11.1–13 STROBOSCOPIC SECTION TOPOGRAPHY OF VIBRATING QUARTZ RESONATORS

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The time structure of the synchrotron radiation source DORIS has been utilized for stroboscopic topography of thickness shear waves in quartz. The investigations concentrated on changes of dislocation contrast and Pendellösung fringes in section patterns.
The results are the following:

1) With increasing vibrational amplitude the Pendellösung fringe contrast nearly disappears at a certain value and occurs again at even higher values, but now with a decreasing fringe distance towards the margins. If the amplitude is raised further the section pattern is dominated by the higher reflectivity of the strained parts in the crystal (Fig. 1).

2) Dislocation contrast shows a complicated behaviour. With increasing vibrational amplitude the direct image always becomes weaker. The intermediary image is strongly changing (Fig. 2). In suitable cases the direct image nearly vanishes and is replaced by a strong contrast at a place which can be geometrically related to the intersection point of the dislocation line with the boundary of the Borrmann fan in the reflected direction. Due to this effect the dislocation image in projection topographs is shifted without a real motion of the dislocation line.

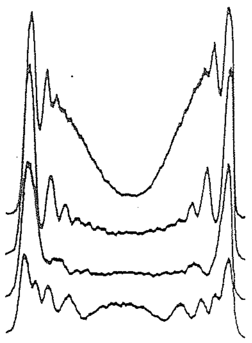

Fig. 1: Change of Pendellösung fringes with increasing vibrational amplitude.

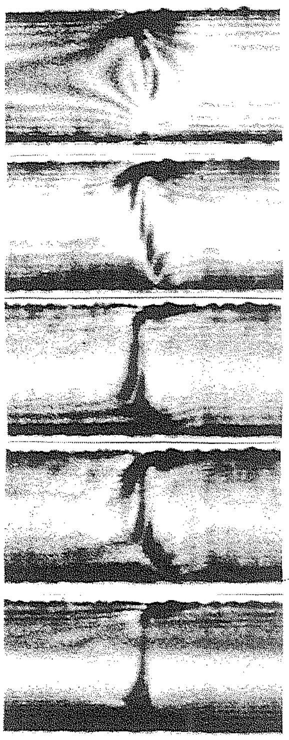

Fig. 2: Section pattern with dislocation image. Acoustic wave amplitude increases from top to bottom.

11.1–14 IMAGE CONTRAST OF SURFACE ACOUSTIC WAVES IN SR-TOPOGRAPHY

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By using the time structure of the synchrotron radiation source DORIS we have investigated travelling acoustic waves on the surface of $LiNbO_3$ with white beam topography. By synchronizing the wave excitation with the source frequency "time frozen" wave images are obtained.

The contrast formation in the Bragg case can be divided into two parts. One contribution is the surface reflected beam which shows intensity modulation due to the periodic curvature of the reflecting net planes. Troughs of the surface wave focus the reflected beam and crests defocus. The focal distance depends on Bragg angle, wave amplitude and the angle between the acoustic wave vector and the plane of incidence.

The second contribution to the image is coming from wavefields which first enter the crystal and are deviated back to the entrance surface by the strain fields of the SAW. Closely above the surface two peaks per acoustic wave period are detected which have different intensities due to the anomalously high or low absorption which has taken place during the wavefield deviation inside the crystal. The peak with the higher intensity is emerging from the troughs, the one with lower intensity from the crests of the wave. With increasing distance from the surface the peak with lower intensity is dispersed whereas the other one is focused resulting in a pattern which is nearly coinciding with the surface reflected pattern.

Experimental evidence and theoretical explanation of the above described image formation will be presented.

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11.1–15 MEMORY EFFECTS OF THE ANTIFERROMAGNETIC DOMAIN STRUCTURES IN MnF_2.

By J.Baruchel and M.El Kadiri, Laboratoire Louis Néel, CNRS-USMG, and Institut Laue-Langevin, Grenoble, France.

MnF_2 is antiferromagnetic below $T_N \simeq 67K$. 180° antiferromagnetic domains are physically distinct because the magnetic moments of opposite sign, directed along the $\vec{c}$ axis of the rutile-type structure, are respectively located at the corners and at the center of the unit cell, and these two sites, although equivalent, are not related by a lattice translation. Fig.1 shows the two kinds of domains on a projection on the (001) plane.

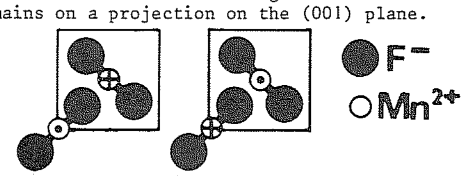
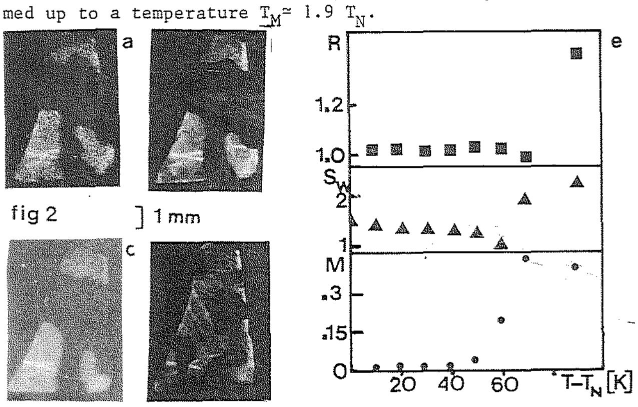


fig 1

Neutrons can distinguish between both types of domains because their structure factors are different for a given neutron polarization parallel to $\vec{c}$-axis. The observation of these domains was performed by polarized neutron diffraction topography [Baruchel, Schlenker and Barbara, J.Magn.Magn.Mat. 15-18,1518 (1980)] : indeed only one domain type is imaged for each polarization state when using the 210 reflection at ∿ 30 K.

The obtained domain structures display several unexpected memory effets. Fig. 2 shows topographs performed at 30 K after cooling from a) room temperature, b) T_N + 30 K, c) T_N + 50 K, d) T_N + 90 K. The first three topographs are very similar but not completely identical: the flipping ratio R, which indicates the ratio of the volumes occupied by each kind of domains, is constant, but the total wall surface S_W is reduced, and the ratio M we define, within the limits of the resolution of our experimental technique, as the fraction of the volume where the domain type switched, is less than 6.10^{-2} for

$T \lesssim T_N + 50K$, and increases with a further increase of the temperature (Fig.2e). The memory of the initial domain structure is thus lost only when the sample is warmed up to a temperature $T_M \simeq 1.9\ T_N$.



When the sample is repeatedly warmed up to $T \simeq T_M$, and cooled under a magnetic field parallel to $\vec{c}$ and $\gtrsim 25$ Oe, the domain structure remaining in virtually zero field is again reproducible [Alperin, Brown, Nathans and Pickart, Phys.Rev.Lett.8, 237 (1962)], the domain type being changed in a given region of the sample when the field is reversed [Baruchel and Schlenker, Nukleonika 25, 911 (1980)] . This effect which depends on the state of stress of the sample, seems to be related to the piezomagnetic properties of MnF_2 [Borovik, Romanov, Soviet Physics JETP 11, 786 (1960)]

Domains are not affected by dislocations or subgrain boundaries, but are very sensitive to planar defects lying in (011) type planes, which seem to be twin lamellas similar to those observed by Van Landuyt, Gevers and Amelinckx [Phys.Stat.Sol. 7,307 (1964)]in TiO_2. This interaction is magnetic field dependent.

11.1–16 THE STUDY OF α-β PHASE TRANSITION OF QUARTZ BY MEANS OF IN-SITU X-RAY TOPOGRAPHY AND FINE BEAM LAUE PHOTOGRAPHY.

By K. Gouhara and N. Kato, Faculty of Engineering, Nagoya University, Chikusa-ku, Nagoya, Japan.

An incommensurate phase (IP) between high and low temperature phases of quartz has been discovered (Gouhara, Li and Kato; J. Phys. Soc. Japan (1983) 52, 3697, ibid. 3821). The experiments of heat capacity and neutron diffraction conform to our results (Dolino & Bachheimer; Solid State Short Comm.(1983) 45, 259 and private comm.). The brief resumé and the recent observations on a new domain structure of IP will be presented. Henceforth, T_C and T_Q will be used for denoting the transition temperatures of α→IP and IP→β, respectively.
Specimens were circular plates (7 mmϕ, 1 mm in thickness) of X and Y cut prepared from synthetic quartz. With high intensity X-ray source of Ag and Cu [RU 1500; H. Uematsu et al; Acta Cryst.(1978) A34, Suppl. S330], three diffraction methods were employed. (a) Ordinary and Laue topography due to the Bragg reflections (BR): They were recorded on TV screen, VIDEO tape, as well as on nuclear emulsion plates. (b) A fine beam Laue photography for observing the satellite reflections (SR). The angular resolution was of 3 min. (c) The topography due to SR. The temperature could be controlled with accuracy of 0.1 degree.
When a temperature gradient was deliberately given in the specimen, as increasing and decreasing temperature, a dark contrast of IP crossed over the specimen, reversiblly (Fig.1). Always, a strain contrast was associated. The analysis shows that the transitions at T_C and T_Q are of first and nearly second order, respectively. Fixing tiny apertures on α, IP and β regions [the method (b)], we could observe SR in vicinity of more than 20 Laue spots, but only in IP phase. The modulation vectors $\tilde{q}_i$ lay in c-plane and were approximately parallel to $\tilde{b}_i$ (primitive reciprocal lattice vectors). Also, the modulation waves were transversal in c-plane.
When the temperature gradient was reduced to less than 0.1° over the specimen, the contrast of IP in the ordinary topograph was much decreased. The strain contrast disappeared. In a suitable condition, the Laue topograph due to SR could be obtained simultaneously but separately from that due to BR [The method (c)]. Under the conditions, the Laue photographs were also recorded sequentially. A super heating of α phase ($\sim 1.5°$) was recognized when the temperature was increased. From the analysis of SR spots observed in decreasing temperature, were obtained the temperature dependences of the modulation wavelength ($n = b/q$) and the deviation angle (ϕ) of $\tilde{q}_i$ from $\tilde{b}_i$ (Fig.2). The intensity of SR also rapidly increases near T_C. The contrast of topograph of BR was generally homogeneous except very near T_C but that of SR (X-cut plate) was stratified along c-axis. It was concluded that IP phase has a new domain structure as shown in Fig.3, each domain being characterized by $\pm\phi$.

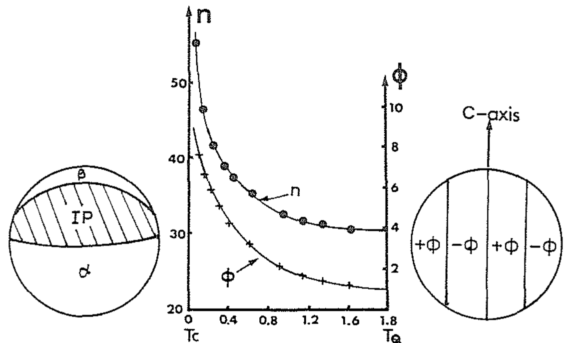


Fig.1. Fig.2. Fig.3.

11.1–17 ON THE CONTRAST OF DISLOCATION DIRECT IMAGE IN X-RAY SECTION TOPOGRAPHY.

By G.Kowalski, Institute of Experimental Physics, University of Warsaw, Warsaw, Poland.

To get an insight into the process of the dislocation image formation in X-ray section topography,the beam trajectories /Fig.1/,both for the so called normal and newly created wavefields are numerically constructed /Kowalski, submitted to phys.stat.sol./.It was found that direct image of dislocation /Authier,Adv.X-Ray Anal./1967/,10,9/ may be interpreted by interbranch scattering occuring near direct beam /Kowalski,ibid./.The influence of the position of dislocation with respect to the direct beam on image formation is also studied.The presented model of direct image was applied to interprete the experimentally obtained 30° dislocation image /Fig.2/.Long black image of dislocation observed on topograph /Fig.2/ results from interaction between strain field along whole dislocation line and wavefields travelling near S_0 edge of Borrmann fan,giving rise to interbranch scattering. The possibility that the same kind of process of image formation will occur along dislocation line but inside the Borrmann fan is also discussed.

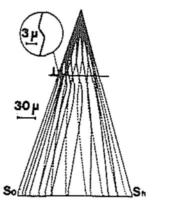


Fig.1

Fig.2