



Designation: E 82 – 91 (Reapproved 1996)

Standard Test Method for Determining the Orientation of a Metal Crystal¹

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1. Scope

1.1 This test method covers the back-reflection Laue procedure for determining the orientation of a metal crystal. The back-reflection Laue method for determining crystal orientation (1, 2)² may be applied to macrograins (3) (0.5-mm diameter or larger) within polycrystalline aggregates, as well as to single crystals of any size. The method is described with reference to cubic crystals; it can be applied equally well to hexagonal, tetragonal, or orthorhombic crystals.

1.2 Most natural crystals have well developed external faces, and the orientation of such crystals can usually be determined from inspection. The orientation of a crystal having poorly developed faces, or no faces at all (for example, a metal crystal prepared in the laboratory) must be determined by more elaborate methods. The most convenient and accurate of these involves the use of X-ray diffraction. The “orientation of a metal crystal” is known when the positions in space of the crystallographic axes of the unit cell have been located with reference to the surface geometry of the crystal specimen. This relation between unit cell position and surface geometry is most conveniently expressed by stereographic or gnomonic projection.

1.3 The values stated in inch-pound units are to be regarded as the standard.

1.4 *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. Referenced Documents

2.1 ASTM Standards:

E 3 Methods of Preparation of Metallographic Specimens³

2.2 Adjunct:

Hyperbolic chart for solving backreflection Laue patterns (1 film positive)⁴

3. Summary of Test Method

3.1 The arrangement of the apparatus is similar to that of the transmission Laue method for crystal structure determination except that the photographic film is located *between* the X-ray source and the specimen. The beam of white X-radiation passes through a pinhole system and through a hole in the photographic film, strikes the crystal, and is diffracted back onto the film. Dark spots, which represent X-ray beams “reflected” by the atomic planes within the specimen, appear on the developed film. The atomic planes these spots represent are identified by crystallographic procedures and the orientation of the metal crystal is determined.

4. Significance and Use

4.1 Metals and other materials are not always isotropic in their physical properties. For example, Young’s modulus will vary in different crystallographic directions. Therefore, it is desirable or necessary to determine the orientation of a single crystal undergoing tests in order to ascertain the relation of any property to different directions in the material.

4.2 This test method can be used commercially as a quality control test in production situations where a desired orientation, within prescribed limits, is required.

4.3 With the use of an adjustable fixed holder that can later be mounted on a saw, lathe, or other machine, a single crystal material can be moved to a preferred orientation, and subsequently sectioned, ground, or processed otherwise.

4.4 If grains of a polycrystalline material are large enough, this test method can be used to determine their orientations and differences in orientation.

5. Apparatus

5.1 *X-Ray Tube*—In order that exposure times be reduced to a minimum, the X-ray tube shall have a target that gives a high yield of white X-radiation. The tube voltage shall be near 50 kVp.

5.2 *Back-Reflection Laue X-Ray Camera*—The X-ray camera shall have (1) a pinhole system about 6 cm in length with openings of ¼ to 1 mm, (2) a flat, light-tight film holder (the hole in the center of the film should be as small as possible, preferably about ⅛ in. (3.2 mm) in diameter), (3) a specimen holder, and (4) means for setting the crystal-to-film distance at 3.00 cm. These parts may be assembled in various ways depending upon the type of specimen being studied and upon the accuracy desired. The main requirement for accurate results

¹ This test method is under the jurisdiction of ASTM Committee E-4 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 method.

³ *Annual Book of ASTM Standards*, Vol 03.01.

⁴ Plate I is available from ASTM Headquarters. Order Adjunct: ADJE0082.