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Concentrated Ar Ion Milling for Aberration – Corrected Electron Microscopy: A Review

R. R. Cerchiara, P. E. Fischione, J. Liu, J. M. Matesa, A. C. Robins

E. A. Fischione Instruments, Inc., 9003 Corporate Circle, Export, PA 15632

Since its introduction as a complement to the Focused Ion Beam (FIB) in 2004, an increasing number of applications have been developed for use of a concentrated Ar ion beam with a diameter on the order of 1 μm. [1 – 11] The material systems that have benefited from such a technique have included metallics, nonmetallics and ceramics. The material properties studied have ranged from those of the bulk to those which vary on the atomic scale. Knowledge of single, multiple and layered phase chemistries has been enhanced. The identification of interphase interfaces in highly ordered crystalline materials has also been aided.

Following final FIB milling with 2 - 5keV Ga ions, thin (0.5 – 2 nm) damaged surface layers are detected during subsequent electron microscopy. [12] These layers contain amorphous material and implanted Ga ions, with the distribution dependent upon the particular specimen and preparation protocol. Unless the damaged layer thickness can be reduced or eliminated, artifacts will occur during imaging and analysis in the transmission electron microscope (TEM). The effect is more severe if the specimen is viewed at the higher resolution possible with aberration - correction.

A survey of the significant improvements gained in image quality and analytical results will be presented. A majority of these results were obtained using a subset of the possible operating conditions: Ion Beam Diameter = 1 – 4 μm, Ion Beam Energy = 100 – 1000 eV, Incident Angles = $\pm 10^{o}$. The specimen was maintained at a temperature between 25^{o} and -175^{o}C depending on the application.

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