13-Defects, Microstructures and Textures

PS-13.02.08 DETERMINATION OF THE VOLUME RATIO OF DOMAINS NEAR THE STRUCTURAL PHASE-TRANSITION TEMPERATURE.

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After passing through a cubic-to-tetragonal phase transition, a crystal generally consists of three kind of domains which are specified by the direction of the c axis. A single reciprocal-lattice point in the cubic phase splits into a set of points in the tetragonal phase with domains; the domain volume ratio can be determined from the relative intensities of the split points. Near the transition of second order, the splitting is so small that we need a high-resolution diffraction technique. To the high-angle double-crystal X-ray diffractometry (HADOX) of a 2θ-resolved version, a four-circle goniometer has been introduced in order to align the specimen crystal in any orientation; by this, three-dimensional intensity distribution in the reciprocal space can be measured with high resolution. In the previous HADOX experiments of the original version, anomalous temperature dependence was observed near the 105 K transition in $SrTiO_3$: the 004 peak of the tetragonal phase gradually disappeared in a temperature range of 10 K below the transition. For this phenomenon, there were two possible explanations: a change in domain orientation and two-phase coexistence. In the present experiment, the 400, 040 and 004 positions in the cubic phase were examined; the intensity distribution was measured as a function of temperature. It is found that the total intensity at the three positions is constant for both 400 and 004 peaks, although the intensity of individual 400 and 004 peaks varies. This means that the previous observation was due to a change in domain orientation.

PS-13.02.09 IMAGING-PLATE X-RAY TOPOGRAPHY ANALYSIS SYSTEM FOR CHARACTERIZING GROWTH STRIATIONS IN SILICON CRYSTALS.

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Using synchrotron plane wave x-ray topography, local lattice distortion due to growth striations in Si crystals was quantitatively determined at a sensitivity of 10^{-8} (Kawado, Kojima, Maekawa & Ishikawa, 1991). Since x-ray topographs were taken on photographic plates, with local variations in the diffracted x-ray intensity being indirectly obtained by microphotometer measurements of variations in the plate's optical density, x-ray exposure and development processing had to be carefully controlled to obtain linearity between the optical density and sample rotation angle. To overcome this disadvantage, an imaging-plate (IP) x-ray topography analysis system has been developed and applied to a quantitative analysis of local lattice distortion due to oxygen striations in magnetic Czochralski (MCZ) Si crystals.

The experimental arrangement for plane wave x-ray topography was set up on beam-line 15C at the Photon Factory. Using the double-crystal monochromator and the asymmetric-reflection collimator, a large-size (50 × 50 mm) incident x-ray beam ($\lambda = 0.1126$ nm) was realized with an angular divergence of ~0.1 arcsec and a wavelength spread of $\sim 3 \times 10^{-5}$. The sample crystal, which was a 10 mm-thick undoped MCZ Si plate with [100] surface orientation perpendicular to the growth axis [001], was aligned to give a symmetric 800 reflection in the Bragg geometry; thereby constructing a non-dispersive (+n, -n) setting between the collimator and the sample crystal.

A series of x-ray topographs were taken at 0.05-arcsec-intervals at the slope of the rocking curve's low-angle side in two sample configurations where the sample crystal was rotated 180° around the surface normal. High-resolution type IP's (Fuji DL UR-III) were used to record the x-ray topographs. A PIXsysTEM (Oikawa, Mori, Takano & Ohnishi, 1990) was used in its high-resolution mode as an IP reader, with signals being logarithmically amplified, digitized into 12-bit data, and then transferred to a data processing system that was constructed on a 32-bit UNIX engineering work station (Sony NEWS). Calculations for lattice distortion measurements were performed using the method proposed by Kikuta, Kohra & Sugita (1966) to separate the lattice spacing variation $\Delta d/d$ from the orientation variation $\Delta\alpha$. The resultant one-dimentional profiles and two-dimentional images of $\Delta d/d$ and $\Delta\alpha$ variations were printed out by a laser beam printer and with a grey scale by a full-color printer, respectively. Examples of two-dimentional images are shown in Fig. 1, where enhanced contrast gives a increase in variation.

This newly developed analysis system, having excellent features such as high speed data process, easy operation and availability of large amount of data, has offered more quantitatively reliable characterization of growth striations in as-grown Si Crystals.

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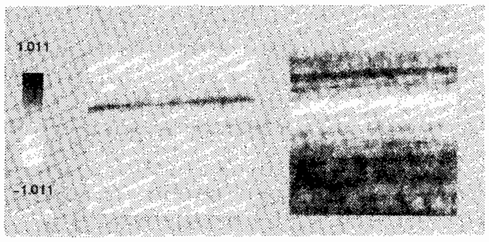

Fig. 1. Two-dimentional images showing Δ d/d and $\Delta\alpha$ variations in an MCZ Si crystal.

PS-13.02.10 THE STUDY OF DIFFRACTION CHANGES OF KTP UNDER A DC FIELD WITH SYNCHROTRON RADIATION WHITE BEAM TOPOGRAPHY.

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Single crystal $KTiOPO_4$ (KTP) is an important nonlinear optical material (F. C. Zumstay, J. D. Bierlein, T. E. Gier, J. Appl. Phys., 1976, 47, 4980). It exhibits a quasi one dimensional Potassium ion conductivity along its crystallographic c—axis (J. D. Bierlein, C. B. Arweilar, Appl. Phys. Lett., 1986, 49, 917). In recent years, Yang et al. (H. G. Yang et al., Phys. Rev. B, 1988, 37, 1161) and Yang (Yang Zhen . Chinese Phys. Lett., 1987, 4, 533) found that when DC voltage is applied along the c—axis of KTP crystals, it produces the same phenomena as these in α—$LiIO_3$ single crystals. The last investigation of these phenomena shows that these can be explained by a grating theory (Y. Y. Li, Solid Stat. ionics, 1988, 31, 99) and classical extinction theory (Q. Li. Y. Zhen, Z. Krist., 1988, 183, 265) respectively, but there are still some controversy especially about the strong anisotropy of the neutron diffraction intensity enhancement effect; On the other hand, the mechanism of the neutron diffraction in crystals is quite similar to that of X—rays. Thus, a Synchrotron Radiation (SR) White Beam Topography investigation of the KTP crystal becomes necessary to see if the diffraction of X—rays is also changed.

The specimen, a good KTP single crystal grown from flux melt, was cut into a rectangular slice with one pair of surfaces parallel to the crystallographic plane a, and the other two pairs of surfaces parallel to the planes b and c, respectively. After grinding and chemical polishing, the specimen linear dimensions are 0. 5×15. 0×3. 7 mm^3 along the a、b