**Rotating sapphire mask cross sectional argon ion milling**

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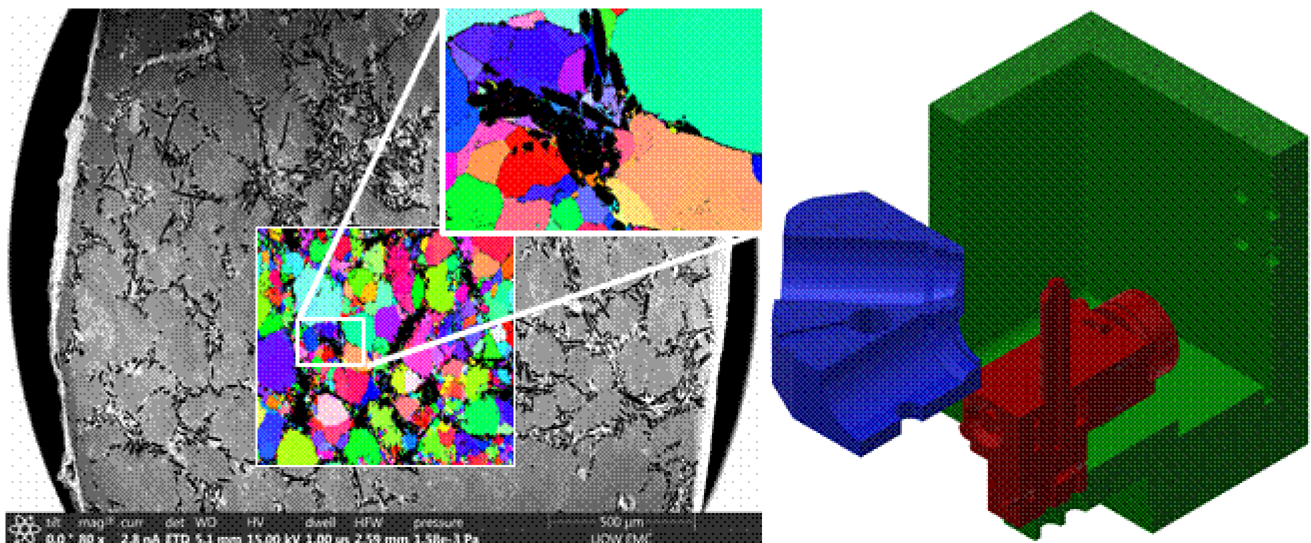
As a means of preparing samples with minimal chemical or mechanical damage few techniques offer the advantages inherent to noble gas ion milling. For transmission imaging, Low energy Ar ion milling has been demonstrated to produce surfaces with ion beam induced damage depths as thin as 4nm (Mitome, 2012) for specialised Transmission Electron Microscopy (TEM) sections. These same advantages are also routinely leveraged to yield detailed, defect free samples for Scanning Electron Microscopy (SEM) investigation. With the advent of high spatial resolution, low voltage Field Emission SEMs (and new low voltage Energy Dispersive X-ray Spectrometers (EDS), CMOS Electron Back-Scattering Diffraction (EBSD) cameras and Soft X-ray Emission Spectrometers (SXES) to yield high spatial resolution analytical information) improvements in preparing SEM samples of exceptional quality is required. The unique combination of large area milling through broad beam or cross sectional Ar milling with very low surface damage offers the ability to observe large interfaces and continua in samples that may be impractical to prepare *via* other methods.

Ion milling is not without challenges however. Cross sectional methods suffer from limited effective milling areas, and due to the unidirectional passage of the ion beam, local heating at the milling interface limits available current and thus slows milling time. Further, for highly inhomogeneous or porous samples, the presence of significant curtaining artifacts are an issue. While sample rocking helps to alleviate these problems, the limitations of a flat mask prevent a complete solution. Here we demonstrate the use of common sapphire jewel bearings on a continuously rotating platform to prepare large, artifact free surfaces in delicate, inhomogeneous samples.




*LEFT: Demonstration of large area EBSD indexation of highly inhomogeneous Al/Carbon fibre composite with no preparation induced damage at boundary. Data is shown as indexed without further processing. RIGHT: Model of rotating mask apparatus (red) inside of ion source assembly (blue) and removable door (green).*

Mitome, M. (2012). Ultrathin specimen preparation by a low-energy Ar-ion milling method. *Microscopy*, *62*(2), 321-326.

Adams, D. P., Vasile, M. J., Mayer, T. M., & Hodges, V. C. (2003). Focused ion beam milling of diamond: effects of H 2 O on yield, surface morphology and microstructure. *Journal of Vacuum Science & Technology B: Microelectronics and Nanometer Structures Processing, Measurement, and Phenomena*, *21*(6), 2334-2343.

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