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Standard Test Method for Preparing Quantitative Pole Figures[1]

This standard is issued under the fixed designation E81; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the use of the X-ray diffractometer to prepare quantitative pole figures.

1.2 The test method consists of several experimental procedures. Some of the procedures (**1-5**)[2] permit preparation of a complete pole figure. Others must be used in combination to produce a complete pole figure.

1.3 Pole figures (**6**) and inverse pole figures (**7-10**) are two dimensional averages of the three-dimensional crystallite orientation distribution. Pole figures may be used to construct either inverse pole figures (**11-13**) or the crystallite orientation distribution (**14-21**). Development of series expansions of the crystallite orientation distribution from reflection pole figures (**22, 23**) makes it possible to obtain a series expansion of a complete pole figure from several incomplete pole figures. Pole figures or inverse pole figures derived by such methods shall be termed calculated. These techniques will not be described herein.

1.4 Provided the orientation is homogeneous through the thickness of the sheet, certain procedures (**1-3**) may be used to obtain a complete pole figure.

1.5 Provided the orientation has mirror symmetry with respect to planes perpendicular to the rolling, transverse, and normal directions, certain procedures (**4, 5, 24**) may be used to obtain a complete pole figure.

1.6 The test method emphasizes the Schulz reflection technique (**25**). Other techniques (**3, 4, 5, 24**) may be considered variants of the Schulz technique and are cited as options, but not described herein.

1.7 The test method also includes a description of the transmission technique of Decker, et al (**26**), which may be used in conjunction with the Schulz reflection technique to obtain a complete pole figure.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Summary of Test Method

2.1 The test method consists of characterizing the distribution of orientations of selected lattice planes with respect to sample-fixed coordinates (**6**). The distribution will usually be obtained by measurement of the intensity of X rays diffracted by the sample. In such measurements the detector and associated limiting slits are fixed at twice the appropriate Bragg angle, and the diffracted intensity is recorded as the orientation of the sample is changed (**1-6, 25, 26, 27**). After the measured data have been corrected, as necessary, for background, defocusing, and absorption, and normalized to have an average value of unity, the results may be plotted in stereographic or equal-area projection.

2.2 The geometry of the Schulz (**25**) reflection method is illustrated in Fig. 1. Goniometers employing this geometry are commercially available. The source of X rays is indicated by *L*. Slit S1 limits divergence of the incident beam in the plane of projection. Slit S2 limits divergence perpendicular to the plane of projection. The sample, indicated by crosshatching, may be tilted about the axis *FF*', which is perpendicular to the diffractometer axis and lies in the plane of the sample. The tilt angle was denoted φ by Schulz (**25**). The sample position shown in Fig. 1 corresponds to $\varphi = 0$ deg, for which approximate parafocusing conditions exist at the detector slit, S3. With the application of a defocusing correction, this method is useful over a range of colatitude φ from 0 deg to approximately 75 deg.

2.2.1 Tilting the sample about *FF* ', so as to reduce the distance between *L* and points in the sample surface above the plane of projection, causes X rays diffracted from these points to be displaced to the left of the center of S3, while X rays diffracted from points in the sample surface below the plane of projection are displaced to the right of the center of S3. The displacement is equal to $2D \tan \varphi \cos \theta$, where *D* is the distance above or below the plane of projection. The integrated, or total, diffracted intensity is influenced only slightly by tilting the sample (**28**). Insofar as possible, the detector slit shall be of

[1] This test method is under the jurisdiction of ASTM Committee E04 on Metallography and is the direct responsibility of Subcommittee E04.11 on X-Ray and Electron Metallography.

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[2] The boldface numbers in parentheses refer to the list of references at the end of this test method.

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