European Journal of Technical and Natural Sciences 2026, No 3
ISSN 2414-2352

PREMIER Publishing
ppublishing.org

DOI:10.29013/EJTNS-26-3-46-51

MODULES FOR ELECTRONIC LIGHTING SYSTEMS. (Integrative modules for electronic lighting systems in smart industrial facilities, including laser diodes, with an intensive cooling system based on diamond-copper composite materials)

Vladimir Blazhevsky [1]

[1] Vice President of the company "New Construction Technologies Odessa" Ukraine, Odesa

Cite: *Blazhevsky V. (2026). Modules for electronic lighting systems. (Integrative modules for electronic lighting systems in smart industrial facilities, including laser diodes, with an intensive cooling system based on diamond-copper composite materials). European Journal of Technical and Natural Sciences 2026, No 3.* https://doi.org/10.29013/EJTNS-26-3-46-51

Abstract

As discussed in the article, innovative integrative solutions for electronic lighting systems based on laser diodes are considered, with a focus on efficient cooling, increased light output, and reduced energy consumption. Particular attention is given to the use of diamond-copper composite materials with a pseudo-porous structure, which provide intensive heat dissipation and stabilization of laser radiation parameters.

The article describes lighting device designs that utilize optical cables, phosphors, and laser radiation conversion systems to produce safe visible-spectrum light with high efficiency. Technological aspects of manufacturing composite elements, as well as the integration of thermoelectric cooling systems, are also examined.

Special emphasis is placed on the development of miniature and flat-emitter lighting devices intended for modern optoelectronic systems. The article highlights the importance of a comprehensive approach that combines traditional technologies, advanced composite materials, and computer modeling methods.

Such an approach makes it possible to create promising lighting devices ready for serial production and further technological modernization.

Keywords: *Integrative modules; Electronic systems; Laser diodes; Light output; Diamond spheres; Plastic material; Composite material; Pseudo-porous structure; Optical cable; Laser radiation; Flat emitter lamp*

Introduction:

In order to eliminate energy losses and increase effective energy output, especially in various lighting systems, active research is being conducted into integrative technical solutions that make it possible to avoid the use of additional structural elements and additional energy consumption for cooling.

At the same time, technical solutions are being developed and refined that make it possible, with the most concise and simple design, to increase the light output power of lighting devices while maintaining relatively low power and, accordingly, low energy consumption.

Figure 1. *The photo shows one of the innovative developments for converting laser radiation into light radiation within conventional and standard light spectra*

The author of this publication considers the most appropriate approach to be comprehensive integrative solutions within the framework of the proposals contained in the scientific and technological publications and books of Alisa Lahunina, a well-known innovation specialist in this field.

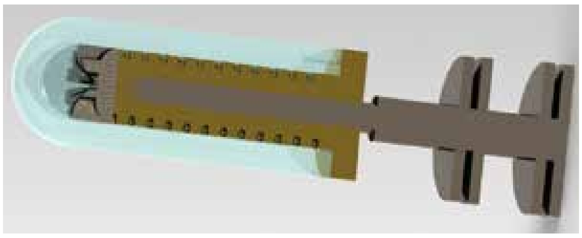
First of all, what distinguishes the proposals and developments of Alisa Lahunina from similar proposals by other authors is the extensive platform for experimental computer modeling, made possible by her broad and profound knowledge of the principal methods and techniques of systemic and combinatorial computer modeling within related innovative processes, including at the intersection of fundamental disciplines.

In analyzing all the innovative technologies proposed in her publications, Alisa Lahunina advances an exceptionally important thesis for solving the problem – the combinatorial structure of each solution, meaning the harmonious combination and mutual complementarity between traditional technologies and materials and innovative technologies and materials, primarily composite materials.

Moreover, among the proposals of Alisa Lahunina, the fundamentally important aspect is precisely the tendency toward integration and comprehensive adaptation of new materials and technological methods within the environment and conditions of existing and proven technologies and materials, prepared for the transformation of properties and capabilities at a new innovative level.

The following image shows an axial cross-section of such a device, which is more convenient for examination and analysis.

Figure 2. *The figure shows that the design of the innovative lamp combines the functions of several basic structural elements*



The lamp holder includes a vortex radiator, the shaft and disks of which are made from a diamond-copper composite, which is the most important component of the lamp cooling system.

Each component of this system is multifunctional. In addition to purely heat-conducting and heat-accumulating functions, the structure of these parts, made from numerous micro-globules of composite material, simultaneously performs the important function of dissipating heat flows, which is ensured by the pseudo-porous structure of the composite.

Let us consider the innovative structure of the diamond-copper composite in more detail (Source 1).

The original process of manufacturing the composite globules begins with the formation of diamond spheres made of synthetic diamond with a diameter of 5–7 microns (this size may vary depending on the profile and dimensions of the part, as well as its operating conditions).

After this, the spheres are coated with copper using specialized equipment and an original innovative technology (Source 2).

The thickness of the coating is selected in such a way that during the molding of the lamp component, there is sufficient plastic material on the diamond spheres to enable the liquid-flow process of the metal and fill the cavities between the synthetic diamond spheres.

As a result, a pseudo-porous structure is obtained in which diamond spheres, representing the best heat-conducting material while being completely non-conductive electrically, are evenly distributed.

Such a structure makes it possible to instantly dissipate heat and distribute it evenly across the cross-sectional area of the radiator disks.

An optical cable is placed in the spiral grooves of the lamp housing, to which a beam of laser radiation is supplied from the laser module. The optical cable is wound into a spiral and placed in the housing grooves at a diameter that causes the cable to glow across the entire cylindrical surface, which is far more efficient than radiation emitted only from the cable end.

In order to separate the laser radiation from the output light radiation of the lamp, a phosphor layer designed for a specific radiation spectrum is applied to the optical cable.

As a result, the final radiation of the lamp is completely non-toxic and, due to the radiation area being thousands of times larger than that of the optical cable end, with a laser diode power of only 1–2 watts, the output equivalent of the lamp corresponds to 60–75 watts.

The presented models demonstrate that, based on the general principles of innovative design proposed by Alisa Lahunina, it is possible within the framework of traditional forms and constructions – for example, an ion-exchange filter – to achieve an almost ideal final result with unusual parameters and properties by using natural and completely safe materials:

- Complete absence of chemical reagents in the process.
- Use of natural ion-exchange conditions.
- Enormous potential for unique exchange capacity, including the purification of liquids contaminated with radioactive substances.

With such design tendencies, the requirements for design itself fundamentally change, making it possible to widely introduce computer modeling methods and techniques, as well as methods for achieving the ideal final result, into the development process.

Figure 3.

Figure 4.

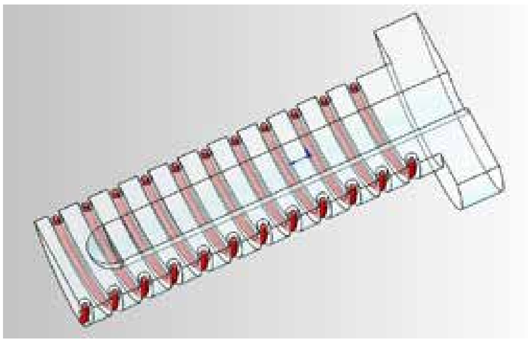
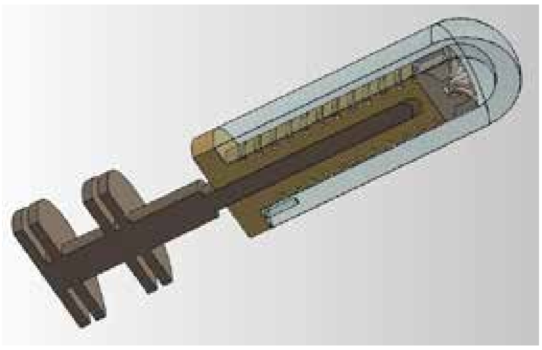


Figure 5.



The formation of radiation from the glow of an optical cable bent to a specific radius has many alternatives, such as the emitter shown in the following cross-sectional image, in which the cylindrical surface of the optical cable begins to emit light at a certain bending radius.

The proposed design contains many innovative elements and, most importantly, is fully ready for serial and mass production. In addition, the configuration of the lamp, together with its combination of technological principles and structural materials, makes it possible to further integrate into the innovative product new technical solutions that may emerge during the continued development of laser technologies, composite material technologies, and new energy-efficient control and cooling systems.

Figure 6.

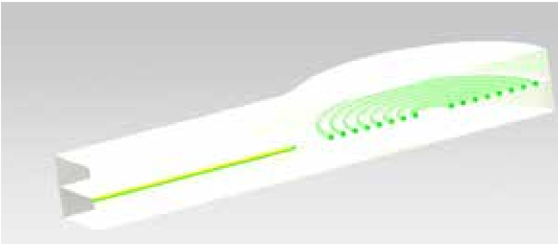


Figure 7. *Image shows a structural diagram of the lamp in a longitudinal cross-sectional view, where individual technical components are clearly visible, each of which carries a specific functional and technical purpose and performs particular technological and conceptual functions*

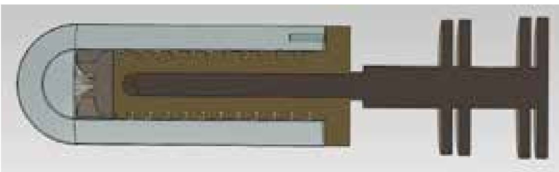
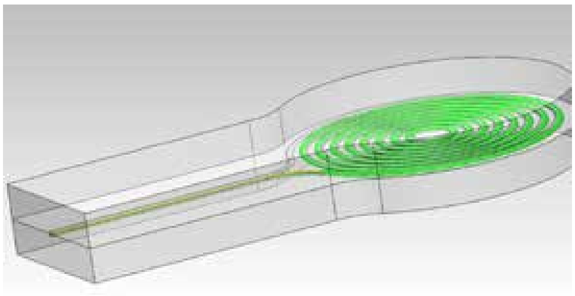


Figure 8.

The following image shows a mini-lamp in which a mixture of phosphors is applied to the end of the optical cable according to a specific geometry within a three-dimensional coordinate system, providing glow (radiation) in the white spectral range.

The diameter of the optical cable is only 120 microns, which makes it possible to create micro-miniature light sources for use in the most compact optoelectronic systems.

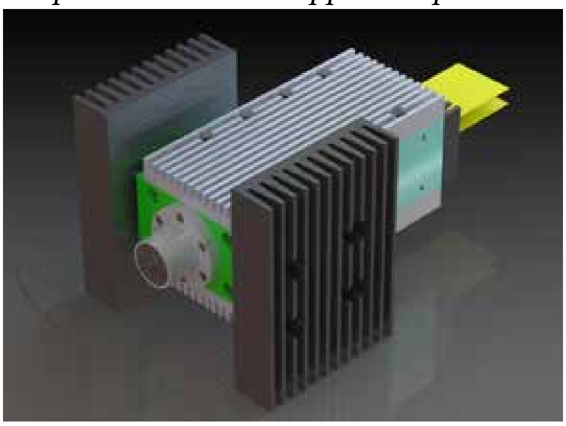
Figure 9. *Image shows a lamp with a flat emitter connected to only one optical cable*



In addition to overall efficiency, such a system makes it possible to achieve the required level of illumination over the required area with minimal cost and maximum simplicity.

The same system also makes it possible to apply virtually any combination or mixture of phosphors to the spiral (flat spiral) section at the end of the optical cable and obtain the required parameters of light radiation.

Figure 10. *A laser diode module built on the principles of active cooling through the dissipative effect in components made from a pseudo-porous diamond-copper composite*

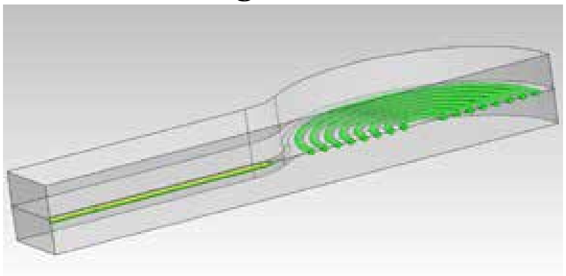


One of the innovative integrative features of the presented design is the use of thermoelectric coolers in combination with heat-conducting and heat-dissipating elements of the module housing structures.

The thermoelectric coolers are positioned between the external radiators and the module housing, while the heat-conducting structural elements transfer heat flows from the printed circuit board to the housing walls on which the thermoelectric coolers are mounted. In turn, the base planes of the radiators are pressed against these coolers, and, if necessary, other module components requiring constant cooling may also be mounted on the radiators.

As practice has shown, reliable cooling makes it possible to maximize the stabilization of the output parameters of laser radiation, which in turn significantly expands the range of the module's output systems and, if necessary, makes it possible to distribute the laser radiation among several optical cables, each of which supplies one lighting device.

Figure 11.



The photo shows models of such devices.

Figure 12.

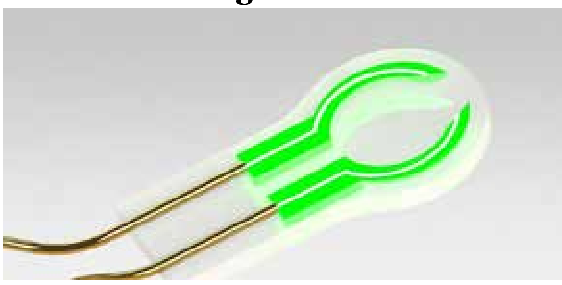
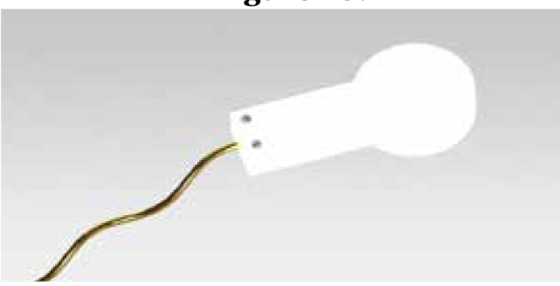


Figure 13.



The most important aspect remains the primary removal of heat directly from the laser diode.

The presented three-dimensional models show heat-conducting elements that simultaneously serve as the basic mounting components for securing the laser diode within the module housing.

As can be seen from the models, despite its simplicity and manufacturability, the supporting disk of the laser diode (highlighted in red in the models) completely protects the laser diode from overheating due to a number of factors, which, as mentioned above, significantly increases the stability of the module operation and reduces energy consumption for lighting.

The models also present a coding and decoding system that makes it possible to identify the optical cables connected to the module together with the lighting devices.

In addition to the primary operating functions, such a system provides the possibility of introducing and controlling various computer models for energy management and distribution.

These functions depend entirely on the purpose and operating conditions of the module, while the possibility of integrating the software component of the system precisely at the most critical point is of particular importance for the further development of the concept.

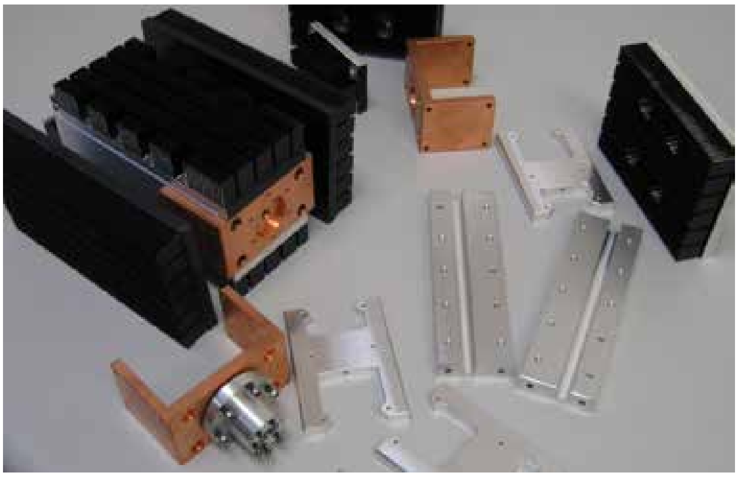
Furthermore, such a fundamental approach to the application of new composite materials in new applications with highly unusual properties and characteristics makes it possible to create new lighting devices and instruments with parameters required by modern technologies.

If attention is given to the fact that, in addition to the latest composite materials, nature also provides exceptionally valuable natural materials, then the application of the tendencies described in the publications of Alisa Lahunina also makes it possible to create a harmonious combination between long-known natural materials and repeatedly tested engineering and technological methods.

The conceptual solutions proposed by Alisa Lahunina make it possible, in the course of further development, for example of carbon-carbon composites in the form of fabric, to create solid components compressed from such fabrics that possess entirely unusual properties and open new innovative possibilities in lighting engineering and related processes.

As can be seen from the photo, all other components of the housing and cooling system of the laser module are made from standard profiles and materials and do not require any special materials or specialized technological equipment for manufacturing – everything is produced using standard cutting and measuring tools.

Figure 14. *Real structural elements of an innovative laser diode module with a cooling system and a laser diode holder made from a diamond-copper composite*



This can be regarded as an example of the integration and combination of innovative solutions for the efficient and safe conversion of laser diode radiation into safe and intensive phosphor radiation, with virtually complete heat dissipation and the absence of thermal and light losses.

All major output parameters of this integrated lighting system fully comply with current standards and safety regulations.

Appendices, list of references, patent and licensing information:

Composite Material, Method of Manufacturing and Device for Moldable Calibration. United States Patent Application No. 20120040166, Kind Code A1, published February 16, 2012.

Device and Method for the Extraction of Metals from Liquids. United States Patent Application No. 20100224497, Kind Code A1, published September 9, 2010.

submitted 15.05.2026;
accepted for publication 29.05.2026;
published 31.05.2026

Contact: V050339113@gmail.com.