5.2 Multidomain Ferroelectric Crystals for Volume Hologram Storage

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Photorefractive gratings can be fixed if a complementary "grating" of some kind is created which does not decay with time or under illumination. One promising mechanism is the fixing in ferroelectric photorefractive crystals through the formation of ferroelectric domains which electrically compensate the space-charge field. In other words, the direction of the spontaneous polarization of the crystal can be selectively reversed such that the bound charge located on the domain walls electrically compensates the light-induced space-charge distribution of the original grating. This effect was observed first in the 70's in $BaTiO_3$ and SBN ($Sr_xBa_{1-x}Nb_2O_6$). Recently interest in this field has been revived and the research has been concentrated again on SBN and $BaTiO_3$.

Usually, the selective reversal of the direction of polarization is accomplished by first creating a space-charge distribution by the usual manner (interfering two light beams in the crystal) and then applying an electric field in the direction opposite to the original poling field. Several models are feasible to describe the local switching of ferroelectric polarization: antiparallel domain generation wherever the total field (applied plus space-charge field) exceeds the coercive field; needle-shaped domains nucleated at one electrode propagate towards the other electrode until they are stopped by the space-charge distribution; deformation of the domain walls by the space-charge field such that this field is screened. Electrical, optical and combined revealing of the fixed grating is possible.

Applications in holographical storage will depend on the magnitudes of the usual photorefractive parameters and on the precision with which one can control the fine shape of the domains and on the minimum domain size.