



Standard Test Method for Determining the X-Ray Elastic Constants for Use in the Measurement of Residual Stress Using X-Ray Diffraction Techniques¹

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INTRODUCTION

When a crystalline material is strained, the spacing between parallel planes of atoms, ions, or molecules in the lattice changes. X-Ray diffraction techniques can measure these changes and, therefore, they constitute a powerful means for studying the residual stress state in a body. The calculation of macroscopic stresses using lattice strains requires the use of x-ray elastic constants (*XEC*) which must be empirically determined by x-ray diffraction techniques as described in this test method.

1. Scope

1.1 This test method covers a procedure for experimentally determining the x-ray elastic constants (*XEC*) for the evaluation of residual and applied stresses by x-ray diffraction techniques. The *XEC* relate macroscopic stress to the strain measured in a particular crystallographic direction in polycrystalline samples. The *XEC* are a function of the elastic modulus, Poisson's ratio of the material and the *hkl* plane selected for the measurement. There are two *XEC* that are referred to as $1/2 S_2^{hkl}$ and S_1^{hkl} .

1.2 This test method is applicable to all x-ray diffraction instruments intended for measurements of macroscopic residual stress that use measurements of the positions of the diffraction peaks in the high back-reflection region to determine changes in lattice spacing.

1.3 This test method is applicable to all x-ray diffraction techniques for residual stress measurement, including single, double, and multiple exposure techniques.

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.5 *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*:²

E4 Practices for Force Verification of Testing Machines
E6 Terminology Relating to Methods of Mechanical Testing
E7 Terminology Relating to Metallography
E1237 Guide for Installing Bonded Resistance Strain Gages

3. Terminology

3.1 *Definitions*:

3.1.1 Many of the terms used in this test method are defined in Terminology E6 and Terminology E7.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *interplanar spacing*—the perpendicular distance between adjacent parallel lattice planes.

3.2.2 *macrostress*—an average stress acting over a region of the test specimen containing many crystals.

3.3 *Symbols*:

3.3.1 x = dummy parameter for $\text{Sum}(x)$ and $\text{SD}(x)$.

3.3.2 c = ordinate intercept of a graph of Δd versus stress.

3.3.3 d = interplanar spacing between crystallographic planes; also called d -spacing.

3.3.4 d_0 = interplanar spacing for unstressed material.

3.3.5 Δd = change in interplanar spacing caused by stress.

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

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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.