Технічні науки

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LASER TECHNOLOGY AND COMPLEX TECHNICAL SYSTEMS

Laser Technology and Complex Technical Systems in Devices and Instruments for Ophthalmology Using Artificial Intelligence Elements Related to Artificial Neural Networks

Summary. *Uniform monochromatic lighting of the operational zone is essential for a wide range of automated production processes.*

Standard-type lasers, under certain conditions, form point-distorted structures and are unsuitable for creating a uniform monochromatic light flow in areas such as an operational zone.

LEDs do not produce distorted structures, but they have lower brightness.

Additionally, LED radiation is non-uniform in the far field.

To comprehensively address this issue, the proposed invention utilizes a phosphor droplet at the fiber end, where the luminous body size is determined either by the droplet diameter (100–150 µm) or the fiber core diameter (30–50 µm).

The invented technology, integrated into a technical supersystem, is so flexible and adaptive that it allows for the incorporation of the most effective and cutting-edge local technical systems during system formation, including high-speed electronic boards (so-called RITM boards) and the most efficient structural materials, including composite materials, carbon-carbon compositions (obtained through vacuum pyrolysis on viscose fabrics), and films made of synthetic diamonds.

The application of these innovative subsystems confidently provides advantages related specifically to the characteristics of laser diodes.

The monochromatic factor of light emission, when using the proposed invention, eliminates chromatic aberration and increases resolution.

Key words: *Laser Technology, Complex Technical Systems, Ophthalmology Instruments, Phosphor Droplet, Monochromatic Light Flow, LEDs, Efficient Structural Materials, Specifics of Laser Diodes, High-Speed Electronic Boards, RHYTHM Boards, Chromatic Aberration, Carbon-Carbon Composites.*

Fig. 1. The figure shows a comprehensive technical system for laser backlighting for ophthalmology needs, implementing a product with the use of artificial intelligence elements connected to artificial neural networks, under the general name "Light Emitting Apparatus with Integrated Emitter"

There is a whole range of medical technologies and a variety of related technologies in which the use of the distinctive features of the aforementioned invention brings a noticeable technical and economic effect. Possible applications of the invention "Light Emitting Apparatus with Integrated Emitter."

1. Machine Vision. For a number of processes, medical and various types of automated production processes, uniform monochromatic light is required to illuminate the operating area.

Standard lasers, under certain conditions, form point-like distorted structures and are unsuitable for creating a uniform monochromatic light flow, for example, in an operating zone.

LEDs do not create distorted structures but also have lower brightness.

Furthermore, the radiation from an LED is non-uniform in the far field.

Here, the solution to the problem is provided by the proposed invention with a drop of phosphor on the fiber's end, where the size of the light-emitting body is determined by the diameter of the drop—100-150 microns—or the fiber core diameter—30-50 microns.

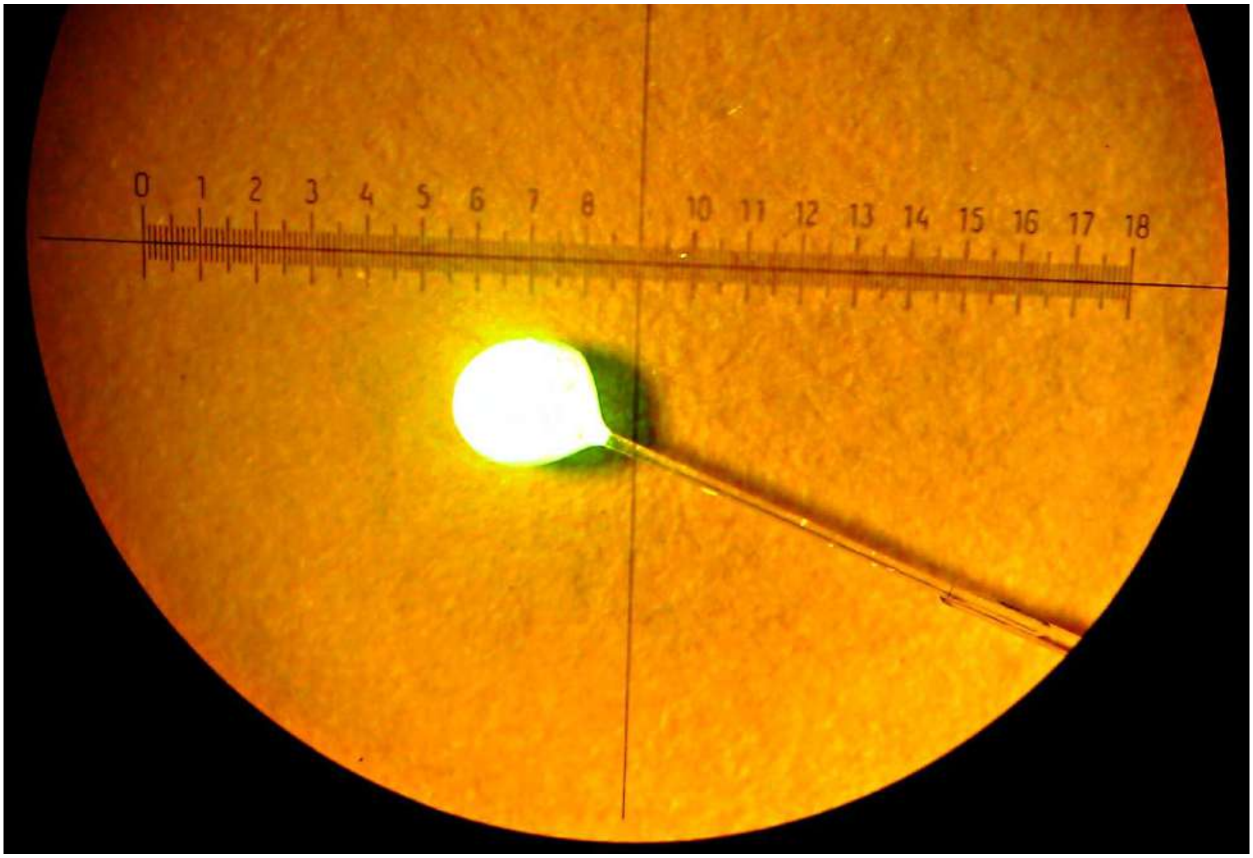

Fig. 2. The figure shows a drop of phosphor mixed with a transparent optical lacquer at the end of the fiber introduced into the microscope at the threshold of generation with the microscope lamp turned on

The application of the distinctive features of the above invention allows for a fundamental change in the situation. This refers to the size of the drop, which is 3 times smaller than that of an LED (light-emitting diode). Additionally, the light will be more uniform and stable.

The cost of a standard machine vision system ranges from $2,000 to $50,000.

The proposed light-emitting device is expected to be 35-50% cheaper in any configuration and version of the device.

The durability of the proposed device is determined by the lifespan of the laser diode.

The proposed device provides all possible versions for increasing the durability of the laser diode, including intensive cooling, a modified installation module with controlling and regulating electronics operating in the radiofrequency range, selective material selection, and special coatings, including films made from artificial diamonds, its durability can be expected to be 10,000 hours or more.

2. Lighting systems in microscopes, primarily in microscopes used in various medical laboratories.

First, it is necessary to compare the complexity and labor intensity of manufacturing the invented technical system with traditionally used technical systems.

The invented technology, integrated into the technical subsystem, is so flexible and adaptive that it allows for the application of the most effective and new local technical systems during system formation, including:

- high-speed electronic boards
- the most efficient construction materials, including composite materials, such as carbon-carbon composites (obtained using pyrolysis methods in a vacuum on viscose fabrics) and including films made from artificial diamonds.

The application of the mentioned innovative subsystems confidently provides advantages related specifically to the characteristics of laser diodes.

The monochromatic factor of light emission in the proposed invention allows for the elimination of chromatic aberration and increases resolution.

The cost of the lighting system in various types of microscopes currently ranges from $2,000.

The energy consumption for lighting using the proposed invention should be reduced by 85-95%, and the cost of the proposed version of the invention is lower than the existing one by at least 50-60%.

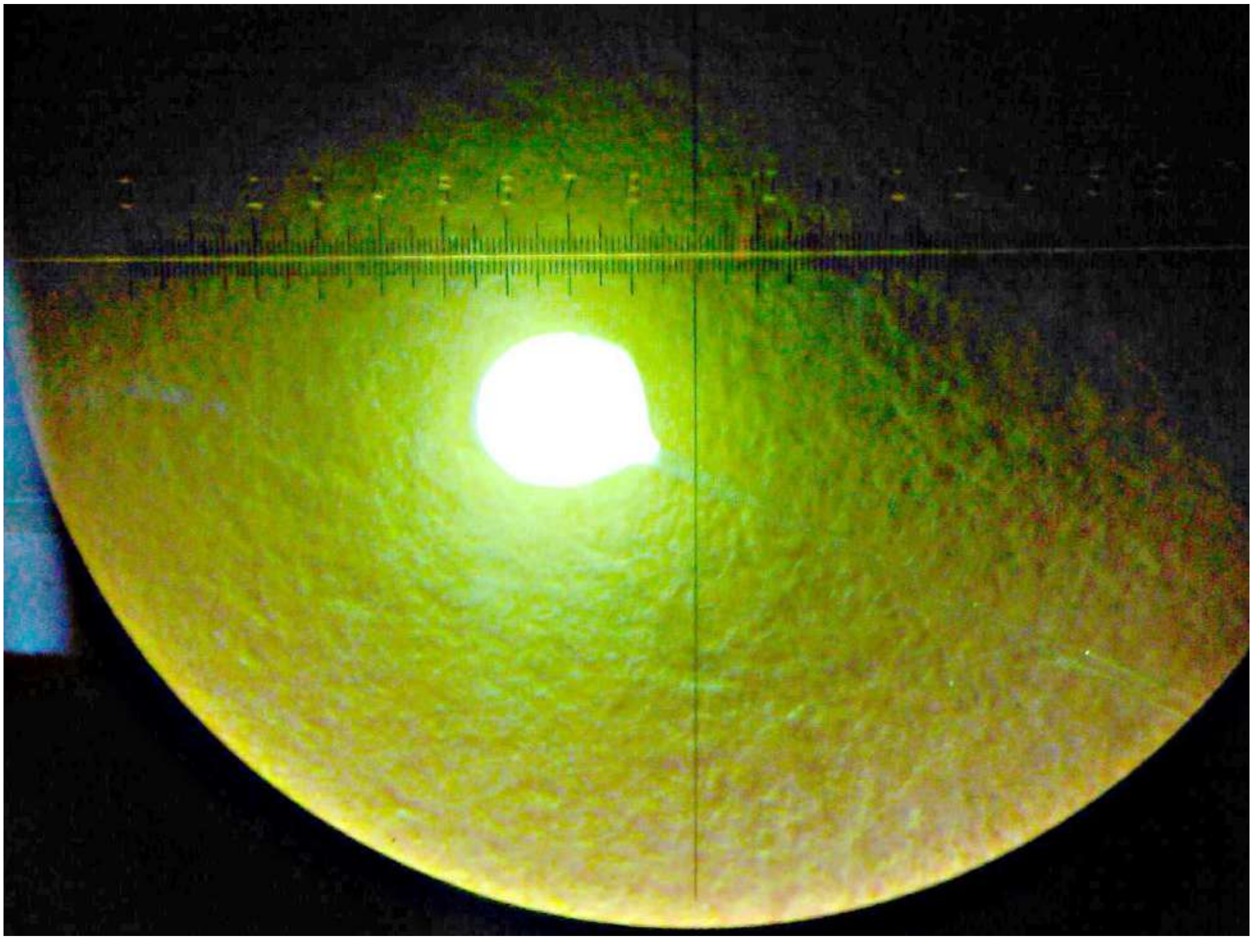

Fig. 3. The figure shows a drop of phosphor mixed with optically transparent varnish, fixed at the end of a fiber in a microscope at the threshold of generation with the microscope lamp turned off

The application of the proposed invention fundamentally changes and improves the overall technical characteristics of microscopes, which defines an expansion of the scope of use in all fields of engineering and technology, and significantly in medicine.

The durability of the proposed apparatus is also determined by the longevity of the laser diode.

Since all possible versions for increasing the durability of the laser diode in the proposed apparatus are provided, including intensive cooling, a modified mounting module with control and regulating electronics working in the radio frequency range, selective material selection, and special coatings, including films made from synthetic diamonds, the durability can be assumed to be 10,000 hours or more.

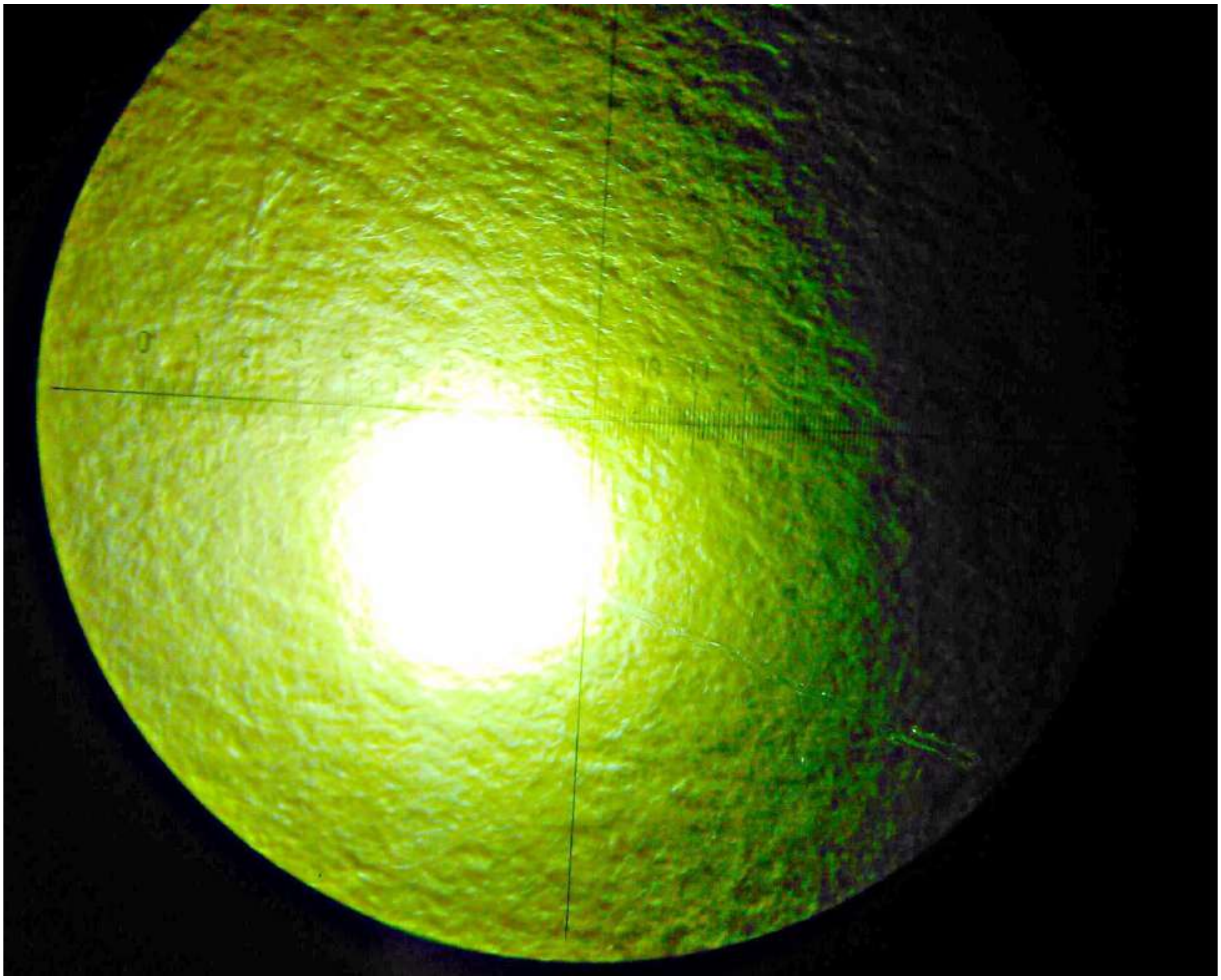

Fig. 4. The figure shows a drop at the end of the fiber transferred to the microscope in a state equivalent to 2 mW of generation with the microscope lamp turned off

3. The use of the proposed device in medicine, medical technologies, and medical equipment.

This primarily concerns endoscopy of all types and varieties.

Again, the optical fiber with the drop of phosphor allows illuminating the entire surrounding area, as the beams will spread in all directions.

Currently, there is an issue since only a narrow area is illuminated, determined by the divergence of radiation from the fiber. In our case, by using the proposed device, lighting in all colors, including white, can be achieved, enabling procedures such as photodynamic therapy and ultraviolet irradiation (additional diagnostic and treatment capabilities).

According to preliminary estimates, the cost of the lighting system for the endoscope, implemented following the proposed invention, will be 35-45% lower, and the efficiency of the endoscope and the entire endoscopic operation will increase significantly.

The durability of the proposed device is also determined by the durability of the laser diode. Since the proposed device includes all possible versions of increasing durability, such as intensive cooling, a modified installation module with controlling and regulating electronics operating in the radio frequency range, selective material selection, and special coatings, including films made from synthetic diamonds, the durability can be estimated to be 10,000 hours or more.

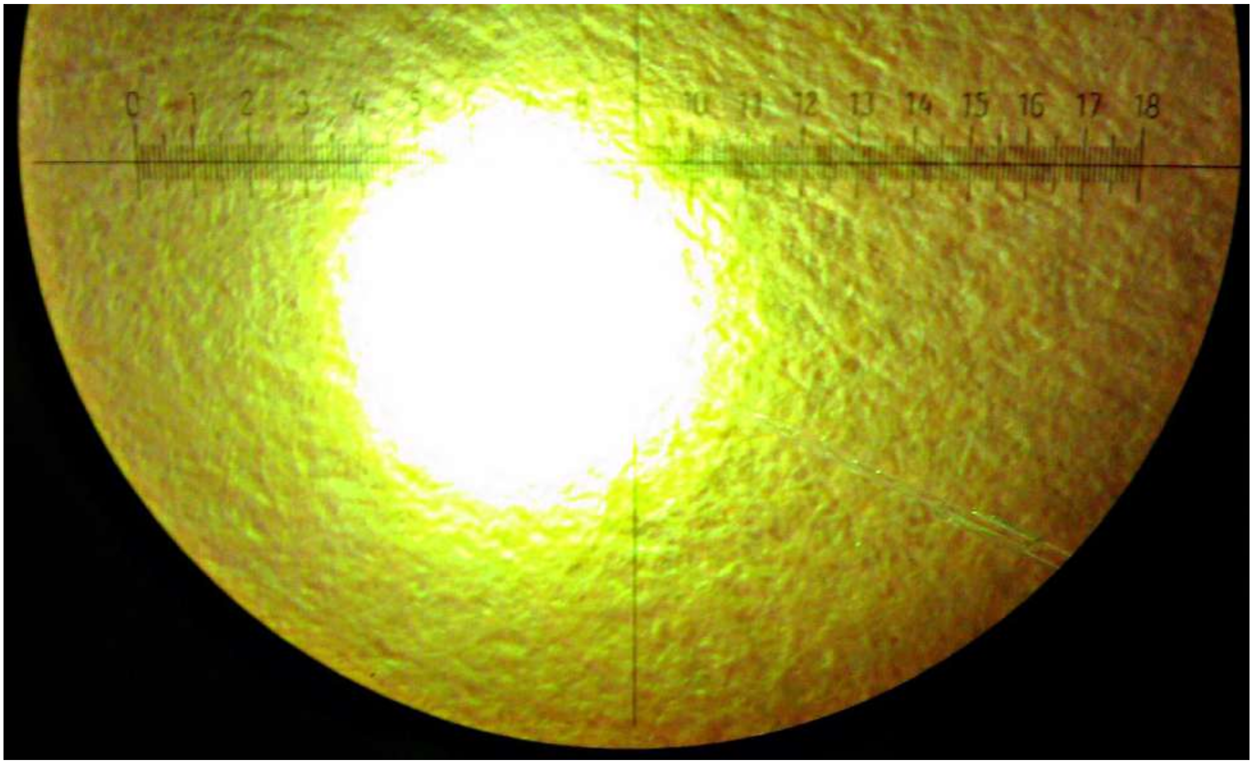

Fig. 5. The figure shows the (formed drop) at the end of the fiber, inserted into the microscope, in a state equivalent to 2 mW of generation with the microscope lamp turned on

4. Another application of the invention in medicine – lighting the surgical field.

Optical fiber can easily be attached to the finger or tool (scalpel, clamp). This possibility is especially important in ophthalmology.

In this case, it is necessary to evenly illuminate the sclera of the eye. The fiber used for this purpose is thin – with a diameter of 100 μm. It can be easily inserted into the eye without causing harm and illuminate the sclera in all directions. This is considered a very important factor is ensuring the success of the operation.

The cost of the proposed local surgical field lighting system may be around $3000.

The durability of the proposed device is also determined by the longevity of the laser diode. Since the device incorporates all possible versions for enhancing the longevity of the laser diode, such as intensive cooling, a modified mounting module with controlling and regulating electronics working in the radio frequency range, selective material selection, and special coatings, including artificial diamond films, the durability can be estimated at 10,000 hours or more.

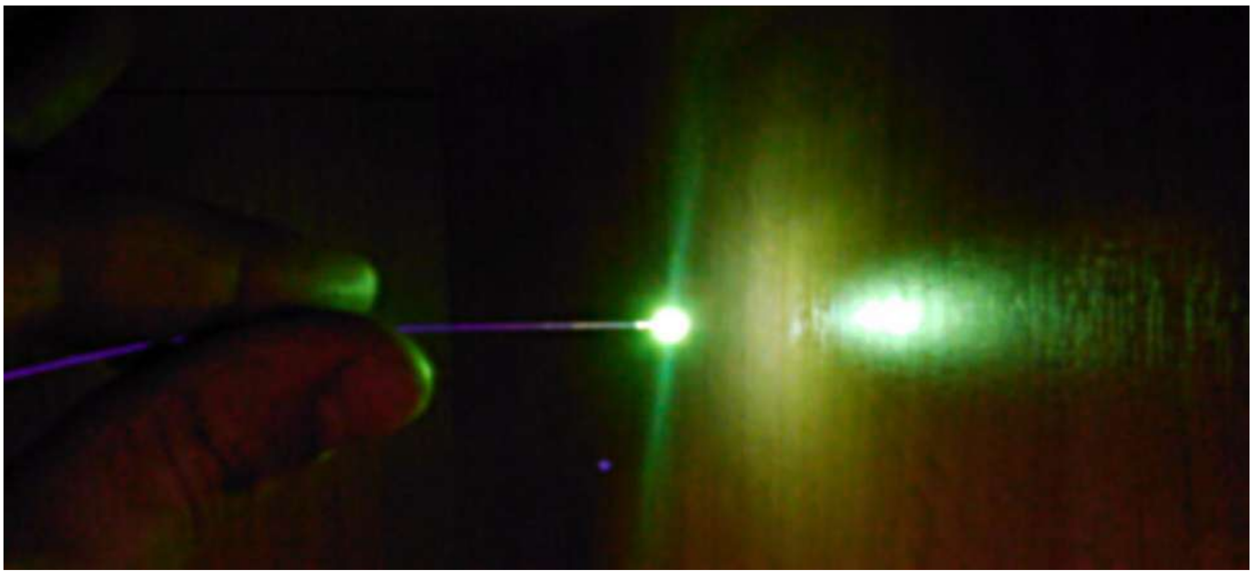

Fig. 6. The figure shows the characteristic glow of the technical subsystem in a darkened area

As the first experiments showed, even on a module composed of standard components, everything works easily and confirms all the calculated assumptions. The light-to-light conversion efficiency is very high, even with a poor, non-selectively chosen phosphor.

The image in Figure 6 immediately suggests new applications, based on the obviously small weight and size of the light source—lighting in hard-to-reach places and lighting of localized areas. For example, once again, primarily in medicine.

Dentistry – illumination of the oral cavity using compact light sources installed on standard medical instruments. Such a local lighting system can be embedded into a dental mirror, a saliva suction system, etc.

In laboratory research – illumination during endoscopic methods. Moreover, it is possible to combine this with fluorescence-based diagnostic methods, including for blood vessels. Local operations with photochemical reactions can be performed by providing illumination at the required wavelength.

In surgery, it is also possible to illuminate dark areas during diagnostic laparoscopy.

Additionally, when developing new applications for the technology, it should be considered that phosphors maintain their fluorescent capability up to very high temperatures, around 600 degrees Celsius.

The technology can be used to create applications for localized or special lighting of hot zones. For example, you could insert fiber with phosphor into the tip of a hot soldering iron to provide visual feedback and monitor the soldering process in real time.

The developers have now taken new photos of the same module with the same phosphor. They have formed a drop of optically transparent lacquer mixed with the necessary type of phosphor at the tip of the 125-micron diameter fiber.

In the initial phase of the experiment, to obtain comparative feedback on the effectiveness of the technical solution, the phosphor was simply placed next to the fiber tip.

The researchers were pleasantly surprised to find that the power of the emitted light was 1 mW when the laser pump light power was 2 mW. This is an exceptionally good result, especially considering that the phosphor was not specially selected.

Other variations of the design are also possible:

- The optical fiber diameter is 125 microns.

- The emitter can have different geometrical shapes.
- The emitter material can be a phosphor or a mixture of phosphors combined with optically transparent adhesive (as one option). The most preferred option is mixing phosphors or their blends with a monomer of an optically transparent and chemically resistant polymer material, such as polymethyl methacrylate (PMMA), polycarbonate, or other materials, followed by polymerization with contactless heating in a vacuum or using microwave technology.

The outer diameter of the emitter should not exceed 0.45 millimeters.

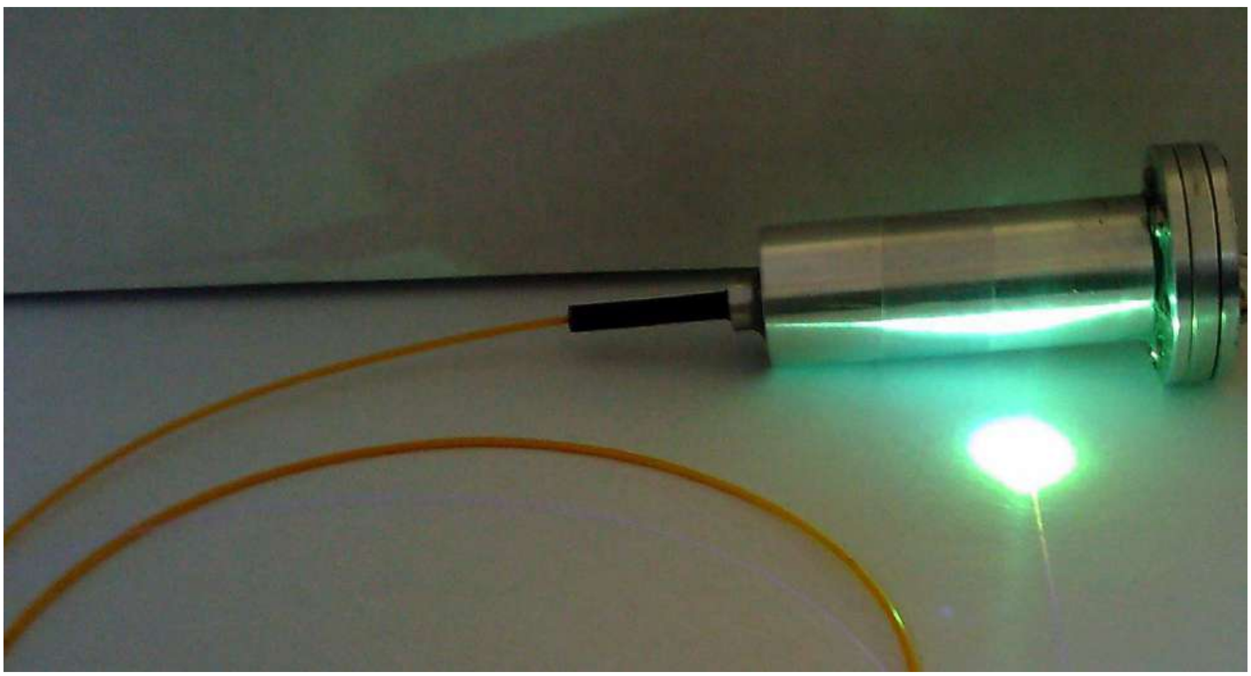

Fig. 7. The figure shows the external appearance of the same module, an optical fiber with a droplet of phosphor mixed with optically transparent lacquer, while the laser is in the generation state

As the results of the comprehensive analysis have shown, this same technical system in various design versions can find effective application in many other technologies, as well as at the intersection of different technologies. Examples include:

5. Online Inspection System for the Condition of Nuclear Reactor Shells and Systems Near Nuclear Reactors.

It is assumed that the proposed version of the invention could cost several hundred thousand dollars.

Several hundred of these devices are needed worldwide. Additionally, several hundred of these devices are required for the inspection of nuclear reactors on submarines and other objects with nuclear power plants.

The durability of the proposed device is also determined by the longevity of the laser diode.

Due to the fact that the proposed device for the laser diode includes all possible versions for increasing longevity, such as intensive cooling, a modified installation module with control and regulation electronics operating in the radio frequency range, selective material selection, and special coatings, including artificial diamond films, the durability can be estimated to be 10,000 hours or more.

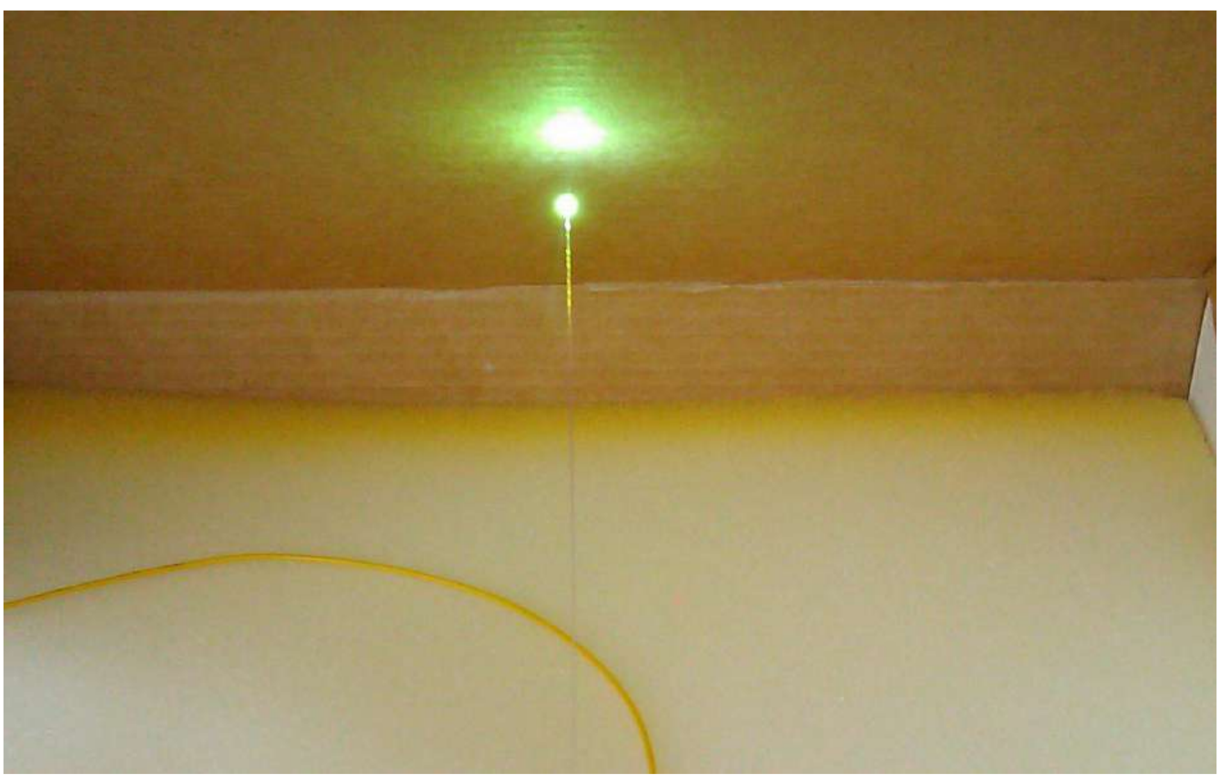

Fig. 8. The figure shows how the light from the phosphor falls onto the screen

6. Underwater lighting systems, particularly for submersibles and divers. The estimated cost can reach up to $100,000.

There are also other variants of standalone products built on the same principle.

Standalone product – light source;

The demand, in the case of single-use products, is over 5,000 units per month. A single-use version is possible at a lower price than the cost of a similar product currently produced and used.

For a reusable version, the estimated demand is around 3,000 modules per month. There is significant potential for the development of numerous special applications for the product.

The standalone product, for which the current demand is at least 5,000 sets per month;

The potential market demand exceeds 1,000,000 sets per month; single-use product; The drawback of the currently produced and sold product is its insufficient light intensity.

Fig. 9. The figure shows how the light from the phosphor falls into the corner of the box

The durability of the proposed device has many component elements, but the durability of the lighting system itself is also determined by the durability of the laser diode. All possible versions for increasing the durability of the laser diode are provided in the proposed device, including intensive cooling, a modified installation module with controlling and regulating electronics working in the radio frequency range, selective selection of materials and special coatings, including artificial diamond films, the durability can be assumed to be 10,000 hours or more.

The durability of the proposed device has many component elements, but the durability of the lighting system itself is also determined by the durability of the laser diode. All possible versions for increasing the durability of the laser diode are provided in the proposed device, including intensive cooling, a modified installation module with controlling and regulating electronics working in the radio frequency range, selective selection of materials and special coatings, including artificial diamond films, the durability can be assumed to be 10,000 hours or more.

7. Underwater communication between divers, ships, and submarines.

Green light in the coastal zone, blue in the ocean. Communication range up to 100 meters. Communication from the ship to the submersible – up to 10,000 meters.

The price of the integrated system is approximately one million dollars, especially if the system is required for use in military operations or emergency and technological disaster situations.

The durability of the proposed device consists of many components, but the durability of the lighting system itself is also determined by the durability of the laser diode. All possible versions for increasing the durability of the laser diode are provided in the proposed device, including intensive cooling, a modified installation module with controlling and regulating electronics working in the radio frequency range, selective selection of materials and special coatings, including artificial diamond films, the durability can be assumed to be 10,000 hours or more.

In case of specific interest, this system can be further developed in more detail.

Other options:

Optical fiber diameter: 125 microns

Outer diameter of the tube (tube material – stainless steel (type 12X18H10T)): 0.6 millimeters

Inner diameter of the tube: 0.45 millimeters; the length of the tube can vary, but this does not limit the product, as the change in the tube length is compensated by the length of the optical fiber.

The emitter can have various geometric shapes; the material of the emitter is a phosphor or a mixture of phosphors, mixed with optically transparent adhesive (as an option) after polymerization or curing.

The most preferred option is the mixing of phosphors or their mixtures with a monomer of optically transparent and chemically resistant polymeric material, such as polymethyl methacrylate, polycarbonate, and others, followed by polymerization through contactless heating in a vacuum or using microwave technology.

The outer diameter of the emitter cannot exceed 0.45 millimeters.

The optical fiber diameter is 125 microns.

The emitter can have various geometric shapes.

The material of the emitter is phosphor or a mixture of phosphors mixed with optically transparent adhesive (as an option), after polymerization or curing. The most preferred option is the mixing of phosphors or their mixtures with a monomer of optically transparent and chemically resistant polymeric material, such as polymethyl methacrylate, polycarbonate, and others, followed by polymerization through contactless heating in a vacuum or using microwave technology. To achieve full neutrality and chemical resistance, it is assumed that the emitter and the associated part of the optical fiber will be coated with a synthetic diamond film of 5 microns thickness.

The outer diameter of the emitter with the diamond coating cannot exceed 0.45 millimeters.

The optical fiber diameter is 125 microns (proposed). The outer diameter of the tube (material of the tube - stainless steel (type 12X 18H10 T)) is 0.6 millimeters.

The inner diameter of the tube is 0.45 millimeters. The length of the tube may vary, but this does not limit the product since the length change of the tube is compensated by the length of the optical fiber.

The emitter can have different geometric shapes.

The material of the emitter is phosphor or a mixture of phosphors mixed with optically transparent adhesive (as an option), after polymerization or curing. The most preferred option is the mixing of phosphors or their mixture with a monomer of optically transparent and chemically resistant polymeric material, such as polymethyl methacrylate, polycarbonate, and others, followed by polymerization via contactless heating in a vacuum or using microwave technology. The outer diameter of the emitter cannot exceed 0.45 millimeters.

The optical fiber diameter is 125 microns. The outer diameter of the tube (material of the tube – stainless steel (type 12X 18H10 T)) is 0.6 millimeters.

The inner diameter of the tube is 0.45 millimeters. The length of the tube can vary, but this does not limit the product, as the change in tube length is compensated by the length of the optical fiber.

The emitter can have different geometric shapes. The material of the emitter is phosphor or a mixture of phosphors mixed with optically transparent adhesive (as an option), after polymerization or curing. The most preferred option is mixing phosphors or their mixture with a monomer of optically transparent and chemically resistant polymeric material, such as polymethyl methacrylate, polycarbonate, and others, followed by polymerization through contactless heating in a vacuum or using microwave technology. The outer diameter of the emitter cannot exceed 0.45 millimeters.

List of references, patent, and licensing information

APPENDIX 1

United States Patent Application	**20190133502**
Kind Code	**A1**
GOMI; SHINICHIRO ; et al.	**May 9, 2019**

OPTICAL ***APPARATUS*** AND INFORMATION PROCESSING METHOD

Abstract

The present technology relates to an optical ***apparatus*** and an information processing method capable of more easily obtaining an indicator value. In the optical ***apparatus*** according to the present technology, irradiation ***light*** including a predetermined irradiation wavelength band is emitted, first reflected ***light*** being a reflected ***light*** in a first wavelength band obtained by reflection of the emitted irradiation ***light*** on a predetermined object and second reflected ***light*** being reflected ***light*** in a second wavelength band obtained by reflection of the irradiation ***light*** on the object are received at a plurality of pixels; and a value of a predetermined indicator relating to a region in a predetermined range of the object is obtained on the basis of a received ***light*** amount of each of the received first reflected ***light*** and the received second reflected ***light***. For example, the present technology can be applied to optical apparatuses, electronic apparatuses, imaging apparatuses, and information processing apparatuses.

APPENDIX 2

United States Patent Application	**20190150247**
Kind Code	**A1**
Eisele; Eric Jon	**May 16, 2019**

SYSTEM AND METHOD FOR ADVANCED HORTICULTURAL LIGHTING

Abstract

Embodiments can provide a system and method of ***light*** validation in a lighting device, comprising communicating setpoint to a lighting device comprising a plurality of emitters; generating control signals for the plurality of emitters in response to the setpoint; calculating an estimate of the intensity and spectral power distribution of the composite radiant flux emitted by the lighting device through computing the control signals relative to lifetime performance data and a reference dataset. Embodiments can further provide a system and method for quality control and reporting, comprising transmitting, via a lighting device, validation signals comprising operating conditions, initial measurements, lifetime operating data, reference datasets, and spectrum and intensity estimates, and a device identifier to a central controller; receiving, via the central controller, one or more condition measurements comprising ***light*** measurements, temperature measurements, humidity measurements, moisture measurements, and nutrient chemistry measurements, and device identifiers from one or more ***light*** sensing devices and growth condition sensors.

APPENDIX 3

United States Patent Application	**20190109973**
Kind Code	**A1**
Riza; Nabeel Agha	**April 11, 2019**

SMART PHOTONIC IMAGING METHOD AND ***APPARATUS***

Abstract

The present invention provides a method for performing high dynamic range optical image detection of a scene comprising: imaging incident ***light*** from a scene onto an object plane; determining the locations of those pixels in the object plane of higher brightness; detecting the optical irradiance values of those pixels of higher brightness to produce a first detected image; detecting the optical irradiance values of those pixels of lower brightness to produce a second detected image; and generating a high dynamic range optical irradiance map of the scene by combining the first detected image and the second detected image into a single image.

APPENDIX 4

United States Patent Application	**20190121141**
Kind Code	**A1**

Dykaar; Douglas R. **April 25, 2019**

FREE SPACE MULTIPLE LASER DIODE MODULE WITH FAST AXIS COLLIMATOR

Abstract

Systems, devices, and methods for optical engines and laser projectors that are well-suited for use in wearable heads-up displays (WHUDs) are described. Generally, the optical engines of the present disclosure integrate a plurality of laser diodes (e.g., 3 laser diodes, 4 laser diodes) within a single, hermetically or partially hermetically sealed, encapsulated package. The optical engines include an optical director element that includes a curved reflective surface (e.g., parabolic cylinder) that redirects laser ***light*** beams and collimates the same along the fast axes thereof. Such optical engines may have various advantages over existing designs including, for example, smaller volumes, better manufacturability, faster modulation speed, etc. WHUDs that employ such optical engines and laser projectors are also described.

APPENDIX 5

United States Patent Application	**20190125191**
Kind Code	**A1**
Siedenburg; Clinton T.	**May 2, 2019**

LIGHT-BASED NON-INVASIVE BLOOD PRESSURE SYSTEMS AND METHODS

Abstract

Light-based non-invasive blood pressure measurement systems and methods that include a sensor having a ***light emitter and a light*** detector are disclosed. The ***light emitter emitting*** coherent or non-coherent ***light*** that is transmitted into and reflected from the tissues of the patient, including reflecting from moving blood. The ***light*** reflected from the moving blood being having a Doppler shift and detected by the ***light*** detector to generate a non-invasive blood pressure signal. The non-invasive blood pressure signal is processed to determine the instantaneous velocity of the blood. Additionally, pulse wave velocity data is obtained nearly, or substantially, simultaneously with the acquisition of the non-invasive blood

pressure signal. Using the pulse wave velocity, the instantaneous velocity of the blood and a density of the blood, an instantaneous blood pressure can be determined.

APPENDIX 6

United States Patent Application	**20190133424**
Kind Code	**A1**
Patel; Neal ; et al.	**May 9, 2019**

ENCASEMENT PLATFORM FOR SMARTDEVICE FOR ATTACHMENT TO ENDOSCOPE

Abstract

A case or encasement for use with a smart - device, such as a smartphone or tablet and an endoscope is disclosed. The encasement includes a power supply, logic for controlling wireless communications, a ***light*** source, and other accessories, for use with an endoscope. In an embodiment, the encasement includes a power supply that may be used to charge a smart - device, power a ***light*** source and a wireless communications module. Other embodiments include a mechanism for communicating between the smart - device and the encasement to control the ***light*** source and any other accessories coupled to the encasement.

APPENDIX 7

United States Patent Application	**20190131491**
Kind Code	**A1**
LEE; Duhyun ; et al.	**May 2, 2019**

LIGHT EMISSION DEVICE INCLUDING OUTPUT COUPLER AND OPTICAL ***APPARATUS*** ADOPTING THE SAME

Abstract

Provided are ***light*** emission devices including an output coupler and optical apparatuses having the same. The ***light*** emission device may include a QD layer containing quantum dots and a nano-antenna structure including an output coupler configured to control an output characteristic of ***light*** emitted from the QD layer. The output coupler may be configured to output an emission wavelength of the QD

layer. The nano-antenna structure may include one of a metallic antenna, a dielectric antenna, and a slit-containing structure, or may have a multi-patch antenna structure or a fishbone antenna structure.

APPENDIX 8

United States Patent Application	**20190117993**
Kind Code	**A1**
Lundmark; David C. ; et al.	**April 25, 2019**

SYSTEM AND METHOD FOR OPTOGENETIC THERAPY

Abstract

Configurations are described for utilizing ***light***-activated proteins within cell membranes and subcellular regions to assist with medical treatment paradigms, such as hypertension treatment via anatomically specific and temporally precise modulation of renal plexus activity. The invention provides for proteins, nucleic acids, vectors and methods for genetically targeted expression of ***light***-sensitive proteins to specific cells or defined cell populations. In particular the invention provides systems, devices, and methods for millisecond-timescale temporal control of certain cell activities using moderate ***light*** intensities, such as the generation or inhibition of electrical spikes in nerve cells and other excitable cells.

APPENDIX 9

United States Patent Application	**20190145585**
Kind Code	**A1**
VAN DE VEN; Antony Paul ; et al.	**May 16, 2019**

LIGHTING DEVICES THAT COMPRISE ONE OR MORE SOLID STATE LIGHT EMITTERS

Abstract

Light engine modules comprise a support member and a solid state ***light emitter,*** in which (1) the ***emitter*** is mounted on the support member, (2) a region of the support member has a surface with a curved cross-section, (3) the ***emitter*** and a compensation circuit are mounted on the support member, (4) an electrical contact element extends to at least two surfaces of the support member, and/or (5) a substantial entirety of the module is located on one side of a plane and the ***emitter*** emits ***light*** into another side of the plane. Also, a module comprising means for supporting a ***light emitter and a light emitter***. Also, a lighting device comprising a housing member and a ***light emitter*** mounted on a removable support member. Also, a lighting device comprising a module mounted in a lighting device element. Also, a method comprising mounting a module to a lighting device element.

APPENDIX 10

United States Patent Application	**20190109260**
Kind Code	**A1**
Khatibzadeh; Mohammad Ali ; et al.	**April 11, 2019**

ULTRA-WIDEBAND LIGHT ***EMITTING*** DIODE AND OPTICAL DETECTOR COMPRISING ALUMINUM GALLIUM ANTIMONIDE AND METHOD OF FABRICATING THE SAME

Abstract

Devices, systems, and methods for providing wireless personal area networks (PANs) and local area networks (LANs) using visible and near-visible optical spectrum. Various constructions and material selections are provided herein. According to one embodiment, a ***light-emitting*** diode (LED) includes a substrate, a carrier confinement (CC) region positioned over the substrate, an active region positioned over the CC region, and an electron blocking layer (EBL) positioned over the active region. The CC region includes a first CC layer comprising aluminum gallium antimonide and a second CC layer position over the first CC layer. The second CC layer and the electron blocking layer (EBL) also each include aluminum gallium antimonide. The active region is configured to have a transient response time of less than 500 picoseconds (ps).

APPENDIX 11

United States Patent Application	**20190145891**
Kind Code	**A1**
Waxman; Allen M. ; et al.	**May 16, 2019**

SYSTEMS AND METHODS FOR MULTISPECTRAL IMAGING AND GAS DETECTION USING A SCANNING ILLUMINATOR AND OPTICAL SENSOR

Abstract

Presented herein are systems and methods directed to a multispectral absorption-based imaging approach that provides for rapid and accurate detection, localization, and quantification of gas leaks. The imaging technology described herein utilizes a scanning optical sensor in combination with structured and scannable illumination to detect and image spectral signatures produced by absorption of ***light*** by leaking gas in a quantitative manner over wide areas, at distance, and in the presence of background such as ambient gas and vapor. Moreover, the specifically structured and scannable illumination source of the systems and methods described herein provides a consistent source of illumination for the scanning optical sensor, allowing imaging to be performed even in the absence of sufficient natural ***light,*** such as sunlight. The imaging approaches described herein can, accordingly, be used for a variety of gas leak detection, emissions monitoring, and safety applications.

APPENDIX 12

United States Patent Application	**20190128808**
Kind Code	**A1**
ASHRAFI; SOLYMAN	**May 2, 2019**

SYSTEM AND METHOD FOR MULTI-PARAMETER SPECTROSCOPY

Abstract

An ***apparatus*** for detecting a material within a sample includes a ***light emitting*** unit for directing at least one ***light*** beam through the sample. A plurality of units receive the ***light*** beam that has passed through the sample and performs a spectroscopic analysis of the sample based on the received ***light*** beam. Each of the plurality of units analyze a different parameter with respect to the sample and provide a separate output signal with respect to the analysis. A processor detects the material with respect each of the provided separate output signals.

APPENDIX 13

United States Patent Application	**20190129206**
Kind Code	**A1**
LEE; Duhyun ; et al.	**May 2, 2019**

OPTICAL MODULATING DEVICE AND ***APPARATUS*** INCLUDING THE SAME

Abstract

An optical modulating device may include a plurality of quantum dot (QD)-containing layers having QDs and a plurality of refractive index change layers. The QD-containing layers may be disposed between the refractive index change layers, respectively. The optical modulating device may be configured to modulate ***light***-emission characteristics of the plurality of QD-containing layers. At least two of the QD-containing layers may have different central emission wavelengths. At least two of the plurality of refractive index change layers may include different materials or have different carrier densities.