11.8–6 KINEMATIC THEORY OF X-RAY SCATTERING FROM CRYSTALS, CONTAINING DISLOCATIONS.

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As the extension of earlier approach(Ryaboshapka C.P."Zavodskaya laboratoriya(1981), 47, N 5, p.26) the results of the X-ray diffraction theory for deformed crystals have been systematically analyzed. The kinematic approximation to the statistical theory of scattering from crystals containing various dislocation structures has been used with the allowance for superposition of displacements made by all the defects in the crystal lattice. Emphasis was made on the necessity to analyze peculiarities in the anisotropic distribution of the X -ray intensity near the directions corresponding to the reciprocal lattice nodes. The optimum schemes are given for the selection of reflex type and the X-ray method in the study of different dislocation structures. X-ray effect (broadening regularities, reflex shifting and weakening, peculiarities in the diffuse background intensity distribution) due to dislocation structures of the 1st kind are discussed. These are dislocations that contribute mainly to the intensity distribution variation along the diffraction vector(straightline dislocation configuration with the total Burgers vector different from zero; split dislocation; dislocation multipoles of an odd order; dislocation configurations bounded in space; loops and unrandom dislocation assemblies). Peculiarities in the intensity distribution of X-rays scattered from crystals containing dislocation structures of the 2nd kind are analyzed. These dislocations contribute mainly to the azimuthal direction (dislocation walls of blocks and fragments; excess concentration of straightline dislocations and dislocation walls of one sign; dislocations of some kind, and so on). The possibilities are discussed to study the parameters of nonuniform distribution of various dislocation structures by the X-ray method. Experimental works are considered where peculiarities in the intensity distribution of X-ray reflexes are connected with the parameters of different dislocation structures. Applicability of various X-ray methods for the experimental evaluation of the parameters that characterize the type of dislocation structures and their spacial distribution is treated. It is shown that the obtained theoretical results may serve as a physical basis for the X-ray study of dislocation structures in deformed crystals. This requires: 1)Investigation of the intensity distribution pattern with the aid of two methods which make it possible to define contributions to radial and azimuthal distribution (e.g.by θ -2θ scanning and ω -scanning with narrow slit). From the distribution curve shape the dislocation structure type may be found and the parameters estimated. 2)Measurement of specially selected reflexes to distinguish between different dislocation structures of the same type and to determine quantitavely their parameters. 3)The study of reflexion system according to the optimum scheme which follows from analysis of particular equations deduced for the dislocation structures that had been found at the stage (2).

11.9–1 THE ACCURATE MEASUREMENT OF ELASTIC BRAGG SCATTERING USING RESONANT GAMMA RAYS.

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The Rayleigh scattering of 14.4keV radiation from the FE57 Mossbauer source has been used for some time to distinguish between the elastic and inelastic scattering at Bragg diffraction peaks (O'Connor and Butt, Physics Letters (1963), 1, 233). In this method it is usually assumed that the source has a uniform recoilless fraction and that a resonant absorber interposed in the scattered beam is uniform and absorbs a constant fraction of the resonant radiation. Using a double-absorber method, with absorbers in the incident and scattered beams, such assumptions are not necessary. The measurement of the recoilless fraction of the source is independent directly of the absorber parameters and the recoilless fraction for the crystal so obtained depends only weakly on the resonant absorption by the absorber, particularly if it is 'black'. A critical reappraisal of the method has been undertaken using strong reflections from aluminium and lithium fluoride crystals. In typical geometry rotation of the crystal effectively scans across the source. It is found that the recoilless fraction can vary by 5% across the width of a cobalt-57 in rhodium source. It is also found that a resonant absorber can show variations of a few percent in its absorption of both resonant and non-resonant radiation across its width, presumably due to the inherent 'graininess' of the enriched material. In spite of these variations it is still possible to measure the recoilless fraction of the crystal to better than 1% using the double absorber method. Measurements of the inelastically scattered radiation are subject to much larger error since the inelastic fraction is obtained by difference between total and elastic, and for a predominantly elastic reflection the error in the inelastic scattering can easily approach 50%. It is suggested that some of the 'structure' apparently seen in the inelastic scattering under the Bragg peak may be due to systematic errors made in the assumption of uniformity for the source and absorbers.