16/188,194 11/12/2018 PAT 10386230
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
and said 16/506,885 07/09/2019
is a CON of 16/241,628 01/07/2019 PAT 10441176
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
and said 16/506,885 07/09/2019
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.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 11/18/2019
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/669,794**
Projected Publication Date: To Be Determined - pending completion of Corrected Papers
Non-Publication Request: No

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

SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

Preliminary Class

501

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

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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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The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/669,794

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))	20 minus 20 =	*	x 50 =	0.00	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	785		TOTAL	

APPLICATION AS AMENDED - PART II

AMENDMENT A

	(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($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
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	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
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.

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/669,794	10/31/2019	Mohammed N. ISLAM	OMNI0102PUSA6

CONFIRMATION NO. 7663

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

FORMALITIES LETTER

OC000000112725352

Date Mailed: 11/20/2019

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to this application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given **TWO MONTHS** from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

The required item(s) identified below must be timely submitted to avoid abandonment:

- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
  - The drawings must be reasonably free from erasures and must be free from alterations, overwriting, interlineations, folds, and copy marks. See Figure(s) 15.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice". https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

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**.

/symohammed/

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

MOHAMMED N. ISLAM

Group Art Unit: 1731

Examiner:

Serial No.: 16/669794

Filed: 10/31/2019

For: SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

Attorney Docket No.: OMNI0102PUSA6

RESPONSE TO NOTICE TO FILE CORRECTED PAPERS, AND 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 measurement system comprising:

a light source comprising a plurality of semiconductor sources that are configured to generate an output optical beam with one or more optical wavelengths, the light source configured to increase signal-to-noise ratio by increasing a light intensity from at least one of the plurality of semiconductor sources;

an apparatus configured to:

receive a portion of the output optical beam, and

deliver an analysis output beam to a sample;

a receiver configured to:

receive and process at least a portion of the analysis output beam reflected or transmitted from the sample,

generate an output signal, ~~signal, and~~

synchronize to the light source,

capture light while the semiconductor sources are off and convert the captured light into a first signal,

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a part of the at least a portion of the analysis output beam reflected or transmitted from the sample, and

the measurement system further configured to improve the signal-to-noise ratio by differencing the first signal and the second signal;

a 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,

store and display the processed output signal, and

transmit at least a portion of the processed output signal over a wireless transmission link; and

a cloud configured to:

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receive, over the wireless transmission link, an output status comprising the at least a portion of the processed output signal,

process the received output status to generate processed data, and

store the processed data.

2. (Cancelled)

3. (Cancelled)

4. (Currently Amended) The measurement system of claim 22~~claim 1~~, wherein the measurement system is configured to use artificial intelligence in making decisions;

wherein the measurement system is configured to perform pattern identification or classification, and wherein the measurement system is configured to apply a threshold function to a comparison with a stored data set; and

wherein the measurement system is at least in part configured for selection or identification of an object, and wherein the measurement system is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

5. (Currently Amended) The measurement system of claim 22~~claim 1~~, wherein the light source is configured to further increase signal-to-noise ratio by increasing a pulse rate of at least one of the plurality of semiconductor sources.

6. (Currently Amended) The measurement system of claim 1, wherein the plurality of semiconductor sources comprises at least one of: light emitting diodes (LEDs), laser diodes (LD's), tunable LD's, and super-luminescent laser diodes (SLDs), and wherein the measurement system further comprises a reflective surface to receive and redirect at least some of the at least a portion of the analysis output beam reflected or transmitted from the sample.

7. (Original) The measurement system of claim 1, wherein the light source is further configured to increase the light intensity from the plurality of semiconductor sources by

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spatially coupling the optical output beam from at least two of the plurality of semiconductor sources.

8. (Currently Amended) A measurement system comprising:

a wearable measurement device for measuring one or more physiological parameters, including a light source comprising a plurality of semiconductor sources that are configured to generate an output optical beam with one or more optical wavelengths;

the light source configured to increase signal-to-noise ratio by increasing a light intensity from at least one of the plurality of semiconductor sources;

the wearable measurement device configured to receive a portion of the output optical beam and to deliver an analysis output beam to a sample;

the wearable measurement device further comprising a receiver ~~configured to~~configured to:

receive and process at least a portion of the analysis output beam reflected or transmitted from the sample, ~~and to~~

generate an output signal, ~~wherein the wearable measurement device receiver is configured to be synchronized~~

synchronize to pulses of the light source,

capture light while the semiconductor sources are off and convert the captured light into a first signal,

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a part of the at least a portion of the analysis output beam reflected or transmitted from the sample,

wherein the measurement system is further configured to improve the signal-to-noise ratio by differencing the first signal and the second signal;

a 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, to store and display the processed output signal, and to transmit a portion of the processed output signal over a wireless transmission link; and

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

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status to generate processed data and to store the processed data, and wherein the cloud is capable of storing a history of at least a portion of the received output status over a specified period of time.

9. (Cancelled)

10. (Cancelled)

11. (Currently Amended) The measurement system of Claim 27~~claim 8~~, wherein the measurement system is configured to use artificial intelligence in making decisions;

wherein the measurement system is configured to perform pattern identification or classification, and wherein the measurement system is configured to apply a threshold function to a comparison with a stored data set; and

wherein the measurement system is at least in part configured for selection or identification of an object, and wherein the measurement system is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

12. (Currently Amended) The measurement system of claim 27~~claim 9~~, wherein the light source is configured to further increase signal-to-noise ratio by one of increasing a pulse rate of at least one of the plurality of semiconductor sources.

13. (Currently Amended) The measurement system of claim 8, wherein the plurality of semiconductor sources comprises at least one of: light emitting diodes (LEDs), laser diodes (LD's), tunable LD's, and super-luminescent laser diodes (SLDs), and the measurement system further comprising a reflective surface to receive and redirect at least some of the at least a portion of the analysis output beam reflected or transmitted from the sample.

14. (Original) A wearable device for use with a smart phone or tablet, the wearable device comprising:

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a measurement device including a light source comprising a plurality of semiconductor sources for measuring one or more physiological parameters, the measurement device configured to:

generate, by modulating at least one of the semiconductor sources having an initial light intensity, an input optical beam having one or more optical wavelengths, and

receive and to deliver a portion of the input optical beam to tissue, wherein the tissue reflects at least a portion of the input optical beam delivered to the tissue;

the measurement device further comprising a receiver configured to:

capture light while the semiconductor sources are off and convert the captured light into a first signal, and

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a portion of the input optical beam reflected from the tissue;

synchronize to the modulation of the at least one of the semiconductor sources;

the measurement device further configured to improve a signal-to-noise ratio of the input optical beam reflected from the tissue by:

differencing the first signal and the second signal, and

increasing the light intensity relative to the initial light intensity from at least one of the semiconductor sources;

the measurement device further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue;

the wearable device configured to communicate with the smart phone or tablet, the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a voice input module, a speaker, and a touch screen; and

the smart phone or tablet configured to:

receive and to process at least a portion of the output signal,

store and display the processed output signal, and

transmit at least a portion of the processed output signal over a wireless transmission link.

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15. (Currently Amended) The wearable device of claim 31~~claim 14~~, wherein the light source is configured to further improve the signal-to-noise ratio of the input optical beam reflected from the tissue by increasing a pulse rate of at least one of the plurality of semiconductor sources.

16. (Original) The wearable device of claim 15, further comprising a cloud configured to:

receive, over the wireless transmission link, an output status comprising the at least a portion of the processed output signal,

process the output status to generate processed data, and

store the processed data, and

wherein the cloud is capable of storing a history of at least a portion of the output status over a specified period of time.

17. (Currently Amended) The wearable device of claim 16~~claim 14~~, wherein the wearable device is configured to use artificial intelligence in making decisions;

wherein the wearable device is configured to perform pattern identification or classification, and wherein the wearable device is configured to apply a threshold function to a comparison with a stored data set; and

wherein the wearable device is at least in part configured for selection or identification of an object, and wherein the wearable device is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

18. (Cancelled)

19. (Currently Amended) The wearable device of claim 17~~claim 14~~, wherein the measurement device further comprises a reflective surface configured to receive and redirect at least a portion of light reflected from the tissue.

20. (Cancelled)

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21. (New) The measurement system of claim 1, wherein the plurality of semiconductor sources comprises six light emitting diodes, and wherein the receiver comprises six detectors.

22. (New) The measurement system of claim 21, wherein the six detectors are located on an arc surrounding the six light emitting diodes.

23. (New) The measurement system of claim 1, wherein the receiver comprises a plurality of detectors arranged along a first arc, and wherein the plurality of semiconductor sources are arranged along a second arc.

24. (New) The measurement system of claim 23, wherein the first arc is offset from the second arc.

25. (New) The measurement system of claim 23, wherein the first arc and the second arc are concentric.

26. (New) The measurement system of claim 8, wherein the plurality of semiconductor sources comprises six light emitting diodes, and wherein the receiver comprises six detectors.

27. (New) The measurement system of claim 26, wherein the six detectors are located on an arc surrounding the six light emitting diodes.

28. (New) The measurement system of claim 8, wherein the receiver comprises a plurality of detectors arranged along a first arc, and wherein the plurality of semiconductor sources are arranged along a second arc that is offset from the first arc.

29. (New) The measurement system of claim 28, wherein the first arc and the second arc are concentric.

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30. (New) The wearable device of claim 14, wherein the plurality of semiconductor sources comprises six light emitting diodes, and wherein the receiver comprises six detectors.

31. (New) The wearable device of claim 30, wherein the six detectors are located on an arc surrounding the six light emitting diodes.

32. (New) The wearable device of claim 14, wherein the receiver comprises a plurality of detectors arranged along a first arc, and wherein the plurality of semiconductor sources are arranged along a second arc that is offset from the first arc.

33. (New) The wearable device of claim 32, wherein the first arc and the second arc are concentric.

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Electronic Patent Application Fee Transmittal

Application Number:	16669794
Filing Date:	31-Oct-2019
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	2202	7	50	350
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**350**

Electronic Acknowledgement Receipt	
EFS ID:	37862484
Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6
Receipt Date:	26-NOV-2019
Filing Date:	31-OCT-2019
Time Stamp:	14:37:35
Application Type:	Utility under 35 USC 111(a)

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Payment Type	DA
Payment was successfully received in RAM	$350
RAM confirmation Number	E2019APE38321346
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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	Drawings-only black and white line drawings	OMNI0102PUSA6_Fig_15.pdf	208069 1cf7f1218f007118095cca153284ea5e303a563b	no	1
Warnings:					
Information:					
2		OMNI0102PUSA6_preliminary_amendment_v2.pdf	169229 73adb4df2c0a46e622690ab9727816771a651359	yes	11

Multipart Description/PDF files in .zip description

Document Description	Start	End
Preliminary Amendment	1	1
Claims	2	9
Drawings-only black and white line drawings	10	10
Applicant Arguments/Remarks Made in an Amendment	11	11

Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30460 b89944d8b2104faa20558d4dac98fe434aa50927	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	407758		

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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.

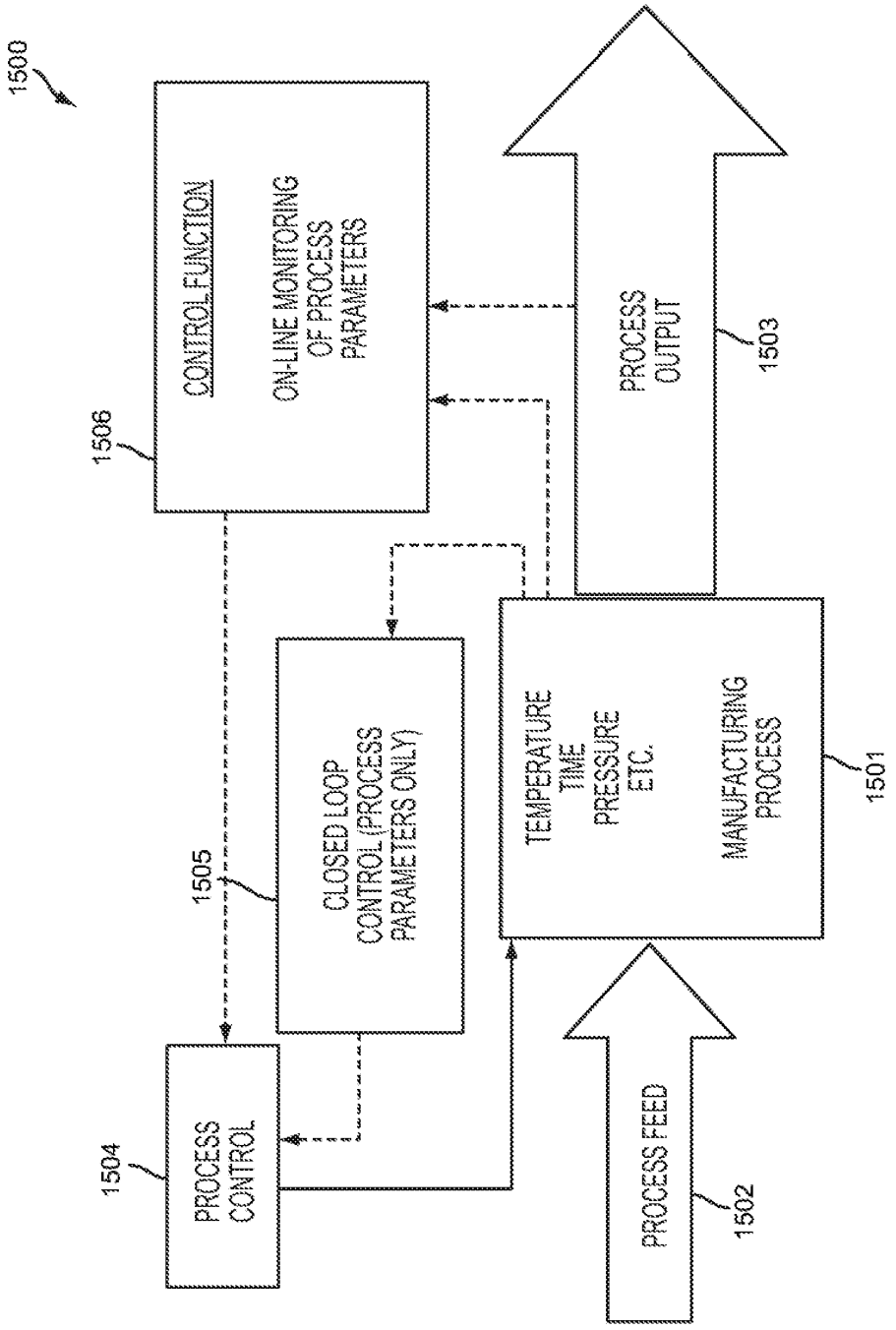

1500
CONTROL FUNCTION
ON-LINE MONITORING OF PROCESS PARAMETERS
1506
PROCESS OUTPUT
1503
CLOSED LOOP CONTROL (PROCESS PARAMETERS ONLY)
1505
TEMPERATURE
TIME
PRESSURE
ETC.
MANUFACTURING PROCESS
1501
PROCESS CONTROL
1504
PROCESS FEED
1502

FIG. 15

Amendments to the Drawings:

The attached sheet(s) of drawings includes changes to Fig. 15. This sheet, which includes Fig. 15, replaces the original sheet(s) including Fig. 15.

Attachment: Replacement Sheet

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Remarks

The USPTO issued a Notice to File Corrected Application Papers on November 20, 2019. The Notice indicates that Figure 15 of the Drawings as filed is not acceptable and replacement drawings are required. Accordingly, by this Response, Applicant amends Figure 15 to remove informalities.

Applicant has also amended various claims, cancelled claims, and added new claims, to more particularly point out the claimed subject matter. Independent claims 1 and 8 are amended to include the limitations of claims 2 and 9, respectively; and claims 6 and 13 are amended to include the limitations of claims 3 and 10, respectively. Claims 2, 3, 9, 10, 18, and 20 are cancelled. Support for new claims 21-33 is found, e.g., in Fig. 5B and paragraphs 77-78 of the application as filed. No new matter is added. Applicant respectfully requests entry of this amendment prior to substantive examination.

The additional claims filing fee of $350 pursuant to 37 C.F.R. § 1.17(a) is being charged to our Deposit Account No. 02-3978 via electronic authorization submitted concurrently herewith. 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,

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Date: November 26, 2019

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Application Number	16669794
Filing Date	2019-10-31
First Named Inventor	Mohammed N. ISLAM
Art Unit	1731
Examiner Name	
Attorney Docket Number	OMNI0102PUSA6

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
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	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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	120	6816241		2004-11-09	Grubisic	
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	131	7133710		2006-11-07	Acosta et al.	
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	133	7209657		2007-04-24	Islam	
	134	7233816		2007-06-19	Blank et al.	
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	142	7468036		2008-12-23	Rulkov et al.	
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	152	7848605		2010-12-07	Ridder et al.	
	153	7890158		2011-02-15	Rowe et al.	
	154	8000574		2011-08-16	Buchter et al.	
	155	8145286		2012-03-27	Arai et al.	
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	160	8180422		2012-05-15	Rebec	
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	164	8315682		2012-11-20	Such et al.	
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	170	8788002		2014-07-22	LeBoeuf et al.	
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	173	9164032		2015-10-20	Islam	

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	176	9207121		2015-12-08	Adler	
	177	9241676		2016-01-26	Lisogurski et al.	
	178	9651533		2017-05-16	Islam	
	179	9675250		2017-06-13	Tverskoy	
	180	9723993		2017-08-08	Vermeulen	
	181	9820658		2017-11-21	Tran	
	182	RE44875		2014-04-29	Kiani et al.	

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	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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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	/Andrew B. Turner/	Date (YYYY-MM-DD)	2019-11-26
Name/Print	Andrew B. Turner	Registration Number	63121

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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.

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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EFS ID:	37867191
Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6
Receipt Date:	26-NOV-2019
Filing Date:	31-OCT-2019
Time Stamp:	16:26:34
Application Type:	Utility under 35 USC 111(a)

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Art Unit	1731
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	1	5408409		1995-04-18	Glassman et al.	
	2	5774213		1998-06-30	Trebino et al.	
	3	5957854		1999-09-28	Besson et al.	
	4	5970457		1999-10-19	Brant et al.	
	5	6044283		2000-03-28	Fein et al.	
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	Attorney Docket Number	OMNI0102PUSA6

	9	6549702		2003-04-15	Islam et al.	
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	11	6898451		2005-05-24	Wuori	
	12	7060061		2006-06-13	Altshuler et al.	
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	14	7263288		2007-08-28	Islam	
	15	7278966		2007-10-09	Hjelt et al.	
	16	7318909		2008-01-15	Lehmann et al.	
	17	7433116		2008-10-07	Islam	
	18	7519253		2009-04-14	Islam	
	19	7787924		2010-08-31	Acosta et al.	

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	20	8198589		2012-06-12	Tolton et al.	
	21	8463576		2013-06-11	Yuen et al.	
	22	8472108		2013-06-25	Islam	
	23	8948832		2015-02-03	Hong et al.	
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	25	9326712		2016-05-03	Kiani	
	26	9596990		2017-03-21	Park et al.	
	27	9757040		2017-09-12	Islam	
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Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6
Receipt Date:	26-NOV-2019
Filing Date:	31-OCT-2019
Time Stamp:	16:28:37
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	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA6_IDS_1_b_US_patents.PDF	1120754 f1fe22aa5d01ccfa58184d8968aa68f04882b127	no	6

Warnings:

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Total Files Size (in bytes):	1120754

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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.

PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	16669794
	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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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	20020013518	A1	2002-01-31	West et al.	
	2	20020019584	A1	2002-02-14	Schulze et al.	
	3	20020032468	A1	2002-03-14	Hill et al.	
	4	20020082612	A1	2002-06-27	Moll et al.	
	5	20020109621	A1	2002-08-15	Khair et al.	

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	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

	6	20020115914	A1	2002-08-22	Russ	
	7	20020128846	A1	2002-09-12	Miller	
	8	20020178003	A1	2002-11-28	Gehrke et al.	
	9	20030022126	A1	2003-01-30	Buchalla et al.	
	10	20030107739	A1	2003-06-12	Lehmann et al.	
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	12	20030152307	A1	2003-08-14	Von Drasek et al.	
	13	20040174914	A1	2004-09-09	Fukatsu	
	14	20040240037	A1	2004-12-02	Harter	
	15	20050049468	A1	2005-03-03	Carlson et al.	
	16	20050111500	A1	2005-05-26	Harter et al.	

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	Art Unit	1731
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	17	20050133691	A1	2005-06-23	Doppke et al.	
	18	20050209516	A1	2005-09-22	Fraden	
	19	20060058683	A1	2006-03-16	Chance	
	20	20060198397	A1	2006-09-07	Korolev et al.	
	21	20060223032	A1	2006-10-05	Fried et al.	
	22	20060245461	A1	2006-11-02	Islam	
	23	20060268393	A1	2006-11-30	Islam	
	24	20060281982	A1	2006-12-14	Grata et al.	
	25	20060283931	A1	2006-12-21	Polli et al.	
	26	20070021670	A1	2007-01-25	Mandelis et al.	
	27	20070078348	A1	2007-04-05	Holman	

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	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

	28	20080086318	A1	2008-04-10	Gilley et al.	
	29	20080105665	A1	2008-05-08	Kondo	
	30	20080240502	A1	2008-10-02	Freedman et al.	
	31	20090028193	A1	2009-01-29	Islam	
	32	20090105605	A1	2009-04-23	Abreu	
	33	20090156932	A1	2009-06-18	Zharov	
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	36	20090244288	A1	2009-10-01	Fujimoto et al.	
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	38	20100007717	A1	2010-01-14	Spektor et al.	

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	39	20100046067	A1	2010-02-25	Fermann et al.	
	40	20100118123	A1	2010-05-13	Freedman et al.	
	41	20100160794	A1	2010-06-24	Banet et al.	
	42	20100160798	A1	2010-06-24	Banet et al.	
	43	20100217099	A1	2010-08-26	LeBoeuf et al.	
	44	20100217102	A1	2010-08-26	LeBoeuf et al.	
	45	20100284082	A1	2010-11-11	Shpunt et al.	
	46	20100322490	A1	2010-12-23	Pan et al.	
	47	20100331637	A1	2010-12-30	Ting et al.	
	48	20110040197	A1	2011-02-17	Welch et al.	
	49	20110143364	A1	2011-06-16	Kim et al.	

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	50	20110188054	A1	2011-08-04	Petronius et al.	
	51	20110208015	A1	2011-08-25	Welch et al.	
	52	20110237911	A1	2011-09-29	Lamego et al.	
	53	20110267688	A1	2011-11-03	Kleppe et al.	
	54	20110282167	A1	2011-11-17	Ridder et al.	
	55	20110292376	A1	2011-12-01	Kukushkin et al.	
	56	20120013722	A1	2012-01-19	Wong et al.	
	57	20120041767	A1	2012-02-16	Hoffman et al.	
	58	20120197093	A1	2012-08-02	LeBoeuf et al.	
	59	20120203077	A1	2012-08-09	He et al.	
	60	20120239013	A1	2012-09-20	Islam	

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	61	20120245439	A1	2012-09-27	Andre et al.	
	62	20120310062	A1	2012-12-06	Li et al.	
	63	20120316455	A1	2012-12-13	Rahman et al.	
	64	20130274569	A1	2013-10-17	Islam	
	65	20130281795	A1	2013-10-24	Varadan	
	66	20130303921	A1	2013-11-14	Chu et al.	
	67	20130327966	A1	2013-12-12	Fidler et al.	
	68	20140078510	A1	2014-03-20	Rubio Guivernau et al.	
	69	20140081100	A1	2014-03-20	Muhsin et al.	
	70	20140236021	A1	2014-08-21	Islam	
	71	20140249427	A1	2014-09-04	Liu	

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	72	20140275852	A1	2014-09-18	Hong et al.	
	73	20140275854	A1	2014-09-18	Venkatraman et al.	
	74	20150011851	A1	2015-01-08	Mehta et al.	
	75	20150338509	A1	2015-11-26	Lange	
	76	20160045118	A1	2016-02-18	Kiani	
	77	20160327476	A1	2016-11-10	Islam	
	78	20180231373	A1	2018-08-16	Pesach et al.	

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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	1148666	EP	A2	2001-10-24	Grant		
	2	101849821	CN	A	2010-10-06	Gong et al.		

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	Mohammed N. ISLAM
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	3	102010012987	DE	A1	2010-10-07	Velten et al.		
	4	2005270544	JP	A	2005-10-06	Maekawa et al.		
	5	1997015240	WO	A1	1997-05-01	Brant et al.		
	6	1997049340	WO	A1	1997-12-31	Wang et al.		
	7	2001050959	WO	A1	2001-07-19	Suhm et al.		
	8	2001089362	WO	A2	2001-11-29	West et al.		
	9	2002027640	WO	A2	2002-04-04	Whittington et al.		
	10	2002028123	WO	A2	2002-04-04	Whittington		
	11	2005013843	WO	A2	2005-02-17	Fried et al.		
	12	2007061772	WO	A1	2007-05-31	Bedwell et al.		
	13	2009130464	WO	A1	2009-10-29	Zakian et al.		

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	14	2012135952	WO	A1	2012-10-11	Mandelis, et al.		
	15	2013012938	WO	A1	2013-01-24	Raskin et al.		
	16	2015084376	WO	A1	2015-06-11	Han 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]
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	Application Number	16669794
	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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	/Andrew B. Turner/	Date (YYYY-MM-DD)	2019-11-26
Name/Print	Andrew B. Turner	Registration Number	63121

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:

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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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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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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Electronic Acknowledgement Receipt

EFS ID:	37867665
Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6
Receipt Date:	26-NOV-2019
Filing Date:	31-OCT-2019
Time Stamp:	16:31:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	OMNI0102PUSA6_IDS_transmittal_2.pdf	101711 e91b4addff6124b99119fb7f074385dffdd19fea	no	2

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2	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA6_IDS_2_US_pubs_foreign.PDF	1212995 7b6b07456a643d4573672a17c394f6ecd1949fe8	no	12
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New Applications Under 35 U.S.C. 111

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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.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

MOHAMMED N. ISLAM

Group Art Unit: 1731

Examiner:

Serial No.: 16/669794

Filed: October 31, 2019

For: SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

Attorney Docket No.: OMNI0102PUSA6

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 and Substitute Form PTO-1449 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. 16/284,514 filed February 25, 2019, (pending) and Serial No. 16/506,885 filed July 9, 2019 (pending), of which the present application is a continuation. Consideration and entry into the record of the listed references is respectfully requested.

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: November 26, 2019

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

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
182/459
IPR2025-01251 Page 00182

Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
	Examiner Name	

U.S. Patent Documents

Examiner Initial	Desig. ID	Document Number	Publication Date	Patentee	Class	Subclass	Filing Date If Appropriate

Foreign Patent Documents or Published Foreign Patent Applications

Examiner Initial	Desig. ID	Document Number	Publication Date	Country or Patent Office	Class	Subclass	Translation Yes	Translation No

Other Documents (include Author, Title, Date, and Place of Publication)

Examiner Initial	Desig. ID	Document
		Aaviksoo, J., et al., "Observation of optical precursors at pulse propagation in GaAs", Physical Review A, vol. 44, No. 9, Nov. 1, 1991, pp. R5353-R5356.
		Abeeluck, Akheelesh K., et al., "Continuous-wave pumping in the anomalous- and normal dispersion regimes of nonlinear fibers for supercontinuum generaffon", Optics Letters, vol. 30, No. 1, Jan. 1, 2005, pp. 61-63.

Examiner Signature	Date Considered
EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
183/459
IPR2025-01251 Page 00183

Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
Information Disclosure Statement by Applicant (Use several sheets if necessary)	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
(37 CFR §1.98(b))	Examiner Name	

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Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
	Applicant Mohammed N. ISLAM	Confirmation Number 7663
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Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
Information Disclosure Statement by Applicant (Use several sheets if necessary)	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
(37 CFR §1.98(b))	Examiner Name	

Other Documents (include Author, Title, Date, and Place of Publication)		
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Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
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Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
	Examiner Name	

Other Documents (include Author, Title, Date, and Place of Publication)		
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		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, Aug. 28, 2018 (Exhibit A), 66 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit AA), 75 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, Aug. 28, 2018 (Exhibit B), 73 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit BB), 65 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, Aug. 28, 2018 (Exhibit C), 85 pps.

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		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit CC), 320 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, Aug. 28, 2018 (Exhibit D), 38 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit DD), 240 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit E), 120 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit F), 40 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit G), 66 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit H), 74 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit I), 102 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit J), 64 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit K), 77 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit L), 64 pps.
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		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit O), 63 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit P), 78 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit Q), 69 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit R), 61 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit S), 50 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit T), 174 pps.

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Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
	Examiner Name	

Other Documents (include Author, Title, Date, and Place of Publication)		
Examiner Initial	Desig. ID	Document
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Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
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Examiner Signature	Date Considered
EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

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Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
	Examiner Name	

Other Documents (include Author, Title, Date, and Place of Publication)		
Examiner Initial	Desig. ID	Document
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Examiner Signature	Date Considered
EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
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Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
	Examiner Name	

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).

☒ 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. 16/284,514 filed February 25, 2019, (pending) and Serial No. 16/506,885 filed July 9, 2019 (pending), of which the present application is a continuation.

☐ 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	/Andrew B. Turner/	Date (YYYY-MM-DD)	November 26, 2019
Name/Print	Andrew B. Turner	Registration Number	63121

Omni MedSci Ex. 2029
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Electronic Acknowledgement Receipt

EFS ID:	37868558
Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6
Receipt Date:	26-NOV-2019
Filing Date:	31-OCT-2019
Time Stamp:	17:11:14
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	Transmittal Letter	OMNI0102PUSA6_IDS_3_transmittal_cited.pdf	101734 23caa4f721b9c7626cfab1bc390d9ab2c826581c	no	2

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA6_IDS_3_NPL.pdf	512770 91bb93cb41849942ca411c2039913e39a5fa8d63	no	24
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
			Total Files Size (in bytes):	614504	

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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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

MOHAMMED N. ISLAM

Group Art Unit: 1731

Examiner:

Serial No.: 16/669794

Filed: October 31, 2019

For: SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

Attorney Docket No.: OMNI0102PUSA6

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 and Substitute Form PTO-1449 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. 16/284,514 filed February 25, 2019, (pending) and Serial No. 16/506,885 filed July 9, 2019 (pending), of which the present application is a continuation. Consideration and entry into the record of the listed references is respectfully requested.

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: November 26, 2019

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Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
Information Disclosure Statement by Applicant (Use several sheets if necessary)	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
(37 CFR §1.98(b))	Examiner Name	

U.S. Patent Documents

Examiner Initial	Cite No.	Document Number	Publication Date	Patentee	Class	Subclass	Filing Date If Appropriate

Foreign Patent Documents or Published Foreign Patent Applications

Examiner Initial	Cite No.	Document Number	Publication Date	Country or Patent Office	Class	Subclass	Translation Yes	Translation No
	1	2458123	2004-09-13	CA	A1			

Other Documents (include Author, Title, Date, and Place of Publication)

Examiner Initial	Cite No.	Document
	2	Claim Construction Memorandum Opinion and Order. Case No. 2:18-CV-000134-RWS (June 24, 2019)
	3	Claim Construction Memorandum Opinion and Order. Case No. 2:18-CV-000429-RWS (August 14, 2019)
	4	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 10,098,546 filed in IPR2020-00029 (Oct. 17, 2019)
	5	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,651,533 filed in IPR2019-00913 (Apr. 10, 2019).
	6	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,651,533 filed in IPR2019-00916 (Apr. 10, 2019).
	7	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,757,040 filed in IPR2019-00910 (Apr. 10, 2019).
	8	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,757,040 filed in IPR2019-00917 (Apr. 10, 2019).
	9	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,861,286 filed in IPR2019-00911 (Apr. 10, 2019).
	10	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,861,286 filed in IPR2019-00914 (Apr. 10, 2019).
	11	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,885,698 filed in IPR2019-00912 (Apr. 10, 2019).
	12	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,885,698 filed in IPR2019-00915 (Apr. 10, 2019).

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Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
	Examiner Name	

Other Documents (include Author, Title, Date, and Place of Publication)		
Examiner Initial	Cite No.	Document
	13	File History for U.S. Patent No. 10,098,546, issued October 16, 2018
	14	Inter Partes Review No. IPR2020-00029; Petition for Inter Partes Review of U.S. Pat. No. 10,098,546; Apple Inc. v. Omni Medsci, Inc.; dated October 17, 2019.
	15	Lister et al., Optical properties of human skin (Journal of Biomedical Optics 2012)
	16	Mark Nelson & Jean-Loup Gailly, The Data Compression Book (Cary Sullivan et al. eds.) (2nd ed. 1996)
	17	Newton, H., Newton's Telecom Dictionary (18th ed. 2002).
	18	Order, Omni MedSci, Inc. v. Apple Inc., No. 2:18-cv-134-RWS in the United States District Court for the Eastern District of Texas Marshall Division (8/16/2019), ECF No. 283
	19	Proof of Service of Summons in Omni MedSci, Inc. v. Apple Inc., No. 2:18-cv-429 (E.D. Tex.).

Examiner Signature	Date Considered
EXAMINER: Initials citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

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	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
	Examiner Name	

CERTIFICATION STATEMENT

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

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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).

☐ This application relies, under 35 U.S.C. § 120, on the earlier filing date of prior application No. _____, filed _____ and the references cited therein are hereby referenced, but are not required to be provided in this application under 37 CFR § 1.98(d).

☐ 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	/Andrew B. Turner/	Date (YYYY-MM-DD)	November 26, 2019
Name/Print	Andrew B. Turner	Registration Number	63121

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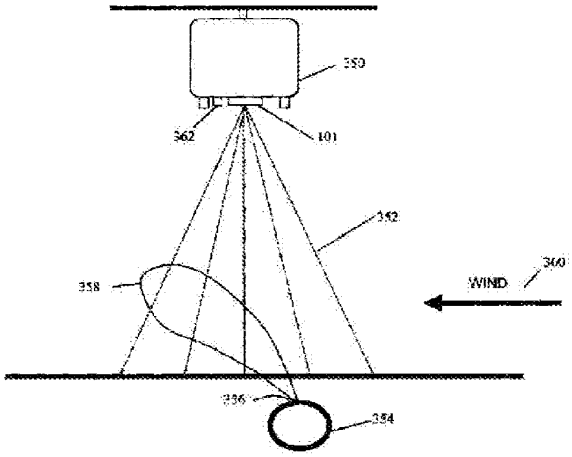
(71) SYNODON INC.,
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BANICA, ADRIAN (CA).
TOLTON, BOYD T. (CA).

(74) LAMBERT, ANTHONY R.

(54) TELEDETECTION DES FUITES DE GAZ
(54) REMOTE SENSING OF GAS LEAKS

(57)
A gas filter correlation radiometer mounted on an aircraft is flown over a target area. The gas filter correlation radiometer is configured to detect ethane (C2H6) gas in the event of a gas leak. The gas filter correlation radiometer uses background radiation to detect ethane.



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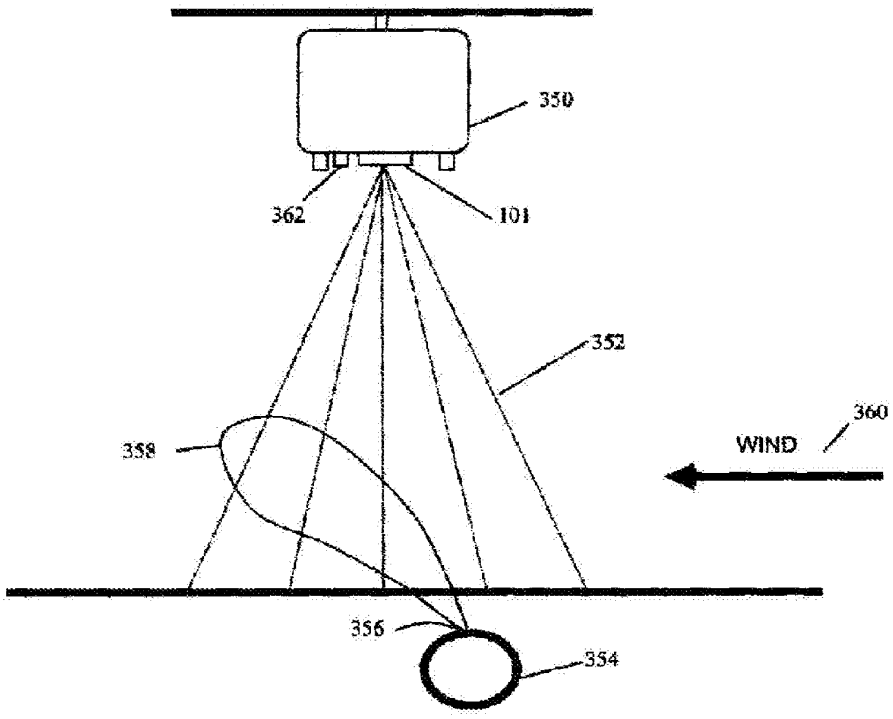
(51) Cl.Int.^{7}/Int.Cl.^{7} G01N 21/31, G01J 3/42, G01M 3/38

(71) Demandeur/Applicant:
SYNODON INC., CA

(72) Inventeurs/Inventors:
TOLTON, BOYD T., CA;
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(74) Agent: LAMBERT, ANTHONY R.

(54) Titre : TELEDETECTION DES FUITES DE GAZ
(54) Title: REMOTE SENSING OF GAS LEAKS



(57) Abrégé/Abstract:
A gas filter correlation radiometer mounted on an aircraft is flown over a target area. The gas filter correlation radiometer is configured to detect ethane (C_2H_6) gas in the event of a gas leak. The gas filter correlation radiometer uses background radiation to detect ethane.

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ABSTRACT OF THE DISCLOSURE

A gas filter correlation radiometer mounted on an aircraft is flown over a target area. The gas filter correlation radiometer is configured to detect ethane (C_2H_6) gas in the event of a gas leak. The gas filter correlation radiometer uses background radiation to detect ethane.

REMOTE SENSING OF GAS LEAKS

CROSS-REFERENCE TO OTHER APPLICATIONS

This application claims priority from provisional application US 60/455,225 filed March 13, 2003.

BACKGROUND OF THE INVENTION

01 This invention relates to remote sensing techniques to detect gas leaks. In particular, the invention involves flying an aircraft with a remote sensing instrument over a target area, such as a pipeline, and measuring absorption of upwelling electromagnetic radiation that has passed through natural gas.

02 Past attempts to remotely detect natural gas leaks have involved detecting increased concentrations of methane (CH_4). CH_4 comprises approximately 95% of the composition of natural gas, which makes it a natural target for detection. One problem that has been experienced is that CH_4 exists in fairly large quantities in the atmosphere (it is well mixed in the atmosphere with a concentration of approximately 1.7 ppm). Therefore, detecting a gas leak required detection of a small increase on a large background. Events such as passing near a source region of CH_4 (such as a farm), or an increase in the altitude of the airplane (an increase in the atmospheric path length) might result in the false signature of a leak.

03 To reduce the influence of the background, some past attempts have tried to detect the excess CH_4 of a natural gas leak by detecting the absorption of CH_4 in the long wavelength infrared region (for example, at 7.8 μm or 2180 cm^{-1}). This provides the advantage that the upwelling radiation is primarily emitted from the earth's surface. This minimises the background CH_4, as only the CH_4 located between the airplane and the earth's surface is detected.

04 However, for underground pipe since the temperature of the surface and the leaked CH_4 are nearly the same, the radiative contrast between the surface and the leaked methane is very small, greatly reducing the detectivity/detectability of the leak. Also, the thermal noise introduced within the instrument itself becomes a serious design constraint. Using a shorter wavelength absorption band of CH_4 could potentially help, as the upwelling radiation would be primarily from the sun. This would greatly increase the radiative contrast between the source and the "leaked" gas, and significantly reduce the thermal noise within the instrument. However, the background of CH_4 becomes very large, as the solar radiation reaching the instrument would have passed through entire atmosphere.

SUMMARY OF THE INVENTION

05 According to an aspect of the invention, leaks from natural gas are detected by remote detection of radiation that has passed through a concentration of ethane gas.

06 Ethane, C_2H_6, is a minor constituent in natural gas, comprising up to 20% of unprocessed natural gas, and approximately 2.5% of processed natural gas. It has the distinct advantage for detection over CH_4 in that it exists in the atmosphere in very minute quantities (global annual average concentration of 860 ppt). Therefore, the natural background is very small (2000 times smaller than CH_4).

07 The two main sources of C_2H_6 in the atmosphere are from leaked natural gas and biomass burning (both of roughly equivalent magnitudes). The main sink is by reaction with the hydroxyl (OH) radical. C_2H_6 has a strong absorption/emission band(s) at 3000 cm^{-1} (3.33 μm). In this spectral region, the upwelling radiation will consist primarily of reflected solar radiation. Also, thermal noise within the instrument is significantly reduced at these shorter wavelengths. This combination of a tiny background, a strong spectral signature in a "solar" region of the spectrum, and reduced thermal noise makes

C_2H_6 suitable for the detection of natural gas pipeline leaks. Preferably, the ethane is detected by using the ethane absorption/emission band(s) at 3000 cm^{-1}.

08 According to a further aspect of the invention, the ethane is detected by tuning the gas filter correlation radiometer to detect ethane using an ethane absorption peak at a bandwidth of 2850 to 3075 cm^{-1}.

09 According to a further aspect of the invention, the ethane is detected by tuning the gas filter correlation radiometer to detect ethane using an ethane absorption peak at a bandwidth up to 150 cm^{-1} above or below 3000 cm^{-1}.

10 According to a further aspect of the invention, remote sensing of leaked ethane from natural gas pipelines is carried out by using a gas filter correlation radiometer (GFCR). The gas filter correlation radiometer comprises a window in a housing; optics defining a first optical path and a second optical path between the window and a detector section mounted in the housing; a beam splitter mounted in the housing as part of the optics for directing radiation entering the window from an outside source to divide the radiation between the first optical path and the second optical path; the first optical path having a first ethane path length and the second optical path having a second ethane path length, the first ethane path length being different from the second ethane path length; and electronics for processing signals produced by the detector section section as a result of radiation being directed by the optics onto the detector section. The ethane path length is provided by gas filters containing differing amounts of ethane, preferably with one of the optical paths having zero ethane path length.

11 According to a further aspect of the invention, the beam splitter comprises a bi-prism.

12 According to a further aspect of the invention, the detector section further comprises a first detector on the first optical path and a second detector on the second optical path, and corresponding pixels on the first detector and second detector having collocated fields of view and being sampled synchronously.

13 According to a further aspect of the invention, the detector section detects radiation using a pushbroom imaging technique.

14 These and other aspects of the invention are described in the detailed description of the invention and claimed in the claims that follow.

BRIEF DESCRIPTION OF THE DRAWINGS

15 There will now be described preferred embodiments of the invention, with reference to the drawings, by way of illustration only and not with the intention of limiting the scope of the invention, in which like numerals denote like elements and in which:

Fig. 1 is a schematic of the gas filter correlation radiometer;

Fig. 2 is a schematic of an alternative embodiment of the gas filter correlation radiometer;

Fig. 3 depicts a helicopter using the gas filter correlation radiometer to detect a leak in a pipeline;

Fig. 4 depicts an overhead view of a helicopter traversing a pipeline and shows successive fields of view, including an exploded view of a portion of a field of view being sampled; and

Fig. 5 shows, upper graph, a spectra of C_2H_6 in a 28.6 mm gas cell with 106 Pa of pure C_2H_6, middle graph, a high resolution spectra of C_2H_6 in a 28.6 mm gas cell with 12.1 kPa of pure C_2H_6 and, lower graph, a calculation of the spectra using the Hitran line database.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

16 In this patent document, the word "comprising" is used in its non-limiting sense to mean that items following the word in the sentence are included and that items not specifically mentioned are not excluded. The use of the indefinite article "a" in the claims before an element means that one of the elements is specified, but does not specifically exclude others of the elements being present, unless the context clearly requires that there be one and only one of the elements.

17 The instrument used in this invention is a type of gas-filter correlation radiometer (GFCR). GFCRs have been used in different configurations for over 3 decades in remote sensing instrumentation.

18 Referring to Fig. 1, there is shown a GFCR 101 incorporated within a housing 100, with a detector section, such as a pair of photodiode arrays 102A, 102B mounted in the housing. Radiation from source 126 passes through a window 103 in the housing 100, is collected by collector optic 124 and filtered by bandpass filter 116 and then directed by collimating lens 122 onto beam splitter 106. In an exemplary embodiment, a 40 cm^{-1} wide band-pass filter 116 centred at 2988 cm^{-1} is specified. The filter width is 1.3% of the central wavenumber. The passband of filter 116 is selected to include the ethane absorption peak at 3000 cm^{-1} and exclude radiation falling outside of the peak. Beam splitter 106 formed by a partially reflective mirror splits the radiation from the radiation source 126 along paths 110 and 112. On the first radiation path 110, the radiation passes through gas correlation cell 114 and is focused by detector lens 104A onto the photodiode 102A. On the second radiation path 112, the radiation is directed by mirror 120 through an evacuated gas cell 118 and is focused by lens 104B onto photodiode 102B. The gas correlation cell 114, also called a gas filter or absorption cell, contains a gas, such as ethane, to be detected.

19 The gas correlation cell 114 may for example be a 1 cm cell with for example a concentration of ethane provided by one atmosphere of pure C_2H_6. The second path 112 has a different path length of C_2H_6, such as may be obtained by providing the cell 118 with for example no C_2H_6, as for example an evacuated gas cell or a cell containing a gas that is optically neutral in relation to the ethane spectra of interest. The output of the photodiodes 102A, 102B is provided to suitable electronics, such as a computer 108, for processing. The GFCR 101 may use a beam splitter, for example, in the form of a partially reflective mirror as shown in Fig. 1, or in the form of a bi-prism, as shown in Fig. 2, or may selectively direct the incoming radiation through separate paths, in a time division manner, using for example a chopper. The use of a beam splitter versus a chopper is a trade-off between simultaneity of the two received signals and loss of signal intensity. A beam splitter, such as a partially reflective mirror or a bi-prism, is preferred for gas leak detection because it provides simultaneous measurement of both detector signals. This can be important because the signals are fast varying due to the forward motion of the helicopter and the variation in the reflective surface.

20 A different optical configuration is shown in an alternative embodiment in Fig. 2. Radiation from source 226 passes through a window 203 in housing 200, is collected on collector optic 224 and focused to a field stop 216. The field stop 216 is used to limit the field of view. The radiation from source 226 is then directed by collimating lens 222 onto prisms 206 and 207 which form the front of a compound gas cell 215 formed by gas cell walls 228, gas cell separator 230, and a plane parallel gas cell window 232. The prisms 206 and 207 split the radiation from the radiation source 226 along paths 210 and 212 by causing the radiation to diverge while passing through gas cells 214 and 218. On the first radiation path 210, the radiation is directed by prism 206 through gas correlation cell 214 and is focused by detector lens 204 onto the photodiode 202A. On the second radiation path 212, the radiation is directed by the prism 207 through an evacuated gas cell 218 and is focused by detector lens 204 onto photodiode 202B.

21 The compound gas cell 215 with prisms 206 and 207 may also be located between the field stop 216 and the collimating lens 222, or between the detector lens 204 and the photodiodes 202A and 202B. Likewise, the prisms 206 and 207 may be located at either the front of the compound gas cell 215 or at the back of the compound gas cell 215.

22 The gas correlation cell 214, also called a gas filter or absorption cell, contains a gas, such as ethane, to be detected. The gas correlation cell 214 may for example be a 1 cm cell with for example a concentration of ethane provided by one atmosphere of pure C2H6. The second path 212 has a different path length of C2H6, such as may be obtained by providing the cell 218 with for example no C2H6, as for example an evacuated gas cell or a cell containing a gas that is optically neutral in relation to the ethane spectra of interest. The output of the photodiodes 202A, 202B is provided to suitable electronics, such as computer 208, for processing.

23 The detector signal on the path 112 is:

$$S_1 = G\int_{\lambda_1}^{\lambda_2} I_\lambda \tau_{filter} d\lambda$$

where I_λ is the intensity of the radiation from the radiation source 126, τ_{filter} is the transmissivity of the filter 116, λ_1 is the low pass of the filter 116, λ_2 is the high pass of the filter 116 and G is the gain of the photodiode 102B.

The detector signal on the path 110 is:

$$S_2 = G\int_{\lambda_1}^{\lambda_2} I_\lambda \tau_{filter} \tau_{corr\_cell} d\lambda$$

where $\tau_{corr\ cell}$ is the transmissivity of the correlation cell 114.

If $S_{avg} = \frac{S_1 + S_2}{2}$ and $S_{diff} = S_1 - S_2$, then the calculation made by the computer is:

$S_{nrm} = \frac{S_{diff}}{S_{avg}}$, which yields a signal that is dependent on the presence of the target gas in the radiation path from the source 126 to the photodetector 102B. The calculation

of the difference in the received signals for both optical paths is made for each pixel of the photodetectors 102A, 102B to yield an image of the field of view that may be displayed on a monitor.

24 Fig. 3 shows the manner of use of the GFCR 101 shown in Fig. 1. A helicopter 350 traverses a pipeline 354 with a GFCR 101 having a field of view 352 oriented towards the pipeline 354. The GFCR 101 is tuned to detect ethane by appropriate selection of the bandpass of the filter 116, and the gas filter 114 contains a sample of ethane. If a leak 356 exists in the pipeline 354, the presence of ethane in the resulting plume 358 that may be moved by the presence of wind 360 will be detected using the GFCR 101. The presence of a leak is indicated by for example displaying the received signal using a monitor that is provided as part of the computer 108. Pixels on the monitor display corresponding to detected ethane may be coloured to enhance the image. Other methods of indication of the presence of a leak may be used such as detecting a concentration of ethane in the path between helicopter 350 and the ground that exceeds a predetermined threshold, and providing an alarm. The threshold is determined readily by calibration of the radiometer and experimentation. Fig. 5 shows that the absorption spectra of ethane at 3000^{-1} cm is larger than the calculated spectrum from the Hitran database, with the result that ethane is unexpectedly a suitable candidate for the detection of pipeline gas leaks. Due to the remote sensing capabilities of the device, the GFCR does not have to fly through the plume in order to detect leaks. The GFCR measures the integrated column concentration of natural gas between the helicopter and the ground, regardless of where in this column the natural gas occurs.

25 In one embodiment as shown in Fig. 4, the field of view 352 covers an area of 128 m^2, representing a swath 64 m long by 2 m wide. The long but narrow swath of the field of view 352 leads to an overall view of the pipeline 354 or target area through the use of a technique known as pushbroom imaging. As the helicopter 350 advances along the helicopter path 464 over the pipeline 354 or other target area,

successive swaths below the helicopter 350 and perpendicular to the helicopter path 464 are detected by the GFCR 101. At a first time interval, the detectors 102A and 102B would sample signals from the field of view 352A, followed moments later by 352B, followed again by 352C and so on.

26 In Fig. 4, the field of view 352F represents the current swath of the target area being detected by the detectors 102A and 102B. Detectors 102A and 102B have corresponding pixels having collocated fields of view 352F where each 2 m X 2 m cell of the field of view 352F is sampled synchronously by detectors 102A and 102B. Therefore, the cell marked P1 would be detected by a first pixel representing a portion of the field of view collocated and synchronized on detectors 102A and 102B. The cell marked P2 would be detected by a second pixel collocated and synchronized on detectors 102A and 102B. The same can be said for the cells marked P3 and P4 and so on. All cells P1 to P32 along a line would be detected simultaneously.

27 In an exemplary embodiment, the GFCR 101 operates using ambient background radiation that passes through the plume 358 of natural gas. The upwelling radiation field is comprised of reflected solar radiation, radiation emitted from the surface, plus upwelling emission from the atmosphere. For operation during cloudy periods or at night, a source of illumination 362 may be used. For example, a powerful 1600W Tungsten Halogen bulb may be mounted on the helicopter 350, with an IR transmitting window (not shown) and a focusing mirror (not shown). This mirror focuses the emission from the illumination source 362 to a 5m spot on the ground. Assuming a lambertian reflective surface and a reflectivity of 5%, the reflected intensity at the surface would be 0.048W m^{-2}. This is roughly equivalent to (or slight greater than) the reflected intensity of sunlight. The illumination source 362 should be mounted to reduce vibrations that could increase the signal to noise ratio of the detected signal. In an alternative embodiment, the GFCR 101 may be mounted on a different type of vehicle, such as a truck, and driving the vehicle along a pipeline or other possible source of a gas

leak. The GFCR 101 may also be tuned to detect other gases by selection of the bandpass of the filter 116.

28 The detected instrument signal is a function of the height of the natural gas column. For an atmospheric background concentration of 1 ppb of C_2H_6, the equivalent total atmospheric column thickness is approximately 8.5 μm. The equivalent CH_4 column thickness would be approximately 1700 times thicker.

29 A linear regression of the signal sensitivity between 0 and 4 mm of natural gas shows that the change in signal per mm of natural gas is -1.69×10^{-3} mm^{-1}. The measurement is actually detecting C_2H_6 which is assumed to be 2.5% of natural gas. Therefore, the detected columns of pure C_2H_6 are 40 times shorter than that of methane. Maximum sensitivity to C_2H_6 occurs at the lowest concentrations. This is the most desirable for detecting the smallest leaks.

30 Uncertainties may be introduced into the measurement by spectral interferences by other gases in the atmosphere (principally H_20 and CH_4), variations in the surface emissivity, temperature variations in the atmospheric temperature, and variations in the altitude of the airplane. These uncertainties tend to reduce the sensitivity of the measurement to concentrations of natural gas, and variations may result in false signatures of leaks. The combined uncertainty is about +/-19 μm. This level of accuracy places a minimum limitation on the measurement's accuracy. Given a measurement resolution of -1.69×10^{-3} per mm natural gas, to measure a column height of ± 19 μm a measurement precision of $\pm 3.2 \times 10^{-5}$ (i.e. a signal-to-noise ratio of 31,000) is required. Such a measurement precision may be obtained from the GFCR 101, and may be adjusted by for example varying the length of the absorption cell 114.

31 The sensitivity of the instrument is ultimately a function of the amount of energy that is collected and focussed onto the detector element. This in turn is a function of the

field-of-view (FOV) of the instrument (which determines the surface resolution), the size of the collector optic 124, the size of the detector pixel in the photodiodes 102A, 102B, the transmission of the instrument, and the observation period (frequency) of the instrument. The FOV and the collector optic size directly affect the energy collected, as the larger the optic and FOV, the more photons collected. However, they also directly affect the detector pixel size, due to the principle of etendue ($A\Omega$) conservation in an optical chain. The transmission of the instrument directly affects the energy collected as any losses in the system directly reduces the number of photons incident on the detector. And finally, the pixel size and observation period directly affect the noise-equivalent power (NEP) of the detector. In an exemplary embodiment, the aircraft may operate at a height of 30 m, with surface resolution 1.5 m, FOV solid angle $2.0x10^{-3}$sr, FOV 2.86°, collector optic diameter 12.2 cm, $A\Omega$ product $2.29x10^{-5}m^2$ sr, transmission 75%, temperature 293K, observation time 10 ms (100 hz), detector element diameter 2 mm, detector FOV 170° and detector D* 10^{11} cm $Hz^{0.5}$.

32 The upwelling radiance reaching the aircraft is calculated to be 0.04 W m^{-2} sr^{-1}. This includes the energy lost due to absorption by atmospheric H_20 and CH_4, and which is reduced to 0.03W m-2 sr^{-1}. Assuming the instrument has a 12.2 cm diameter optic to collect upwelling radiation with a field-of-view of 2.86° and an instrument transmission of 75%, the collected energy by the instrument will be 5.2 X 10^{-7} W. The noise equivalent power (NEP) for a 2 mm diameter liquid nitrogen cooled InSb detector would be 2 X 10^{-11} W, providing a radiative S/N ratio of approximately 25,800. Given this level of precision and the calculated sensitivity to natural gas of -1.69 X 10^{-3} mm^{-1}, the measurement is able to detect below a 23 μm column of natural gas.

33 A person skilled in the art could make immaterial modifications to the invention described in this patent document without departing from the invention.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method of detecting gas leaks, the method comprising the steps of:

traversing a target area with a gas filter correlation radiometer having a field of view oriented towards the target area, the gas filter correlation radiometer being tuned to detect ethane; and

identifying a gas leak upon the gas filter correlation radiometer detecting the presence of ethane.

2. The method of claim 1 in which the gas filter correlation radiometer is tuned to detect ethane using an ethane absorption peak at 3000 cm^{-1}.

3. The method of claim 1 in which the gas filter correltation radiometer is tuned to detect ethane using an ethane absorption peak at a bandwidth of 2850 to 3075 cm^{-1}.

4. The method of claim 1 in which the gas filter correlation radiometer is tuned to detect ethane using an ethane absorption peak at a bandwidth up to 150 cm^{-1} above or below 3000 cm^{-1}.

5. The method of claim 1 in which the gas filter correlation radiometer comprises:

a window in a housing;

optics defining a first optical path and a second optical path between the window and a detector section mounted in the housing;

a beam splitter mounted in the housing as part of the optics for directing radiation entering the window from an outside source to divide the radiation between the first optical path and the second optical path;

the first optical path having a first ethane path length and the second optical path having a second ethane path length, the first ethane path length being different from the second ethane path length; and

electronics for processing signals produced by the detector section as a result of radiation being directed by the optics onto the detector section.

6. The method of claim 5 in which the beam splitter comprises a bi-prism.

7. The method of claim 5 in which the gas filter correlation radiometer is tuned to detect ethane using an ethane absorption peak at 3000 cm^{-1}.

8. The method of claim 5 in which the gas filter correlation radiometer is tuned to detect ethane using an ethane absorption peak at a bandwidth of 2850 to 3075 cm^{-1}.

9. The method of claim 5 in which the gas filter correlation radiometer is tuned to detect ethane using an ethane absorption peak at a bandwidth up to 150 cm^{-1} above or below 3000 cm^{-1}.

10. The method of claim 6 in which the gas filter correlation radiometer is tuned to detect ethane using the ethane absorption peak at 3000 cm^{-1} by incorporating a filter in the optics that selects radiation in a passband that includes the ethane absorption peak at 3000 cm^{-1}.

11. The method of claim 5 in which the first optical path is provided with an ethane path length by incorporation into the first optical path of a gas filter containing ethane.

12. The method of claim 11 in which the second ethane path length is lower than the first ethane path length.

13. The method of claim 5 in which the detector section further comprises:

a first detector on the first optical path and a second detector on the second optical path, and corresponding pixels on the first detector and second detector having collocated fields of view and being sampled synchronously.

14. The method of claim 5 in which the detector section detects radiation using a pushbroom imaging technique.

15. The method of claim 1 in which the gas filter correlation radiometer is mounted in an aircraft.

16. The method of claim 1 in which the gas leak is located along a pipeline.

17. The method of claim 1 in which the gas leak is detected as part of a reservoir mapping process.

18. A gas filter correlation radiometer, comprising:

a window in a housing;

optics defining a first optical path and a second optical path between the window and a detector section mounted in the housing;

a beam splitter mounted in the housing as part of the optics for directing radiation entering the window from an outside source to divide the radiation between the first optical path and the second optical path;

the first optical path having a first ethane path length and the second optical path having a second ethane path length, the first ethane path length being different from the second ethane path length; and

electronics for processing signals produced by the detector section as a result of radiation being directed by the optics onto the detector section.

19. The gas filter correlation radiometer of claim 18 in which the beam splitter comprises a bi-prism.

20. The gas filter correlation radiometer of claim 18 in which the gas filter correlation radiometer is tuned to detect ethane using the ethane absorption peak at 3000 cm^{-1}.

21. The gas filter correlation radiometer of claim 18 in which the gas filter correlation radiometer is tuned to detect ethane using an ethane absorption peak at a bandwidth of 2850 to 3075 cm^{-1}.

22. The gas filter correlation radiometer of claim 18 in which the gas filter correlation radiometer is tuned to detect ethane using an ethane absorption peak at a bandwidth up to 150 cm^{-1} above or below 3000 cm^{-1}.

23. The gas filter correlation radiometer of claim 20 in which the gas filter correlation radiometer is tuned to detect ethane using the ethane absorption peak at 3000 cm^{-1} by incorporating a filter in the optics that selects radiation in a passband that includes the ethane absorption peak at 3000 cm^{-1}.

24. The gas filter correlation radiometer of claim 18 in which the first optical path incorporates a gas filter containing ethane.

25. The gas filter correlation radiometer of claim 24 in which the second ethane path length is lower than the first ethane path length.

26. The gas filter correlation radiometer of claim 18 in which the detector section further comprises:

a first detector on the first optical path and a second detector on the second optical path, and corresponding pixels on the first detector and second detector having collocated fields of view and being sampled synchronously.

27. The gas filter correlation radiometer of claim 18 in which the detector section detects radiation using a pushbroom imaging technique.

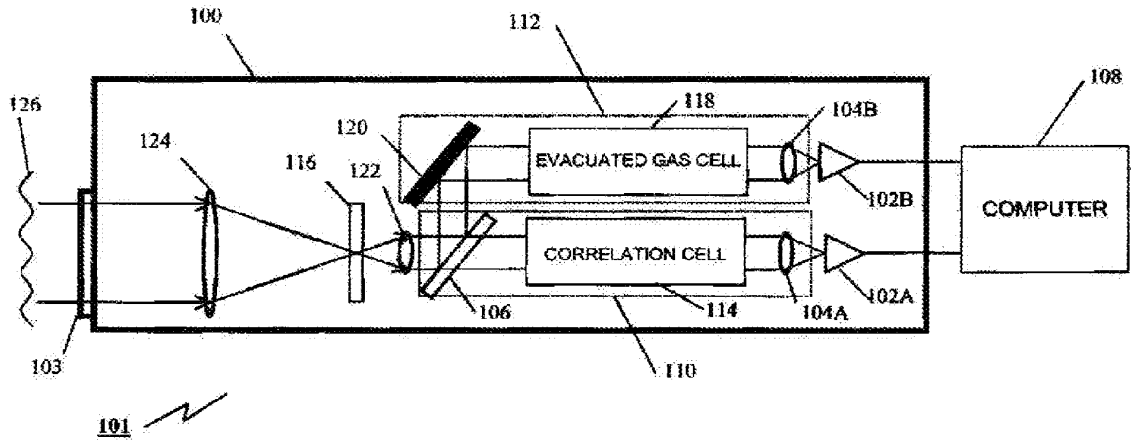

100
112
108
126
118
104B
120
124
116
122
EVACUATED GAS CELL
102B
COMPUTER
CORRELATION CELL
102A
106
114
104A
103
110
101

FIG. 1

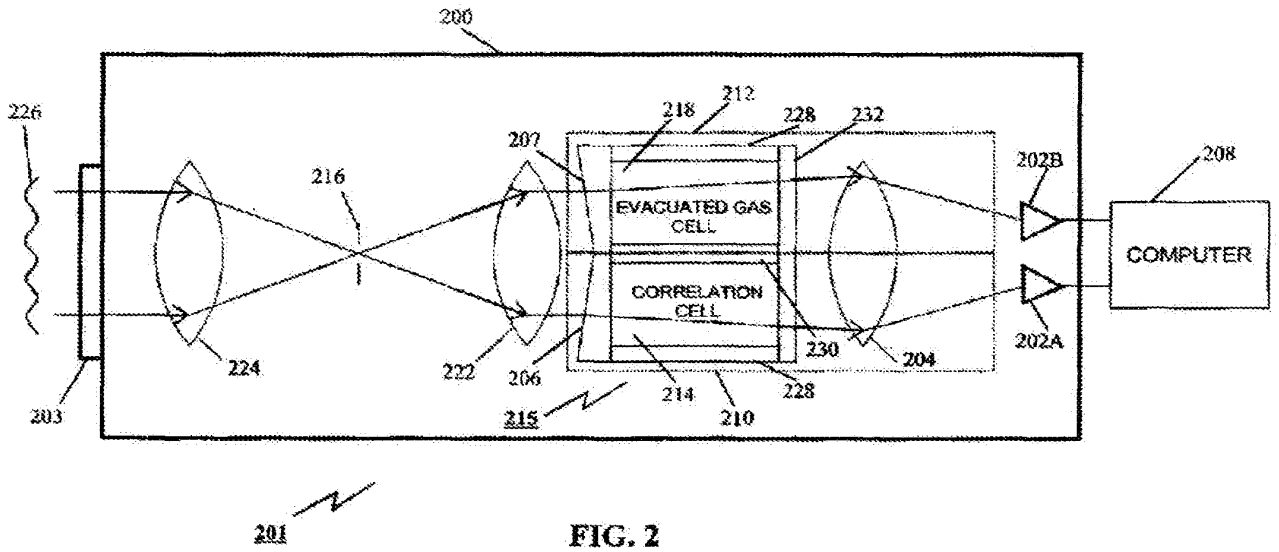

200
226
218
212
228
232
207
216
202B
208
EVACUATED GAS CELL
COMPUTER
CORRELATION CELL
224
222
206
230
204
202A
203
214
228
215
210
201

FIG. 2

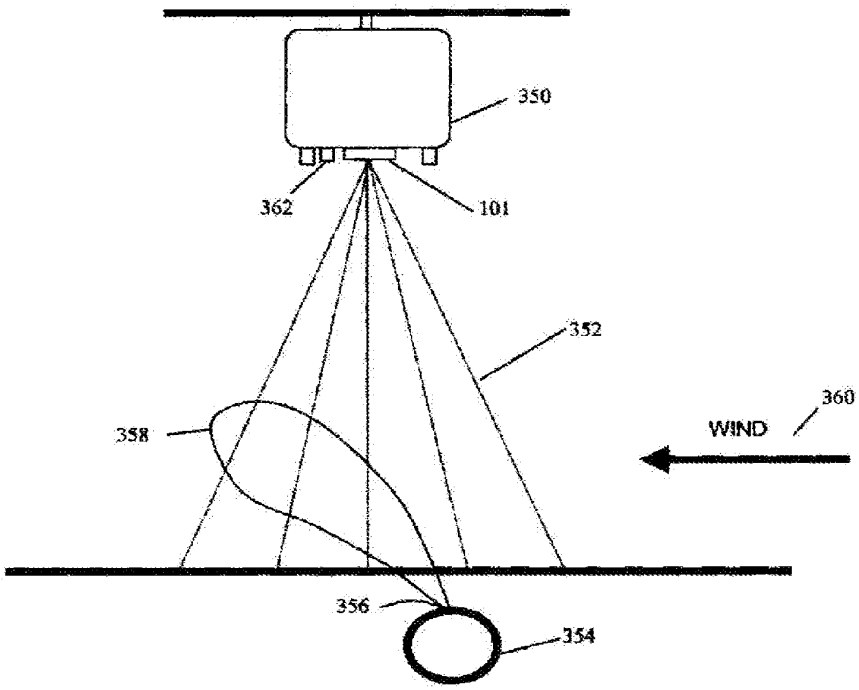


FIG. 3

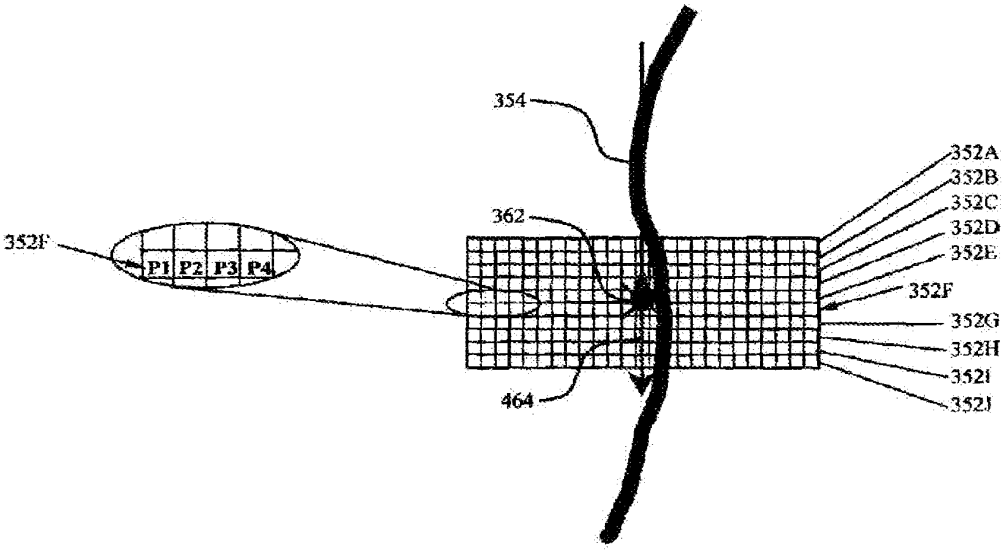

354
362
352A
352B
352C
352D
352E
352F
352G
352H
352I
352J
352F
P1
P2
P3
P4
464

FIG. 4

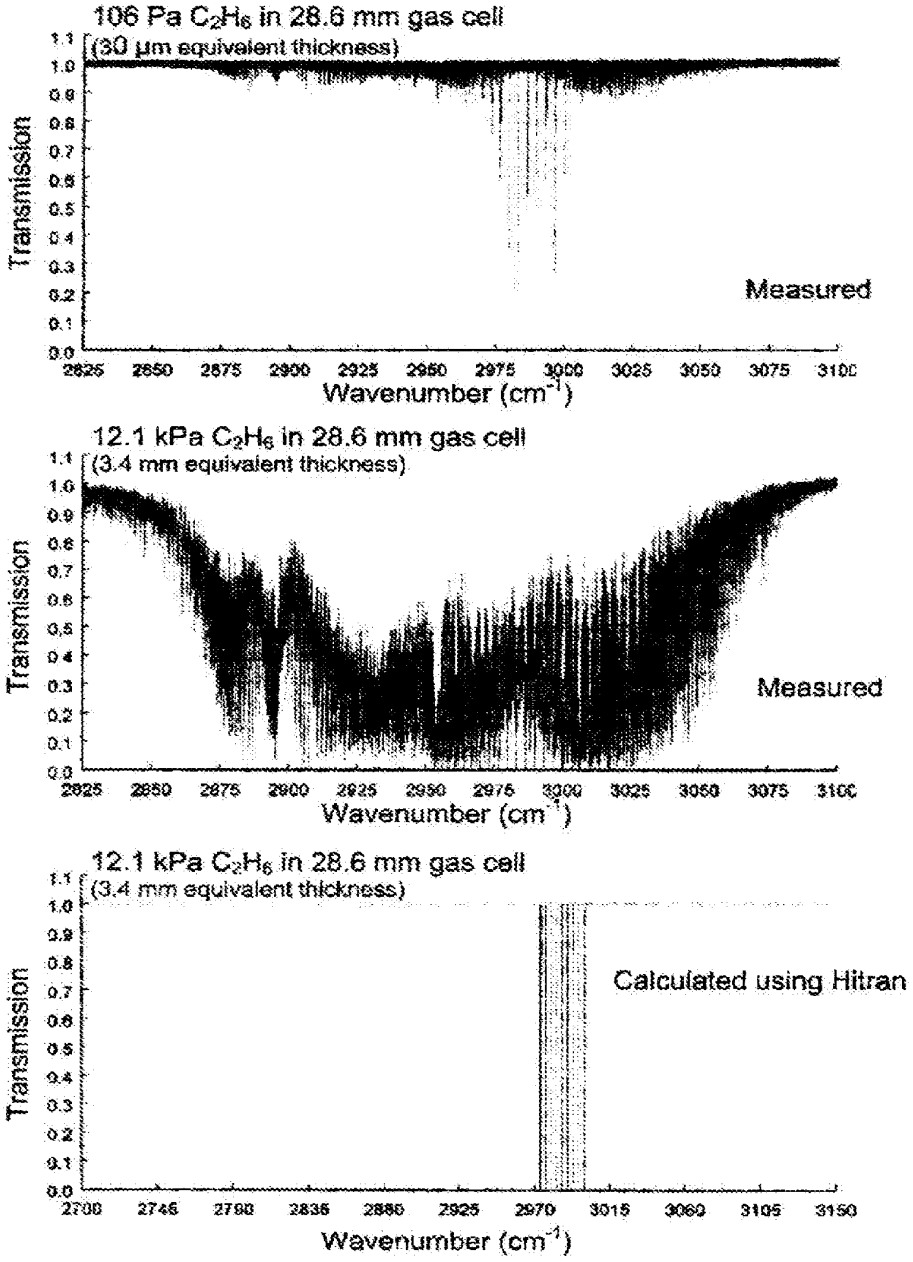

106 Pa C_2H_6 in 28.6 mm gas cell
(30 µm equivalent thickness)
Transmission
Measured
Wavenumber (cm^{-1})
12.1 kPa C_2H_6 in 28.6 mm gas cell
(3.4 mm equivalent thickness)
Transmission
Measured
Wavenumber (cm^{-1})
12.1 kPa C_2H_6 in 28.6 mm gas cell
(3.4 mm equivalent thickness)
Transmission
Calculated using Hitran
Wavenumber (cm^{-1})

FIG. 5

Electronic Acknowledgement Receipt	
EFS ID:	37869328
Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO
First Named Inventor/Applicant Name:	Mohammed N. ISLAM
Customer Number:	109543
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Filer Authorized By:	Andrew B. Turner
Attorney Docket Number:	OMNI0102PUSA6
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3	Non Patent Literature	02_Claim_Construction_Memorandum_Opinion_Order_Case No_218_CV_000134_RWS_20190624.PDF	11099957 3cd53ad4962890aaf2cef14574c979c532891b89	no	19
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6	Non Patent Literature	05_Anthony_Declaration_USPat_9651533_IPR2019_00913_20190410_V2.PDF	2880060 a63de478f4206c3397c0dfba83c8c320283eab96	no	105
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11	Non Patent Literature	10_Anthony_Declaration_USPat_9861286_IPR2019_00914_20190410_V2.PDF	5225985 a4aebad86a00ed9ed65c3918046204c6a02b6147	no	115
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National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

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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
16/669,794	10/31/2019	1731	1135	OMNI0102PUSA6	27	3

CONFIRMATION NO. 7663

UPDATED FILING RECEIPT

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



Date Mailed: 12/03/2019

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.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

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 16/284,514 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
This application 16/669,794
is a CON of 16/506,885 07/09/2019
which 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

Omni MedSci Ex. 2029
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243/459
IPR2025-01251 Page 00243

which is a 371 of PCT/US2013/075700 12/17/2013
which claims benefit of 61/747,472 12/31/2012
and said 16/506,885 07/09/2019
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
and said 16/506,885 07/09/2019
is a CON of 16/188,194 11/12/2018 PAT 10386230
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
and said 16/506,885 07/09/2019
is a CON of 16/241,628 01/07/2019 PAT 10441176
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
and said 16/506,885 07/09/2019
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.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 11/18/2019
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/669,794**
Projected Publication Date: 03/12/2020
Non-Publication Request: No

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
244/459
IPR2025-01251 Page 00244

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

SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

Preliminary Class

501

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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IPR2025-01251 Page 00246

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/669,794

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))	27 minus 20 =	* 7	x 50 =	350	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	1135		TOTAL	

APPLICATION AS AMENDED - PART II

AMENDMENT A

	(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($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
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	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
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.

PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16669794
Filing Date	2019-10-31
First Named Inventor	Mohammed N. ISLAM
Art Unit	2886
Examiner Name	
Attorney Docket Number	OMNI0102PUSA6

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	5497769		1996-03-12	Gratton et al.	
	2	6078833		2000-06-20	Hueber	
	3	8649838		2014-02-11	Chen et al.	
	4	8725226		2014-05-13	Isaacson	
	5	10188299		2019-01-29	Islam	
	6	10213113		2019-02-26	Islam	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

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

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16669794
	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	2886
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

	1							
	2							

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FOREIGN PATENT DOCUMENTS Remove

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							

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

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 IPR2020-00175; Petition for Inter Partes Review of US Patent No. 10,188,299; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-91; dated December 11, 2019	
	2	Inter Partes Review No. IPR2020-00209; Petition for Inter Partes Review of US Patent No. 10,213,113; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-91; dated December 11, 2019	
	3	File History for U.S. Patent No. 10,213,113 issued February 26, 2019, 686 pps.	
	4	Declaration of Brian W. Anthony , PhD, regarding USPN 10,213,113 in IPR2020-00209, December 11, 2019, 101 pps.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16669794
	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	2886
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

	5	United States District Court Eastern District of Texas Marshall Division; Omni Medsci, Inc. vs. Apple Inc.; Civil Action No. 2:18-cv-00429; Second Amended Complaint; Feb. 26, 2019; 274 pps.	
	6	United States District Court Northern District of California Oakland Division;Omni Medsci, Inc. vs. Apple Inc.; Civil Action No. 19-cv-05673-YGR; Order staying the case; Nov. 20, 2019, 5 pps.	
	7	File History for U.S. Patent No. 10,188,299 issued January 29, 2019, 787 pps.	
	8	Declaration of Brian W. Anthony , PhD, regarding USPN 10,188,299 in IPR2020-00175, December 11, 2019, 119 pps.	
	9	United States District Court Eastern District of Texas Marshall Division; Omni Medsci, Inc. vs. Apple Inc.; Civil Action No.2:18-cv-429; Amended Complaint; January 28, 2019; 169 pps.	

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16669794
	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	2886
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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	/Andrew B. Turner/	Date (YYYY-MM-DD)	2020-02-26
Name/Print	Andrew B. Turner	Registration Number	63121

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.

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.

Electronic Acknowledgement Receipt

EFS ID:	38630837
Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6
Receipt Date:	26-FEB-2020
Filing Date:	31-OCT-2019
Time Stamp:	15:59:44
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	Other Reference-Patent/App/Search documents	001_1_IPR2020_00175_Petition_.pdf	20192792 9badf43e870a5d766864dbe2639fee8aeafdffd3	no	91

Warnings:

Information:					
2	Other Reference-Patent/App/Search documents	001_2_IPR2020_00209_Petition_.pdf	15367763 cbcf40fb1c3fd7a66b246ea29f439879395d5021	no	91
Warnings:					
Information:					
3	Other Reference-Patent/App/Search documents	001_3_Ex_1002_US10213113_FH_Part1.pdf	21708932 6302a3c487d49f22a7989a87add436b03cdeba45	no	363
Warnings:					
Information:					
4	Other Reference-Patent/App/Search documents	001_3_Ex_1002_US10213113_FH_Part2.pdf	16632617 192b6ab1245261bfd1508e4d6ab11215f760624b	no	231
Warnings:					
Information:					
5	Other Reference-Patent/App/Search documents	001_3_Ex_1002_US10213113_FH_Part3.pdf	13140183 4d504fedec7dbc06c83b371af8221f155c038217	no	92
Warnings:					
Information:					
6	Other Reference-Patent/App/Search documents	001_4_Ex_1003_Anthony_Declaration_113_Patent_12_11_2019_IPR2020_00209.pdf	9443745 453555a49b2d9ba877354b3e81c16e37109b9a08	no	101
Warnings:					
Information:					
7	Other Reference-Patent/App/Search documents	001_5_Ex_1004_OmniMedSci_2_D052_2nd_Amended_Complaint_Exhs_20190226.pdf	25503938 13dcc79139a3e29179fe2083729b65b8c980cfb3	no	274
Warnings:					
Information:					
8	Other Reference-Patent/App/Search documents	001_6_Ex_1062_OmniMedSci_2_D219_Stip_Order_to_Stay_20191120_.pdf	414690 f7d6da0318cb3fa2647b95b2882cd51fcbeec27e	no	5
Warnings:					
Information:					

9	Other Reference-Patent/App/Search documents	001_7_Ex_1002_US10188299_File_History_Part1.pdf	24143720 e9b21d5a2aa900b8a5fcd314f9c521b06343712c	no	425
Warnings:					
Information:					
10	Other Reference-Patent/App/Search documents	001_7_Ex_1002_US10188299_File_History_Part2.pdf	25195936 288745c29d3b65d613bfa5c8cd312ed03e09a59b	no	362
Warnings:					
Information:					
11	Other Reference-Patent/App/Search documents	001_8_Ex_1003_Anthony_Declaration_299_Patent_12_11_2019_IPR2020_00175.pdf	15361505 7c21cbefad65d656b83d3e07da369d2e939f4bdc	no	119
Warnings:					
Information:					
12	Other Reference-Patent/App/Search documents	001_9_Ex_1004_OmniMedSci_2_D042_Amended_Complaint_20190128.pdf	15613274 034837c314f57bfd6855b5eed5fcb85be586374	no	169
Warnings:					
Information:					
13	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA6_Supp_IDS.PDF	653464 7e0190c168cb72e2808ab8793ef97ae443cc9329	no	5
Warnings:					
Information:					
A U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form. You may remove the form to add the required data in order to correct the Informational Message or if you chose not to, 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.					
		Total Files Size (in bytes):	203372559		

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.

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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
16/669,794	10/31/2019	Mohammed N. ISLAM	OMNI0102PUSA6

CONFIRMATION NO. 7663

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

PUBLICATION NOTICE



Title:SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

Publication No.US-2020-0077898-A1
Publication Date:03/12/2020

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT**
Application Number	16669794
Filing Date	31-Oct-2019
First Named Inventor	Mohammed ISLAM
Attorney Docket Number	OMNI0102PUSA6
Title of Invention	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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) 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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9757040

9500635

10213113

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.

Applicant 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:	16669794
Filing Date:	31-Oct-2019
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6

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.: 16669794

Filing Date: 31-Oct-2019

Applicant/Patent under Reexamination: ISLAM

Electronic Terminal Disclaimer filed on August 4, 2020

☒ 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:	40188687
Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6
Receipt Date:	04-AUG-2020
Filing Date:	31-OCT-2019
Time Stamp:	14:03:06
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	E202084E03031081
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	35337 056b6bd4ddbb8a5396dddb5d41e4939654fd74eb	no	3
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30607 a25b8494752c5891e8a46e1d580805b97a68e74c	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	65944		

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.

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www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

109543 7590 08/14/2020
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: 08/14/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/669,794	10/31/2019	Mohammed N. ISLAM	OMNI0102PUSA6	7663

TITLE OF INVENTION: SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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	11/16/2020

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 08/14/2020
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.
16/669,794	10/31/2019	Mohammed N. ISLAM	OMNI0102PUSA6	7663

TITLE OF INVENTION: SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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	11/16/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
RAHMAN, MD M	2886	356-300000

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. _____

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - IPR2025-00063
267/459
IPR2025-01251 Page 00267

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
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/669,794	10/31/2019	Mohammed N. ISLAM	OMNI0102PUSA6	7663

109543 7590 08/14/2020

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: 08/14/2020

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.

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
268/459
IPR2025-01251 Page 00268

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 aaware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 16/669,794	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 10/31/19.
   ☐ 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 See Continuation Sheet . 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

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
270/459
IPR2025-01251 Page 00270

Continuation of 3. The allowed claim(s) is/are: 1,4-8,11-17,19 and 21-33

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.

Terminal Disclaimer

The terminal disclaimer filed on 8/4/20 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of (US 10098546, 9861286, 9757040, 9500635, 10213113) has been reviewed and is accepted. The terminal disclaimer has been recorded.

Information Disclosure Statement

Acknowledgment is made of Applicant's Information Disclosure Statement (IDS) form PTO 1449.These IDS has been considered.

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Andrew Turner on 08/10/20.

The application has been amended as follows:

1. (Currently Amended) A measurement system comprising:

a light source comprising a plurality of semiconductor sources that are configured to generate an output optical beam with one or more optical wavelengths, the

light source configured to increase signal-to-noise ratio by increasing a light intensity relative to an initial light intensity from at least one of the plurality of semiconductor sources;

an apparatus configured to:

receive a portion of the output optical beam, and

deliver an analysis output beam to a sample;

a receiver configured to:

receive and process at least a portion of the analysis output beam reflected or transmitted from the sample,

generate an output signal representing at least in part a non-invasive measurement on blood contained within the sample,

synchronize to the light source,

capture light while the semiconductor sources are off and convert the captured light into a first signal,

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a part of the at least a portion of the analysis output beam reflected or transmitted from the sample, and

the measurement system further configured to improve the signal-to-noise ratio by differencing the first signal and the second signal;

a 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,

store and display the processed output signal, and

transmit at least a portion of the processed output signal over a wireless transmission link; and

a cloud configured to:

receive, over the wireless transmission link, an output status comprising the at least a portion of the processed output signal,

process the received output status to generate processed data, and

store the processed data.

2.-3. (Cancelled)

4. (Previously Presented) The measurement system of claim 22, wherein the measurement system is configured to use artificial intelligence in making decisions;

wherein the measurement system is configured to perform pattern identification or classification, and wherein the measurement system is configured to apply a threshold function to a comparison with a stored data set; and

wherein the measurement system is at least in part configured for selection or identification of an object, and wherein the measurement system is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

5. (Previously Presented) The measurement system of claim 22, wherein the light source is configured to further increase signal-to-noise ratio by increasing a pulse rate of at least one of the plurality of semiconductor sources.

6. (Previously Presented) The measurement system of claim 1, wherein the plurality of semiconductor sources comprises at least one of: light emitting diodes (LEDs), laser diodes (LD's), tunable LD's, and super-luminescent laser diodes (SLDs), and wherein the measurement system further comprises a reflective surface to receive and redirect at least some of the at least a portion of the analysis output beam reflected or transmitted from the sample.

7. (Original) The measurement system of claim 1, wherein the light source is further configured to increase the light intensity from the plurality of semiconductor sources by spatially coupling the optical output beam from at least two of the plurality of semiconductor sources.

8. (Currently Amended) A measurement system comprising:

a wearable measurement device for measuring one or more physiological parameters, including a light source comprising a plurality of semiconductor sources that are configured to generate an output optical beam with one or more optical wavelengths;

the light source configured to increase signal-to-noise ratio by increasing a light intensity relative to an initial light intensity from at least one of the plurality of semiconductor sources;

the wearable measurement device configured to receive a portion of the output optical beam and to deliver an analysis output beam to a sample;

the wearable measurement device further comprising a receiver configured to:

receive and process at least a portion of the analysis output beam reflected or transmitted from the sample,

generate an output signal representing at least in part a non-invasive measurement on blood contained within the sample,

synchronize to pulses of the light source,

capture light while the semiconductor sources are off and convert the captured light into a first signal,

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a part of the at least a portion of the analysis output beam reflected or transmitted from the sample,

wherein the measurement system is further configured to improve the signal-to-noise ratio by differencing the first signal and the second signal;

a 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, to store and display the processed output signal, and to transmit a portion of the processed output signal over a wireless transmission link; and

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, and wherein the cloud is capable of storing a history of at least a portion of the received output status over a specified period of time.

9.-10. (Cancelled)

11. (Previously Presented) The measurement system of Claim 27, wherein the measurement system is configured to use artificial intelligence in making decisions;

wherein the measurement system is configured to perform pattern identification or classification, and wherein the measurement system is configured to apply a threshold function to a comparison with a stored data set; and

wherein the measurement system is at least in part configured for selection or identification of an object, and wherein the measurement system is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

12. (Previously Presented) The measurement system of claim 27, wherein the light source is configured to further increase signal-to-noise ratio by one of increasing a pulse rate of at least one of the plurality of semiconductor sources.

13. (Previously Presented) The measurement system of claim 8, wherein the plurality of semiconductor sources comprises at least one of: light emitting diodes (LEDs), laser diodes (LD's), tunable LD's, and super-luminescent laser diodes (SLDs), and the measurement system further comprising a reflective surface to receive and redirect at least some of the at least a portion of the analysis output beam reflected or transmitted from the sample.

14. (Original) A wearable device for use with a smart phone or tablet, the wearable device comprising:

a measurement device including a light source comprising a plurality of semiconductor sources for measuring one or more physiological parameters, the measurement device configured to:

generate, by modulating at least one of the semiconductor sources having an initial light intensity, an input optical beam having one or more optical wavelengths, and

receive and to deliver a portion of the input optical beam to tissue, wherein the tissue reflects at least a portion of the input optical beam delivered to the tissue;

the measurement device further comprising a receiver configured to:

capture light while the semiconductor sources are off and convert the captured light into a first signal, and

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a portion of the input optical beam reflected from the tissue;

synchronize to the modulation of the at least one of the semiconductor sources;

the measurement device further configured to improve a signal-to-noise ratio of the input optical beam reflected from the tissue by:

differencing the first signal and the second signal, and

increasing the light intensity relative to the initial light intensity from at least one of the semiconductor sources;

the measurement device further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue;

the wearable device configured to communicate with the smart phone or tablet, the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a voice input module, a speaker, and a touch screen; and

the smart phone or tablet configured to:

receive and to process at least a portion of the output signal,

store and display the processed output signal, and

transmit at least a portion of the processed output signal over a wireless transmission link.

15. (Previously Presented) The wearable device of claim 31, wherein the light source is configured to further improve the signal-to-noise ratio of the input optical beam reflected from the tissue by increasing a pulse rate of at least one of the plurality of semiconductor sources.

16. (Original) The wearable device of claim 15, further comprising a cloud configured to:

receive, over the wireless transmission link, an output status comprising the at least a portion of the processed output signal,

process the output status to generate processed data, and

store the processed data, and

wherein the cloud is capable of storing a history of at least a portion of the output status over a specified period of time.

17. (Previously Presented) The wearable device of claim 16, wherein the wearable device is configured to use artificial intelligence in making decisions;

wherein the wearable device is configured to perform pattern identification or classification, and wherein the wearable device is configured to apply a threshold function to a comparison with a stored data set; and

wherein the wearable device is at least in part configured for selection or identification of an object, and wherein the wearable device is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

18. (Cancelled)

19. (Previously Presented) The wearable device of claim 17, wherein the measurement device further comprises a reflective surface configured to receive and redirect at least a portion of light reflected from the tissue.

20. (Cancelled)

21. (Previously Presented) The measurement system of claim 1, wherein the plurality of semiconductor sources comprises six light emitting diodes, and wherein the receiver comprises six detectors.

22. (Previously Presented) The measurement system of claim 21, wherein the six detectors are located on an arc surrounding the six light emitting diodes.

23. (Previously Presented) The measurement system of claim 1, wherein the receiver comprises a plurality of detectors arranged along a first arc, and wherein the plurality of semiconductor sources are arranged along a second arc.

24. (Previously Presented) The measurement system of claim 23, wherein the first arc is offset from the second arc.

25. (Previously Presented) The measurement system of claim 23, wherein the first arc and the second arc are concentric.

26. (Previously Presented) The measurement system of claim 8, wherein the plurality of semiconductor sources comprises six light emitting diodes, and wherein the receiver comprises six detectors.

27. (Previously Presented) The measurement system of claim 26, wherein the six detectors are located on an arc surrounding the six light emitting diodes.

28. (Previously Presented) The measurement system of claim 8, wherein the receiver comprises a plurality of detectors arranged along a first arc, and wherein the plurality of semiconductor sources are arranged along a second arc that is offset from the first arc.

29. (Previously Presented) The measurement system of claim 28, wherein the first arc and the second arc are concentric.

30. (Previously Presented) The wearable device of claim 14, wherein the plurality of semiconductor sources comprises six light emitting diodes, and wherein the receiver comprises six detectors.

31. (Previously Presented) The wearable device of claim 30, wherein the six detectors are located on an arc surrounding the six light emitting diodes.

32. (Previously Presented) The wearable device of claim 14, wherein the receiver comprises a plurality of detectors arranged along a first arc, and wherein the plurality of semiconductor sources are arranged along a second arc that is offset from the first arc.

33. (Previously Presented) The wearable device of claim 32, wherein the first arc and the second arc are concentric.

Allowable Subject Matter

Claims 1, 4-8, 11-17, 19 and 21-33 are allowed.

The following is an examiner's statement of reasons for allowance:

As to claims 1, 8 and 14, the prior arts alone or in combination fail to disclose the claimed limitations such as, "generate an output signal representing at least in part a non-invasive measurement on blood contained within the sample,

synchronize to the light source,

capture light while the semiconductor sources are off and convert the captured light into a first signal,

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a part of the at least a portion of the analysis output beam reflected or transmitted from the sample,

the measurement system further configured to improve the signal-to-noise ratio by differencing the first signal and the second signal;

a 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,

store and display the processed output signal, and

transmit at least a portion of the processed output signal over a wireless transmission link; and

a cloud configured to:

receive, over the wireless transmission link, an output status comprising the at least a portion of the processed output signal,

process the received output status to generate processed data, and store the processed data" along with all other limitations of the claim.

Claims 4-7, 11-13, 15-17, 19 and 21-33 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

Examiner-Initiated Interview Summary	Application No. 16/669,794	Applicant(s) ISLAM, Mohammed N.	
	Examiner MD M RAHMAN	Art Unit 2886	AIA (FITF) Status Yes

All participants (applicant, applicant's representative, PTO personnel):

(1) MD M. RAHMAN. (3) _____.

(2) Andrew Turner. (4) _____.

Date of Interview: 10 August 2020.

Type: ☑ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☐ 101 ☐ 112 ☐ 102 ☐ 103 ☐ Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: _____.

Identification of prior art discussed: _____.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Examiner initiated an interview notifying the applicant's representative that the application would be in condition for allowance considering applicant agrees to examiners proposed amendment. Examiner and applicant's representative has multiple communications regarding the proposed amendment and finally applicant's representative agreed and gave authorization to do this by examiner's amendment.

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/MD M RAHMAN/ Primary Examiner, Art Unit 2886	

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
287/459
IPR2025-01251 Page 00287

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

CPC						
Symbol					**Type**	**Version**
A61B	/	5	/	0088	F	2013-01-01
A61B	/	5	/	7203	I	2013-01-01
A61B	/	5	/	0075	I	2013-01-01
A61B	/	5	/	4547	I	2013-01-01
A61C	/	19	/	04	I	2013-01-01
G16H	/	40	/	67	I	2018-01-01
A61B	/	5	/	0013	I	2013-01-01
A61B	/	5	/	0022	I	2013-01-01
A61B	/	5	/	0086	I	2013-01-01
A61B	/	5	/	14532	I	2013-01-01
A61B	/	5	/	14546	I	2013-01-01
A61B	/	5	/	1455	I	2013-01-01
A61B	/	5	/	6801	I	2013-01-01
A61B	/	5	/	7257	I	2013-01-01
A61B	/	5	/	7405	I	2013-01-01
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G01J	/	3	/	42	I	2013-01-01
G01J	/	3	/	453	I	2013-01-01
G01N	/	21	/	35	I	2013-01-01
G01N	/	21	/	3563	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
G01N	/	33	/	02	I	2013-01-01
G01N	/	33	/	025	I	2013-01-01
G01N	/	33	/	15	I	2013-01-01

NONE (Assistant Examiner) (Date)	**Total Claims Allowed:** 27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886 (Primary Examiner) 11 August 2020 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 16B

U.S. Patent and Trademark Office — Part of Paper No.: 20200809

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

CPC						
Symbol					**Type**	**Version**
G01N	/	33	/	442	I	2013-01-01
G01N	/	33	/	49	I	2013-01-01
G06F	/	19	/	00	I	2013-01-01
H01S	/	3	/	06758	A	2013-01-01
H01S	/	3	/	0092	A	2013-01-01
A61B	/	5	/	0024	A	2013-01-01
A61C	/	1	/	0046	A	2013-01-01
A61B	/	2562	/	0233	A	2013-01-01
A61B	/	2562	/	0238	A	2013-01-01
A61B	/	2562	/	146	A	2013-01-01
A61B	/	2576	/	02	A	2013-01-01
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G01J	/	2003	/	104	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
G01N	/	21	/	85	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
G01N	/	2201	/	08	A	2013-01-01
G01N	/	2201	/	12	A	2013-01-01
G01N	/	2201	/	129	A	2013-01-01
H01S	/	3	/	302	A	2013-01-01

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	11 August 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	16B

U.S. Patent and Trademark Office — Part of Paper No.: 20200809

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

CPC Combination Sets				
Symbol	**Type**	**Set**	**Ranking**	**Version**
/ /				

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	11 August 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	16B

U.S. Patent and Trademark Office — Part of Paper No.: 20200809

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

INTERNATIONAL CLASSIFICATION					
CLAIMED					
G01J	/	3	/	00	
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)	27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	11 August 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	16B

U.S. Patent and Trademark Office — Part of Paper No.: 20200809

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	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	5	19	19	28								
	2	17	11		20	20	29								
	3	18	12	6	21	22	30								
8	4	14	13	7	22	23	31								
9	5	21	14	10	23	26	32								
2	6	24	15	11	24	27	33								
3	7	25	16	12	25										
13	8	4	17	15	26										
	9		18	16	27										

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	11 August 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	16B

U.S. Patent and Trademark Office Part of Paper No.: 20200809

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	ISLAM, Mohammed N.
	Examiner	Art Unit
	MD M RAHMAN	2886

CPC - Searched*		
Symbol	Date	Examiner
G 01J 3/02 G 01J 3/28 G 01J 3/42 , G 01N 21/31, G 01N 21/552	08/11/2020	MR

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
356	300	08/11/2020	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	08/11/2020	MR

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
G 01J 3/02	G 01J 3/28 G 01J 3/42 , G 01N 21/31, G 01N 21/552	08/11/2020	MR

/MD M RAHMAN/ Primary Examiner, Art Unit 2886	

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
293/459
IPR2025-01251 Page 00293

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	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									
1	1									
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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
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	16669794
Filing Date	2019-10-31
First Named Inventor	Mohammed N. ISLAM
Art Unit	2886
Examiner Name	
Attorney Docket Number	OMNI0102PUSA6

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	5497769		1996-03-12	Gratton et al.	
	2	6078833		2000-06-20	Hueber	
	3	8649838		2014-02-11	Chen et al.	
	4	8725226		2014-05-13	Isaacson	
	5	10188299		2019-01-29	Islam	
	6	10213113		2019-02-26	Islam	

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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	Inter Partes Review No IPR2020-00175; Petition for Inter Partes Review of US Patent No. 10,188,299; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-91; dated December 11, 2019	
	2	Inter Partes Review No. IPR2020-00209; Petition for Inter Partes Review of US Patent No. 10,213,113; Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-91; dated December 11, 2019	
	3	File History for U.S. Patent No. 10,213,113 issued February 26, 2019, 686 pps.	
	4	Declaration of Brian W. Anthony , PhD, regarding USPN 10,213,113 in IPR2020-00209, December 11, 2019, 101 pps.	

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	First Named Inventor	Mohammed N. ISLAM
	Art Unit	2886
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

	5	United States District Court Eastern District of Texas Marshall Division; Omni Medsci, Inc. vs. Apple Inc.; Civil Action No. 2:18-cv-00429; Second Amended Complaint; Feb. 26, 2019; 274 pps.	
	6	United States District Court Northern District of California Oakland Division;Omni Medsci, Inc. vs. Apple Inc.; Civil Action No. 19-cv-05673-YGR; Order staying the case; Nov. 20, 2019, 5 pps.	
	7	File History for U.S. Patent No. 10,188,299 issued January 29, 2019, 787 pps.	
	8	Declaration of Brian W. Anthony , PhD, regarding USPN 10,188,299 in IPR2020-00175, December 11, 2019, 119 pps.	
	9	United States District Court Eastern District of Texas Marshall Division; Omni Medsci, Inc. vs. Apple Inc.; Civil Action No.2:18-cv-429; Amended Complaint; January 28, 2019; 169 pps.	

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	First Named Inventor	Mohammed N. ISLAM
	Art Unit	2886
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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	/Andrew B. Turner/	Date (YYYY-MM-DD)	2020-02-26
Name/Print	Andrew B. Turner	Registration Number	63121

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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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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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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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
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Application Number	16669794
Filing Date	2019-10-31
First Named Inventor	Mohammed N. ISLAM
Art Unit	1731
Examiner Name	
Attorney Docket Number	OMNI0102PUSA6

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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	5408409		1995-04-18	Glassman et al.	
	2	5774213		1998-06-30	Trebino et al.	
	3	5957854		1999-09-28	Besson et al.	
	4	5970457		1999-10-19	Brant et al.	
	5	6044283		2000-03-28	Fein et al.	
	6	6278975		2001-08-21	Brant et al.	
	7	6289238		2001-09-11	Besson et al.	
	8	6441747		2002-08-27	Khair et al.	

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	Attorney Docket Number	OMNI0102PUSA6

	9	6549702		2003-04-15	Islam et al.	
	10	6603910		2003-08-05	Islam et al.	
	11	6898451		2005-05-24	Wuori	
	12	7060061		2006-06-13	Altshuler et al.	
	13	7167300		2007-01-23	Fermann et al.	
	14	7263288		2007-08-28	Islam	
	15	7278966		2007-10-09	Hjelt et al.	
	16	7318909		2008-01-15	Lehmann et al.	
	17	7433116		2008-10-07	Islam	
	18	7519253		2009-04-14	Islam	
	19	7787924		2010-08-31	Acosta et al.	

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	20	8198589		2012-06-12	Tolton et al.	
	21	8463576		2013-06-11	Yuen et al.	
	22	8472108		2013-06-25	Islam	
	23	8948832		2015-02-03	Hong et al.	
	24	9142117		2015-09-22	Muhsin et al.	
	25	9326712		2016-05-03	Kiani	
	26	9596990		2017-03-21	Park et al.	
	27	9757040		2017-09-12	Islam	
	28	9861286		2018-01-09	Islam	
	29	9885698		2018-02-06	Islam	
	30	6505133		2003-01-07	Hanna et al.	

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Examiner Signature	/MD M RAHMAN/	Date Considered	08/10/2020

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Name/Print	Andrew B. Turner	Registration Number	63121

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Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063

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Bibliographic Data

Application No: 16/669,794

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /MD M RAHMAN/ Examiner's Signature | Initials

Title: SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
10/31/2019	433	2886	OMNI0102PUSA6
RULE			

APPLICANTS

Omni Medsci, Inc., Ann Arbor, MI, UNITED STATES

INVENTORS

Mohammed N. ISLAM, Ann Arbor, MI, UNITED STATES

CONTINUING DATA

This application is a CON of 16506885 07/09/2019 PAT 10517484

16506885 is a CON of 16284514 02/25/2019ABN

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15212549 is a CON of 14650897 06/10/2015 PAT 9494567

14651367 is a 371 of PCT/US2013/075736 12/17/2013

16004359 is a CON of 14109007 12/17/2013 PAT 9993159

14875709 is a CON of 14108986 12/17/2013 PAT 9164032

14650981 is a 371 of PCT/US2013/075767 12/17/2013

14651367 is a 371 of PCT/US2013/075736 12/17/2013

14650897 is a 371 of PCT/US2013/075700 12/17/2013

PCT/US2013/075736 has PRO of 61754698 01/21/2013

PCT/US2013/075700 has PRO of 61747472 12/31/2012

PCT/US2013/075736 has PRO of 61747477 12/31/2012

14108986 has PRO of 61747487 12/31/2012

PCT/US2013/075767 has PRO of 61747485 12/31/2012

14109007 has PRO of 61747553 12/31/2012

FOREIGN APPLICATIONS

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	18	((Andrew) near2 (Forbes)).INV.	US-PGPUB; USPAT	OR	OFF	2015/10/23 16:24
S2	2	scale near invariant near3 modal with decomposition	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/10/23 16:32
S3	2	scale near invariant and modal with decomposition	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/10/23 16:33
S4	223	scale near invariant and modal	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/10/23 16:33
S5	18	((Andrew) near2 (Forbes)).INV.	US-PGPUB; USPAT	OR	OFF	2015/11/21 15:03
S6	4	S5 and (spatial with light with modulator)	US-PGPUB; USPAT	OR	OFF	2015/11/21 15:28
S7	11	(spatial with light with modulator with complex with amplitude with laser)	US-PGPUB; USPAT	OR	OFF	2015/11/21 15:34
S8	18	(spatial with light with modulator with complex with amplitude with laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/21 15:35
S9	6	modal with decomposit$3 with laser	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/21 15:38
S10	8,674	G01J1/0407 G01J1/0411 G01J1/0437 G01J1/4228 G01J1/4257 G01J1/4257 H01S3/09415 H01S3/0014 H01S3/0014	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/21 15:40
S11	13	"10" and (spatial with light with modulator same complex with amplitude with laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2015/11/21 23:48

			DERWENT; IBM_TDB			
S12	8,674	G01J1/0407 G01J1/0411 G01J1/0437 G01J1/4228 G01J1/4257 G01J1/4257 H01S3/09415 H01S3/0014 H01S3/0014	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/21 23:48
S13	3	S12 and (spatial with light with modulator same complex with amplitude with laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/21 23:48
S14	3	S12 and (spatial with light with modulator and complex with amplitude with laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/21 23:49
S15	1	modal with decomposition with superpositions	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 00:00
S16	10	modal with decomposition with superposit$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 00:00
S17	350	modal with decomposition	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 00:01
S18	3	S17 and (spatial with light with modulator and diffraction and laser and fourier with lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 00:01
S19	3	S17 and ((spatial with light with modulator "SLM") and diffraction and laser and fourier with lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 00:02
S20	3	S17 and ((spatial with light with modulator "SLM") and diffraction and laser and lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 00:02

S21	1,404	((spatial with light with modulator "SLM") and diffraction and laser and fourier with lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 00:02
S22	0	S21 and (complex near amplitude near3 modulatio)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 00:02
S23	2,637	"SLM" and ("ccd" camera) and lens and laser and spatial with modula$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 00:14
S24	825	"SLM" and ("ccd" camera) and (Fourier with lens) and laser and spatial with modula$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 00:14
S25	6	S24 and (detect$3 with focal with diffraction)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 00:15
S26	85	S24 and (focal with diffraction)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 00:19
S27	29	S24 and (focal with diffraction near3 pattern)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 00:19
S28	130	determin$3 near3 phases with unknown withmodes with laser	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 09:44
S29	3	S28 and (modal with decomposit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 09:45
S30	3	S28 and (modal same decomposit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2015/11/22 09:47

			DERWENT; IBM_TDB			
S31	3	S28 and (modal and decomposit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 09:47
S32	3,444	(modal and decomposit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 09:48
S33	486	(modal same decomposit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 09:48
S34	4	S33 and (phases with unknown withmodes with laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 09:48
S35	9	S28 and (decomposit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 09:49
S36	3	determin$3 near3 phases with unknown with modes with laser	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 09:49
S37	4	phases with unknown with modes with laser	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 09:49
S38	4	phases with unknown with modes	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 09:49
S39	7	phases with unknown with mode	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 09:49

S40	9	S33 and (laser with phase)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 09:50
S41	1,864	(phases with unknown withmodes with laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 10:07
S42	9	(phases with unknown with mode$1 with laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 10:07
S43	383	(phases with mode$1 with laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 10:07
S44	79	(phases with modes near3 laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 10:08
S45	10	S44 and (decay decomposition)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 10:09
S46	500	modal near3 laser	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 10:10
S47	3	S46 and (spatial adj light adj modulator and Fourier near3 transform$3 and (camera "CCD" detector))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 10:11
S48	5	S46 and (spatial adj light adj modulator and (camera "CCD" detector))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/22 10:11
S49	39	((Amnon) near2 (MANASSEN)).INV.	US-PGPUB; USPAT	OR	OFF	2015/11/22 10:37

S50	33	S49 AND (metrology)	US-PGPUB; USPAT	OR	OFF	2015/11/22 10:38
S51	0	S50 and (pattern with target same spectral)	US-PGPUB; USPAT	OR	OFF	2015/11/22 10:38
S52	7	S50 and (pattern with target)	US-PGPUB; USPAT	OR	OFF	2015/11/22 10:39
S53	28,998	metrology	US-PGPUB; USPAT	OR	OFF	2015/11/22 10:48
S54	0	S53 and (pattern with target) and (spectral with range) and (compressive near3 (sensor detect$3))	US-PGPUB; USPAT	OR	OFF	2015/11/22 10:49
S55	224	S53 and (pattern with target) and (spectral with range) and ((sensor detect$3))	US-PGPUB; USPAT	OR	OFF	2015/11/22 10:49
S56	106	S53 and (pattern with target) and (spectral with range) and ((sensor detect$3)) and (pupil near3 plane)	US-PGPUB; USPAT	OR	OFF	2015/11/22 10:50
S57	0	S56 and (collect$3 near3 pupil with pixels)	US-PGPUB; USPAT	OR	OFF	2015/11/22 10:53
S58	0	S56 and (pupil with pixels)	US-PGPUB; USPAT	OR	OFF	2015/11/22 10:53
S59	0	S56 and (pupil with pixel)	US-PGPUB; USPAT	OR	OFF	2015/11/22 10:53
S60	17	((Hiroaki) near2 (Kasai)).INV.	US-PGPUB; USPAT	OR	OFF	2015/11/22 11:01
S61	149,267	distance near3 (detect$3 sensor)	US-PGPUB; USPAT	OR	OFF	2015/11/22 11:02
S62	36,502	S61 and (reflect$3 near3 light)	US-PGPUB; USPAT	OR	OFF	2015/11/22 11:03
S63	3,065	S62 and (separat$3 near3 unit)	US-PGPUB; USPAT	OR	OFF	2015/11/22 11:03
S64	501	S63 and (select$3 near3 unit)	US-PGPUB; USPAT	OR	OFF	2015/11/22 11:04
S65	153	S64 and (measur$3 near3 (light beam laser))	US-PGPUB; USPAT	OR	OFF	2015/11/22 11:04
S66	60	S65 and (plural$3 near3 light)	US-PGPUB; USPAT	OR	OFF	2015/11/22 11:05
S67	61,761	distance near (sensor detect$3)	US-PGPUB; USPAT	OR	OFF	2015/11/22 13:12
S68	45,837	S67 and (detect$3 with reflect$3 with objectwith measur$3)	US-PGPUB; USPAT	OR	OFF	2015/11/22 13:12

S69	3,406	S68 and ((calculat$3 comput$3) near3 distance with (sample object))	US-PGPUB; USPAT	OR	OFF	2015/11/22 13:13
S70	26	S69 and (separat$3 near3 measur$3 with light)	US-PGPUB; USPAT	OR	OFF	2015/11/22 13:13
S71	1	distance near sensor and separating near unit and selecting near unit	US-PGPUB; USPAT	OR	OFF	2015/11/23 09:38
S72	3	distance near sensor and separating near unit and selecting near unit	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 09:38
S73	12	"20080080864"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 09:46
S74	4,850	shape adj measuring with device	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 09:50
S75	133	S74 and (distance near3 sensor)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 09:50
S76	115,514	Distance near3 sensor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 09:55
S77	3	S76 and (wavelength adj variable adj filter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 09:55
S78	1	S76 and (filter near3 separat$3 with plural$3 near3 (light measurment beams))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 09:58
S79	400	(filter near3 separat$3 with plural$3 near3 (light measurment beams))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 09:59

S80	18	S79 and (distance near3 (sensor detect$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 09:59
S81	254	S74 and (distance near3 (detect$3 sensor))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 10:01
S82	26	S81 and (separat$3 near3 measur$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 10:01
S83	26	S82	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 10:01
S84	9	"2011145194"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 10:11
S85	27,696	shape adj (measur$4 calculat$3 comput$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 12:23
S86	4	S85 and (selecting with light with separating)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 12:23
S87	64	S85 and (select$3 with (beams laser light) with separat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 12:24
S88	667	wavelength adj variable adj filter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 12:29
S89	5	S88 and (separating near3 unit)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2015/11/23 12:29

			DERWENT; IBM_TDB			
S90	107	calculat$3 near3 shape with object with measur$3 with distance	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/23 20:42
S91	2	"20130094853"	US-PGPUB; USPAT	OR	OFF	2015/11/24 11:26
S92	5	"20130094853"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/24 11:26
S93	27,714	shape adj (measur$4 calculat$3 comput$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/24 11:31
S94	123	S93 and (plural$3 near3 interference)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/24 11:32
S95	13	S94 and (distance near3 interference)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/24 11:32
S96	45	S94 and (distance with interference)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/24 11:58
S97	0	S94 and (distance with interferences)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/24 11:59
S98	37,546	G01B9/02 G01B11/2441 G01B11/0675, G01B11/303, G01N21/9501	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/24 12:22
S99	1,356	S98 and (distance with interference)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2015/11/24 12:22

			DERWENT; IBM_TDB			
S100	15	S99 and (distance with interferences)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/24 12:22
S101	1	jp2008304407	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/11/24 12:29
S102	2	"20130294468"	US-PGPUB; USPAT	OR	OFF	2015/12/16 19:09
S103	344	laser and (SLM spatial adj light adj modulator) and (diffraction with grating) and (fourier near3 transform with lens)	US-PGPUB; USPAT	OR	OFF	2015/12/16 20:19
S104	0	S103 and (detect$3 and pahse with modes)	US-PGPUB; USPAT	OR	OFF	2015/12/16 20:27
S105	7	S103 and (detect$3 and phase with modes)	US-PGPUB; USPAT	OR	OFF	2015/12/16 20:27
S106	276	S103 and (detect$3 and phase)	US-PGPUB; USPAT	OR	OFF	2015/12/16 20:55
S107	516,528	detect$3 with distance withg focal with length	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/16 21:21
S108	179	S107 and (Fourier with transform$3 with lens same diffraction near3 pattern)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/16 21:22
S109	0	S108 and (modal with decompostion)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/16 21:22
S110	3	S108 and (phases with unknown with modes)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/16 21:25
S111	5	S108 and (phases near3 modes)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2015/12/16 21:25

			DERWENT; IBM_TDB			
S112	87,593	MONITOR$3 WITH DIFFRACTIONNEAR3 PATTERN WITH LASER	US-PGPUB; USPAT	OR	OFF	2015/12/18 23:37
S113	57	MONITOR$3 WITH DIFFRACTIONNEAR3 PATTERN WITH LASER WITH REFLECT$3 WITH (SLM)	US-PGPUB; USPAT	OR	OFF	2015/12/18 23:37
S114	0	S113 AND (PHASES SAME MODES)	US-PGPUB; USPAT	OR	OFF	2015/12/18 23:38
S115	1	S113 AND (PHASE SAME MODES)	US-PGPUB; USPAT	OR	OFF	2015/12/18 23:38
S116	4	S113 AND (PHASE AND MODES)	US-PGPUB; USPAT	OR	OFF	2015/12/18 23:38
S117	4	S113 AND (PHASE AND MODES)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/18 23:38
S118	29,980	phase$1 with modes	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/18 23:39
S119	4,986	S118 and (phases with modes)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/18 23:39
S120	0	S119 and (MONITOR$3 WITH DIFFRACTIONNEAR3 PATTERN WITH LASER WITH REFLECT$3 WITH (SLM))	US-PGPUB; USPAT	OR	OFF	2015/12/18 23:40
S121	0	S119 and (DIFFRACTIONNEAR3 PATTERN WITH LASER WITH REFLECT$3 WITH (SLM))	US-PGPUB; USPAT	OR	OFF	2015/12/18 23:40
S122	0	S119 and (DIFFRACTION NEAR3 PATTERN WITH LASER WITH REFLECT$3 WITH (SLM))	US-PGPUB; USPAT	OR	OFF	2015/12/18 23:40
S123	0	S119 and (DIFFRACTION NEAR3 PATTERN WITH LASER WITH REFLECT$3 WITH (SLM))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/18 23:40

S124	0	S119 and (DIFFRAC$4 with PATTERN WITH LASER WITH REFLECT$3 WITH (SLM))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/18 23:40
S125	1	S119 and (DIFFRAC$4 with PATTERN WITH LASER WITH REFLECT$3 and (SLM))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/18 23:40
S126	1	S119 and (DIFFRAC$4 with PATTERN WITH LASER and (SLM))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/18 23:40
S127	41	S119 and (DIFFRAC$4 with PATTERN WITH LASER and (SLM modulator))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/18 23:40
S128	257	modal near3 decomposition	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/18 23:41
S129	59	S128 and phases	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/18 23:41
S130	5	S129 and (diffract$3 with pattern)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/18 23:41
S131	356	modal with decomposition	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/18 23:42
S132	13	S131 and (diffract$3 with pattern)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/18 23:42
S133	2	"20130278744"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2015/12/19 13:10

			DERWENT; IBM_TDB			
S134	47,603	spatial with light with modulator "SLM"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 13:11
S135	2,311	S134 and (diffraction with pattern)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 13:11
S136	829	S135 and (Fourier with transform)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 13:11
S137	217	S136 and (determin$3 with phase$1)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 13:12
S138	13	S137 and (decomposi$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 13:12
S139	47,603	spatial with light with modulator "SLM"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 17:56
S140	2,311	S139 and (diffraction with pattern)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 17:56
S141	829	S140 and (Fourier with transform)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 17:56
S142	89	S141 and (phases and modes)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 17:56

S143	14	S141 and (phases and modes and modal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 18:07
S144	113	S141 and (phases and (modes decomposition modal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 18:08
S145	5,344	(detect$3 with diffraction with pattern)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 18:12
S146	730	S145 and (Fourier with transform)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 18:12
S147	174	S145 and (Fourier with transform near3 lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 18:12
S148	12	S147 and (phases and modes)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 18:12
S149	42	S147 and (spatial with light with modulator "SLM")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/19 18:12
S150	14	"8026837"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:22
S151	2	"14437794"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:26
S152	27,799	spatial adj light adj modulator	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2015/12/21 00:39

			DERWENT; IBM_TDB			
S153	1	S152 and (complex with conjugate near4 orthonormal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:39
S154	1	S152 and (complex with conjugate with orthonormal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:39
S155	1	S152 and (complex with conjugate same orthonormal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:39
S156	65	(complex with conjugate same orthonormal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:39
S157	1	S156 and (SLM)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:40
S158	1	S156 and (spatial adj light adj modulator)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:40
S159	1	S156 and (spatial with light with modulator)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:40
S160	1	S156 and (light with modulator)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:40
S161	130	spatial adj light adj modulator and orthonormal	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:40

S162	8	S161 and (complex with conjugate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:41
S163	1	S152 and (hologram and grey with scale with proportional)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:53
S164	109	S152 and (hologram and grey with scale)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:53
S165	15	S152 and (hologram and grey with scale and phase near change)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 00:53
S166	3	"20120262713"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 12:08
S167	3	"20120262713"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 12:11
S168	5	"20100073667"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 14:33
S169	1	"14603700"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2015/12/21 14:34
S170	1	"20100229943"	US-PGPUB; USPAT	OR	OFF	2015/12/22 11:16
S171	6	"5434934"	US-PGPUB; USPAT	OR	OFF	2015/12/22 11:17
S172	1	"20120322166"	US-PGPUB; USPAT	OR	OFF	2015/12/22 11:18
S173	1	"20140166863"	US-PGPUB; USPAT	OR	OFF	2015/12/22 11:21

S174	16	((Peter) near2 (Koudelka)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2016/03/16 09:27
S175	1	S174 and (detect$3 with blood)	US-PGPUB; USPAT	OR	OFF	2016/03/16 09:28
S176	30	"6254784"	US-PGPUB; USPAT	OR	OFF	2016/03/16 10:00
S177	8,515	centrifuge with rotat$5	US-PGPUB; USPAT	OR	OFF	2016/03/16 11:33
S178	128	S177 and (light with transmissive) and (light with reflect$3)	US-PGPUB; USPAT	OR	OFF	2016/03/16 11:56
S179	73	S178 and (fluid with process$3)	US-PGPUB; USPAT	OR	OFF	2016/03/16 11:56
S180	73	S179 and (sensor detect$3)	US-PGPUB; USPAT	OR	OFF	2016/03/16 11:58
S181	1	S180 and (emit with scan$4)	US-PGPUB; USPAT	OR	OFF	2016/03/16 11:58
S182	55	S180 and (scan$4)	US-PGPUB; USPAT	OR	OFF	2016/03/16 11:59
S183	0	S177 and (reflector with scanning with coaxile same centrifuge)	US-PGPUB; USPAT	OR	OFF	2016/03/16 12:49
S184	1	S177 and (reflector with scanning with coaxial same centrifuge)	US-PGPUB; USPAT	OR	OFF	2016/03/16 12:49
S185	1	S177 and (reflector with scanning with coaxial)	US-PGPUB; USPAT	OR	OFF	2016/03/16 12:49
S186	1	(reflector with scanning with coaxial same centrifuge)	US-PGPUB; USPAT	OR	OFF	2016/03/16 12:49
S187	6	(reflector with scan$4 with coaxial same centrifuge)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/03/16 12:50
S188	6	(reflector with sensor with coaxial same centrifuge)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/03/16 12:52
S189	6	(reflector with sensor with coaxial and centrifuge)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/03/16 12:52
S190	14	(reflect$3 'with sensor with coaxial and centrifuge)	US-PGPUB; USPAT; USOCR;	OR	OFF	2016/03/16 12:53

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S191	14	(reflect$3 with sensor with coaxial and centrifuge)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/03/16 12:53
S192	273,290	(centrifuge)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/03/16 12:57
S193	8	S192 and (reflector with coaxial)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/03/16 12:58
S194	6	S192 and (reflector with scanning with coaxial)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/03/16 13:00
S195	6	S192 and (reflect$3 with scanning with coaxial)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/03/16 13:00
S196	21	S192 and (reflect$3 with coaxial)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/03/16 13:10
S197	1	S174 and (centrifuge)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:11
S198	211	(reflect$3 with scanning with coaxial)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/03/16 13:12
S199	5	S198 and (blood centrifuge)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:12
S200	5	S198 and (blood)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:22
S201	881,547	(blood centrifuge)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:22

S202	1,072	S201 and (coaxial with light)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:23
S203	231	S201 and (reflect$3 with coaxial with light)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:23
S204	4	S201 and (reflect$3 with scan$4 with coaxial with light)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:24
S205	231	S201 and (reflect$3 with coaxial with light)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:24
S206	126,710	(centrifuge)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:27
S207	9	S206 and (reflect$3 with coaxial with light)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:28
S208	5,287	Blood near Processing	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:29
S209	1	S208 and (reflect$3 with coaxial with light)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:29
S210	28,250	Blood with Processing	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:29
S211	30	S210 and (reflect$3 with coaxial with light)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:29
S212	2,834	(coaxial) and (centrifuge)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:30
S213	411	S212 and (reflect$3 and scanning)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:31
S214	280	S212 and (reflect$3 and scanning and sensor)	US-PGPUB; USPAT	OR	OFF	2016/03/16 13:31
S215	28,250	Blood with Processing	US-PGPUB; USPAT	OR	OFF	2016/03/16 18:15
S216	431	"1" and (scan$4 with retroreflector)	US-PGPUB; USPAT	OR	OFF	2016/03/16 18:15
S217	4	S215 and (scan$4 with retroreflector)	US-PGPUB; USPAT	OR	OFF	2016/03/16 18:15
S218	7	S215 and (scan$4 same retroreflector)	US-PGPUB; USPAT	OR	OFF	2016/03/16 18:16
S219	5	(centrifuge) and (scan$4 same retroreflector)	US-PGPUB; USPAT	OR	OFF	2016/03/16 18:16
S220	5,249	S215 and (white near3 light and (plural$3) near3 detect$3 adn reflect)	US-PGPUB; USPAT	OR	OFF	2016/03/16 19:54
S221	54	S215 and (white near3 light and (plural$3) near3 detect$3 and reflect)	US-PGPUB; USPAT	OR	OFF	2016/03/16 19:54
S222	974	centrifuge with rotational with axis	US-PGPUB; USPAT; USOCR;	OR	OFF	2016/06/30 00:10

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S223	20	S222 and (light with transmis$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 00:10
S224	12	S223 and (fluid with process)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 00:11
S225	1	S224 and yoke	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 00:11
S226	12	S224 and (sensor detect$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 00:11
S227	38	"6254784"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 00:17
S228	321	yoke with arm with rotat$3 same transmis$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 11:52
S229	0	S228 and (yoke with lens with (detect$3 sensor))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 11:53
S230	1	S228 and (yoke with (transmissive lens) with (detect$3 sensor))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 11:53
S231	3	S228 and ((transmissive lens) with (detect$3 sensor))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 11:53

S232	10	S228 and ((transmis$4 lens) with (detect$3 sensor))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 11:53
S233	2	"20140231365"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 11:56
S234	4	S228 and (blood)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 11:57
S235	16	((Peter) near2 (Koudelka)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2016/06/30 11:58
S236	1	S235 and yoke	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 11:58
S237	7	((Ryan) near2 (Eckman)).INV.	US-PGPUB	OR	OFF	2016/06/30 11:58
S238	8	((Lubomir) near2 (Koudelka)).INV.	USPAT; USOCR	OR	OFF	2016/06/30 11:59
S239	44	((Steven) near2 (Katz)).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2016/06/30 11:59
S240	6	S239 and yoke	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 11:59
S241	745	yoke with (arm holder) with fluid	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 12:01
S242	2	S241 and ((transmissive lens) with (detect$3 sensor))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 12:01
S243	4	S241 and ((transmissive lens) same (detect$3 sensor))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 12:01

S244	70	yoke with (arm holder) with light with rotat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 12:02
S245	15	S244 and ((transmissive lens) same (detect$3 sensor))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 12:02
S246	1,625,848	blood	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 12:06
S247	8	S246 and (yoke with (arm holder) with light with rotat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 12:06
S248	3,144	blood and yoke and rotat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 12:07
S249	199	S248 and ((transmissive lens) same (detect$3 sensor))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 12:07
S250	63	S249 and (light with rotat$3 and fluid)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 12:07
S251	5	"20140008277"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 12:52
S252	238	S246 and (fiber with bundle same arm)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 15:23
S253	194	S252 and ((sensor detect$3) and light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2016/06/30 15:23

			DERWENT; IBM_TDB			
S254	157	S252 and ((sensor detect$3) and light and lens)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 15:23
S255	7	"20040133086"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/06/30 15:58
S256	627	yoke with (arm support) with light	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/09/20 14:22
S257	71	S256 and (light adj3 support)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/09/20 14:23
S258	3	S256 and (light adj3 support and blood)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/09/20 14:24
S259	11	yoke with arm near3 rotat$3 with light	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/10/27 11:01
S260	20	yoke with (support arm) near3 rotat$3 with light	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/10/27 11:02
S261	21	(harness coller yoke) with (support arm) near3 rotat$3 with light	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/10/27 11:03
S262	1,689,558	blood	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/10/27 11:06

S263	515	S262 and (yoke and rotat$3 near3 arm)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/10/27 11:07
S264	1,779	(plural$3 multiple) near3 (sensor detect$3) with different near3 time	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/10/27 11:33
S265	8	S264 and centrifuge	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2016/10/27 11:33
S281	2,073	true near3 white	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/10/04 17:02
S282	315	true near3 white near3 (laser light beam source)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/10/04 17:02
S283	24	S282 and (blood)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/10/04 17:02
S284	196	true near white near3 light	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/10/05 17:31
S285	11	S284 and (optical with sensor)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/10/05 17:33
S286	5	"20080045394"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/10/05 17:57
S287	177,163	(plural$3 mutiple) adj2 (sensor detect$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2017/10/05 18:47

			DERWENT; IBM_TDB			
S288	365	S287 and (spectral with splitter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/10/05 18:47
S289	198	S288 and (different near3 wavelengths)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/10/05 18:48
S290	256	S288 and (different near3 wavelengths)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/10/05 18:48
S291	3	"20090279902"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/10/05 18:49
S292	18,760	white near3 light and blood	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/10/06 11:50
S293	1,265	S292 and ((plural$3 mutiple) adj2 (sensor detect$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/10/06 11:51
S294	99	S293 and (controller and fluid and character)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/10/06 11:51
S295	5	"20080045394"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/01/03 12:32
S296	18	(("KOUDELKA") near3 ("Peter")).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2018/01/03 12:42
S297	5	S296 and (white near3 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2018/01/03 12:42

			DERWENT; IBM_TDB			
S298	1	"15414717"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/01/03 12:45
S299	310	true near3 white near3 light	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/04/26 18:26
S300	23	S299 and blood	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/04/26 18:26
S301	5	"20130109938"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/04/26 19:58
S302	310	true near3 white near3 light	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/04/26 19:58
S303	5	S302 and (blood and centrifuge)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/04/26 19:58
S304	82,527	(blood and centrifuge)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/04/26 19:59
S305	1,898	S304 and (white near3 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/04/26 19:59
S306	1	S304 and (only adj2 white near3 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/04/26 19:59

S307	12	S304 and ((single true only) adj2 white near3 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/04/26 20:00
S308	3	"20090279902"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/04/26 20:51
S309	84,764	(blood and centrifuge)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/24 16:24
S310	12	S309 and ((single true only) adj2 white near3 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/24 16:24
S311	84,764	(blood and centrifuge)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/24 16:25
S312	1	S309 and (only adj2 white near3 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/24 16:25
S313	2,329	(plural$3 multiple) near3 (sensor detect$3) with different near3 time	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/24 16:25
S314	20,508	white near3 light and blood	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/24 16:25
S315	1,395	S314 and ((plural$3 mutiple) adj2 (sensor detect$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/24 16:25
S316	110	S315 and (controller and fluid and character)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2018/09/24 16:25

			DERWENT; IBM_TDB			
S317	27	(harness coller yoke) with (support arm) near3 rotat$3 with light	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/24 16:25
S330	859,663	(light laser source) and (fiber fibre) and (detect$3 sensor)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/03/22 10:35
S331	7,265	S330 and (adjust$3 near3 fiber)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/03/22 10:37
S332	163	S331 and (light near3 housing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/03/22 10:38
S333	1	"16215711"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/03/22 10:39
S334	62	S331 and (blood near3 process$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/03/22 10:52
S335	82	(plural$3 multiple) adj2 fiber with adjust$3 adj3 position	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/03/22 11:28
S336	6	(plural$3 multiple) adj2 fiber with adjust$3 adj3 position same housing	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/03/22 11:28
S337	24	(plural$3 multiple) adj2 fiber with adjust$3 adj3 position and housing	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/03/22 11:28

S338	344	(plural$3 multiple) adj2 fiber with beam adj2 splitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/03/22 11:56
S339	25	S338 and (opposite near3 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/03/22 11:57
S340	61	S338 and (blood near3process)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/03/22 11:59
S341	0	S338 and (blood near3 process)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/03/22 11:59
S342	2	"20070239033"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/03/22 12:02
S343	29,404	fiber with angle with light	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/03/22 12:09
S344	306	S343 and (fiber with perpendicular adj2 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/03/22 12:09
S374	30,102	fiber with angle with light	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/08/09 14:39
S375	309	S374 and (fiber with perpendicular adj2 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/08/09 14:39
S376	10,574	G01J1/0407 G01J1/0411 G01J1/0437 G01J1/4228 G01J1/4257 G01J1/4257	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2020/08/09 14:39

		H01S3/09415 H01S3/0014 H01S3/0014	DERWENT; IBM_TDB			
S377	2	S376 and (spatial with light with modulator and complex with amplitude with laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:39
S378	25	(plural$3 multiple) adj2 fiber with adjust$3 adj3 position and housing	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/08/09 14:40
S379	25	(plural$3 multiple) adj2 fiber with adjust$3 adj3 position and housing	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/08/09 14:40
S380	2	S376 and (spatial with light with modulator and complex with amplitude with laser)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:40
S381	356	(plural$3 multiple) adj2 fiber with beam adj2 splitter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/08/09 14:40
S382	64	S381 and (blood near3process)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/08/09 14:40
S383	2,988	(plural$3 multiple) near3 (sensor detect$3) with different near3 time	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:40
S384	893,401	(light laser source) and (fiber fibre) and (detect$3 sensor)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:40
S385	24,836	white near3 light and blood	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:40

S386	1,803	S385 and ((plural$3 mutiple) adj2 (sensor detect$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:40
S387	163	S386 and (controller and fluid and character)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/08/09 14:40
S388	43,618	metrology	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:40
S389	184	S388 and (pattern with target) and (spectral with range) and ((sensor detect$3)) and (pupil near3 plane)	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:40
S390	96,510	(blood and centrifuge)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:40
S391	16	S390 and ((single true only) adj2 white near3 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:40
S392	16,267	S390 and (deoxy hemoglobin)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:41
S393	71	S390 and (deoxy NEAR3 hemoglobin)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:41
S394	71	S390 and (deoxy near3 hemoglobin)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:41
S395	35	(harness coller yoke) with (support arm) near3 rotat$3 with light	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:41
S396	2	S390 and (only adj2 white near3 light)	US-PGPUB; USPAT; USOCR;	OR	OFF	2020/08/09 14:41

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S397	7,477	S384 and (adjust$3 near3 fiber)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:41
S398	167	S397 and (light near3 housing)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:41
S399	2,988	(plural$3 multiple) near3 (sensor detect$3) with different near3 time	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/08/09 14:41
S400	42,924	Blood with Processing	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:41
S401	162	S400 and (white near3 light and (plural$3) near3 detect$3 and reflect)	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:41

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S266	783	G01J1/0407 G01J1/0411 G01J1/0437 G01J1/4228 G01J1/4257 G01J1/4257 H01S3/09415 H01S3/0014 H01S3/0014	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:00
S267	0	S266 and (yoke and rotat$3 near3 arm).CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:00
S268	5	yoke with (support arm) near3 rotat$3 with light.CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:00
S269	122	S266 and ((sensor detect$3) and light and lens).CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:00
S270	100	S266 and ((transmissive lens) with (detect$3 sensor)).CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:01
S271	715	(coaxial) and (centrifuge).CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:01

S272	6	(harness coller yoke) with (support arm) near3 rotat$3 with light.CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:01
S273	123	S266 and ((transmissive lens) same (detect$3 sensor)).CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:01
S274	523	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:01
S275	0	S266 and centrifuge.CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:01
S276	0	S267 and (select$3 with (beams laser light) with separat$3).CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:01
S277	2	S274 and (select$3 with (beams laser light) with separat$3).CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:02
S278	1	S268 and (light with transmissive) and (light with reflect$3).CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:02
S279	0	S278 and ((plural$3 multiple) near3 (sensor detect$3) with different near3 time).CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:02
S280	0	S274 and (yoke with (support arm) near3 rotat$3 with light).CLM.	US-PGPUB; USPAT	OR	OFF	2016/11/04 19:02
S318	659	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.CLM.	US-PGPUB; USPAT	OR	OFF	2018/11/13 14:12
S319	0	S318 and (yoke with (support arm) near3 rotat$3 with light).CLM.	US-PGPUB; USPAT	OR	OFF	2018/11/13 14:12
S320	659	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.CLM.	US-PGPUB; USPAT	OR	OFF	2018/11/13 14:13
S321	7	yoke with (support arm) near3 rotat$3 with light.CLM.	US-PGPUB; USPAT	OR	OFF	2018/11/13 14:13
S322	2	S321 and (light with transmissive) and (light with reflect$3).CLM.	US-PGPUB; USPAT	OR	OFF	2018/11/13 14:13
S323	0	S322 and ((plural$3 multiple) near3 (sensor detect$3) with different near3 time).CLM.	US-PGPUB; USPAT	OR	OFF	2018/11/13 14:13

S324	7	yoke with (support arm) near3 rotat$3 with light.CLM.	US-PGPUB; USPAT	OR	OFF	2018/11/13 14:13
S325	0	S318 and ((single true only) adj2 white near3 light).clm.	USPAT	OR	OFF	2018/11/13 14:13
S326	327	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.clm.	USPAT	OR	OFF	2018/11/13 14:13
S327	327	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.clm.	USPAT	OR	OFF	2018/11/13 14:13
S328	1,238	white near3 light and blood.clm.	USPAT	OR	OFF	2018/11/13 14:13
S329	5	(harness coller yoke) with (support arm) near3 rotat$3 with light.clm.	USPAT	OR	OFF	2018/11/13 14:13
S345	7	(plural$3 multiple) adj2 fiber with adjust$3 adj3 position and housing.clm.	USPAT	OR	ON	2020/06/23 14:31
S346	41	(plural$3 multiple) adj2 fiber with beam adj2 splitter.clm.	USPAT	OR	ON	2020/06/23 14:31
S347	140,530	(light laser source) and (fiber fibre) and (detect$3 sensor).clm.	USPAT	OR	OFF	2020/06/23 14:31
S348	5	(harness coller yoke) with (support arm) near3 rotat$3 with light.clm.	USPAT	OR	OFF	2020/06/23 14:31
S349	394	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.clm.	USPAT	OR	OFF	2020/06/23 14:31
S350	394	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.clm.	USPAT	OR	OFF	2020/06/23 14:31
S351	777	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:31
S352	0	S351 and (yoke with (support arm) near3 rotat$3 with light).CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:31
S353	7	yoke with (support arm) near3 rotat$3 with light.CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:32
S354	2	S353 and (light with transmissive) and (light with reflect$3).CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:32
S355	0	S354 and ((plural$3 multiple) near3 (sensor detect$3) with different near3 time).CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:32

S356	0	S354 and ((plural$3 multiple) near3 (sensor detect$3) with different near3 time).CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:32
S357	7	yoke with (support arm) near3 rotat$3 with light.CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:32
S358	394	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.clm.	USPAT	OR	OFF	2020/06/23 14:32
S359	777	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:32
S360	2,151	G01J1/0407 G01J1/0411 G01J1/0437 G01J1/4228 G01J1/4257 G01J1/4257 H01S3/09415 H01S3/0014 H01S3/0014	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:32
S361	777	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:32
S362	0	S351 and ((single true only) adj2 white near3 light).clm.	USPAT	OR	OFF	2020/06/23 14:32
S363	7	yoke with (support arm) near3 rotat$3 with light.CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:32
S364	0	S351 and ((single true only) adj2 white near3 light).clm.	USPAT	OR	OFF	2020/06/23 14:32
S365	2	S353 and (light with transmissive) and (light with reflect$3).CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:32
S366	777	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:32
S367	1	((detect$3 sensor) and (reflect$3 and centrifuge and blood and immune)).CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:34
S368	0	((detect$3 sensor) and (reflect$3 and centrifuge and blood and immune and noise and vibrat$3)).CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:35
S369	0	S360 and ((detect$3 sensor) and (reflect$3 and centrifuge and blood and immune and noise and vibrat$3)).CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:35
S370	86	S360 and (light with transmissive) and (light with reflect$3).CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:35

S371	6	S360 and (select$3 with (beams laser light) with separat$3).CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:35
S372	0	S360 and ((single true only) adj2 white near3 light).clm.	USPAT	OR	OFF	2020/06/23 14:35
S373	316	S360 and ((transmissive lens) same (detect$3 sensor)).CLM.	US-PGPUB; USPAT	OR	OFF	2020/06/23 14:35
S402	2,192	G01J1/0407 G01J1/0411 G01J1/0437 G01J1/4228 G01J1/4257 G01J1/4257 H01S3/09415 H01S3/0014 H01S3/0014	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:42
S403	321	S402 and ((transmissive lens) same (detect$3 sensor)).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:42
S404	89	S402 and (light with transmissive) and (light with reflect$3).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:42
S405	7	yoke with (support arm) near3 rotat$3 with light.CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:42
S406	2	S405 and (light with transmissive) and (light with reflect$3).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:42
S407	0	((detect$3 sensor) and (reflect$3 and centrifuge and blood and immune and noise and vibrat$3)).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:42
S408	0	S402 and (deoxy adj2 hemoglobin).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:42
S409	0	S402 and (deoxy near2 hemoglobin).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:42
S410	0	((detect$3 sensor) and (reflect$3 and centrifuge and blood and immune and noise and vibrat$3)).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:42
S411	787	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:42
S412	0	S411 and ((single true only) adj2 white near3 light).clm.	USPAT	OR	OFF	2020/08/09 14:42
S413	0	S411 and ((single true only) adj2 white near3 light).clm.	USPAT	OR	OFF	2020/08/09 14:43
S414	2	S405 and (light with transmissive) and (light with reflect$3).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:43

S415	0	S414 and ((plural$3 multiple) near3 (sensor detect$3) with different near3 time).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:43
S416	787	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:43
S417	6	S402 and (select$3 with (beams laser light) with separat$3).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:43
S418	787	(plural$3 multiple) near3 (sensor detect$3) with different near3 time.CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:44
S419	89	S402 and (light with transmissive) and (light with reflect$3).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:44
S420	0	S404 and (deoxy near2 hemoglobin).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:44
S421	89	S404 and (light with transmissive) and (light with reflect$3).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:44
S422	0	S403 and (deoxy adj2 hemoglobin).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:44
S423	0	S411 and (deoxy adj2 hemoglobin).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:44
S424	0	S418 and (deoxy adj2 hemoglobin).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:44
S425	0	S419 and (deoxy adj2 hemoglobin).CLM.	US-PGPUB; USPAT	OR	OFF	2020/08/09 14:44

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	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
	Examiner Name	

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Examiner Initial	Desig. ID	Document Number	Publication Date	Patentee	Class	Subclass	Filing Date If Appropriate

Foreign Patent Documents or Published Foreign Patent Applications

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Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
	Applicant Mohammed N. ISLAM	Confirmation Number 7663
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		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit AA), 75 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, Aug. 28, 2018 (Exhibit B), 73 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit BB), 65 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, Aug. 28, 2018 (Exhibit C), 85 pps.

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Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
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		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit CC), 320 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendant's Invalidity Contentions, Aug. 28, 2018 (Exhibit D), 38 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit DD), 240 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit E), 120 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit F), 40 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit G), 66 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit H), 74 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit I), 102 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit J), 64 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit K), 77 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit L), 64 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit M), 119 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit N), 50 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit O), 63 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit P), 78 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit Q), 69 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit R), 61 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit S), 50 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit T), 174 pps.

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		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit U), 334 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit V), 137 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit W), 384 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit X), 291 pps.
		Omni Medsci, Inc. V. Apple Inc.; Case No. 2:18-cv-134-RWS (E.D. Tex.); Defendants Invalidity Contentions, Aug. 28, 2018 (Exhibit Y), 120 pps.
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Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
	Examiner Name	

Other Documents (include Author, Title, Date, and Place of Publication)		
Examiner Initial	Desig. ID	Document
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	Examiner Name	

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	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
	Examiner Name	

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).

☒ 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. 16/284,514 filed February 25, 2019, (pending) and Serial No. 16/506,885 filed July 9, 2019 (pending), of which the present application is a continuation.

☐ 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	/Andrew B. Turner/	Date (YYYY-MM-DD)	November 26, 2019
Name/Print	Andrew B. Turner	Registration Number	63121

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Omni MedSci Ex. 2029
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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	16669794
Filing Date	2019-10-31
First Named Inventor	Mohammed N. ISLAM
Art Unit	1731
Examiner Name	
Attorney Docket Number	OMNI0102PUSA6

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	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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	First Named Inventor	Mohammed N. ISLAM
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	16	2015084376	WO	A1	2015-06-11	Han et al.		

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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		

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EXAMINER SIGNATURE

Examiner Signature	/MD M RAHMAN/	Date Considered	08/10/2020

*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/

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Application Number	16669794
	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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	/Andrew B. Turner/	Date (YYYY-MM-DD)	2019-11-26
Name/Print	Andrew B. Turner	Registration Number	63121

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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Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063

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.

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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.

Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
	Examiner Name	

U.S. Patent Documents

Examiner Initial	Cite No.	Document Number	Publication Date	Patentee	Class	Subclass	Filing Date If Appropriate

Foreign Patent Documents or Published Foreign Patent Applications

Examiner Initial	Cite No.	Document Number	Publication Date	Country or Patent Office	Class	Subclass	Translation Yes	Translation No
	1	2458123	2004-09-13	CA	A1			

Other Documents (include Author, Title, Date, and Place of Publication)

Examiner Initial	Cite No.	Document
	2	Claim Construction Memorandum Opinion and Order. Case No. 2:18-CV-000134-RWS (June 24, 2019)
	3	Claim Construction Memorandum Opinion and Order. Case No. 2:18-CV-000429-RWS (August 14, 2019)
	4	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 10,098,546 filed in IPR2020-00029 (Oct. 17, 2019)
	5	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,651,533 filed in IPR2019-00913 (Apr. 10, 2019).
	6	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,651,533 filed in IPR2019-00916 (Apr. 10, 2019).
	7	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,757,040 filed in IPR2019-00910 (Apr. 10, 2019).
	8	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,757,040 filed in IPR2019-00917 (Apr. 10, 2019).
	9	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,861,286 filed in IPR2019-00911 (Apr. 10, 2019).
	10	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,861,286 filed in IPR2019-00914 (Apr. 10, 2019).
	11	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,885,698 filed in IPR2019-00912 (Apr. 10, 2019).
	12	Declaration of Brian W. Anthony, PhD regarding U.S. Pat. No. 9,885,698 filed in IPR2019-00915 (Apr. 10, 2019).

Examiner Signature	Date Considered
/MD M RAHMAN/	08/10/2020

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.M.R/

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
381/459
IPR2025-01251 Page 00381

Substitute Form PTO-1449 (Modified) U.S. Department of Commerce Patent and Trademark Office **Information Disclosure Statement by Applicant** (Use several sheets if necessary) (37 CFR §1.98(b))	Attorney Docket No. OMNI0102PUSA6	Application No. 16/669,794
	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
	Examiner Name	

Other Documents (include Author, Title, Date, and Place of Publication)		
Examiner Initial	Cite No.	Document
	13	File History for U.S. Patent No. 10,098,546, issued October 16, 2018
	14	Inter Partes Review No. IPR2020-00029; Petition for Inter Partes Review of U.S. Pat. No. 10,098,546; Apple Inc. v. Omni Medsci, Inc.; dated October 17, 2019.
	15	Lister et al., Optical properties of human skin (Journal of Biomedical Optics 2012)
	16	Mark Nelson & Jean-Loup Gailly, The Data Compression Book (Cary Sullivan et al. eds.) (2nd ed. 1996)
	17	Newton, H., Newton's Telecom Dictionary (18th ed. 2002).
	18	Order, Omni MedSci, Inc. v. Apple Inc., No. 2:18-cv-134-RWS in the United States District Court for the Eastern District of Texas Marshall Division (8/16/2019), ECF No. 283
	19	Proof of Service of Summons in Omni MedSci, Inc. v. Apple Inc., No. 2:18-cv-429 (E.D. Tex.).

Examiner Signature	Date Considered
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	Applicant Mohammed N. ISLAM	Confirmation Number 7663
	Filing Date 10-31-2019	Group Art Unit 1731
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☐ 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).

☐ This application relies, under 35 U.S.C. § 120, on the earlier filing date of prior application No. _____, filed _____ and the references cited therein are hereby referenced, but are not required to be provided in this application under 37 CFR § 1.98(d).

☐ 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	/Andrew B. Turner/	Date (YYYY-MM-DD)	November 26, 2019
Name/Print	Andrew B. Turner	Registration Number	63121

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063

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

Application Number	16669794
Filing Date	2019-10-31
First Named Inventor	Mohammed N. ISLAM
Art Unit	1731
Examiner Name	
Attorney Docket Number	OMNI0102PUSA6

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	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.	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.M.R/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

	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.	
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	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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	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

	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	5246004		1993-09-21	Clarke et al.	
	28	5267152		1993-11-30	Yang et al.	
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	30	5267323		1993-11-30	Kimura	

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	Art Unit	1731
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	Attorney Docket Number	OMNI0102PUSA6

	31	5300097		1994-04-05	Lerner et al.	
	32	5303148		1994-04-12	Mattson et al.	
	33	5305427		1994-04-19	Nagata	
	34	5313306		1994-05-17	Kuban et al.	
	35	5323404		1994-06-21	Grubb	
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	38	5400165		1995-03-21	Gnauck et al.	
	39	5458122		1995-10-17	Hethuin	
	40	5544654		1996-08-13	Murphy et al.	
	41	5563710		1996-10-08	Webb et al.	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /M.M.R/

Omni MedSci Ex. 2029
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	Art Unit	1731
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	Attorney Docket Number	OMNI0102PUSA6

	42	5572999		1996-11-12	Funda et al.	
	43	5617871		1997-04-08	Burrows	
	44	5631758		1997-05-20	Knox et al.	
	45	5687734		1997-11-18	Dempsey et al.	
	46	5695493		1997-12-09	Nakajima et al.	
	47	5696778		1997-12-09	MacPherson	
	48	5704351		1998-01-06	Mortara et al.	
	49	5718234		1998-02-17	Warden et al.	
	50	5746206		1998-05-05	Mannheimer	
	51	5747806		1998-05-05	Khalil et al.	
	52	5748103		1998-05-05	Flach et al.	

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	53	5792204		1998-08-11	Snell	
	54	5795300		1998-08-18	Bryars	
	55	5812978		1998-09-22	Nolan	
	56	5855550		1999-01-05	Lai et al.	
	57	5862803		1999-01-26	Besson et al.	
	58	5867305		1999-02-02	Waarts et al.	
	59	5912749		1999-06-15	Harstead et al.	
	60	5919134		1999-07-06	Diab	
	61	5944659		1999-08-31	Flach et al.	
	62	5950629		1999-09-14	Taylor et al.	
	63	6014249		2000-01-11	Fermann et al.	

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	Attorney Docket Number	OMNI0102PUSA6

	64	6031603		2000-02-29	Fine et al.	
	65	6043927		2000-03-28	Islam	
	66	6115673		2000-09-05	Malin et al.	
	67	6181414		2001-01-30	Raz et al.	
	68	6185535		2001-02-06	Hedin et al.	
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	70	6212310		2001-04-03	Waarts et al.	
	71	6224542		2001-05-01	Chang et al.	
	72	6246707		2001-06-12	Yin et al.	
	73	6246896		2001-06-12	Dumoulin et al.	
	74	6273858		2001-08-14	Fox et al.	

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	Attorney Docket Number	OMNI0102PUSA6

	75	6281471		2001-08-28	Smart	
	76	6285897		2001-09-04	Kilcoyne et al.	
	77	6301271		2001-10-09	Sanders et al.	
	78	6301273		2001-10-09	Sanders et al.	
	79	6325978		2001-12-04	Labuda et al.	
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	82	6340806		2002-01-22	Smart et al.	
	83	6350261		2002-02-26	Domankevitz et al.	
	84	6364834		2002-04-02	Reuss et al.	
	85	6374006		2002-04-16	Islam et al.	

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	86	6381391		2002-04-30	Islam et al.	
	87	6402691		2002-06-11	Peddicord et al.	
	88	6407853		2002-06-18	Samson et al.	
	89	6436107		2002-08-20	Wang et al.	
	90	6442430		2002-08-27	Ferek-Petric	
	91	6443890		2002-09-03	Schulze et al.	
	92	6450172		2002-09-17	Hartlaub et al.	
	93	6453201		2002-09-17	Daum et al.	
	94	6454705		2002-09-24	Cosentino et al.	
	95	6458120		2002-10-01	Shen et al.	
	96	6462500		2002-10-08	L'Hegarat et al.	

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	97	6463361		2002-10-08	Wang et al.	
	98	6480656		2002-11-12	Islam et al.	
	99	6509566		2003-01-21	Wamsley et al.	
	100	6512936		2003-01-28	Monfre et al.	
	101	6534012		2003-03-18	Hazen et al.	
	102	6567431		2003-05-20	Tabirian et al.	
	103	6587702		2003-07-01	Ruchti et al.	
	104	6605080		2003-08-12	Altshuler et al.	
	105	6611643		2003-08-26	Birk et al.	
	106	6619835		2003-09-16	Kita	
	107	6625180		2003-09-23	Bufetov et al.	

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	108	6631025		2003-10-07	Islam et al.	
	109	6640117		2003-10-28	Makarewicz et al.	
	110	6659947		2003-12-09	Carter et al.	
	111	6659999		2003-12-09	Anderson et al.	
	112	6701170		2004-03-02	Stetson	
	113	6708048		2004-03-16	Chance	
	114	6731967		2004-05-04	Turcott	
	115	6738652		2004-05-18	Mattu et al.	
	116	6760148		2004-07-06	Islam	
	117	6773922		2004-08-10	Jeng et al.	
	118	6788965		2004-09-07	Ruchti et al.	

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	119	6802811		2004-10-12	Slepian	
	120	6816241		2004-11-09	Grubisic	
	121	6847336		2005-01-25	Lemelson et al.	
	122	6864978		2005-03-08	Hazen et al.	
	123	6885498		2005-04-26	Islam	
	124	6885683		2005-04-26	Fermann et al.	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16669794
	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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	Application Number	16669794
	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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	Application Number	16669794
	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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	Application Number	16669794
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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	16669794
	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	1731
	Examiner Name	
	Attorney Docket Number	OMNI0102PUSA6

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	/Andrew B. Turner/	Date (YYYY-MM-DD)	2019-11-26
Name/Print	Andrew B. Turner	Registration Number	63121

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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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.

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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).

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.

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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.: 16/669794

Filed: 10/31/2019

For: SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

Attorney Docket No.: OMNI0102PUSA6

AMENDMENT AFTER ALLOWANCE
UNDER 37 C.F.R. § 1.312

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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 measurement system comprising:

a light source comprising a plurality of semiconductor sources that are configured to generate an output optical beam with one or more optical wavelengths, the light source configured to increase signal-to-noise ratio by increasing a light intensity relative to an initial light intensity from at least one of the plurality of semiconductor sources;

a measurement device ~~an apparatus~~ configured to:

receive a portion of the output optical beam, and

deliver an analysis output beam to a sample;

a receiver configured to:

receive and process at least a portion of the analysis output beam reflected or transmitted from the sample,

generate an output signal representing at least in part a non-invasive measurement on blood contained within the sample,

synchronize to the light source,

capture light while the semiconductor sources are off and convert the captured light into a first signal,

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a part of the at least a portion of the analysis output beam reflected or transmitted from the sample, and

the measurement system further configured to improve the signal-to-noise ratio by differencing the first signal and the second signal;

a 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,

store and display the processed output signal, and

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transmit at least a portion of the processed output signal over a wireless transmission link; and

a cloud configured to:

receive, over the wireless transmission link, an output status comprising the at least a portion of the processed output signal,

process the received output status to generate processed data, and

store the processed data.

2.-3. (Cancelled)

4. (Previously Presented) The measurement system of claim 22, wherein the measurement system is configured to use artificial intelligence in making decisions;

wherein the measurement system is configured to perform pattern identification or classification, and wherein the measurement system is configured to apply a threshold function to a comparison with a stored data set; and

wherein the measurement system is at least in part configured for selection or identification of an object, and wherein the measurement system is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

5. (Previously Presented) The measurement system of claim 22, wherein the light source is configured to further increase signal-to-noise ratio by increasing a pulse rate of at least one of the plurality of semiconductor sources.

6. (Previously Presented) The measurement system of claim 1, wherein the plurality of semiconductor sources comprises at least one of: light emitting diodes (LEDs), laser diodes (LD's), tunable LD's, and super-luminescent laser diodes (SLDs), and wherein the measurement system further comprises a reflective surface to receive and redirect at least some of the at least a portion of the analysis output beam reflected or transmitted from the sample.

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7. (Original) The measurement system of claim 1, wherein the light source is further configured to increase the light intensity from the plurality of semiconductor sources by spatially coupling the optical output beam from at least two of the plurality of semiconductor sources.

8. (Previously Presented) A measurement system comprising:

a wearable measurement device for measuring one or more physiological parameters, including a light source comprising a plurality of semiconductor sources that are configured to generate an output optical beam with one or more optical wavelengths;

the light source configured to increase signal-to-noise ratio by increasing a light intensity relative to an initial light intensity from at least one of the plurality of semiconductor sources;

the wearable measurement device configured to receive a portion of the output optical beam and to deliver an analysis output beam to a sample;

the wearable measurement device further comprising a receiver configured to:

receive and process at least a portion of the analysis output beam reflected or transmitted from the sample,

generate an output signal representing at least in part a non-invasive measurement on blood contained within the sample,

synchronize to pulses of the light source,

capture light while the semiconductor sources are off and convert the captured light into a first signal,

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a part of the at least a portion of the analysis output beam reflected or transmitted from the sample,

wherein the measurement system is further configured to improve the signal-to-noise ratio by differencing the first signal and the second signal;

a 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

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signal, to store and display the processed output signal, and to transmit a portion of the processed output signal over a wireless transmission link; and

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, and wherein the cloud is capable of storing a history of at least a portion of the received output status over a specified period of time.

9.-10. (Cancelled)

11. (Currently Amended) The measurement system of claim 8~~Claim 27~~, wherein the measurement system is configured to use artificial intelligence in making decisions;

wherein the measurement system is configured to perform pattern identification or classification, and wherein the measurement system is configured to apply a threshold function to a comparison with a stored data set; and

wherein the measurement system is at least in part configured for selection or identification of an object, and wherein the measurement system is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

12. (Currently Amended) The measurement system of claim 11~~claim 27~~, wherein the light source is configured to further increase signal-to-noise ratio by one of increasing a pulse rate of at least one of the plurality of semiconductor sources.

13. (Previously Presented) The measurement system of claim 8, wherein the plurality of semiconductor sources comprises at least one of: light emitting diodes (LEDs), laser diodes (LD's), tunable LD's, and super-luminescent laser diodes (SLDs), and the measurement system further comprising a reflective surface to receive and redirect at least some of the at least a portion of the analysis output beam reflected or transmitted from the sample.

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14. (Original) A wearable device for use with a smart phone or tablet, the wearable device comprising:

a measurement device including a light source comprising a plurality of semiconductor sources for measuring one or more physiological parameters, the measurement device configured to:

generate, by modulating at least one of the semiconductor sources having an initial light intensity, an input optical beam having one or more optical wavelengths, and

receive and to deliver a portion of the input optical beam to tissue, wherein the tissue reflects at least a portion of the input optical beam delivered to the tissue;

the measurement device further comprising a receiver configured to:

capture light while the semiconductor sources are off and convert the captured light into a first signal, and

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a portion of the input optical beam reflected from the tissue;

synchronize to the modulation of the at least one of the semiconductor sources;

the measurement device further configured to improve a signal-to-noise ratio of the input optical beam reflected from the tissue by:

differencing the first signal and the second signal, and

increasing the light intensity relative to the initial light intensity from at least one of the semiconductor sources;

the measurement device further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue;

the wearable device configured to communicate with the smart phone or tablet, the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a voice input module, a speaker, and a touch screen; and

the smart phone or tablet configured to:

receive and to process at least a portion of the output signal,

store and display the processed output signal, and

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transmit at least a portion of the processed output signal over a wireless transmission link.

15. (Currently Amended) The wearable device of claim 14~~claim 31~~, wherein the light source is configured to further improve the signal-to-noise ratio of the input optical beam reflected from the tissue by increasing a pulse rate of at least one of the plurality of semiconductor sources.

16. (Currently Amended) The wearable device of claim 14~~claim 15~~, further comprising a cloud configured to:

receive, over the wireless transmission link, an output status comprising the at least a portion of the processed output signal,

process the output status to generate processed data, and

store the processed data, and

wherein the cloud is capable of storing a history of at least a portion of the output status over a specified period of time.

17. (Currently Amended) The wearable device of claim 14~~claim 16~~, wherein the wearable device is configured to use artificial intelligence in making decisions;

wherein the wearable device is configured to perform pattern identification or classification, and wherein the wearable device is configured to apply a threshold function to a comparison with a stored data set; and

wherein the wearable device is at least in part configured for selection or identification of an object, and wherein the wearable device is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

18. (Cancelled)

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19. (Currently Amended) The wearable device of claim 14~~claim 17~~, wherein the measurement device further comprises a reflective surface configured to receive and redirect at least a portion of light reflected from the tissue.

20. (Cancelled)

21. (Previously Presented) The measurement system of claim 1, wherein the plurality of semiconductor sources comprises six light emitting diodes, and wherein the receiver comprises six detectors.

22. (Previously Presented) The measurement system of claim 21, wherein the six detectors are located on an arc surrounding the six light emitting diodes.

23. (Previously Presented) The measurement system of claim 1, wherein the receiver comprises a plurality of detectors arranged along a first arc, and wherein the plurality of semiconductor sources are arranged along a second arc.

24. (Previously Presented) The measurement system of claim 23, wherein the first arc is offset from the second arc.

25. (Previously Presented) The measurement system of claim 23, wherein the first arc and the second arc are concentric.

26. (Currently Amended) The measurement system of claim 12~~claim 8~~, wherein the plurality of semiconductor sources comprises six light emitting diodes, and wherein the receiver comprises six detectors.

27. (Previously Presented) The measurement system of claim 26, wherein the six detectors are located on an arc surrounding the six light emitting diodes.

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28. (Previously Presented) The measurement system of claim 8, wherein the receiver comprises a plurality of detectors arranged along a first arc, and wherein the plurality of semiconductor sources are arranged along a second arc that is offset from the first arc.

29. (Previously Presented) The measurement system of claim 28, wherein the first arc and the second arc are concentric.

30. (Currently Amended) The wearable device of claim 15~~claim 14~~, wherein the plurality of semiconductor sources comprises six light emitting diodes, and wherein the receiver comprises six detectors.

31. (Previously Presented) The wearable device of claim 30, wherein the six detectors are located on an arc surrounding the six light emitting diodes.

32. (Currently Amended) The wearable device of claim 15~~claim 14~~, wherein the receiver comprises a plurality of detectors arranged along a first arc, and wherein the plurality of semiconductor sources are arranged along a second arc that is offset from the first arc.

33. (Previously Presented) The wearable device of claim 32, wherein the first arc and the second arc are concentric.

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Remarks

Applicant amends claim 17 to correct its dependency in response to a request from the Examiner. Applicant also amends claims 1, 11, 12, 15-17, 19, 26, 30, and 32 to address informalities.

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/Agent for Applicant

Date: September 25, 2020

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EFS ID:	40673303
Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO
First Named Inventor/Applicant Name:	Mohammed N. ISLAM
Customer Number:	109543
Filer:	Andrew B. Turner/Rachael Wronkowicz
Filer Authorized By:	Andrew B. Turner
Attorney Docket Number:	OMNI0102PUSA6
Receipt Date:	25-SEP-2020
Filing Date:	31-OCT-2019
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Application Type:	Utility under 35 USC 111(a)

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		OMNI0102PUSA6_Amendment_After_Allowance.PDF	118266 4ddd5522696ceb4049269968f41fd097f52fd815	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment after Notice of Allowance (Rule 312)	1	1
	Claims	2	9
	Applicant Arguments/Remarks Made in an Amendment	10	10
Warnings:			
Information:			
	Total Files Size (in bytes):	118266	

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/669,794	10/31/2019	Mohammed N. ISLAM	OMNI0102PUSA6	7663

109543 7590 09/30/2020

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	

NOTIFICATION DATE	DELIVERY MODE
09/30/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@brookskushman.com

Corrected ***Notice of Allowability***	**Application No.** 16/669,794	**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 9/23/20.
   ☐ 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 See Continuation Sheet . 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

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
417/459
IPR2025-01251 Page 00417

Continuation of 3. The allowed claim(s) is/are: 1,4-8,11-17,19 and 21-33

Response to Rule 312 Communication	Application No.	Applicant(s)	
	16/669,794	ISLAM, Mohammed N.	
	Examiner	Art Unit	AIA (FITF) Status
	MD M RAHMAN	2886	Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

1. ☑ The amendment filed on 25 September 2020 under 37 CFR 1.312 has been considered, and has been:
   a) ☑ entered.
   b) ☐ entered as directed to matters of form not affecting the scope of the invention.
   c) ☐ disapproved because the amendment was filed after the payment of the issue fee.
      Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.
   d) ☐ disapproved. See explanation below.
   e) ☐ entered in part. See explanation below.

/MD M RAHMAN/
Primary Examiner, Art Unit 2886

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

CPC						
Symbol					**Type**	**Version**
A61B	/	5	/	0088	F	2013-01-01
A61B	/	5	/	7203	I	2013-01-01
A61B	/	5	/	0075	I	2013-01-01
A61B	/	5	/	4547	I	2013-01-01
A61C	/	19	/	04	I	2013-01-01
G16H	/	40	/	67	I	2018-01-01
A61B	/	5	/	0013	I	2013-01-01
A61B	/	5	/	0022	I	2013-01-01
A61B	/	5	/	0086	I	2013-01-01
A61B	/	5	/	14532	I	2013-01-01
A61B	/	5	/	14546	I	2013-01-01
A61B	/	5	/	1455	I	2013-01-01
A61B	/	5	/	6801	I	2013-01-01
A61B	/	5	/	7257	I	2013-01-01
A61B	/	5	/	7405	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	/	21	/	3563	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
G01N	/	33	/	02	I	2013-01-01
G01N	/	33	/	025	I	2013-01-01
G01N	/	33	/	15	I	2013-01-01

NONE (Assistant Examiner) (Date)	**Total Claims Allowed:** 27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886 (Primary Examiner) (Date) 25 September 2020	O.G. Print Claim(s) 1	O.G. Print Figure 16B

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

CPC						
Symbol					**Type**	**Version**
G01N	/	33	/	442	I	2013-01-01
G01N	/	33	/	49	I	2013-01-01
G06F	/	19	/	00	I	2013-01-01
H01S	/	3	/	06758	A	2013-01-01
H01S	/	3	/	0092	A	2013-01-01
A61B	/	5	/	0024	A	2013-01-01
A61C	/	1	/	0046	A	2013-01-01
A61B	/	2562	/	0233	A	2013-01-01
A61B	/	2562	/	0238	A	2013-01-01
A61B	/	2562	/	146	A	2013-01-01
A61B	/	2576	/	02	A	2013-01-01
G01J	/	3	/	1838	A	2013-01-01
G01J	/	2003	/	104	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
G01N	/	21	/	85	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
G01N	/	2201	/	08	A	2013-01-01
G01N	/	2201	/	12	A	2013-01-01
G01N	/	2201	/	129	A	2013-01-01
H01S	/	3	/	302	A	2013-01-01

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	25 September 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	16B

U.S. Patent and Trademark Office — Part of Paper No.: 20200924

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

CPC Combination Sets				
Symbol	**Type**	**Set**	**Ranking**	**Version**
/ /				

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	25 September 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	16B

U.S. Patent and Trademark Office — Part of Paper No.: 20200924

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

INTERNATIONAL CLASSIFICATION					
CLAIMED					
G01J	/	3	/	00	
NON-CLAIMED					
	/		/		

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**
356	300

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886 (Primary Examiner)	25 September 2020 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 16B

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
423/459
IPR2025-01251 Page 00423

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	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	27	19	17	28								
	2	12	11		20	18	29								
	3	13	12	4	21	21	30								
6	4	16	13	5	22	22	31								
7	5	19	14	8	23	23	32								
2	6	20	15	9	24	24	33								
3	7	25	16	10	25										
11	8	26	17	14	26										
	9		18	15	27										

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	25 September 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	16B

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
424/459
IPR2025-01251 Page 00424

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Application Number	16669794
	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	2886
	Examiner Name	RAHMAN, MD M
	Attorney Docket Number	OMNI0102PUSA6

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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
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	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]

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16669794
	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	2886
	Examiner Name	RAHMAN, MD M
	Attorney Docket Number	OMNI0102PUSA6

	1	Inter Partes Review No IPR2019-00916; Final Written Decision of US Patent No. 9,651,533 Apple Inc. v. OMNI MEDSCI, INC.; pps. 1-67; dated October 14, 2020.	

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16669794
	Filing Date	2019-10-31
	First Named Inventor	Mohammed N. ISLAM
	Art Unit	2886
	Examiner Name	RAHMAN, MD M
	Attorney Docket Number	OMNI0102PUSA6

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	/Andrew B. Turner/	Date (YYYY-MM-DD)	2020-10-20
Name/Print	Andrew B. Turner	Registration Number	63121

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.**

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.

Electronic Acknowledgement Receipt

EFS ID:	40888710
Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6
Receipt Date:	20-OCT-2020
Filing Date:	31-OCT-2019
Time Stamp:	15:37:33
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	Information Disclosure Statement (IDS) Form (SB08)	OMNI0102PUSA6_IDS_IPR_2020Oct.PDF	619609 61908f863d51bfae1eca5513f6888ad2521e6cf5	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.					
2	Other Reference-Patent/App/Search documents	IPR2019_00916_20201014.PDF	962227 2b24ecc6e9b83d77cc6cee88ac8e83ed8a17e56a	no	67
Warnings:					
Information:					
			Total Files Size (in bytes):	1581836	

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

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

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New International Application Filed with the USPTO as a Receiving Office

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UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/669,794	10/31/2019	Mohammed N. ISLAM	OMNI0102PUSA6	7663

7590 10/23/2020

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	

NOTIFICATION DATE	DELIVERY MODE
10/23/2020	ELECTRONIC

NOTICE OF NON-COMPLIANT INFORMATION DISCLOSURE STATEMENT

An Information Disclosure Statement (IDS) filed *10/20/2020* in the above-identified application fails to meet the requirements of 37 CFR 1.97(d) for the reason(s) specified below. Accordingly, the IDS will be placed in the file, but the information referred to therein has not been considered.

The IDS is not compliant with 37 CFR 1.97(d) because:

☑ The IDS lacks a statement as specified in 37 CFR 1.97(e).

☐ The IDS lacks the fee set forth in 37 CFR 1.17(p).

☐ The IDS was filed after the issue fee was paid. Applicant may wish to consider filing a petition to withdraw the application from issue under 37 CFR 1.313(c) to have the IDS considered. See MPEP 1308.

N. Horne, for

571-272-4200 or 1-888-786-0101
Application Assistance Unit
Office of Data Management

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.: 16/669794

Filed: 10/31/2019

For: SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

Attorney Docket No.: OMNI0102PUSA6

SECOND AMENDMENT AFTER ALLOWANCE
UNDER 37 C.F.R. § 1.312

Mail Stop Issue Fee
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:

Electronic Acknowledgement Receipt

EFS ID:	41049482
Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6
Receipt Date:	05-NOV-2020
Filing Date:	31-OCT-2019
Time Stamp:	17:21:25
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		OMNI0102PUSA6_Second_amendment_after_allowance.pdf	118370 bc86960d56121bbf2aad0a961bd1477048392b68	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Applicant Arguments/Remarks Made in an Amendment	10	10
	Claims	2	9
	Amendment after Notice of Allowance (Rule 312)	1	1
Warnings:			
Information:			
	Total Files Size (in bytes):	118370	

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.

Remarks

Applicant amends claims 5, 8, 12, 15, 21, 22, 26, 27, 30 and 31 to address informalities.

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: November 5, 2020

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Amendments to the Claims:

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

1. (Previously Presented) A measurement system comprising:

a light source comprising a plurality of semiconductor sources that are configured to generate an output optical beam with one or more optical wavelengths, the light source configured to increase signal-to-noise ratio by increasing a light intensity relative to an initial light intensity from at least one of the plurality of semiconductor sources;

a measurement device configured to:

receive a portion of the output optical beam, and

deliver an analysis output beam to a sample;

a receiver configured to:

receive and process at least a portion of the analysis output beam reflected or transmitted from the sample,

generate an output signal representing at least in part a non-invasive measurement on blood contained within the sample,

synchronize to the light source,

capture light while the semiconductor sources are off and convert the captured light into a first signal,

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a part of the at least a portion of the analysis output beam reflected or transmitted from the sample, and

the measurement system further configured to improve the signal-to-noise ratio by differencing the first signal and the second signal;

a 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,

store and display the processed output signal, and

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transmit at least a portion of the processed output signal over a wireless transmission link; and

a cloud configured to:

receive, over the wireless transmission link, an output status comprising the at least a portion of the processed output signal,

process the received output status to generate processed data, and

store the processed data.

2.-3. (Cancelled)

4. (Previously Presented) The measurement system of claim 22, wherein the measurement system is configured to use artificial intelligence in making decisions;

wherein the measurement system is configured to perform pattern identification or classification, and wherein the measurement system is configured to apply a threshold function to a comparison with a stored data set; and

wherein the measurement system is at least in part configured for selection or identification of an object, and wherein the measurement system is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

5. (Currently Amended) The measurement system of claim 22, wherein the light source is configured to further increase signal-to-noise ratio by increasing a pulse rate of at least one of the plurality of semiconductor sources from an initial non-zero pulse rate.

6. (Previously Presented) The measurement system of claim 1, wherein the plurality of semiconductor sources comprises at least one of: light emitting diodes (LEDs), laser diodes (LD's), tunable LD's, and super-luminescent laser diodes (SLDs), and wherein the measurement system further comprises a reflective surface to receive and redirect at least some of the at least a portion of the analysis output beam reflected or transmitted from the sample.

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7. (Original) The measurement system of claim 1, wherein the light source is further configured to increase the light intensity from the plurality of semiconductor sources by spatially coupling the optical output beam from at least two of the plurality of semiconductor sources.

8. (Currently Amended) A measurement system comprising:

a wearable measurement device for measuring one or more physiological parameters, including a light source comprising a plurality of semiconductor sources that are configured to generate an output optical beam with one or more optical wavelengths;

the light source configured to increase signal-to-noise ratio by increasing a light intensity relative to an initial light intensity from at least one of the plurality of semiconductor sources;

the wearable measurement device configured to receive a portion of the output optical beam and to deliver an analysis output beam to a sample;

the wearable measurement device further comprising a receiver configured to:

receive and process at least a portion of the analysis output beam reflected or transmitted from the sample,

generate an output signal representing at least in part a non-invasive measurement on blood contained within the sample,

synchronize to ~~pulses of~~ the light source,

capture light while the semiconductor sources are off and convert the captured light into a first signal,

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a part of the at least a portion of the analysis output beam reflected or transmitted from the sample,

wherein the measurement system is further configured to improve the signal-to-noise ratio by differencing the first signal and the second signal;

a 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

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signal, to store and display the processed output signal, and to transmit a portion of the processed output signal over a wireless transmission link; and

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, and wherein the cloud is capable of storing a history of at least a portion of the received output status over a specified period of time.

9.-10. (Cancelled)

11. (Previously Presented) The measurement system of claim 8, wherein the measurement system is configured to use artificial intelligence in making decisions;

wherein the measurement system is configured to perform pattern identification or classification, and wherein the measurement system is configured to apply a threshold function to a comparison with a stored data set; and

wherein the measurement system is at least in part configured for selection or identification of an object, and wherein the measurement system is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

12. (Currently Amended) The measurement system of claim 11, wherein the light source is configured to further ~~increase~~ increase the signal-to-noise ratio by ~~one of~~ increasing a pulse rate of at least one of the plurality of semiconductor sources from an initial non-zero pulse rate.

13. (Previously Presented) The measurement system of claim 8, wherein the plurality of semiconductor sources comprises at least one of: light emitting diodes (LEDs), laser diodes (LD's), tunable LD's, and super-luminescent laser diodes (SLDs), and the measurement system further comprising a reflective surface to receive and redirect at least some of the at least a portion of the analysis output beam reflected or transmitted from the sample.

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14. (Original) A wearable device for use with a smart phone or tablet, the wearable device comprising:

a measurement device including a light source comprising a plurality of semiconductor sources for measuring one or more physiological parameters, the measurement device configured to:

generate, by modulating at least one of the semiconductor sources having an initial light intensity, an input optical beam having one or more optical wavelengths, and

receive and to deliver a portion of the input optical beam to tissue, wherein the tissue reflects at least a portion of the input optical beam delivered to the tissue;

the measurement device further comprising a receiver configured to:

capture light while the semiconductor sources are off and convert the captured light into a first signal, and

capture light while at least one of the semiconductor sources is on and convert the captured light into a second signal, the captured light including at least a portion of the input optical beam reflected from the tissue;

synchronize to the modulation of the at least one of the semiconductor sources;

the measurement device further configured to improve a signal-to-noise ratio of the input optical beam reflected from the tissue by:

differencing the first signal and the second signal, and

increasing the light intensity relative to the initial light intensity from at least one of the semiconductor sources;

the measurement device further configured to generate an output signal representing at least in part a non-invasive measurement on blood contained within the tissue;

the wearable device configured to communicate with the smart phone or tablet, the smart phone or tablet comprising a wireless receiver, a wireless transmitter, a display, a voice input module, a speaker, and a touch screen; and

the smart phone or tablet configured to:

receive and to process at least a portion of the output signal,

store and display the processed output signal, and

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transmit at least a portion of the processed output signal over a wireless transmission link.

15. (Currently Amended) The wearable device of claim 14, wherein the light source is configured to further improve the signal-to-noise ratio of the input optical beam reflected from the tissue by increasing a pulse rate of at least one of the plurality of semiconductor sources from an initial non-zero pulse rate.

16. (Previously Presented) The wearable device of claim 14, further comprising a cloud configured to:

receive, over the wireless transmission link, an output status comprising the at least a portion of the processed output signal,

process the output status to generate processed data, and

store the processed data, and

wherein the cloud is capable of storing a history of at least a portion of the output status over a specified period of time.

17. (Previously Presented) The wearable device of claim 14, wherein the wearable device is configured to use artificial intelligence in making decisions;

wherein the wearable device is configured to perform pattern identification or classification, and wherein the wearable device is configured to apply a threshold function to a comparison with a stored data set; and

wherein the wearable device is at least in part configured for selection or identification of an object, and wherein the wearable device is configured to improve a signal-to-noise ratio of the selection or identification by applying regression signal processing methodologies or multivariate techniques.

18. (Cancelled)

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19. (Previously Presented) The wearable device of claim 14, wherein the measurement device further comprises a reflective surface configured to receive and redirect at least a portion of light reflected from the tissue.

20. (Cancelled)

21. (Currently Amended) The measurement system of claim 25~~claim 1~~, wherein the plurality of semiconductor sources comprises six light emitting diodes, and wherein the receiver comprises six detectors.

22. (Currently Amended) The measurement system of claim 21, wherein the six detectors are located on the first arc ~~an arc~~ surrounding the six light emitting diodes.

23. (Previously Presented) The measurement system of claim 1, wherein the receiver comprises a plurality of detectors arranged along a first arc, and wherein the plurality of semiconductor sources are arranged along a second arc.

24. (Previously Presented) The measurement system of claim 23, wherein the first arc is offset from the second arc.

25. (Previously Presented) The measurement system of claim 23, wherein the first arc and the second arc are concentric.

26. (Currently Amended) The measurement system of claim 29~~claim 12~~, wherein the plurality of semiconductor sources comprises six light emitting diodes, and wherein the receiver comprises six detectors.

27. (Currently Amended) The measurement system of claim 26, wherein the six detectors are located on the first arc ~~an arc~~ surrounding the six light emitting diodes.

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28. (Previously Presented) The measurement system of claim 8, wherein the receiver comprises a plurality of detectors arranged along a first arc, and wherein the plurality of semiconductor sources are arranged along a second arc that is offset from the first arc.

29. (Previously Presented) The measurement system of claim 28, wherein the first arc and the second arc are concentric.

30. (Currently Amended) The wearable device of claim 33~~claim 15~~, wherein the plurality of semiconductor sources comprises six light emitting diodes, and wherein the receiver comprises six detectors.

31. (Currently Amended) The wearable device of claim 30, wherein the six detectors are located on the first arc ~~an arc~~ surrounding the six light emitting diodes.

32. (Previously Presented) The wearable device of claim 15, wherein the receiver comprises a plurality of detectors arranged along a first arc, and wherein the plurality of semiconductor sources are arranged along a second arc that is offset from the first arc.

33. (Previously Presented) The wearable device of claim 32, wherein the first arc and the second arc are concentric.

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IPR2025-01251 Page 00443

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/669,794	10/31/2019	Mohammed N. ISLAM	OMNI0102PUSA6	7663

109543 7590 11/13/2020

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	

NOTIFICATION DATE	DELIVERY MODE
11/13/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@brookskushman.com

Response to Rule 312 Communication	Application No.	Applicant(s)	
	16/669,794	ISLAM, Mohammed N.	
	Examiner	Art Unit	AIA (FITF) Status
	MD M RAHMAN	2886	Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

1. ☑ The amendment filed on 05 November 2020 under 37 CFR 1.312 has been considered, and has been:
   a) ☑ entered.
   b) ☐ entered as directed to matters of form not affecting the scope of the invention.
   c) ☐ disapproved because the amendment was filed after the payment of the issue fee.
      Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.
   d) ☐ disapproved. See explanation below.
   e) ☐ entered in part. See explanation below.

/MD M RAHMAN/
Primary Examiner, Art Unit 2886

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063

OK TO ENTER: /M.M.R/

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.: 16/669794

Filed: 10/31/2019

For: SEMICONDUCTOR SOURCE BASED NEAR INFRARED MEASUREMENT DEVICE WITH IMPROVED SIGNAL-TO-NOISE RATIO

Attorney Docket No.: OMNI0102PUSA6

SECOND AMENDMENT AFTER ALLOWANCE
UNDER 37 C.F.R. § 1.312

Mail Stop Issue Fee
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:

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 08/14/2020
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.

Amy Tanner	(Typed or printed name)
/Amy Tanner/	(Signature)
November 13, 2020	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/669,794	10/31/2019	Mohammed N. ISLAM	OMNI0102PUSA6	7663

TITLE OF INVENTION: SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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	11/16/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
RAHMAN, MD M	2886	356-300000

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 BROOKS KUSHMAN P.C.
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: OMNI MEDSCI, INC.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Ann Arbor, MI

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. 023978

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 /Andrew B. Turner/ Date November 13, 2020

Typed or printed name Andrew B. Turner Registration No. 63121

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Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
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Electronic Patent Application Fee Transmittal

Application Number:	16669794
Filing Date:	31-Oct-2019
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	2501	1	500	500

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**500**

Electronic Acknowledgement Receipt	
EFS ID:	41114480
Application Number:	16669794
International Application Number:	
Confirmation Number:	7663
Title of Invention:	SEMICONDUCTOR SOURCE BASED NEAR INFRARED 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:	OMNI0102PUSA6
Receipt Date:	13-NOV-2020
Filing Date:	31-OCT-2019
Time Stamp:	14:27:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$500
RAM confirmation Number	E2020ACE27329098
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	Issue Fee Payment (PTO-85B)	OMNI0102PUSA6_issue_fee.PDF	196689 7208e6124a989a0adef6b70ebf7486581b0b6f4d	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30437 016543bf37b8219e97b4ecae2ac5ad6fcf9ae9b9	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	227126		

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

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/669,794	10/31/2019	Mohammed N. ISLAM	OMNI0102PUSA6	7663

109543 7590 11/25/2020

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	

NOTIFICATION DATE	DELIVERY MODE
11/25/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@brookskushman.com

Corrected ***Notice of Allowability***	**Application No.** 16/669,794	**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 11/19/20.
   ☐ 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 1,4-8,11-17,19 and 21-33 . 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

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

CPC						
Symbol					**Type**	**Version**
A61B	/	5	/	0088	F	2013-01-01
A61B	/	5	/	7203	I	2013-01-01
A61B	/	5	/	0075	I	2013-01-01
A61B	/	5	/	4547	I	2013-01-01
A61C	/	19	/	04	I	2013-01-01
G16H	/	40	/	67	I	2018-01-01
A61B	/	5	/	0013	I	2013-01-01
A61B	/	5	/	0022	I	2013-01-01
A61B	/	5	/	0086	I	2013-01-01
A61B	/	5	/	14532	I	2013-01-01
A61B	/	5	/	14546	I	2013-01-01
A61B	/	5	/	1455	I	2013-01-01
A61B	/	5	/	6801	I	2013-01-01
A61B	/	5	/	7257	I	2013-01-01
A61B	/	5	/	7405	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
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G01J	/	3	/	453	I	2013-01-01
G01N	/	21	/	35	I	2013-01-01
G01N	/	21	/	3563	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
G01N	/	33	/	02	I	2013-01-01
G01N	/	33	/	025	I	2013-01-01
G01N	/	33	/	15	I	2013-01-01

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	20 November 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	16B

U.S. Patent and Trademark Office — Part of Paper No.: 20201120

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

CPC						
Symbol					**Type**	**Version**
G01N	/	33	/	442	I	2013-01-01
G01N	/	33	/	49	I	2013-01-01
G06F	/	19	/	00	I	2013-01-01
H01S	/	3	/	06758	A	2013-01-01
H01S	/	3	/	0092	A	2013-01-01
A61B	/	5	/	0024	A	2013-01-01
A61C	/	1	/	0046	A	2013-01-01
A61B	/	2562	/	0233	A	2013-01-01
A61B	/	2562	/	0238	A	2013-01-01
A61B	/	2562	/	146	A	2013-01-01
A61B	/	2576	/	02	A	2013-01-01
G01J	/	3	/	1838	A	2013-01-01
G01J	/	2003	/	104	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
G01N	/	21	/	85	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
G01N	/	2201	/	08	A	2013-01-01
G01N	/	2201	/	12	A	2013-01-01
G01N	/	2201	/	129	A	2013-01-01
H01S	/	3	/	302	A	2013-01-01

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	20 November 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	16B

Omni MedSci Ex. 2029
Samsung Electronics Co. Ltd., et al., v. Omni MedSci - PGR2025-00063
455/459
IPR2025-01251 Page 00455

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

CPC Combination Sets									
Symbol						**Type**	**Set**	**Ranking**	**Version**
	/		/						

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	20 November 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	16B

U.S. Patent and Trademark Office — Part of Paper No.: 20201120

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	ISLAM, Mohammed N.
	Examiner	**Art Unit**
	MD M RAHMAN	2886

INTERNATIONAL CLASSIFICATION					
CLAIMED					
G01J	/	3	/	00	
NON-CLAIMED					
	/		/		

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**
356	300

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886 (Primary Examiner)	20 November 2020 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 16B

U.S. Patent and Trademark Office — Part of Paper No.: 20201120

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/669,794	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	27	19	15	28								
	2	12	11		20	16	29								
	3	13	12	7	21	23	30								
9	4	14	13	8	22	24	31								
10	5	19	14	4	23	21	32								
2	6	20	15	5	24	22	33								
3	7	25	16	6	25										
11	8	26	17	17	26										
	9		18	18	27										

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	27	
/MD M RAHMAN/ Primary Examiner, Art Unit 2886	20 November 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	16B

U.S. Patent and Trademark Office — Part of Paper No.: 20201120

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/669,794	12/29/2020	10874304	OMNI0102PUSA6	7663

109543 7590 12/09/2020

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

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

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 Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Mohammed N. ISLAM, Ann Arbor, MI;
Omni Medsci, Inc., Ann Arbor, MI;

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