Proceedings of the

XI INTERNATIONAL CONFERENCE «ELECTRONICS AND APPLIED PHYSICS»

October, 21-24, 2015, Kyiv, Ukraine

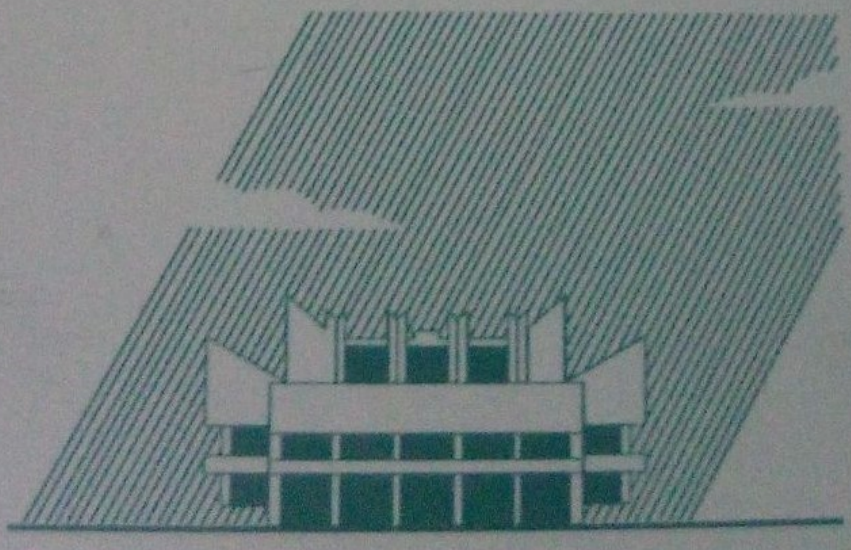
Taras Shevchenko National University of Kyiv
Faculty of RadioPhysics, Electronics and Computer Systems

Праці

XI МІЖНАРОДНОЇ КОНФЕРЕНЦІЇ «ЕЛЕКТРОНІКА ТА ПРИКЛАДНА ФІЗИКА»

21-24 жовтня 2015 року, Київ, Україна

Київський національний університет імені Тараса Шевченка
Факультет радіофізики, електроніки та комп'ютерних систем



THE STUDY POLARIZATION CONTROL USING THE LC CELLS INSIDE THE RESONATOR OF A FIBER FEMTOSECOND LASER

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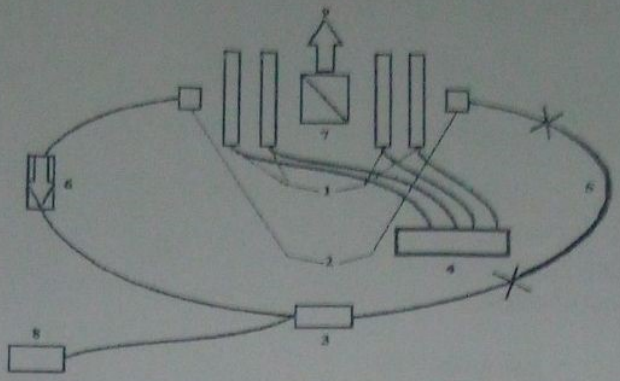
Abstract: *In this article reviewed the implementation of lasing in the fiber ring laser. All phases are connected to each other in a certain way. The phase difference of neighboring modes have the same value, in other words, modes synchronized. Due to synchronization mode locking of the fiber resonator we got femtosecond pulses. Synchronization mode can be made a well-known way – with the help of wave plates, which can be controlled by rotating the polarization. But it is not very reliable method and requires a relatively large effort. Not reliable due to the fact that the plates are very sensitive to external influences, such as vibration, so that any deviation can lead to the disruption of generation. We, in turn, offer easy decision. Replace wave plate – liquid crystal cells that control voltage. When a one-time setup of polarization - in the following settings is not necessary, because the liquid crystal cells are not susceptible to such influences as vibrations.*

Introduction

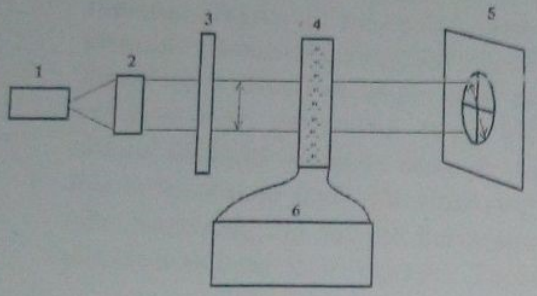
According to the Fourier transform, the pulse duration τ should have a spectral width $\Delta\nu > \tau^{-1}$, therefore, a prerequisite for the generation of ultra-short pulses is the use of the active medium with a sufficiently broad band amplification. Because of the large width of the generation spectrum is required, of course, multimode operation of the laser. There are two extreme cases multimode lasing. First, when the phase of the electromagnetic waves of all the modes have nothing to do with each other when the phase difference between adjacent modes are distributed randomly. Second, when all phases are connected to each other in a certain way. The phase difference of neighboring modes have the same value, in other words, modes synchronized. In a laser, each mode varies independently, without a fixed relation between self and other modes, in essence, a set of independent lasers that emit light at slightly different frequencies. The individual phases of the light waves in each mode are not fixed and may be changed at random due to factors such as thermal fluctuations of the laser structure. In lasers, supporting only a few oscillating modes, the interference between the modes can cause the effect of the beating at the laser output, which leads to random fluctuations in intensity; lasers with many thousands of modes, these interference effects are generally averaged to nearly constant output intensity, and a mode called a continuous emission. If, instead of independent vibrations, each mode ranges with a fixed ratio between its phase and the other phases of the modes, the output power of the laser behaves quite differently. Instead of a random or constant output intensity, the laser mode will be occasionally interfere with each other, creating a burst or pulse of light intensity. This laser is called a mode-locked laser or synchronization phase. Currently, of particular interest, femtosecond fiber lasers with passive mode locking. They have their advantages and disadvantages, so the aim of this study was to investigate the LC cells for passive mode-locked femtosecond fiber in a ring laser with nonlinear evolution of mode.

1. Diagram of the laser, analysis.

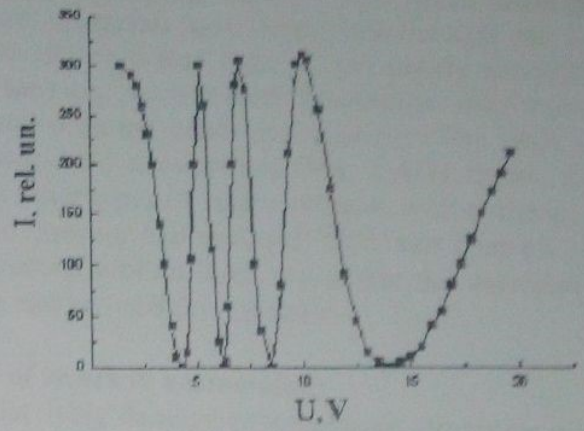
Synchronization mode can be carried out well-known way – with the help of the wave plates that are rotating in space, you can control the polarization. But it is not very reliable method and requires a relatively large effort. Such plates are usually manually operated, which causes great difficulty in setting. Not reliable due to the fact that the plates are very sensitive to external influences, such as vibration, so that any deviation can lead to the disruption of generation. And it would have to carry out the adjustment plate almost every time you turn on the laser. We, in turn, offer easy decision. Replace wave plates – liquid crystal cells (pic. 1), which are controlled by voltage. When a one-time setup of polarization - in the following settings is not necessary, because the liquid crystal cells are not susceptible to such influences as vibrations. And the next time you turn on the control unit liquid crystal cells (pic. 1, 4) - the required polarization is already exhibited. This eliminates the probability of failure generation from external influences. Before introducing the liquid crystal cell in the open part of the resonator fiber laser – we conducted an experiment. In it we checked as the liquid crystal cell influences the laser power and intensity (pic. 2, pic. 3).



Picture 1 – scheme fiber laser with LC cells: 1 – LC cells; 2 – collimators; 3 – device for input emission into the resonator; 4 – control block LC cells; 5 – one meter of fiber alloyed erbium.; 6 – optical isolator; 7 – polarizing beam splitter; 8 – diode pumping at 980 nm; 9 – generation of emission with a wavelength of 1550 nm



Picture 2 – Schematic layout of the experiment Governance polarized laser emission using the liquid crystal cells: 1 – light emission 1550 nm; 2 – collimator; 3 – polarizing plate; 4 – LC cell; 5 – recording unit; 6 – control block LC cell



Picture 3 – The light transmittance of the LC cell depending on the applied AC voltage supplied from a frequency of 1 kHz.

Conclusions

In this paper we were investigated the LC cell to control the polarization of the laser emission. These results serve to create an annular femtosecond fiber laser with passive mode locking, which is adjusted by applying an electrical signal of the LC cell. It is assumed that such a laser is easy to set up and stable work, regardless of external influences, such as micro-vibration, temperature drift diode pumping or simply pressing the power of the laser. But very important, that the use of LC cheaper than the use of expensive rotary systems with high accuracy, which are based engines. This involves optimization and low cost of the services provided in the areas that use a fiber femtosecond laser at 1550 nm.

Reference

[1] Kristin M. Spaulding, Darryl H. Yong, Arnold D. Kim, J. Nathan Kutz, J. Opt. Soc. Am. B, 2002,Vol. 19 № 5, pp.1045-1051.

[2] M. Salhi, H. Leblond, and F. Sanchez, Physical Review A67, 2003, pp 1130-1131.

[3] A.S. Gnatenko, Y.P. Machekhin, Radiotechnics. 2014, № 178, pp. 48—51.

[4] A.S. Gnatenko, Yu.P. Machekhin, 2015, Vol.74, Issue 7, pp.641-647.