Optical induction of phase diffraction structures by laser beams with bessel-like profiles in photorefractive Lithium Niobate

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Laser radiation is characterized by an extremely high degree of monochromaticity, coherence, directionality and brightness.

The purpose of our study is to demonstrate the use of light fields obtained in the schemes using prism elements and on the basis of light diffraction on amplitude transparencies when diffraction structures are formed in photorefractive lithium niobate ($LiNbO_3$) samples. Evolution of characteristics of one-dimensional phase diffraction structures at their optical induction by bessele-like monochromatic beams in photorefractive lithium niobate is experimentally investigated.

The solid-state YAG:Nd^{3+} laser with light wavelength of λ=532 nm and He-Ne laser (λ=633 nm) . One-dimensional Bessel-like beams can be obtained with the help of Fresnel's biprism. A laser beam with a Gaussian profile falls along the normal to a biprism and splits into two coherent beams interfering in the region of their overlap. In the experiment, the interference pattern is investigated using a laser beam analyzer. The imaging lens allows us to scale the image.

As a result of the interference, a light patterns is formed, the cross distribution of the intensity of which can be quite close to the desired one. In experiments obtuse angle a biprism was 186˚, other - 178˚. The pictures in Figure 1 show how the transverse intensity distribution changes as the laser beam passes through a prism with an obtuse angle of 186 °. It can be seen that in light picture the strong contribution is made by diffraction of light on the sharp edge of the prism (Fig. 1b). To eliminate this effect, an opaque strip was introduced into the light field, oriented parallel to the scattering

Alternatively, to generate a quasi-one-dimensional bessel-like beam, laser radiation illuminates the amplitude transparency located in the focal plane of the lens (cylindrical or spherical).

Figure 2 shows examples of light fields and intensity profiles in the direction of the optical axis of the crystal, when they are formed in a circuit with an amplitude transparency, in a sample of $LiNbO_3$: Cu. According to the results, at the initial instant of time, when the sample is exposed, the intensity distribution on the output surface of the crystal corresponds to that for the light pattern. However, over time, the intensity ratio of the various maxima in the intensity profile (Figure 2) changes. At an exposure time of 80s and a laser beam power of 3 mW, the intensities of the certain maxima become practically the same. This is due to the saturable nature of the nonlinear-optical response of the structure at photorefractive effect.

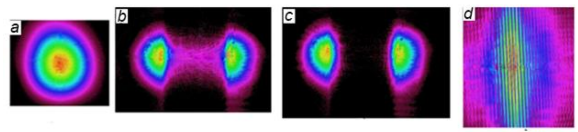
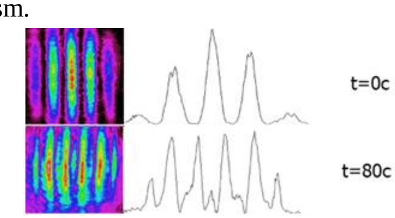


Fig. 1. Gaussian beam distribution to the biprism (a), picture (b) indicates a strong light scattering on the edge of the prism, a field of beams with an opaque strip (c), an interference pattern (d) in the region after the prism.



a b

Fig. 2. Light pattern (a) at the output plane of the $LiNbO_3$: Cu plate (a) and its intensity profile at different exposure times (b).

One-dimensional photonic structures with spatial periods of 7 - 30 μm were also obtained in a sample of LiNbO3: Fe by means of bessel-like beams formed both in schemes with amplitude transparency and with Fresnel biprisms. In these structures, the features of discrete diffraction of light have been studied [1, 2], associated with a small number of elements and a difference in the parameters of the waveguide elements.

Thus, experimentally demonstrated the creation of photonic structures in photorefractive crystals by bessel-like light beams.

[1] D. Christodoulides, "Discretizing light behaviour in linear and nonlinear waveguide lattices", Nature 424, 817-823 (2003).

[2] F. Diebel, M. Boguslawski, "Controlled soliton formation in tailored Bessel photonic lattices", Optics Express 24, 12933-12940 (2016).

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