



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 may be applied to macrograins and micrograins depending on the beam size within polycrystalline aggregates, as well as to single crystals of any size. This test method is described with reference to cubic crystals and other structures such as: 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) shall 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 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with 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.*

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. Referenced Documents

2.1 *ASTM Standards*:²

E3 Guide for Preparation of Metallographic Specimens

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^{3,4} except that the detector is located between the X-ray source and the specimen or beside the X-ray source in the case of side reflection geometry. The incident beam of white X-radiation passes through a pinhole aperture, strikes the crystal, and is then diffracted back to the detector. White spots, which represent X-ray beams “diffracted” by the atomic planes within the crystalline specimen, appear on the digital picture collected by the detector. The indexation of the spots and their positions in space are calculated by simulation of the Laue pattern superimposed onto the digital image collected by the detector. Older techniques based on film technology can also be used to index the spots and to calculate the orientation of the crystal.

4. Significance and Use

4.1 The physical properties of metals and other materials are often anisotropic (for example: Young’s modulus will typically vary in different crystallographic directions). As such, it is often desirable or necessary to determine the orientation of a single crystal to ascertain the relation of any pertinent physical properties with respect to different directions in the material.

4.2 This test method can be used commercially as a quality control test in production situations in which 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

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

³ Cullity, B. D., *Elements of X-ray Diffraction*, second edition, Addison-Wesley, Reading, MA, 1978.

⁴ Barrett, C. S. and Massalski, T. B., *The Structure of Metals*, 3rd edition, McGraw-Hill Inc., New York, 1966, pp. 211–227.