An Analysis of the Fringe Contrast seen on X-ray Topographs of the \(-X, Z\) Growth Sector Boundary in Synthetic Quartz

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Parallel stacking-fault type fringes on Lang topographs of synthetic quartz have been observed in the region of the growth sector boundary when the boundary is inclined at a shallow angle to the X-ray entrance and exit faces of the specimen. Fringes have been previously reported at the growth sector boundary on Lang topographs of a number of different materials under similar diffraction conditions [Klapper, H. (1971). J. Cryst. Growth. 10, 13-25; Ikeno, S., Maruyama, H. & Kato, N. (1968). J. Cryst. Growth. 3, 4, 683-693]. However, the only previous attempt at accounting for these fringes quantitatively (by Ikeno et al.) is conceded by its authors to yield unsatisfactory results. The X-ray energy flow pattern in the crystal in the vicinity of the growth sector boundary has been determined by X-ray section topography and the pattern closely resembles the energy flow observed in a crystal of calcite containing a thin twinned lamella and analysed theoretically by Authier, A. & Sauvage, M. [J. Physique, 27, C3-137-C3-150] to be due to a change in X-ray incidence conditions close to the boundaries between the two halves of the crystal separated by the thin twinned region. An analysis of a number of section topographs for different orders of reflexion from the same set of lattice planes using Cu Kα and Mo Kα radiation employing the Authier & Sauvage theory shows that there is a pure tilt of \(2.8 \times 10^{-6}\) radians between the two growth regions. The origin of this tilt is discussed in terms of the lattice deformation in the vicinity of the growth sector boundary proposed by Parpia [J. Appl. Cryst. (1975). 8, 203].

An Investigation of the Nature of the \(-X, Z\) Growth Sector Boundary in Synthetic Quartz

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Growth sector boundaries exist in all crystals where adjacent regions which have grown on crystallographically different faces meet one another. There is however disagreement in the literature [Fishman, Yu. M. & Lutsau, V. G. (1970). Phys. Stat. Sol. (a), 3, 828-837; Beswick, D. M. & Lang, A. R. (1972). Phil. Mag. 26, 1057-1070] about the nature of this boundary, and the diffraction contrast seen at the interface between the two regions of growth on Lang X-ray topographs is not satisfactorily explained. The boundary between the \(-X\) and \(Z\) growth regions in synthetic quartz has been studied using X-ray topography and other techniques and it has been found that the crystal lattice remains coherent at the boundary. A comparison of the X-ray powder diffraction photographs obtained from the material from the two sectors shows that the \(-X\) region is expanded in the direction of the \(c\) axis relative to the \(Z\) region with \(\Delta c/c \approx 7.2 \times 10^{-5}\) and contracted with respect to the \(Z\) region in the \(a\) direction with \(\Delta a/a \approx 7.4 \times 10^{-5}\). The result that there is a contraction of the material in the \(-X\) region of growth in the \(a\) direction, which also colours preferentially on X-irradiation, is in agreement with Bonse's finding [Bonse, U. (1965). Z. Phys. 184, 71-84] that the growth bands in natural quartz which colour preferentially on X-irradiation are also contracted in the \(a\) direction relative to the ones which do not colour. It is therefore possible to account for the direct image contrast of the growth sector boundary seen on X-ray topographs in terms of the proposed model of the lattice deformation in the region of a coherent boundary between adjacent regions having relative differences in lattice spacings.