an effect of large light storage in single crystals in comparison with powders with cathode excitation. It was explained by the reabsorption of the UV-radiation in the excitation process which led to the storage of the light sum over the whole thickness of the crystal. Such an explanation is not applicable to the specimens investigated since no UV luminescence was observed and the reabsorption of the blue and green radiation is extremely small.

LITERATURE CITED


INVESTIGATION OF ANOMALOUS ACOUSTOOPTIC INTERACTION IN LITHIUM NIOBATE CRYSTAL

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Expressions are derived for the calculation of the central frequencies $f_{0,2}^{0,2}$ and the frequency band $\Delta f$ of wide-band anomalous acoustooptic interaction in crystals of arbitrary symmetry class. The effect of the difference between the ray and phase velocities of the diffracted light on the magnitude of $f_{0,2}^{0,2}$ and $\Delta f$ is pointed out. Results are presented of the computed acoustooptic quality factor $M_2$, the frequencies $f_{0,2}^{0,2}$, $\Delta f$ and the electromechanical coupling constant for the tangential field $K_D$ for cuts of LiNbO3 crystals ensuring maximum diffraction efficiency. It is shown that the maximum $M_2 = 22 \times 10^{-18}$ cgs units in this crystal is attained in the case of anomalous light diffraction by the slow shear wave propagating in the Y-120° direction. To the same cut there corresponds the maximum $K_D = 0.685$. The design of anomalous acoustooptic deflectors developed is described. Experimental results are presented.

The lithium niobate LiNbO3 crystal is one of the most widely used serially manufactured crystals in acoustooptics.

The study and investigation of the electrooptic properties of this material was up to now restricted mainly to the examination of the simplest cuts, i.e., to directions of the elastic wave vector parallel to the crystallographic axes. However, the anisotropy of the physical properties of the crystal leads to a complex functional dependence of the main characteristics of the anomalous acoustooptic interaction (AOI) on the orientations of the elastic and light-wave vectors. Therefore, to find the crystal cuts ensuring optimal acoustooptic device characteristics, one must calculate the acoustooptic quality factor $M_2$, the
frequency band \( \Delta f \), and the central frequencies \( f^0 \) of anomalous wide-band diffraction for an arbitrary orientation of these vectors. Such a general approach makes it possible to derive not only quantitatively different results of the value of \( M_2 \), the extremum of which does not necessarily correspond to a simple cut, but also qualitative differences involving, for example, the existence for a given direction of the sound wave normal and diffraction plane of two different frequencies \( f^0 \) at which wide-band anomalous AOI is possible.

In the present paper more general expressions are derived for \( f^0 \) and \( \Delta f \). Results of calculations of the factor \( M_2 \), the frequencies \( f^0, \Delta f \), as well as of the electromechanical coupling constant for the tangential field characteristic of the excitation efficiency of elastic waves by slit electrodes from the surface of the piezoelectric, are presented for LiNbO₃ cuts having the highest AOI efficiency.

Results are also presented of the development and experimental investigation of anomalous electrooptic deflectors (AOD) constructed on the basis of these cuts.

The acoustooptic interaction assumes the fulfillment of the following relation between the light and elastic wave vectors which results from the conservation of momentum,

\[
\kappa_d = \kappa_i \pm K,
\]

where \( \kappa_i \) and \( \kappa_d \) are the wave vectors of the incident and diffracted waves; \( K \) is the wave vector of the elastic wave.

Making use of (1), it is not difficult to derive an expression for the frequency dependence of the diffraction angle \( \Omega_d \) and the Bragg angle \( \Omega_B \) which determine the frequency characteristic of the acoustooptic device

\[
\sin \Omega_d = \frac{\lambda f}{2n_{d}v} \left[ 1 - \frac{\nu^2}{f^2} (n_i^2 - n_d^2) \right];
\]

\[
\sin \Omega_B = \frac{\lambda f}{2n_{i}v} \left[ 1 + \frac{\nu^2}{f^2} (n_i^2 - n_d^2) \right],
\]

where \( \nu, f \) are the velocity and frequency of the elastic wave; \( \lambda \) is the light wavelength in vacuum; \( n_i, n_d \) are the refractive index of the incident and diffracted light waves.

To construct wide-band devices using the anomalous AOI, the frequencies \( f^0 \) in whose vicinity the Bragg angle depends weakly on the frequency of the elastic wave, i.e., the following condition

\[
\left. \frac{\partial \Omega_B}{\partial f} \right|_{f=f^0} = 0.
\]

is fulfilled, are of utmost interest.

It is not difficult to show that in the general case, Eq. (3) satisfies condition (4) at two different frequencies \( f^0_1 \) and \( f^0_2 \) given by

\[
f^0_1,2 = \frac{v}{\lambda} n_d \frac{\partial n_d}{\partial Q} \left|_{Q-Q_d} \right. \frac{\partial Q_d}{\partial f} \pm \frac{v}{\lambda} \left[ \left( n_d \frac{\partial n_d}{\partial Q} \left|_{Q-Q_d} \right. \frac{\partial Q_d}{\partial f} \right)^2 + (n_i^2 - n_d^2) \right]^{1/2}.
\]

Here to each of the frequencies \( f^0_1,2 \) there corresponds its direction of incident light \( \kappa_{i1}, \kappa_{i2} \) (Fig. 1) and the refraction indices \( n_{i1} \) and \( n_{i2} \) which in the general case may differ, \( Q \) is the angle in the diffraction plane.

The physical meaning of Eq. (5) is that in the elastic-wave frequency range in which anomalous AOI is possible, the Bragg angle reaches its minimum value \( \Omega_d \) at the frequencies \( f^0_1,2 \). It is easy to see that the partial derivative \( \partial Q_d/\partial f \) which enters in expression (5) is, at frequencies to \( f^0_1,2 \), practically constant, while the derivative \( \partial n_d/\partial Q \) is related to the angle \( \gamma \) between the phase and radial velocities of the diffracted wave in the following way:

\[
\frac{1}{n_d} \frac{\partial n_d}{\partial Q} = \tan \gamma, \quad \frac{\partial Q_d}{\partial f} = \frac{\lambda}{vn_d}.
\]

The angle between the \( K \) and \( \kappa_d \) vectors differs in this case, from the direct one by the magnitude "\( \gamma \)." In the case of anomalous wide-band AOI in negative uniaxial crystals (Fig. 1) the incident light is the ordinary wave, and, therefore, \( n_{i1} = n_{i2} \). Consequently, expression (5) for the frequencies \( f^0_1,2 \) is simplified.