Why is Selective Carbon Coating of TEM Samples so Effective?

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Electrostatic charging of nonconducting specimens occur in the transmission electron microscope due to highly complex inelastic-scattering processes of impinging electrons resulting in ionisation and subsequent emission of secondary electrons and Auger electrons [1,2].

The accumulation of positive charge in the sample can be significantly reduced by e.g. preparing powdered samples onto an electrically conducting support film such as carbon. However, if bulk samples (for example cross sections of thin films) are to become studied, the deposition of a conducting thin film covering the entire sample has the disadvantage that this film is both deteriorating image quality (in high-resolution TEM) and enhances contamination (in all electron nanoprobe related techniques including all kinds of analyitics, convergent electron beam diffraction, Z-contrast etc.).

It was hence proposed to rather use selective coating utilising a laser-cut blind [3]. The latter mask is shielding the areas of interest from direct deposition with the conducting thin film. With this technique, for example, a sapphire sample possessing a 100 µm diameter hole was imaged at 1 Å resolution in a 200 kV TEM after selective coating with a 500 µm diameter blind. At a similar sample, a beam of 3 nm diameter was kept for five minutes at one and the same position without any indication of contamination in a 400 kV electron microscope.

In the present contribution, electron energy-loss spectroscopy, secondary ion mass spectroscopy, and cross-sectional TEM are combined to explain the mechanisms making this preparation technique so excellent for the suppression of charging and the avoidance of contamination.

References