11.1-06 OBSERVATION OF CHIRALITY DOMAINS IN TERBIUM BY POLARIZED NEUTRON DIFFRACTION TOPOGRAPHY.

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Terbium has an antiferromagnetic helical phase in the temperature range $T_c = 219 - T_N = 226$ K ; the magnetic moments then lie normal to the sixfold $\vec{c}$ axis , are ferromagnetically aligned in basal planes and rotate by about 19° between successive Tb sheets. The rotation can be right-handed or left-handed, leading to the possibility of two kinds of spiral-spin or chirality domains. These domains have been invoked to explain anomalies in susceptibility measurements (Del Moral and Lee, J.Phys.F, 4, 280 (1974)) or ultrasound attenuation (Palmer, J.Phys.F., 5, 2370 (1975)), and some evidence for their actual existence was given by polarized neutron diffraction measurements (Felcher and al, J. de Phys. 32, C 1 - 577 (1971)). We have carried out the first observation of chirality domains, using a good quality (10$\bar{1}$0) single crystal of terbium (grown at the Centre for Materials Science, Birmingham), by polarized neutron topography. Different domain structures are observed depending on the thermal history of the sample. When it is warmed from the ferromagnetic phase, one observes stripe domains elongated perpendicular to the helical axis, about 0.15 mm wide. Cooling the sample from the paramagnetic phase produces walls of rather irregular shapes, the domain structure being reproducible in successive coolings. This suggests that the wall locations could be related to crystal defects when cooling through T_N, while the more regular arrangement we obtain when warming through T_c could be associated with the ferromagnetic domain structure of the low temperature phase.

11.1-07 NEUTRON DIFFRACTION TOPOGRAPHIC INVESTIGATION OF THE ELECTRIC FIELD RELATED EXTINCTION REDUCTION IN α-LiIO$_3$.

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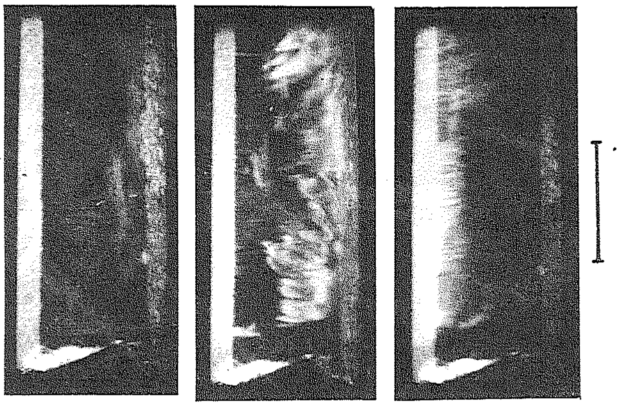
A strong reduction of the extinction in neutron diffraction was recently reported (Xu-Zheng Yi et al, Acta Physica Sinica 28, 694 (1979)) in the pyroelectric, piezoelectric and ionic conductor (Remoissenet et al., Mat.Res.Bull. 10, 181 (1975)) α-LiIO$_3$, when an electric field is applied along the $\vec{c}$-axis. In order to improve the understanding of this phenomenon, we have performed neutron and γ-ray diffraction measurements, and neutron diffraction topography experiments on samples produced in various growth conditions. Neutron diffraction measurements indicate that extinction is reduced in the 002 reflection for all the samples, but the rate of enhancement of the diffracted intensity as a function of the applied field varies from sample to sample. The width of half maximum of the γ-ray rocking curves is not modified by the application of an electric field but tails associated with regions misoriented by about ∿ 20" with respect to the matrix appear on both sides of these curves. Neutron section topographs (Schlenker et al, J.Appl.Phys. 46, 2845 (1975)) show (fig. 1) that the extinction reduction is neither homogeneous across the sample volume nor localized near the electrodes only but appears as a strong enhancement of the defect image visibility. The effect only occurs where an electric field parallel to $\vec{c}$ is present. This suggests that the mechanism leading to an enhanced distortion of regions in the neighbourhood of the defects could be an accumulation of charges in these regions. Topographs made at 170 K and 354 K show that the ionic conductivity is a crucial parameter of the problem and are in agreement with this model. Other experiments were performed in order to test the influence of piezoelectricity on the observed phenomenon.

This work is at present under further development.



a b c

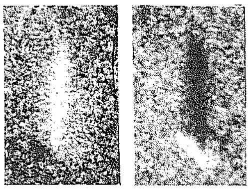
Fig. 1 : 002 section topographs of a sample of α-LiIO$_3$, which differ by the applied electric field :
a) short circuited
b) + 200 V cm^{-1}
c) - 200 V cm^{-1}.
Scale mark : 5 mm ; $\vec{c}$ is horizontal

11.1-08 THE DIFFRACTION CONTRAST OF DISLOCATION OBSERVED IN THE CASE OF X-RAY ANOMALOUS TRANSMISSION.

By E. Zielińska-Rohozińska, Institute of Experimental Physics, University of Warsaw, Warsaw, Poland.

In absorbing crystals (μt>>1) the image of dislocations recorded on X-ray topographs usually appears as a bright shadow. The brightness of the dislocation diffraction contrast has been explained either by the absorption effects (Borrmann, Phys. Bl. (1959) 15, 508; Shulpina & Datsenko, Ukr. fiz. Zh. (1967) 12, 1974; Chukhovskii & Shtolberg, Zh. eksper. Fiz. (1973) 64, 1033) or by interbranch scattering (Suvorov et al., Phys. Stat. Sol. a, (1980) 60, 27). Observations of the 30°-type dislocation diffraction contrast performed by means of the Lang technique for the [001] oriented GaAs sample (μt∿5) show a white dislocation image for the $\underline{g}$ vector (Fig. 1a) and a black one for the reversed $\underline{g}$ vector (Fig. 1b). In the present case also the path curvature effect of anomalously transmitted Bloch wave seems to play a significant role in the image formation. Topographs taken for 220 and $\overline{22}0$ reflections are presented in Fig. 2 (a,b) respectively. The white image is seen very well in Fig. 2a, whereas a black one is observed in Fig. 2b. Moreover,

Fig. 1

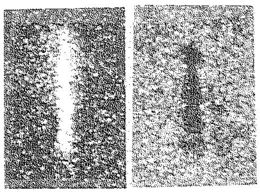


a b

040 0$\bar{4}$0

the image oscillations are recognized there (more pronounced on the original plate). The interaction between the new created wave fields in the highly distorted region of the dislocation core and wave fields curved by a long range stress field seems to be responsible for such a dislocation image formation in the case of the anomalous X-ray transmission.

Fig. 2



11.1-09 SURFACE LAYER OF $BaTiO_3$ a-PLATE AND ITS DEPENDENCE ON ELECTRIC FIELD. By H.Kawata, S.Suzuki and M.Takagi, Physics Department, Tokyo Institute of Technology, Oh-okayama, Meguro-ku, Tokyo, Japan.

The lattice strain near the surface of $BaTiO_3$ a-plate (P_S//surface, 50-200µm thick) was studied by X-ray topography. It was found that; 1) the lattice near the surface was intrinsically distorted and 2) the lattice state of the layer was changed by applying an electric field (applied potential:V_0). The detail is as follows.

1) The surface layer is schematically shown in Fig.1(a) as shaded region. The (001) lattice planes with and without shear strain are drawn by solid and dotted lines respectively. The strain component is only ε_{xz} and its sign depends uniquely on the directions of the spontaneous polarization P_S and the surface normal. The sign of ε_{xz} in ⊖ and ⊕ domains are opposite to each other (Fig.1(b)). The domain contrast on the surface reflection topographs(Fig.2(a)) is due to the difference in Bragg condition between them. The strain and the thickness of the layer were measured by the experiment(Fig.3) to detect the angular spread of the diffracted beam from the strained region. The image of Fig.2(b) has a tail at lower or higher angle sides depending on the direction of P_S. From the analysis of the micro-densitometer trace of Fig.2(b), the maximum shear strain $\varepsilon_0=1.5\times10^{-4}$ and the thickness $t=1/k=0.15$µm were estimated by assuming the strain distribution as $\varepsilon_{xz}(x)=\varepsilon_0\exp(-kx)$ at the depth x.

2) When an weak electric field was applied perpendicular to P_S(Fig.3), the image was changed as shown in Fig.2(c), (d),(e) and (f) which correspond to -1, -4, +1 and +4 volts per 220µm respectively. The strain and the thickness of the layer largely increased at the cathode, on increasing an applied field. If such an increase was caused by piezo-electric effect, V_0 should be drastically dropped only near the cathode. Such a localized field has been suggested by H.Motegi(J.Phys.Soc.Jpn. 32(1972) 202). Under V_0=-4V(Fig.2(d)), the images of ⊕ domains spread broadly to lower angle side, but that of ⊖ domains has a sharp peak at higher angle side. The explanation to this phenomenon is that there are both contributions from ε_{xx}(electro-striction) and ε_{xz}(piezo-electric effect) to the strain of the surface layer and they are additive in ⊕ domains but are subtractive in ⊖ domains. It was confirmed by mapping the intensity distribution around a reciprocal lattice point (303). The strain field $\varepsilon_{xz}(x)$ and $\varepsilon_{xx}(x)$ can be estimated from this map.

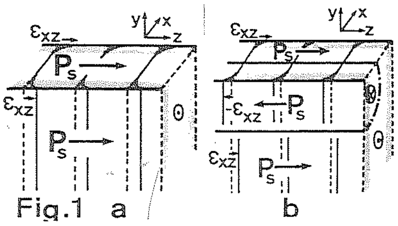
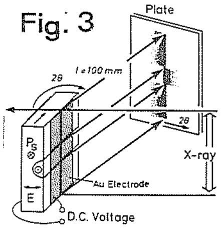
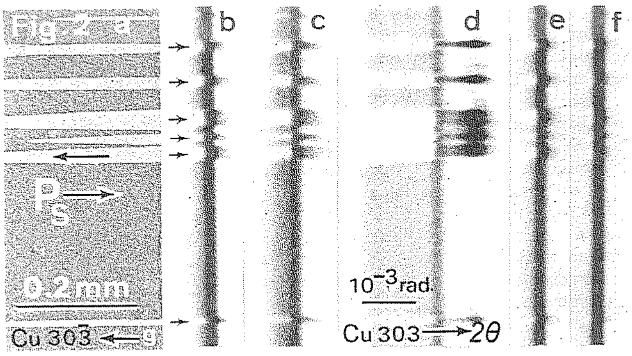


Fig.1 a b





11.1-10 REAL TIME X-RAY TOPOGRAPHIC STUDY OF FERRO-ELECTRIC $BaTiO_3$ CRYSTAL. By S.Suzuki,H.Kawata,M.Tachikawa and M.Takagi. Department of Physics, Tokyo Institute of Technology, Oh-Okayama, Meguro-ku, Tokyo, Japan

We have made the real time observation of X-ray topographs of the ferroelectric $BaTiO_3$ crystal by video display technique. The image formed on the fluorescent Gd_2O_2S film was optically magnified and displayed on TV screen through the image intensifier, TV camera and the video tape recorder. The resolution of our set up was restricted to 50 µm due to the beam divergence of the incident X-ray and other experimental conditions. But it will hopefully be improved to 10 µm in the case of synchrotron use. In this paper we show the following three real time observations.

(1) Polarization reversal of c-domain(P_S⊥surface)

A single crystal plate (1×2×0.06mm) of $BaTiO_3$ with the spontaneous polarization perpendicular to the surface (c-domain) was used. The wall motion with the velocity of the order of 10^{-5}m/sec was successfully resolved. In (200) symmetric reflection, any contrast is not expected for the stationary 180° domains. But the 180° walls were clearly observed with this reflection when the walls were moving under the electric field as has been observed with the polarizing microscope(R.C.Miller et al.; Phys.Rev.Letters,2(1959)294). In Fig.1(a) it is seen that the reversed domains (R) have emerged from the edges of the electrodes and a small reversed domain (R') was nucleated under the electrodes too. They grew continuously and have coalesced to each other (Fig.1(b) and (c)). Domain boundaries had habit nearly parallel to [110] when the wall velocity was about 10^{-5}m/sec. But they took irregular shape at the higher wall velocity. This X-ray technique is very sensitive to the change in the crystal lattice and can give information which can not be obtained by the optical microscope. A great advantage is in the application to the crystal which is opaque in the visible