ESRF	**Experiment title:** DIFFRACTION STUDY OF HYDROGEN IMPLANTED $LiNbO_3$ CRYSTALS WITHOUT AND UNDER A DC ELECTRIC FIELD	**Experiment number:** HS-253
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Background

Lithium niobate ($LiNbO_3$) displays a number of large-magnitude physical effects which make it an attractive material for applications in guide-wave optics. Implantation by energetic (- MeV) light ions such as hydrogen or helium has the effect of considerably lowering the refractive index in the implanted region, while the refractive index of the layer only traversed by the implanted ions remains approximately the same as the bulk one. The 0.2-l μm thick implanted layer, with lower refractive index, can thus define the boundary of a waveguiding region, i.e. the traversed layer (thickness up to 15 pm). By varying the ion dose and energy a variety of waveguide profiles can be generated.

The aim of this work was the characterization of the layers produced in $LiNbO_3$ crystals by hydrogen implantation. Section topographs of an implanted platelet-shaped crystal, often already without and mostly under the electric field applied along the normal to the main surface, show the image of a layer associated with the implantation. This line-shaped image moves with respect to the image of the bulk when changing the polarity of the applied field. The misorientation is proportional to the field and appears to be strongly related to the piezoelectric effect.

Results

The experiment was successful in determination of the origin of the misorientation between the image of the bulk and the image of the layer associated with implantation.

Some of the samples investigated topographically were polished on the small area surfaces and chemically etched ($HF+2HNO_3$ at about 105°C). This etching is different for the opposite surfaces and reveals eventual anti-parallel ferroelectric domains. Around the expected location of the implanted layer (less than 1 pm thick) a grey layer parallel to the surface was observed (using optical microscope) being several μm thick. It only occurs where the crystal is implanted and displays a different etching rate with respect to the bulk.

The set of etching and topographic experiments obtained during the last experiment confirmed that the implantation by hydrogen produces a layer of inverse polarization, compared to the bulk, around the implanted layer. The traversed zone and the bulk are piezoelectrically deformed (when an electric field is applied) with an opposite sign with respect to the inversed layer which surrounds the implanted one. The total misorientation between the inversed layer and the bulk results from an algebraic sum of shear and relative modification of the cell parameter. The calculated and experimental line-bulk misorientations under a dc field are in fair agreement [1].

The reason why the implantation creates the layer of inversed polarization is probably related to the strain imposed by the implanted ions in the neighborhood of their locations. This strain-related occurrence of inversed polarization regions was checked and confirmed: small reversed domains of inversed polarization were often observable after etching around the scratches produced by a diamond stylus on the polished surfaces of our samples.

Further experimentation is required to resolve the uncertainty of the origin of observed diffracted intensity increasing under the electrodes. An expansion, or contraction, of the image of the bulk occurs according to the orientation of the applied field. This expansion (or contraction) of the image of the bulk is associated with a curvature of the reflecting planes under an applied field. The corresponding radius of curvature is of the order of several meters for an applied field about 30 kV/cm. In addition, the origin of the layer-bulk misorientation without an applied field is not clear.

References

[l] P. Rejmankova, J. Baruchel and P. Moretti, Physica B 226 (1996) 293-303.