## 5.2 Photorefractive Grating Fixing and Enhancement in Multidomain Ferroelectric Crystals

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Photorefractive gratings, which normally decay under illumination, can be fixed in ferroelectric crystals through the formation of ferroelectric domains which electrically compensate the space-charge field. In other words, the direction of the spontaneous polarization $\mathbf{P}_s$ 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 ($Sr_{0.75}Ba_{0.25}Nb_2O_6$). 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 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. Exactly how this combination of the space-charge distribution and the applied electric field produces the domain grating as well as what configuration domain walls take to compensate the space-charge distribution is not known and several models are feasible: local switching of $\mathbf{P}_s$ 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. The last case offers the possibility, to the best of our knowledge not previously explored, that one should be able to record and simultaneously compensate through bound charge an optically induced space-charge pattern in a ferroelectric crystal by de-poling the crystal before the grating is created. We have shown that this is possible; furthermore, if the crystal is returned to the single-domain state the diffraction efficiency can be much larger (more than 20 times) than that of a grating recorded in a single-domain crystal under identical conditions.