CHARACTERIZATION OF NONLINEAR REFRACTIVE INDICES OF KDP, KTP, LiNbO₃ AND BBO CRYSTALS AT 1064 nm AND 532 nm

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We present our studies of nonlinear refractive indices of various nonlinear crystals (KDP, LiNbO₃, BBO, and KTP) in IR and visible ranges. The experimental results were analysed in a framework of Gaussian decomposition, paraxial approximation and numerical methods.

The development of femtosecond pulse amplification technique stimulated the growth of laser radiation intensity and led to the necessity of high-order nonlinear-optical processes influence on second-order ones to be taken into account [1,2]. The measurements of third-order nonlinear susceptibilities responsible for the self-action processes in nonlinear-optical crystals of KDP, LiNbO₃, BBO, and KTP were provided at the wavelengths of 1064 nm and 532 nm. The nonlinear adding to the refractive index and nonlinear absorption coefficients were determined. The measured results interpretation was done in a framework of Gaussian decomposition, paraxial approximation and numerical methods.

The Zscan method based on inhomogeneous phase shift in the different beam regions with different radiation intensity was used. The phase shift in nonlinear media along with self-action effect (we call it as the "self-action channel") can be due to different parametric processes. In anisotropic media possessing a high value of second order susceptibility responsible for second harmonic generation, the competing channel of induced phase shift is the process of direct and reverse frequency conversion [3] (the processes of the second and sub-harmonic generation). We call this channel as the "cascade channel".

It was shown that application of fitting parameters in paraxial approximation expands the bounds of measured results processing. The comparison of measured data with results calculated on the basis of simple empirical model and with known experimental and theoretical results was carried out. To estimate the relation between the nonlinearity components the angular and polarization dependences were analyzed.

In all crystals at the wavelength of 532 nm the self-focusing properties were observed and the sign of measured nonlinearities was positive. The highest values of the Kerr nonlinearities were observed in the KTP crystals. The measured nonlinearity value for KDP crystal was lower than that at the wavelength of 1064 nm. The nonlinearity decreasing in this frequency range coincides with result obtained by empirical model. In BBO crystal, the growth of nonlinearity with the wavelength decreasing was observed, that is also in a good agreement with calculation.

The ranges of the cascade nonlinear process influence on nonlinear phase shift are determined. It was shown that at λ=532 nm in KDP and BBO crystals the nonlinear losses were due to three-photon absorption, whereas in LiNbO₃ due to two-photon absorption. At λ=1064 nm in LiNbO₃ the nonlinear losses were determined to be due to four-photon absorption.

The results of nonlinear refractive indices, nonlinear susceptibilities, and nonlinear absorption measurements are presented.