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The Characteristic Times of Storage and Optical Erasing Photorefractive Holograms in Strontium-Barium Niobate Crystals

T. R. VOLK

Institute of Crystallography, Academy of Sciences of the USSR, Moscow

The Strontium-Barium Niobate crystals (SBN),[1] especially doped with cerium[2] are known to be successfully used as a medium for holographic recording.

The purpose of this work was to investigate some characteristics of recording, storage and optical erasing holograms (photorefraction) in SBN both pure and doped with cerium ($Ba_{0.25}Sr_{0.75}Nb_2O_6$ and $Ba_{0.4}Sr_{0.6}Nb_2O_6+$ 0.05 wt.% Ce correspondingly).

The photorefractive effect in SBN crystals is not due to the bulk photovoltaic effect since the values of photo emfs in them do not exceed 0.3–0.5 V up to intensities of 100 $W \cdot cm^{-2}$.[3]

The lux-current dependence of photoconductivity in SBN-Ce for $\lambda = 488$ nm is linear

$$\sigma_{ph} = 1.2 \cdot 10^{-10} I \Omega^{-1}\, cm \cdot W^{-1},$$

(I—the light intensity).

The kinetics of optical erasing for a given wavelength may be described by the exponential law with a characteristic time τ_{er}. It was shown that the experimental dependence of τ_{er} on the light intensity is in good agreement with the same dependence of dielectric relaxation time $\tau_{max} = \varepsilon/4\pi\sigma_{ph}$ extimated from the photoconductivity measurements.[4]

The dark storage time of photorefraction τ_{stor} in SBN-Ce is shown to be in agreement with the values of $\tau_{max} = \varepsilon/4\pi\sigma_d$ (σ_d:dark conductivity). The dark conductivity for polydomain (field or temperature depolarised) crystals increases by one order of magnitude as compared to monodomain crystals. Correspondingly the value of τ_{stor} decreases in polydomain SBN. In pure SBN dark storage time τ_{stor} is shorter than $\tau_{max} = \varepsilon/4\pi\sigma_d$ because of the existence of a high remanent photoconductivity[4] which is an order higher than the equilibrium dark conductivity. The effect of field quenching of remanent photoconductivity permits to control the value of σ_d and correspondingly the τ_{stor} in SBN.

The kinetics of the optical erasing holograms in SBN for all wavelengths may be described by the exponential law

$$\Delta(n_e - n_0)_t / \Delta(n_e - n_0)_0 = \exp(-kW)$$

where W—the erasing light energy, k depends only on the wavelength. The spectral dependence of the optical erasing constant k in SBN reveals two maxima.[5] One of them in the photoactive visible region coincides with the maximum of the photoconductivity and is due to the dielectric relaxation time decreasing. The second maximum in the IR region at $\sim 1\ \mu m$ is not connected with increase in photoconductivity and might be ascribed to the photoexcitation of some capture levels responsible for the formation of the internal local field.

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