11.7-14 ANOMALOUS TRANSMISSION OF THERMALLY SCATTERED DIFFUSE X-RAYS IN A PERFECT GERMANIUM CRYSTAL.

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A fine excess line was observed across the 220 thermal diffuse spot on diffraction photographs of a germanium crystal in the Laue case by using monochromatized X-rays of synchrotron radiation (Y. Kashiwase et al., J. Phys. Soc. Jpn., 1986, 55, 4172). Properties of the line were investigated under various experimental conditions. The wavelengths were chosen to be 1.5405 Å and 1.15 Å. The X-ray beam was collimated with slits in the cross section 0.3mm×2.5mm. Specimens of crystal plates, prepared by polishing and chemical etching, were about 0.1∼0.2mm thick. Their surfaces were parallel to the (111) plane. The crystals were perfect so that the rocking curves of the Bragg reflection had reflection widths close to the theoretical value for ideal crystals. The photographs were taken at incident angles deviating by -0.4°∼0.4° from the Bragg angle of the 220 reflection. The specimen-film distance was 45cm. Exposure times were about 10∼30 minutes for cosmic ray films and 1∼4 hours for medical X-ray films. In diffraction patterns, the excess line was found in the middle of the thermal diffuse spot and the Laue spot due to weak continuous X-rays scattered from the monochromator. The profile of the excess line depends on the wavelength of X-rays. A pure excess line was observed for 1.5405 Å. The excess-defect structure appeared in the line for 1.15Å. The profile was not so affected by incident angles. The excess line can be attributed to the anomalous transmission of the thermal diffuse waves which satisfy the Bragg condition for the 220 reflection in propagating through absorbing perfect crystals. This shows a remarkable contrast to the case of defect lines from mosaic crystals.

11.7-15 EXPERIMENTAL STUDY ON THE DIFFRACTION OPTICS OF CRYSTAL MOIRÉ. By J. Yoshimura, Faculty of Engineering, Yamanashi Univ., Kofu, Japan.

Introduction Moiré fringes observed in crystal diffraction have been regarded so far to be the projection of the intensity distribution on the exit surface of the crystal in the direction of the wave propagation. The character of the projection accords with a common restriction, $\Delta\vec{K}\perp\bar{\vec{K}}$, i.e. $|\vec{K}|=|\vec{K}'|$ ($\vec{K}$, $\vec{K}'$: wave vectors of interfering waves; $\Delta\vec{K}=\vec{K}'-\vec{K}$; $\bar{\vec{K}}$: mean of $\vec{K}$ and $\vec{K}'$), upon the interference between elastically scattered waves. However, several considerations suggest an idea that moiré patterns are not such a projection, but an observation of equiphase surfaces $(\Delta\vec{g}\cdot\vec{r})=n$ ($\Delta\vec{g}$: difference in the reciprocal lattice vector; $\vec{r}$: position vector of an observation point; n: integer) which extend three-dimensionally in space. This idea was tested by the following experiment.

Experimental Moiré patterns were observed in X-ray topography, using a double crystal arrangement of parallel setting for Si 220 with Mo Kα radiation. A monolithic bi-crystal with a narrow gap (total thickness 3.5mm; gap width 260μm) was prepared for the specimen. Lattice distortion $\Delta\vec{g}$ was introduced by putting a 7g weight on the top of the specimen. Moiré patterns were recorded simultaneously on two or three photographic films set at different orientations and/or different distances from the specimen. As far as a moiré pattern is produced by interference between two waves, observed moiré fringes can be regarded as the intersections of equiphase surfaces $(\Delta\vec{K}\cdot\vec{r})=2\pi n$ and an observation plane. The wave-vector difference $\Delta\vec{K}$ was determined on this assumption by analyzing moiré patterns on different photographic films as mentioned above.

Results Fig.1 compares moiré patterns recorded on photographic films at different orientations. For pattern (a), the photographic film is nearly perpendicular to $\bar{\vec{K}}$. Regarding the fringe directions in the right-side region of the patterns, the slopes of fringes in (a) are larger on the right side of the arrow-indicated position, while on the left side the slopes in (b) are larger. It is easy to see that such two patterns are not in the relation of the projections of a two-dimensional figure. Table 1 gives the analysis of $\Delta\vec{K}$ for the fringes around marks a and b in Fig.1 (The x- and z-axes are perpendicular and parallel to the diffraction plane, respectively, and the y-axis is normal to the plane of incidence). This analysis confirms that the direction of $\Delta\vec{K}$ is greatly deviated from that of $\Delta\vec{K}\perp\bar{\vec{K}}$ (τ= -10.6°). Comparison of the analysis of $\Delta\vec{K}$ with the presumed distribution of $\Delta\vec{g}$ suggests $\Delta\vec{K}\neq 2\pi\Delta\vec{g}$. To clarify the whole of the phenomena, much more study must be done. Nevertheless, from the results so far obtained, it is clear that the rule $\Delta\vec{K}\perp\bar{\vec{K}}$ does not hold in the moiré interference. It is indicated that crystal moiré is an inelastic phenomenon.

ΔK_x	ΔK_y	ΔK_z	τ
0.4,	2.5,	0.3,	39°
1.0,	2.6,	-0.8,	-40°

Table 1. Upper row for a, lower row for b. The unit of the values is $10^{-7}\times(2\pi/d)$ (d: lattice spacing). $\tau\equiv\tan^{-1}(\Delta K_z/\Delta K_x)$.

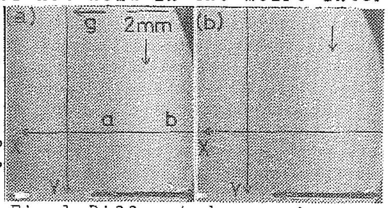

Fig.1 Diffracted-wave images. (a) φ= 8.6°; (b) φ= -9.4°. (X,Y): coordinate system in the observation plane; φ: angle between the X- and x-axes. The films were set vertically in both cases (a) and (b).

11.7-16 DYNAMICAL EFFECTS IN GRAZING INCIDENCE DIFFRACTION OF X-RAYS IN Si

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X-rays incident on a surface under grazing angle may undergo total external reflection and excite an interior wave field damped exponentially into the bulk. These evanescent waves are a sensitive probe to study the structure of the near surface region. We measure Bragg-diffracted intensity (220-reflection) under grazing incidence conditions. We focus on the dependence of intensity on the angle of glancing exit which allows the study of the dispersion surface with high resolution. Detailed comparison of various experimental scans through rèciprocal space with predictions of the dynamical theory yields excellent quantitative agreement. Ion implantation induces characteristic changes in the Bragg-profiles through the presence of amorphous or strongly disturbed surface layers. Bragg-profiles of $Si\text{-}Si_xGe_{1-x}$ layered structures exhibit features related to the periodic variation of susceptibilities. Experimental results on both problems are discussed within dynamical theory.