

National Bureau of Standards

Certificate

Standard Reference Material 469

Scanning Electron Microscope Resolution Test Specimen (Aluminum-Tungsten Dendrites)

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This Standard Reference Material is intended for use in evaluating the resolution and performance of scanning electron microscopes (SEM). The dendritic structure formed on the surface of this SRM has various spacings that can be used to evaluate the resolution at both low and high magnification and has a high secondary electron emission. An SEM photomicrograph is provided with each unit that locates this structure. SRM 469 is nonmagnetic, vacuum clean, has no adverse reaction (melting) to an electron beam, and no surface preparation or coating is necessary.

SRM 469 should be cemented with a conductive cement or clamped on its side to an SEM specimen stub. If a cement is used it can be set and outgassed by a short bake in a vacuum oven at 60 °C. After placement on the SEM stage the stub should be tilted toward the SEM scintillator at an angle between 10 and 20 degrees. Selection of instrument operation parameters is at the discretion of the operator. Photomicrographs are taken in the secondary emission mode at known magnifications with the Al-W dendrites oriented so that the elongated structure is perpendicular to the axis of tilt. Measurement should be made on an unenhanced photograph because additional electronic or photographic modification could bias the determination of the instruments resolution.

The resolution is determined by:

$$R = \frac{D \cdot 10^6}{M} \text{ nm}$$

Where: R = resolution in nm (1nm = 10Å)
M = magnification
D = width of dark space in mm between dendrites of near equal intensity that can be clearly delineated.

When determining the value of D by eye with the aid of a millimeter scale, estimates to the nearest 0.5mm should be used. The magnification can be calibrated with SRM 484, an SEM Magnification Standard available from NBS.

The five photomicrographs shown on the last page are typical of the results obtained with SRM 469 and are provided for information and orientation purposes. Figures 1, 2, and 3 show the dendrites at increasing magnifications. Figure 4 simulates the results obtained with an SEM having a lower resolution. Figure 5 is a photomicrograph of an extraction replica taken with a transmission electron microscope (TEM) which illustrates the smooth curved edges of the dendrites.

The support aspects concerning the certification and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by R. Keith Kirby.

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George A. Uriano, Chief
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Supplementary Information

The loss of contrast between the dendrites and the substrate may indicate the loss of voltage bias on the scintillator or degradation of scintillator conversion efficiency.

The appearance of a dark band parallel to the edges of the dendrites at magnifications above 20,000X indicates a large amount of specimen contamination due to SEM electron beam interaction with residual hydrocarbons in the vacuum system.

If an energy dispersive x-ray analyzer is attached to the specimen chamber different SEM parameters can be studied by observing the change in peak intensity, shape, and location of K, L, and M lines that are characteristic of aluminum and tungsten.