## Properties of reflection holograms in cubic (110)-cut and (111)-cut crystals

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A comparison of the thickness dependences of the diffraction efficiency of the reflection holographic gratings in cubic photorefractive crystals of (110) and (111) crystallographic cuts is fulfilled. The theoretical model is based on the standard coupled wave theory with taking the linear electro-optic, inverse piezoelectric, photoelastic effects and optical activity of the crystals into account. The possible influence of the inverse flexoelectric effect on diffraction efficiency of the reflection hologram formed in the photorefractive crystals is considered too. Properties of the inverse flexoelectric effect tensor for photorefractive crystals of 23 and classes and expressions for the coupling constants for wave equations are analyzed.

## Experimental observation of the diffraction-induced femtosecond pulse splitting in a linear photonic crystal

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Photonic crystals (PhC) - periodic structures with period of about the wavelength of a visible light - can reveal a lot of optical effects induced by its structure, e.g. photonic band gap, second harmonic generation etc. Some effects are inspired by x-ray optics: Borrmann effect, pendular effect. In this work we present the results of analytical prediction of the dynamical Diffraction-Induced femtosecond laser Pulse Splitting (DIPS) in a linear 1d photonic crystal at the Laue geometric scheme and the experimental confirmation of the effect. When a short laser pulse comes into 1d PhC (array of alternating dielectric layers of two types) at the Laue scheme (crystal layers are parallel to normal direction of incident surface), the pulse undergoes two splittings: spatial and temporal. The spatial splitting occurs due to diffraction on the PhC volume grating: formation of two pulses propagating in two directions under the Bragg condition is observed. The temporal splitting is caused by formation of two spatial modes inside the crystal: borrmann and antiborrmann, each of them is spatially localized into PhC layers of its own type. Therefore two pulses with different group velocities are forming and the temporal splitting occurs. The experimental sample was made of porous fused silica [1] with length of 0.5...2.0 mm, a Ti:Sapphire laser (800 nm, 100 fs, 100 mW) was used as a pump, a conventional autocorrelometer (10 fs precision, 15 ps range) was used as detector. We experimentally observed the DIPS effect for p-polarization of the incident pulse [2]. The splitting value is 600 fs for sample of 2 mm and is proportional to the sample length in all observable range. The value of splitting is independent on the incident power which confirms the optical linearity of the effect. For s-polarization of incident pulse the splitting value is 1.4 times less (theory) and 1.64 times less (experiment). This difference can be explained by different birefringence of materials of PhC layers. The porosity of PhC material gives a possibility to fill layers of the crystal with nonlinear substance (e.g. $NaNO_2$). Therefore nonlinear effects, such as selective focusing and compression can be observed in this structure.

[1] S.E. Svyakhovskiy, A.I. Maydykovskiy, T.V. Murzina "Mesoporous silicon photonic structures with thousands of periods". J. Appl. Phys. 112, 013106 (2012).
[2] S.E. Svyakhovskiy, V.O. Kompanets, A.I. Maydykovskiy, et al. "Observation of the temporal Bragg-diffraction-induced laser-pulse splitting in a linear photonic crystal". Phys. Rev. A. (accepted).

## Spectral and temporal characteristics of resonant medium radiation excited at the superluminal velocity

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In the present work, spectral and temporal characteristics of the resonant medium radiation excited by an ultrashort light pulse propagating through the medium at the superluminal velocity are studied theoretically. The case is considered when the spatial density of atoms is modulated periodically along the direction of propagation of the superluminal excitation. The obtained results demonstrate that under the superluminal excitation in the linear case the spectrum of radiation of the medium, along with the fundamental frequency of the oscillators, possesses new frequencies that depend on the spatial frequency of oscillators' distribution and on the angle of observation. In nonlinear case, the solution of optical Bloch equations for two-level atom displays two short pulses of the medium radiation. The distance between two pulses in the time scale depends on the velocity of excitation and on the parameters of medium.

## Optical pulse dynamics in case of the Laue scheme of Bragg diffraction in metamaterial photonic crystals

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We solve analytically the boundary problem of Bragg diffraction at the Laue scheme in a weakly modulated linear one-dimensional photonic crystal (PC) composed of metamaterial layers with the two-wave approximation. Contrary to conventional PCs, under certain conditions these structures display a new type of