11.1–1 *THE X-RAY DIFFRACTION CONTRAST OF NON-CRYSTALLOGRAPHIC DISLOCATION.* By *E. Zielińska-Rohozińska, Institute of Experimental Physics, Warsaw University, Warsaw, Poland.*

The diffraction contrast of grown-in dislocations in the [111] oriented Si single crystals was studied by X-ray section topography. Particular attention was paid to the direct image. Formation of such an elongated direct image (Fig. 1) is a result of creation of new wavefields for the dislocation situated near the S_0 side of the Borrmann prism (Kowalski, this conference). The dislocation line direction found by fitting the Lang topographic kinematical images with the computed projections onto the topograph plane is marked by x in Fig. 2. In spite of Hornstra's considerations (J. Phys. Chem. Soc. 5, 124, (1958)) it is not a crystallographic direction. The geometrical position of the elongated direct image on all the section topographs agrees very well with the computed one.

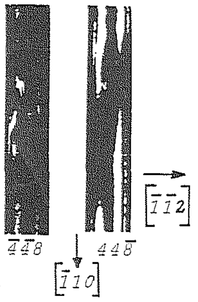

Fig. 1.

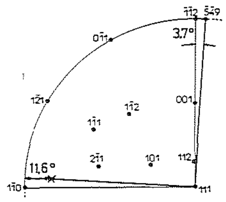

Fig. 2.

11.1–3 SYNCHROTRON SECTION TOPOGRAPHY (SST). By A.R. Lang, A.P.W. Makepeace, Q.L. Zhao, H.H. Wills Physics Laboratory, University of Bristol, BS8 1TL, England and M. Moore, W.G. Machado, Physics Department, Royal Holloway College, Egham, Surrey TW20 OEX, England.

The X-ray topographic technique most commonly practised with non-monochromatised, white synchrotron radiation employs a broad incident beam which covers most or all of the area of the crystal that is of concern for the investigation in progress. This technique is most obviously applicable to plate-shaped specimens, and is illustrated, for example, in a study of polished sections < 0.2 mm thick of natural beryl (N. Herres and A.R. Lang, J. Appl. Cryst. 16 (1983) 47–56). Sometimes, however, the location of a particular defect within the crystal needs to be pinpointed. To do so one reverts to the section topograph technique (A.R. Lang, Acta Metallurgica 5 (1957) 358–369). This is the most fundamental X-ray topographic method from the diffraction-theoretical point of view, and it is X-ray section topograph patterns which are the first targets for attempted matching with simulated X-ray diffraction contrast images of lattice defects. Embodiment of the section topograph technique for use with synchrotron radiation has involved the design of a miniature goniometer which can be easily transferred between the synchrotron source at Daresbury and home-laboratory conventional sources of characteristic radiation (A.R. Lang, Rev. Sci. Instrum. 54 (1983) 897–899). Optical means are used for quick and reproducible alignment of this goniometer at Daresbury. Applications of the SST technique have included dynamical diffraction phenomena exhibited by nearly perfect crystals. Advantage has been taken of the polarised nature of synchrotron radiation to enable separate recording of the σ and π polarisation mode patterns of Pendellösung, stacking fault and Borrmann-Lehmann fringes.

11.1–2 STRAIN MEASUREMENT BY X-RAY TOPOGRAPHIC CONTOUR MAPPING.* By S. R. Stock,** Haydn Chen and H. K. Birnbaum, Dept. of Met. and Min. Eng., University of Illinois, Urbana, Illinois, USA.

Because of its high sensitivity to strain, conventional x-ray diffraction topography can only be used to examine specimens with low dislocation densities. The distribution of elastic and plastic deformation in more highly dislocated crystals may be studied by x-ray topographic techniques, however, by mapping the positions of equi-inclination contours (analogs of TEM bend contours) as a function of rotation. White beam topography may also be used to map deformation: absorption edge contours are formed if the specimen is oriented to diffract a range of wavelengths encompassing that of an absorption edge of an element in the specimen. By comparing contour maps obtained with different diffraction vectors and specimen rotation axes, all of the components of the strain tensor can be determined as a function of position. Examples of contours produced with monochromatic radiation and with white radiation are given, and the mapping technique is used to analyze components of the strain field surrounding a precipitate of niobium hydride. Preliminary measurements of the distribution and magnitude of deformation in and around the plastic zone in a notched niobium crystal are also described. Errors in the analysis arise mainly from the uncertainty in contour positions (±10 micrometers), and the estimated error in the strain components of the matrix surrounding the hydride precipitate is on the order of 20%.

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11.1–4 X-RAY TOPOGRAPHIC STUDY OF BRAZILIAN NATURAL BERYL CRYSTALS. By C. K. Suzuki, Y. Koishi and J. Yoshimura*, Instituto de Física Gleb Wataghin, Universidade Estadual de Campinas, 13.100 - Campinas, SP, Brazil.

Transparent and perfect beryl crystals have a high potenciality for synchrotron radiation monochromator in the wavelength region of the order of 10 Å. Previous observations of natural beryl (e.g., Scandale et al., J. Appl. Cryst., 12 (1979) 70-83) reveal a quite imperfect structure with various types of growth defects: macroscopic channels, dislocations, inclusions, growth bands and growth sectors.

In order to obtain more wide knowledge on the perfection of natural beryl crystals, we have carried out an X-ray topographic study of more than ten faceted beryl gems collected from the region of Teófilo Otoni, Minas Gerais, Brazil. We have used a double crystal arrangement of non-parallel (+,-) and (+,+) setting, in most of the topographic work conducted. A highly asymmetric Si(111) reflection was employed as monochromator with Cu Kα radiation (the angular spread of incident beam is estimated to be 1.5 sec. of arc).

Among the samples examined, we could find some crystals of considerably high perfection, which contain no channels and very few dislocations, and present a good homogeneity (Fig. 1). Unlike the crystals examined by Scandale et al. in the majority of the present samples, prismatic growth regions occupy a large volume fraction, and pyramidal growth regions have only a small volume. Topographs of plates cut parallel to the c-axis with diffraction vector perpendicular to the c-axis, reveal growth striations parallel to this axis. These are not observed with diffraction vectors parallel to the c- axis. This situation is advantageous for the utilization as soft X-ray monochromator for synchrotron radiation.

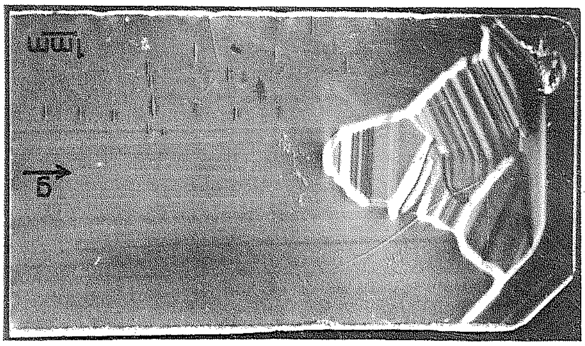

Fig. 1. X-ray topography of a natural beryl plate parallel to [0001] . Cu Kα (0002) reflection.

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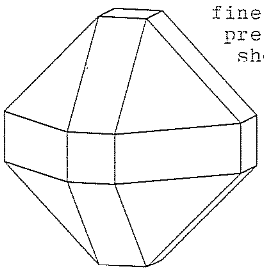
* On leave from Yamanashi University, Japan.

11.1–5 PSEUDO-DODECAHEDRAL GROWTH OF NATURAL DIAMOND. By Moreton Moore and W.G. Machado, Royal Holloway College, University of London, Egham, Surrey, TW20 0EX, and G.S.Woods, CSO Valuations Ltd., 17 Charterhouse St.,London, EC1N 6RA, England.

The rhombic dodecahedron is not usually a growth form for natural diamond, but one of dissolution (Moore & Lang, J.Cryst.Growth (1974) 26, 133). {110} may however predominate in the growth of synthetic diamond (Kanda et al., J.Cryst.Growth (1982) 60, 441). In natural coated diamonds there is a sharp transition from the growth of good quality crystal to fibrous growth under conditions of constitutional supercooling. Some such diamonds exhibit rhombic dodecahedral facets, in addition to the more usual octahedral and cuboid faces. X-ray topography has shown that these {110} faces have grown by fibre branching along octahedral directions: [111] + [11$\bar{1}$] → (110). The cube faces result from branching in all four <111> directions (Moore & Lang, Phil. Mag. (1972) 26, 1313). The rhombicuboctahedral habit is a natural consequence of <111> fibrous growth upon an octahedral core. The dodecahedral faces are finely corrugated,with trigons present on the sloping sides, showing that they are composed of numerous {111} surfaces. The dodecahedron is not a true growth form for natural diamond.



11.1–6 X-RAY STUDY OF Ti DIFFUSED $LiNbO_3$ CRYSTAL PERFECTION

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Diffusion of Ti into $LiNbO_3$ single crystals is the most widely used method for fabricating optical waveguides, since because of this there are large increases in both the ordinary and extraordinary refractive indices. Ti:$LiNbO_3$ waveguides are made by coating $LiNbO_3$ substrates with thin (200-500 Å)Ti films; then the samples are annealed in a controlled atmosphere (flowing dry O_2 was used) at about 1000 C for a few hours. During heat treatment Ti oxides forming a $(Ti_{0.65}Nb_{0.35})O_2$ layer and then it diffuses for a few microns into $LiNbO_3$. Owing to the large Ti concentration within the diffused layer and to the high temperature treatment, the crystal perfection of the diffused layer may worsen. To correlate optical and structural properties of the waveguides, X-ray diffraction studies of diffused layers were performed.

Precise determination of strain in the diffused layers was obtained with the double crystal rocking curve method, using the parallel arrangement and a high perfection $LiNbO_3$ single crystal as a monochromator. In undiffused samples, X-ray rocking curves were as narrow as those theoretically predicted, while in diffused crystals, in addition to the well resolved peak of the unperturbed substrate, a broad satellite peak from the diffused layer was also present. The angular shift between the two peaks makes the lattice mismatch (or strain) determination possible.

The presence of induced crystal defects was investigated by X-ray diffraction topography, using a conventional Lang camera in the scanning reflection geometry. Both Y-cut and Z-cut $LiNbO_3$ samples were investigated. Moreover, the main diffusion parameters, i.e. Ti film thickness (250-550 Å) and diffusion time (1-50 hs) were changed.

A large increase of misfit dislocation density and a relevant strain decrease at increasing diffusion times were observed in all of the above cases. Furthermore, a correlation between crystal perfection and optical in-plane energy losses in waveguides was obtained.