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Amorphous Silicon TEM Windows: Half the Chromatic Blur and No Organic Contamination

A comparison analysis of the thinnest amorphous carbon and 5 nm amorphous UltraSM® Silicon TEM Windows revealed that UltraSM® Silicon TEM Windows:

- Yield half the inelastic scattering of ultra-thin amorphous carbon
- Are 35%+ thinner
- Tolerate aggressive plasma cleaning and high-beam currents

These results were obtained through a grant program at Cornell University in collaboration with Dr. David Muller, Associate Professor of Applied and Engineering Physics

Comparison of UltraSM® Non-Porous Silicon TEM Windows to the thinnest commercially available amorphous carbon grids reveals key differences for TEM imaging and analysis. UltraSM® Silicon TEM Windows yield half the inelastic scattering of ultra-thin amorphous carbon and are more uniformly thin. Combined with their tolerance for high-beam current and plasma cleaning, UltraSM® Silicon TEM Windows enable the preparation of higher quality samples, leading to improved imaging and reduced instrument time.

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David Muller, Ph.D., is Associate Professor of Applied and Engineering Physics at Cornell University in Ithaca, NY. His research interests focus on the development of high-resolution electron microscopy tools for the characterization of materials properties.

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Comparison of Amorphous Silicon and Amorphous Carbon

A comparative analysis of electron energy loss spectroscopy (EELS) was performed at Cornell University by Dr. David Muller, a leading researcher in transmission electron microscopy. The analysis compared 5 nm amorphous UltraSM® Non-Porous Silicon TEM Windows with the thinnest commercially available amorphous carbon TEM grids (advertised 5 nm thick). The spectral data shown below reveal two important distinctions:

- Thickness: The ultra-thin amorphous carbon grids are 5-10 nm thick, while the amorphous UltraSM® Silicon are 3.5-5 nm thick.

- Inelastic Scattering: The spectra reveal two-times less inelastic scattering of the electron beam within amorphous UltraSM® Silicon compared to amorphous carbon. Note the two-fold greater broadening of the spectrum from amorphous carbon, leading to twice the chromatic blur for the inelastically scattered electrons.

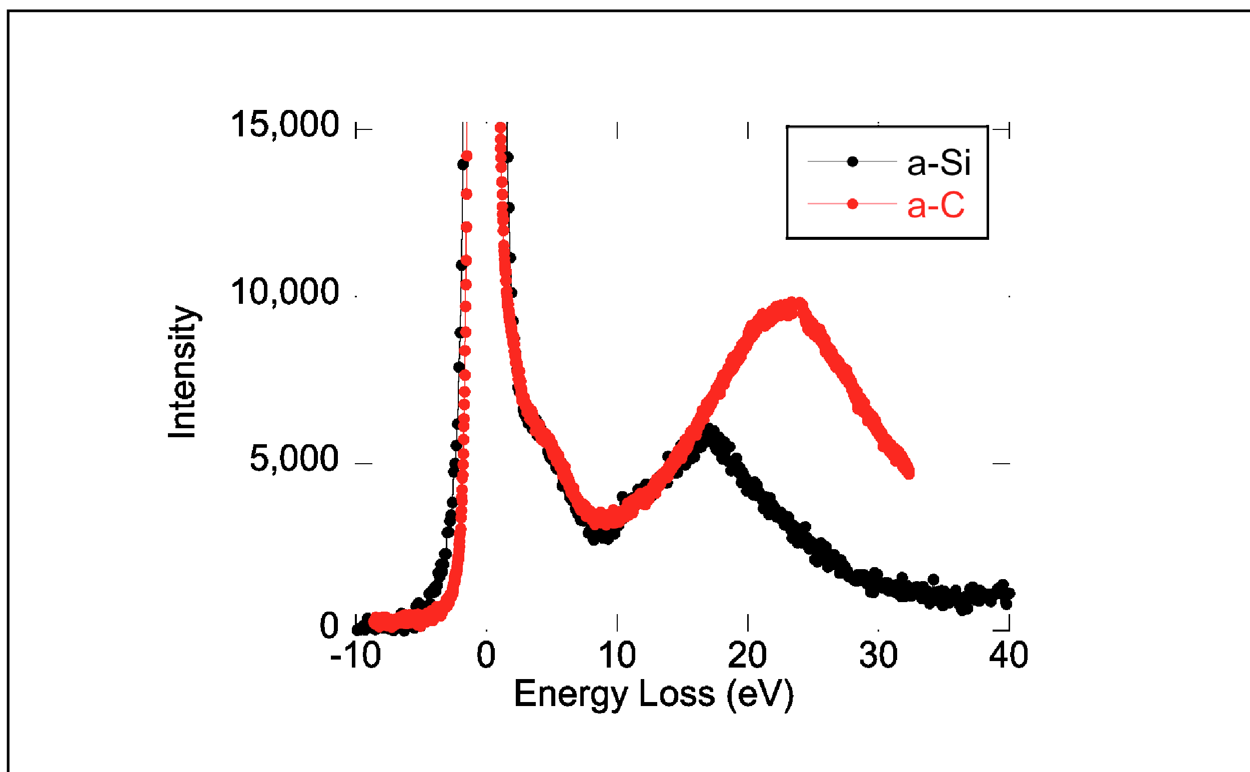

Figure 1: Electron Energy Loss Spectroscopy Analysis of 5 nm Amorphous UltraSM® Silicon (a-Si) and 5 nm Amorphous Carbon (a-C) EELS spectra were recorded on a 200 keV FEI Tecnal F20 and normalized to equal zero peak intensities. The sample thickness, t, can be extracted from the ratio of the inelastic/ elastic scattering if the inelastic mean free path, λ , is known. For a-C, $t/\lambda = 0.1$ and $t = 10$ nm. For a-Si, $t/\lambda = 0.05$ and $t = 6.5$ nm. Inelastic mean free paths, λ, were calculated using equation 5.2 from Egerton (1996)[1].

[1] R.F. Egerton, "Electron Energy-Loss Spectroscopy in the Electron Microscope", 2nd ed., Plenum, NY (1996).

Effectively thinner with reduced inelastic scattering, 5 nm amorphous UltraSM® Silicon TEM Windows help minimize chromatic blur, improving image resolution, and offering improved contrast relative to the best amorphous carbon TEM grids.

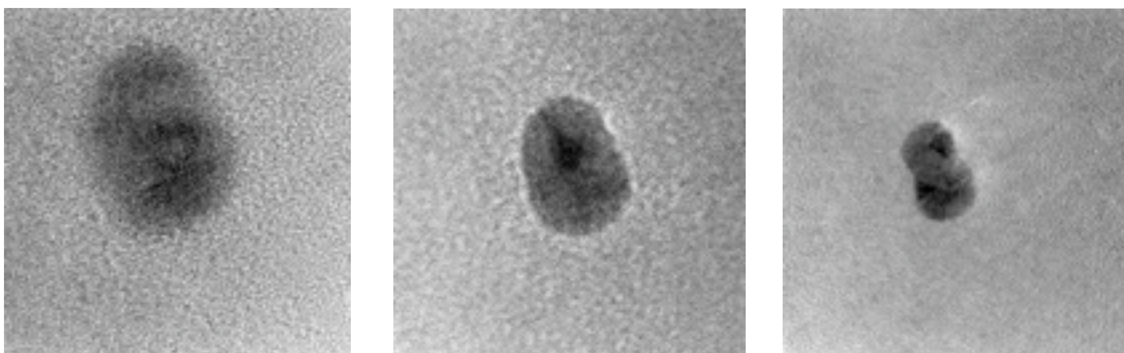

Figure 2: Representative images of gold nanoparticles imaged on 5 nm UltraSM® Silicon; plasma cleaned for 120 seconds prior to imaging.

The pure silicon composition of UltraSM® Silicon TEM Windows improves substrate tolerance for high-beam currents and offers stability against vigorous plasma cleaning. In addition, the absence of a carbon background simplifies the materials analysis of carbon-containing materials using EDX and EELS. Any organic signatures are a direct reflection of the composition of the sample.

Ideal Substrate for High-Resolution Imaging and Analysis

These properties improve sample quality to a great extent, potentially reducing hours of costly TEM time. As a result, UltraSM® Non-Porous Silicon TEM Windows are an ideal sample substrate for high-resolution imaging and for high-beam current analyses such as EDX and EELS.

About TEMwindows.com

UltraSM® Non-Porous TEM Windows
- Amorphous Pure Silicon
- 200 micron thick frame, fits standard 3 mm TEM sample holders
- (9) 100 x 100 micron square windows with 5, 9 or 15 nm thick membranes
- (2) 100 x 1,500 micron slot windows with 9 and 15 nm thick membranes

TEMwindows.com is the online source of innovative sample preparation solutions for the imaging and analysis of nanoscale materials. TEMwindows.com features state-of-the-art transmission electron microscopy windows that enable researchers to characterize their cutting-edge nanomaterials. By incorporating the latest MEMS and thin film technologies, TEMwindows.com provides researchers with the resources to advance their research and development programs.