2.6 Intrinsic Electro-optic and Dielectric Properties of Photorefractive $BaTiO_3$ and $KNbO_3$ Crystals

(M. Zgonik and K. Nakagawa)

The photorefractive effect is based on space-charge fields which can be produced in photoconductive crystals. These space charge fields in turn induce variations in indices of refraction through the linear electro-optic effect. A crystal-deformation in the form of a static plane wave is also produced by the piezoelectric coupling. The total refractive index change is obtained by adding together the strain-free electro-optic contribution and the elasto-optic contribution.

We used the recently determined complete sets of materials parameters describing the dielectric, elastic, piezoelectric, elasto-optic, and electro-optic properties of $BaTiO_3$ and $KNbO_3$ crystals at room temperature to calculate the effective electro-optic coefficients and dielectric constants required for describing the photorefractive phenomena. We showed a substantial deviation of the new values from the electro-optic coefficients for homogeneously applied electric fields, which have been used until now. We derived angular dependencies of the effective electro-optic coefficients and the effective dielectric constants relevant for grating recording in both crystals and verified them experimentally.

The experimental arrangement was a two-beam coupling set-up with small grating vectors. A sample in the form of a parallelepiped was rotated about the axis which coincided with the face normal and bisected the direction of the two beams. The rotation angle of the sample determined the direction of the grating vector. The polarizations of the two interacting beams were parallel with each other and were rotated by the same angle as the sample. The two-beam coupling gain could be measured as a function of the rotation angle in the whole range of 360˚ for one or the other eigen-polarization.