Designation: E986 – 04 (Reapproved 2010)

Standard Practice for Scanning Electron Microscope Beam Size Characterization[1]

This standard is issued under the fixed designation E986; 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 practice provides a reproducible means by which one aspect of the performance of a scanning electron microscope (SEM) may be characterized. The resolution of an SEM depends on many factors, some of which are electron beam voltage and current, lens aberrations, contrast in the specimen, and operator-instrument-material interaction. However, the resolution for any set of conditions is limited by the size of the electron beam. This size can be quantified through the measurement of an effective apparent edge sharpness for a number of materials, two of which are suggested. This practice requires an SEM with the capability to perform line-scan traces, for example, *Y*-deflection waveform generation, for the suggested materials. The range of SEM magnification at which this practice is of utility is from 1000 to 50 000 ×. Higher magnifications may be attempted, but difficulty in making precise measurements can be expected.

1.2 *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]

E7 Terminology Relating to Metallography

E766 Practice for Calibrating the Magnification of a Scanning Electron Microscope

3. Terminology

3.1 *Definitions:* For definitions of terms used in this practice, see Terminology E7.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *Y-deflection waveform*—the trace on a CRT resulting from modulating the CRT with the output of the electron detector. Contrast in the electron signal is displayed as a change in *Y* (vertical) rather than brightness on the screen. This operating method is often called *Y*-modulation.

4. Significance and Use

4.1 The traditional resolution test of the SEM requires, as a first step, a photomicrograph of a fine particulate sample taken at a high magnification. The operator is required to measure a distance on the photomicrograph between two adjacent, but separate edges. These edges are usually less than one millimetre apart. Their image quality is often less than optimum limited by the S/N ratio of a beam with such a small diameter and low current. Operator judgment is dependent on the individual acuity of the person making the measurement and can vary significantly.

4.2 Use of this practice results in SEM electron beam size characterization which is significantly more reproducible than the traditional resolution test using a fine particulate sample.

5. Suggested Materials

5.1 SEM resolution performance as measured using the procedure specified in this practice will depend on the material used; hence, only comparisons using the same material have meaning. There are a number of criteria for a suitable material to be used in this practice. Through an evaluation of these criteria, two samples have been suggested. These samples are nonmagnetic; no surface preparation or coating is required; thus, the samples have long-term structural stability. The sample-electron beam interaction should produce a sharply rising signal without inflections as the beam scans across the edge. Two such samples are:

5.1.1 *Carbon fibers, NIST*—SRM 2069B.[3]

5.1.2 *Fracture edge of a thin silicon wafer*, cleaved on a (111) plane.

6. Procedure

6.1 Inspect the specimen for cleanliness. If the specimen appears contaminated, a new sample is recommended as any cleaning may adversely affect the quality of the specimen edge.

6.2 Ensure good electrical contact with the specimen by using a conductive cement to hold the specimen on a SEM

[1] This practice 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.

Current edition approved April 1, 2010. Published May 2010. Originally approved in 1984. Last previous edition approved in 2004 as E986 – 04. DOI: 10.1520/E0986-04R10.

[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] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.