ROLE OF LASERS IN CONTROL OF ENVIRONMENTAL QUALITY

LĀZERU LOMA VIDES KVALITĀTES KONTROLĒ

Authors: **Khrystyna Yartym,** e-mail: hristinaartim2@gmail.com, **Mariia Liakhovych**, e-mail: Liahovuch17@gmail.com, **Andrii Kos**, e-mail: cos555569@gmail.com, **Anastasiia Ischenko**, e-mail: Ishchenkon4677@gmail.com, **Tatiana Yefimova,** e-mail: tanichkasmirnova22@gmail.com
Supervisor of scientific work: **Antons Pacejs, Bc.sc.ing.**
Rēzeknes Tehnoloģiju akadēmija, Atbrīvošanas aleja 115, Rēzekne

Abstract: *This article describes different ways of using laser technology in different fields of science. In biology, lasers are used to study the microstructure of cells, their organelles (living cells and their preparations). In medicine they are used for a special type of surgery. With the development of lasers, they have become safer, easier to use. Technologies for the use of lasers in medicine have also improved to such a level that they cause almost no complications after their application.*

Keywords: *LIDAR, Scanner, Environment, Laser, Semiconductor*

Introduction

From the very moment of development, the laser was called a device that itself seeks to solve problems. Lasers have been used in a wide variety of fields - from vision correction to driving vehicles, from spaceflight to fusion. The laser has become one of the most significant inventions of the XX century.

Today's lidar technology is one of the most popular optical-electronic instrumentation in the world. This is due to the fact that sensors based on remote laser sensing allow a detailed analysis of the studied objects and environmental components for their characteristics. The main factors include the following: traditional, for example, physicochemical, related to remote, non-contact, the possibility of continuous and profile search with simultaneous determination of gamma elements and compounds, as well as high detection speed. In addition, it is important that lidar complexes carry out operational sensing of the environment without destructive effects on it. Compared to radio wave radars, the advantages of laser sensors are, first of all, in noise immunity and higher spatial resolution, not to mention the detection of spectral features of detected objects.

Photochemistry

Some types of lasers can produce ultrashort light pulses measured in pico and femtoseconds (10–12 - 10–15 s). Such pulses can be used to trigger and analyze chemical reactions. Ultrashort pulses can be used to study chemical reactions with high time resolution, allowing reliable isolation of short-lived compounds. The manipulation of the polarization of the pulse allows you to selectively select the direction of a chemical reaction from several possible ones (coherent control). Such methods find their application in biochemistry, where they study the formation and functioning of proteins.

Advantages:

- Reduced use of reagents (photons are ideal reagents, they activate the reaction and completely disappear without leaving direct pollution);
- Low reaction temperatures
- Selectivity control

https://doi.org/10.17770/het2020.24.6765

Disadvantages:

- Special photochemical reactors required
- "Unpopular" technological processes
- Clogged lamp glass [1]

Laser spectroscopy

Laser spectroscopy can be divided into linear and nonlinear. The field of linear spectroscopy is determined by the conditions measurements when the intensity of laser radiation is such that ignore non-linear phenomena. The classification of laser spectroscopy methods can be carried out on the basis of the most typical and convenient for registration physical phenomena in the interaction of laser radiation with substance.

The primary effect of the interaction is the population of the upper resonance transition levels compared to the initial Boltzmann distribution of populations. Transitions carried out by absorption of photons with energy.

The main advantages of using laser spectroscopy sources consists in the possibility of obtaining high spatial and temporal coherence and achieving high spectral brightness radiation.

The most sensitive method for detecting weak lines visible and ultraviolet absorption based on registration of luminescence excited by an absorbed laser radiation. The advantages of this method are achieved when working with low pressure of absorbing molecules in gas cells, or in molecular bunches.

The use of lasers in combination with other modern optical and electronic devices has opened up qualitatively new possibilities in spectroscopy. These capabilities can be conditionally divided into two groups: 1) a significant improvement of previously existing methods, which allows to obtain new results, and 2) fundamentally new methods. A radical improvement of pre-existing methods is determined by the possibilities of laser radiation concentration, which approach the limit allowed by the laws of physics and are possible only for coherent (regular in space and time) electromagnetic radiation [1].

CO^2 laser

The use of lasers in surgery, for example, a CO^2 laser, allows solving two existing problems:

- the creation of methods of "bloodless operations" that provide minimal bleeding and loss of blood. Exposure to focused laser radiation leads to blood coagulation and a significant reduction in bleeding;
- tissue healing. Statistics show that when using lasers in surgical operations, the healing time is significantly reduced.

The advantages of using a laser beam in surgery include sterility, high hemostatic effect, strictly local action (minimal tissue trauma), smooth wound healing (good cosmetic results). In addition, the laser beam does not affect the highly sensitive sensors of medical electronic equipment.

Laser radiation with l = 10.6 mkm is commonly called a laser scalpel. The section of biological tissue is carried out by a focused laser beam due to layer-by-layer evaporation.

With a radiation power of 20 W and a diameter of the focused beam of 1 mm, a surface power density of 2.5 kW / cm2 is achieved. The thickness of the tissue layer affected by the radiation of a CO^2 laser of the indicated power is ~ 50 µm. Given such a depth of penetration of laser radiation, the volumetric power density of laser radiation is 500 kW / cm^3, which provides fast, almost instantaneous heating and evaporation of tissue in the area of the laser beam, where the temperature reaches several hundred degrees. The depth of cut is determined by the duration of the exposure.

The unique properties of the laser scalpel did not give a positive effect when used to perform operations on the digestive tract. When a hollow organ is dissected, the surface of the incision and surrounding tissues may be infected with its contents. The stomach and intestines are richly vascularized organs.

An incision with a laser scalpel of blood vessels with d> 1 mm causes heavy bleeding. The spilled blood shields the laser radiation, as a result of which the dissection rate quickly decreases, and the laser loses the properties of the scalpel.

In addition, there is a danger of accidental damage to the underlying organs, as well as overheating of tissue structures. All this made it difficult to use a CO^2 laser in abdominal surgery [5].

In 1973, it was proposed:

· Temporarily stop blood circulation along the dissection line. And this allowed the maximum use of the positive properties of the CO^2 laser;

· Reduce the area of coagulation necrosis;

· Increase the speed of the cut;

· Achieve complete hemostasis;

· Biological welding of dissected tissue layers with a laser radiation power of only 15 - 25 watts.

Light adhesion due to surface coagulation of tissues keeps different layers of the intestinal wound (serous membrane, muscle and submucous layer, mucous membrane) at the same level. With this quality of the cut, optimal conditions are created for the most time-consuming and critical part of the operation, because stitching occurs in conditions of good visibility without contamination of the surgical field with blood, the edges of the intestine are less injured, because there is no need for drainage and hemostatic measures. The area of coagulation necrosis on the incision surface is a biological barrier against infection in morphologically preserved tissue [2].

The new principle of using a laser scalpel when performing operations on hollow organs is implemented using the developed set of special laser surgical instruments and staplers.

3.1. Laser mechanical staplers

They have a number of drawbacks: the lines of the mechanical suture are bleeding, the high supra-cushion roller requires careful peritonization, this seam does not have mechanical and biological tightness.

A laser mechanical stapler uses the principle of dosed local tissue compression before being dissected by a laser beam [3].

The sequence of laser staplers:

First, the walls of the hollow organ are stitched with tantalum brackets, then tissue compression is achieved on both sides along the seam line. Next, the organ walls between two rows of superimposed brackets are cut with a laser beam. The wall dissected by the laser beam is sterile, mechanically and biologically tight, does not bleed. A thin film of coagulation necrosis along the incision line prevents the penetration of microbes into the tissues. The supra-cushion roller is low and easily immersed with serous-muscular sutures.

For operations on the digestive organs, special laser mechanical staplers are usually used. However, serial mechanical staplers with a two-line linear seam are also used.

During the operation, the stitched organ with the help of a strap pressed against the abutting sponge stretches the fabric, the spring hook locks the strap, preventing the organ from moving. Then a brace half is placed on the thrust sponge and the apparatus closes. The wedge of the apparatus without a blade moves forward and sews the organ walls with a two-row seam. The brace half is removed by installing the pointer of the laser fiber there, when moving, laser cutting occurs. When you press the spring hook, the bar releases both parts of the stitched organ.

The laser is successfully used for thermal burns. The wound surface excised by the laser method is almost immediately closed by an its own skin. The use of a laser provides high sterility, good graft engraftment and reduced blood loss [4].

Conclusion

Lasers are extremely necessary and in demand in modern science and industry. They are used in various fields of science and used for various human needs, they also solve many problems that were previously solved much more difficult.

Laser biologists have been given the opportunity to examine cell preparations more accurately and in detail. Also, laser spectroscopy (one, but not the only laser technology that is widely used in biology) allowed us to make research more accurate and convenient.

In medicine, lasers are used in various industries - from diagnostics to operations. Laser operations have made life easier for surgeons and patients. Nevertheless, this method needs many improvements. Perhaps in the future, surgeons who use lasers will not have any problems at all.

References

1. Кёбнер Г. Промышленное применение лазеров. - М., Машиностроение, 1988. - ISBN 5-217-00266-2. - Тираж 19700 экз. - 280 с.
2. Хромов Б. М. Лазеры в экспериментальной хирургии. — Медицина.
3. Дударев А.Л. Лучевая терапия, Л.: Медицина, 1982, 191 с.
4. Лазерная и магнитно-лазерная терапия в медицине, Тюмень, 1984, 144 с.
5. Современные методы лазерной терапии, Отв. Ред. Б.И. Хубутия, - Рязань.:1988 г.,126 с.