ESRF	**Experiment title:** Investigation of the relationship between the lattice distortions and the variation of optical refractive index in photorefractive doped $LiNbO_3$	**Experiment number:** HS- 877
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Report: It was reported by several authors that lithium niobate when illuminated, besides the bulk photovoltaic and the photorefractive effects, presents also, a lattice deformation in the illuminated region. The purpose of our experiments was to study the photoinduced lattice deformation with the use of in situ synchrotron topography.

Experiments

We investigated three Fe- doped lithium niobate samples with z,y (0.1%-mol) and (104) (0.138% mol) cuts. The experiments consisted in the constant illumination of a small rectangular region of the samples with homogeneous light from a Xenon arc lamp. In situ recording of the topographs from the whole sample was realized in monochromatic mode (Laue and Bragg cases) using the Frelon CCD Camera. The experimental setup for the Laue case is shown in figure 1.

In order to examine different aspects of the distortions we performed in general three types of experiments.

1. Projection synchrotron topographs both in Bragg and Laue geometry for all the possible symmetric reflections of the samples ((006), (300), (120), (208)) with different illumination directions. These experiments were done in order to investigate the tensorial properties of the deformation and especially its relation with the polarization axis c of the crystal.

2. Rocking curve topographs performed in Bragg and Laue cases. They are of importance to extract both quantitative and qualitative information concerning the type and the order of magnitude of the deformation.
3. Combining these set up,we performed real time experiments in order to study the time evolution of the diffracted intensity from the deformed region, as well as the spatial expansion of the deformed region as a function of the illumination time.

Results

Figure 2 presents the Laue synchrotron topographs of the symmetric planes of the z-cut and the y-cut sample, before and after illumination. We observe that after illumination a high contrast has appeared at the borders of the illuminated rectangle. For the z- cut sample the contrast is always perpendicular to the diffraction vectors **G** [300] and [120], indicating that there is a deformed region at the borders of the illuminated rectangle both along its x and y sides. For the y-cut sample, the contrast is always perpendicular to the polarization axis c, suggesting that a highly deformed region appears only at the +c and –c borders of the illuminated rectangle. This deformed region is not homogeneous and is expanding both inside and outside the illuminated region, along the c axis. These results are consistent with a model of a deformation having a cylindrical symmetry along the c- axis.

Based on a simple model of lattice planes dilation along c-axis within the illuminated region, the rocking topographs analysis leads to a vlaue of $\Delta c/c$ of the order of 10^{-4}.

Both intensity and expansion increase exponentially with illumination time till a saturation value, but with different relaxation times τ (τ_1=3.04mn and τ_2=10.81mn, respectively). The deformation is still present for several hours when the sample is kept at the dark. It can be erased by illuminating the whole sample.

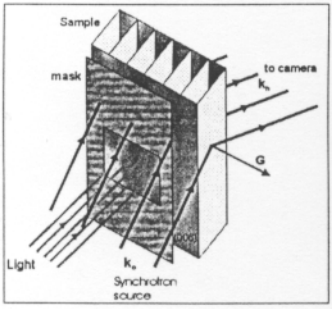

Fig.1 Setup for Laue topographs

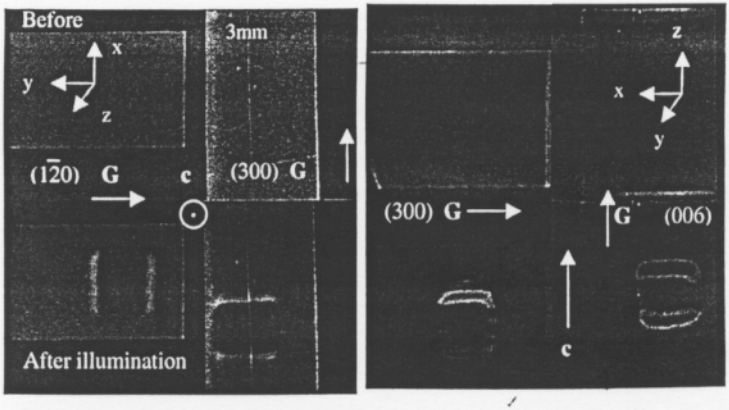

Fig. 2 Laue transmission topographs before and after illumination. Samples: z-cut (left), y-cut (right). x ⊥ (100) planes, y ⊥ (120) planes, z ⊥ (001) planes

Conclusions

Combined X-ray topography and real time experiments have been a valuable tool to investigate the deformation evolution as a function of time. It would be now of great interest to perform section topography under the same conditions, and also to play on time evolution (by decreasing the temperature) to know more about the activation energy of the deformation.