National Institute of Standards & Technology

Certificate

Standard Reference Material 2069b

SEM Performance Standard

This Standard Reference Material (SRM) is primarily intended for use in evaluating the performance of scanning electron microscopes (SEM). SRM 2069b consists of graphitized rayon fibers. The fibers in this SRM have surfaces that are very smooth, uniform, and relatively free of debris. Transmission electron microscope studies of microtomed fiber cross sections show rounded edges. Two bundles of fibers, 3-5 mm long, are mounted in a specially designed SEM specimen mount. They are held in place with carbon cement so that one end is protruding over the recessed area machined into the top of the mount. This mounting technique provides a low background signal. The specimen mount is constructed of aluminum 12.5 mm in diameter and has a 3 mm peg that most SEMs will accept. Additional bundles of fibers are enclosed in a glassine envelope, unmounted, so that the user can mount them in any special type of mount particular to the SEM.

One edge of a single fiber is used as a clearly defined boundary across which the electron beam is scanned. The slope of the resultant detector signal waveform is a measure of the SEM performance that can be related to the resolution capability of the SEM. The procedure to be followed in determining SEM performance is given on the reverse side of this certificate and additional details are given in ASTM E986. (1)

Performance Test Procedure

SRM 2069b can be used as mounted in the SEM mount or the operator can prepare his own mount by using the following procedure. One end of the fiber bundle should protrude over the holder edge so the fibers are hanging out in space. They are held in place with carbon or electrically conductive cement and allowed to dry. Once they are dry, several blasts of clean air will usually spread the fiber bundle so that a single fiber can be selected. Additional spreading may be necessary and can be accomplished by using a clean probe such as a needle. The specimen mount should be held rigidly in place in the SEM to prevent vibration. A clean vacuum of $1.3 \cdot 10^{-2}$ Pa or better is needed to minimize specimen surface contamination which will affect the waveform slope. The mount should be tilted and rotated so that the electron beam scans across a single fiber in a direction perpendicular to the fiber axis. A photomicrograph of the fiber should be made to verify edge position and quality.

Select a high SEM magnification so that when the beam scans across a fiber edge, the waveform (display of the transition from black to white) will have a sufficiently large horizontal displacement (see Fig. 1 and paragraph on reverse side for details). Since slow scans or stationary high brightness waveforms damage the CRT screen, the recorded waveform should be made in two seconds or less.

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(over)

On the recorded waveform (an illustration is given in Fig. 1) measure the difference between the minimum and maximum signal levels. Using this value, compute the positions on the Y axis that correspond to 20% and 80% of the maximum signal levels. Locate these positions on the waveform and measure the horizontal distance, D, between them (in mm). The distance, D, should range between 2 to 4 mm. The performance, P, in nanometers can then be computed from

$$P = \frac{D \times 10^6}{M}$$

where M is the magnification of the SEM. An average of three measurements from different fiber edge positions should be used as representing the performance of the SEM at the magnification and instrument settings.

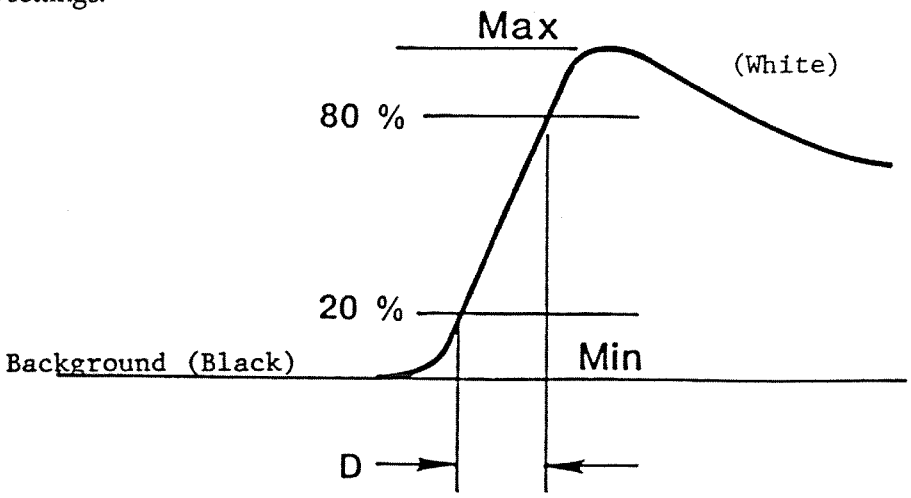

Figure 1: Typical Waveform with 20 and 80 % Contrast Levels Illustrated.

The graphitized carbon fibers in this renewal SRM are part of the original batch of material that was donated to NIST by C.J. Leistner of Ultra Carbon Corp., Bay City, Michigan.

The preparation and technical aspects leading to the certification of this SRM were performed by D.B. Ballard of M.E. Taylor Engineering, Inc. Brookeville, Maryland.

The support aspects concerning the certification and issuance of this Standard Reference Material were coordinated through the Standard Reference Materials Program by T.E. Gills.

Reference

(1) Available from ASTM, 1916 Race St., Philadelphia, PA 19103, Tel: (215) 977-9679.