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Optimizing SEM Sample Preparation and FIB Techniques for Reliable Electron Microscopy Analysis

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Abstract: High-quality electron microscopy analysis begins with proper specimen preparation. In scanning electron microscopy (SEM), image quality is limited not only by instrumental performance but also by practical factors, including charge-up, contamination, thermal damage, poor grounding, inappropriate coating, and unstable imaging conditions. Therefore, systematic SEM sample preparation is essential for obtaining reliable surface morphology and compositional information from advanced materials.

In this presentation, practical SEM specimen preparation strategies will be introduced based on various analysis cases. The first part focuses on major factors that degrade SEM image quality, such as charge-up, contamination, and thermal damage, discussing how these problems can be minimized through proper coating, conductive mounting, vacuum management, and optimized sample handling. The effects of coating materials and thickness on SEM images will be evaluated, including cases where unsuitable coating distorts fine surface structures. Additionally, imaging parameters like accelerating voltage, working distance, lens mode, and scan speed will be considered for high-resolution imaging.

The second part introduces cross-sectional specimen preparation and advanced FIB-based methods. Conventional mechanical cutting, ion beam cross-sectioning, and focused ion beam (FIB) preparation will be compared in terms of surface damage, cross-sectional quality, and applicability to multilayered materials. The use of Ga-FIB, Ar ion milling, and Cryo-FIB will be discussed as effective approaches for reducing artifacts and preserving sensitive microstructures, particularly in functional materials like battery electrodes, thin films, and beam-sensitive samples.

Through these examples, this talk emphasizes that reliable electron microscopy analysis requires both advanced instruments and optimized specimen preparation. Combining practical SEM preparation methods with advanced FIB techniques significantly improves microstructural observation and supports accurate materials characterization

Keywords: *Scanning Electron Microscopy (SEM), Specimen Preparation, Focused Ion Beam (FIB), Beam-Sensitive Materials, Characterization.*

