Effects of light polarization and crystal orientation on the holographic recording efficiency in doped $LiNbO_3$ crystals

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Holographic grating recording by He-Ne laser (633 nm) in $LiNbO_3$:Fe, $LiNbO_3$:Cu, $LiNbO_3$:Fe+Cu, $LiNbO_3$:Fe+Ti crystals has been experimentally studied depending on their oxidation degree, on the recording and readout light polarization as well as on the crystal orientation ($\boldsymbol{K} \parallel \boldsymbol{P_s}$ or $\boldsymbol{K} \perp \boldsymbol{P_s}$, $\boldsymbol{K}$ being the holographic grating vector, $\boldsymbol{P_s}$ – spontaneous polarization). The crystals were kept about 20 years at room temperature before the first recording. Each next recording was performed after the annealing of crystal at 200^oC.

Annealing considerably improved the diffraction efficiency η and the specific recording energy W in all cases except $LiNbO_3$:Fe at $\boldsymbol{K} \perp \boldsymbol{P_s}$ case.The $\boldsymbol{K} \parallel \boldsymbol{P_s}$ orientation was much more efficient than $\boldsymbol{K} \perp \boldsymbol{P_s}$ one. The best results were obtained for $LiNbO_3$:Cu crystals (η_{oomax} =40%, W_{eomax} =6.8J/(cm^2%); indices denote the recording and readout polarization). Recording efficiency of crystals decreases in the following order: $LiNbO_3$:Cu, $LiNbO_3$:Fe, $LiNbO_3$:Fe+Cu, $LiNbO_3$:Fe+Ti. The recording efficiency polarization dependence of $LiNbO_3$:Cu crystals markedly differed from the known polarization dependence of $LiNbO_3$:Fe crystals . The obtained results can be explained regarding the influence of possible defects on the absorption and photogalvanic effect as well as electrooptic properties of crystals.

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