Nanooptics and photonics

Emerging optical extreme events at light-matter coupling in multi-channel hybrid liquid crystal cell

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Enhancement of physical effects due to the presence of nano- or micro-structured surfaces stands out as one of the priority direction in the nanoscience. We investigate amplification of the nonlinear optical effect in hybrid liquid (LC) crystal cells comprising micro-structured photonic crystals made on a silicon substrate [1]. A nonlinear hybrid LC cell is composed with a glass substrate, a silicon substrate of a photonic crystal and an LC layer between them. A distinctive feature of such hybrid cells is that they form spatial multi-channel light pattern due to reflection from the micro-structured surface. We show that one can control the intensity distribution in spatial channels by means of the dynamic holographic technique. For these studies we propose and fabricate nonlinear dynamic hybrid LC cells. We apply a layer of a dynamic LC mixture, which includes the dye Ethyl Red. Then we use these dynamical cells in the two-wave mixing method, which is distinguished by the formation of a dynamic grating in the nonlinear LC cell and the self-diffraction of the input two waves on this grating. Our theoretical studies show that the nonlinear process of the dynamical two-wave mixing may lead to formation of envelope solitons for amplitude distribution in the dynamic grating. The process of wave coupling in such spatially non-uniform dynamic grating will depend on the parameters of the input beams, control of which will influence the solitone's envelope and, in turn, allow for manipulation of the output orders. In our research we determine and classify the extreme events in dependence on relation between the duration of the laser pulses and the time relaxation constant of the nonlinearity in the hybrid LC cell. Possibilities of application of these extreme events for the optical information security are considered.

1. *Bugaychuk S., Iljin A., Lytvynenko O., Tarakhan L., Karachevtseva L.* Enhanced nonlinear optical effect in hybrid liquid crystal cells based on photonic crystal // Nanoscale Research Lett. (in Press). .