Piezoelectric crystals structure investigation under electric field using X-Ray diffraction

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The examples of X-Ray diffraction applications for investigation of functional properties and real structure behavior under external electric field in piezoelectric crystals are presented in the work. New approaches are developed and implemented for measuring of piezoelectric constants using quasimultiwave diffraction and triple-axis diffractometry techniques. Application of these methods makes it possible to determine piezoelectric coefficients by measuring of lattice parameter changing caused by influence of external electric field on the crystal [1]. These techniques have been tested during the investigation of lanthanum-gallium tantalate crystal piezoelectric properties, the potential has been estimated and the results have been compared with ones obtained by high-resolution double-axis diffractometry.

In paratellurite crystals new effect of slowly relaxing domains formation was observed at application of external electric field to the samples [2]. These domains differ from those arising in ferroics (ferromagnets, ferroelectrics, ferroelastics, etc.). The effect is characterized by the existence of a threshold field strength (at which domains begin to be formed) and long equilibrium settling times (up to a few hours, depending on the electric field strength). A crystal returns to the initial single-domain state also after a few hours after the field is switched off. High-resolution triple-crystal X-ray diffractometry used for reciprocal space mapping has revealed that domains retaining the paraelastic tetragonal phase rotate with respect to each other in space without changing their lattice parameter. The domain sizes are 2–4 mm, depending on the field strength.

For investigation of stimulated by external electric field real structure behavior in lithium borate crystal time-resolved double-axis diffractometry technique was used. The time resolution of one second per one rocking curve was reached at laboratory facility by using of the special optical element for fast X-Ray beam angular position managing based on bidomain bending lithium niobate crystal. Time dependencies of rocking curve parameters (FWHM, maximum and integral intensity, angular position) after application of external electric field were measured. Application of such approach allows to separate faster lattice parameter changing process caused by inverse piezoeffect from slower process of crystal lattice deformation induced by the charge drain process.

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