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# Standard Test Method for Verifying the Alignment of X-Ray Diffraction Instrumentation for Residual Stress Measurement[1]

This standard is issued under the fixed designation E 915; 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 preparation and use of a flat stress-free test specimen for the purpose of checking the systematic error caused by instrument misalignment or sample positioning in X-ray diffraction residual stress measurement, or both.

1.2 This test method is applicable to apparatus intended for X-ray diffraction macroscopic residual stress measurement in polycrystalline samples employing measurement of a diffraction peak position in the high-back reflection region, and in which the θ, 2θ, and ψ rotation axes can be made to coincide (see Fig. 1).

1.3 This test method describes the use of iron powder which has been investigated in round-robin studies for the purpose of verifying the alignment of instrumentation intended for stress measurement in ferritic or martensitic steels. To verify instrument alignment prior to stress measurement in other alloys, base metal powder having the same crystal structure as the alloy should be prepared in similar fashion and used to check instrument alignment at the appropriate diffraction angle.

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 11 Specification for Wire-Cloth Sieves for Testing Purposes[2]

## 3. Significance and Use

3.1 This test method provides a means of verifying instrument alignment in order to quantify and minimize systematic experimental error in X-ray diffraction residual stress measurement. This method is suitable for application to conventional diffractometers or to X-ray diffraction instrumentation of either the diverging or parallel beam types.[3, 4]

3.2 Application of this test method requires the use of a flat specimen of stress-free material that produces diffraction in the angular region of the diffraction peak to be used for stress measurement. The specimen must be sufficiently fine-grained so that large numbers of individual crystals contribute to the diffraction peak produced. The crystals must provide intense diffraction at all angles of tilt, ψ, which will be employed (see Note 1).

NOTE 1—Complete freedom from preferred orientation in the stressfree specimen is, however, not critical in the application of the technique.

## 4. Procedure

4.1 *Instrument Alignment*:

4.1.1 Align the X-ray diffraction instrumentation to be used for residual stress measurement in accordance with the instructions supplied by the manufacturer. In general, this alignment must achieve the following, whether the θ, 2θ, and ψ axes are variable or fixed (see Fig. 1):

4.1.1.1 The θ, 2θ, and ψ axes shall coincide.

4.1.1.2 The incident X-ray beam shall be centered on the ψ and 2θ axes, within a focusing range, which will conform to the desired error and precision tolerances (see sections 5 and 6).

4.1.1.3 The X-ray tube focal spot, the ψ and 2θ axes, and the receiving slit positioned at 2θ equals zero degrees shall be on a line in the plane of diffraction. Alternatively, for instrumentation limited to the back reflection region, the diffraction angle 2θ shall be calibrated.

4.1.1.4 The proper sample position shall be established, using whatever means are provided with the instrument, such that the surface of the sample is positioned at the θ and ψ axes , within the focal distance range which will conform to the desired error and precision tolerances (see sections 5 and 6).

4.1.1.5 The angle ψ must be determined accurately.

4.2 *X-Ray Optics*:

4.2.1 When the Kα characteristic radiation doublet is used for stress measurement, it is desirable to select incident and receiving X-ray beam optics that will produce maximum

[1] This test method is under the jurisdiction of ASTM Committee E-28 on Mechanical Testing and is the direct responsibility of Subcommittee E28.13 on Residual Stress Measurement.

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[2] *Annual Book of ASTM Standards*, Vol 14.02.

[3] Hilley, M. E., Larson, J. A., Jatczak, C. F., and Ricklefs, R. E., eds., *Residual Stress Measurement by X-ray Diffraction*, SAE J784a, Society of Automotive Engrs., Inc., Warrendale, PA (1971).

[4] "Standard Method for X-Ray Stress Measurement," *Committee on Mechanical Behavior of Materials*, The Society of Materials Science, Japan, (20 April 1973).