11. REAL AND IDEAL CRYSTALS

EFFECTS OF ELECTROSTATIC FIELD ON THE X-RAY BRAGG DIFFRACTION OF $\alpha$-QUARTZ.


An increase of the X- and $\nu$-ray integrated intensity of $\alpha$-Quartz under the influence of an electrostatic field has been observed by Yasuda and Kato (Appl. Cryst. (1975) 8, 623) and Douss and Kern (Acta Cryst. (1980) A36, 966) respectively, but the mechanism responsible for such an effect is not yet completely clear. We report here the results of an experimental study, in which a series of rocking curve experiments of the (004) X-ray Bragg reflection of $\alpha$-Quartz were measured in the presence of an electrostatic field up to 113 kV/cm. The integrated intensity at constant field was found to be time-dependent, suggesting the existence of relaxation effects. A field-dependent saturation value was reached after time intervals ranging from 20 to 45 min for field values of 16 to 113 kV/cm. Rocking curve characteristics such as peak position, peak intensity and half width were measured as a function of the field at saturation level (fig. la,b,c and d for percentage change of the integrated intensity). They all show hysteresis effects. It was also observed that the strength of the effect depends on the field polarity. When the negative electrode was attached to the irradiated face the effects were considerably reduced (fig. 2a,b,c,d). The measured peak shifts $\Delta \theta$ are typically one order of magnitude larger than those calculated on the basis of the reverse piezoelectric effect. It appears that crystal defects are largely responsible for the rather sizeable effects observed, thus preventing one from distinguishing field-dependent intrinsic contributions, such as those due to piezoelectricity and internal strains (Anastassakis, phys.stat.sol.(b) (1982) 110, 169).

Figure 1. Dependence of (a) peak shift, (b) maximum intensity, (c) half-width and (d) percentage integrated intensity on the applied DC voltage [(204) reflection, thickness of crystal $t=0.31 \text{mm}$, irradiated face at positive potential). • increasing field; o decreasing field

Figure 2. Same as fig. 1 with reversed polarity.

The intensity of the Compton scattering was independently measured at a few scattering angles by taking advantage of the energy resolution of a Si(Li) detector to partially separate the modified radiation. The Compton scattering data were interpolated by means of calculated incoherent scattering functions and then subtracted from the $I_x$. The $I_x$ intensity of the scattering due to composition wave is not dependent on the scattering vector $Q$, while the $I_x$ intensity of the one-phonon scattering by $L_a$ and $L_0$ branches is proportional to $Q^2$. This made it possible to separate the two contribu-
11.6-1 X-RAY POLARIZATION BY BREAGG DIFFRACTION FROM
BENT AND FLAT CRYSTALS. By J. Zahn, Chemistry Dept.,
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Recently much attention has been given to the utilization
of polarized x-rays in x-ray fluorescence spectrome-
ters (R. A. Yon, et al., Adv. in X-Ray Anal. 25, 63
(1982)). The introduction of the extra scattering event
to polarize the beam decreases the intensity. 90°scat-
tering from the interior of a nuclear reaction increases
the intensity by utilizing a manifold of beams. This
paper concerns itself with the development of a phenom-
ological theory, based on the mosaic model, to serve
as a guide to developing better x-ray optics for Bragg
scattered polarized x-ray spectrometers. The improved
efficiency of the bent crystal (Johann) over the flat
crystal has two sources: 1) it is purely geometric and
depends on the collimator(s) length t, and radius r, the
radius of the Rowland circle R, and the displacement
of the isotropic source from the Rowland circle s. The
other source of improvement arises from the mosaic block
size t, and from the mosaic distribution function here
assumed to be Gaussian, the width 
 and s.
in the approximation of negligible true absorption and
and the second extinction the theoretical results depend only
upon geometry.

For Cu Ka diffraction from Cu(113) and f=1cm, e=0.88cm,
R=15cm and =0.15cm the reported efficiency ratio is
bent/flat=3 (P. Houbrechts, personal comm.). Using
these parameters and t and equal to 0.001cm and 0.001
rad (flat) and 0.0095rad and 0.002 rad (bent) I calcu-
lated the ratio to be 3.3. Taken the t’s 2 times lar-
ger and the s’s 2 times larger gives 4.2. Taking De=0
and the first set of crystal parameters gives 5.9.

I hope these results will be an aid in the construction
of better spectrometers and encourage the determination
of the mosaic parameters.

11.6-2 A TWO-CRYSTAL X-RAY INTERFEROMETER OF DIFFE-
RENT SILICON MATERIALS. By P. Becker, Physik-Techn.
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It has been shown that an x-ray interferometer con-
sisting of two crystals cut from different silicon ma-
terials can be successfully operated. Experiments of
this kind are of particular interest if lattice spacings
of different crystals are to be measured on the meter
scale, or if more space in the interfering beam paths is
needed. Each of the two crystals shown in the figure be-
longs to a complete Laue-case interferometer tested se-
parately in order to measure the homogeneity of the
crystal lattice. The first crystal, bearing both the
beam splitter S and the mirror M, was part of the
scanning x-ray interferometer used for the absolute de-
termination of the (230) lattice plane spacing (Becker,
Dorenwendt, Ebeling, Lauer, Lucas, Probst, Rademacher,
1540). The second crystal with the analyzer A belongs
to an interferometer cut in a similar way for the same
purpose. The relative difference in the Bragg-plane
spacings of the two silicon materials was about
(3.5 x 10⁻²) measured by crystal-to-crystal compari-
sion experiments (Becker, Seyfried, Siegert, Z. Phys.

The geometrical deviations of the interferometer from
the ideal shape caused by the manufacturing process are
thoroughly investigated. In order to align the lattice
planes of the two crystals parallel to one another by
light optical means, the crystal surfaces are polished
to form optical mirrors. Spacing marks are etched on the
mirrors in order to realize equal distances between the
three lamellas, S, M and A, by use of an optical length
measuring device. Only a low interference contrast of
50.05 was observed in the outgoing beams. The reason for
this is mainly the difference in thickness of more than
100 μm between the beam splitter S and the analyzer A.