Laser

About laser

LASER is an acronym and stands for **L**ight **A**mplification by **S**timulated **E**mission **R**adiation. It is a source of highly coherent electromagnetic radiation most commonly in the visible, ultraviolet or infrared part of a spectrum, which is generated by stimulated radiation emission of active particles (atoms, molecules, ions, electrons) excited by external energy source. This energy can be concentrated in a very short time. Emitted light is monochromatic.

Physical principle

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The laser is based on the principle of stimulated (forced) radiation emission. Electrons in atoms of an active medium are first excited to the upper energy level, however they can not remain there therefore in a millionth of a second they jump to the working surface (metastable path). Due to the weak pulse in the form of a stimulating photon, deexcitation occurs associated with the emission of the same photon as the stimulating one. As a result, identical photons are produced, which are radiated in the same direction. The light has certain properties, including high coherence, high monochromaticity and low divergence.

Components

Pumping (emitting) radiation generates emission in the active substance which is bounded by paralel mirrors. After excitation of stimulated emission the light is reflected between the mirrors and it passes multiple through the active substance, which increases its intensity. After reaching sufficient intensity the parallel coherent beam leaks out through the semi-transparent mirror.

THE MAIN COMPONENTS OF LASER:

1. Active environment.

The active environment consists of a substance that contains separate quantum energy levels of electrons. It might be a solid substance with admixtures, a liquid or a mixture of gases.

2. Resonator.

The laser uses the resonator to amplify the light. The resonator in its simplest form is composed of two reciprocally paralel mirrors and at the same time perpendicular to the laser axis. One of them is nontransparent and the other one is semi-transparent. The mirrors are mostly planar but they could be also curved.

3. Pump source.

The pump source is used to deliver energy to electrons in the active environment so they can move from a lower energy level to a higher energy level. Examples of a pump sources are an electric current, a discharge lamp, a chemical reaction or other lasers.

4. Laser beam.

A laser beam comming out of an active environment through the semi-transparent mirror is coherent (non-diverging) and monochrome (unicoloured).

Types of lasers

According to the laser mode:

1. Continuous lasers
2. Pulse lasers
3. Quasi-continuous lasers

According to the active environment:

1. Ultrasonic lasers
2. Semiconductors lasers
3. Gas lasers
4. Liquid lasers
5. Plasma lasers
6. Lasers with free electrons

Application

For applications in medicine, see subpage: /Application

Use

At present, lasers are used in many fields. Most often we encounter it in medicine (for example, a source of radiation in optical instruments), industry, microelectronics, measuring and computing, but also in military.

Use in medicine

The effect of the laser depends on its intensity. When low intensity is used, only tissue heating occurs, at higher intensity can occur contraction of soft tissue, and at the highest intensities, cell destruction and burning (using the laser as a scalpel) can occur. In the beginning, lasers were used in ophthalmology and dermatology. Doctors began to use laser in surgery because of their ability to focus the radiation into small area, thus the possibility of cutting the tissue with very narrow cuts and the possibility of tissue evaporation. The advantages of this technique are also in the safety and security of surgeries, since wound infection is in this case not an issue.

Now the laser is used in dermatology, plastic surgery, neurosurgery, gynecology, dentistry and other medical branches.

Risks

The main risk of using the laser is the possibility of eye damage. Some lasers work on frequencies that are captured and recognized by the eye. Because the laser is coherent and has low divergence, its beam is concentrated on a very small area of the retina, and is capable of overheating a certain point and can lead to permanent eye damage.

Laser use in medicine

The laser beam is used in medicine in so-called phototherapy quite often, including, for example, correction of vision defects or smoothening of micro-scars. The first interventions were carried out in the 70s of the 20th century, but the common use of laser in various medicine fields really began in third millennium.

Brief Description of the Laser Function

Laser is a device emitting coherent electromagnetic waves - radiation whose rays have the same phase, direction and wavelength. The name derives from the English abbreviation Light Amplification by Stimulated Emission of Radiation. Photon is an elemental particle mediating electromagnetic interaction and it is carrying certain energy. The directed stream of many photons (e.g. laser) can carry large amounts of energy that can be used in some medical procedures, most often by converting it to thermal energy.

Fields utilizing a laser

The fields of medicine using laser for treatment are i.e. neurology, surgery, plastic surgery, but also dermatology, gynecology or dentistry.

Lasers used in medicine

Medical laser devices are divided according to their performance. The higher the power, the more energy the rays carry. Depending on their performance, their practical use is assigned. Each medical discipline requires for its purpose exact characteristics of the use of the laser, simply because different laser wavelength is suitable for different kind of tissue. Longer wavelength penetrates deeper into the tissue, but it does not affect the tissue so hard. Shorter wavelengths are suitable, for example, for dentistry, those with longer wavelengths are used in rehabilitation. Basic laser division according to performance:

Non-invasive - or therapeutic. Their power does not exceed 500mW.

Invasive - or surgical. The power of these devices is greater than 1W.

Advantages of using a laser

In medicine, the laser has expanded its use due to several specific attributes as a means of healing.

Sterility - When using the laser as a scalpel, there is no tissue contact with a foreign entity that could contain different sources of infection, such as bacteria.

Accuracy - The laser scalpel has much narrower effective surface than a conventional steel scalpel, but it is not less effective. On the contrary, the cut is very thin and only necessarily long, healing is faster and the whole process is more friendly towards the body.

The possibility of tissue vaporization - the laser can warm the tissue to very high temperature and remove it from the body.

Links

Related articles

- Laser Issues

External links

Sources

- Lecture: Physical factors of environment (J. Rameš) 2011
- Wikipedia contributors. *List of laser types* [online]. Wikipedia, The Free Encyclopedia., The last revision 27 February 2012 02:15 UTC, [cit. 28 February 2012 12:39 UTC]. <http://en.wikipedia.org/w/index.php?title=List_of_laser_types&oldid=479054044>.

Further reading