

Project proposal: Fabrication and characterization of electron and ion microscope 3D resolution standards

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Motivation

Modern charged particle microscopes, including scanning electron microscopes (SEMs) and ion microscopes, have revolutionized our ability to visualize structures at the nanoscale with resolutions below 1 nanometer. These instruments are indispensable tools across physics, materials science, engineering, and interdisciplinary research fields. However, achieving optimal performance from these sophisticated instruments requires precise calibration—a process that depends heavily on standardized reference objects.

Currently, there is a significant need for well-defined, reliable 3D calibration targets that can ensure consistency of measurements across different microscopes and standardize equipment performance. The development of such resolution standards is critical for advancing microscopy techniques, enabling reproducible research, and facilitating accurate comparisons between studies conducted using different instruments. This project addresses this technological gap by developing fabrication protocols for high-precision 3D resolution standards specifically designed for charged particle microscopy.

Objective

To develop and optimize a reproducible fabrication protocol for 3D resolution standards with sub-micron precision for electron and ion microscopes, creating well-defined calibration targets for precise microscope performance evaluation.

Scope

This project will focus on the fabrication, characterization, and optimization of 3D resolution standards using complementary lithography techniques, primarily laser writing and proton beam writing. The fabrication process will include the creation of fine grids followed by metallization to produce metal grid structures with precisely defined dimensions. The project will involve:

1. Design and simulation of grid patterns optimized for electron and ion microscope calibration
2. Metallization processes to create the final metal grid structures
3. Comprehensive characterization of the fabricated standards using multiple microscopy techniques
4. Optimization of the fabrication protocol based on characterization results

The project will not include the mass production of standards but will develop and document a protocol that can be used for future manufacturing. Additionally, while the standards will be tested on various microscopes, developing new microscopy techniques is outside the scope of this project.

Deliverables

- A set of prototype 3D resolution standards fabricated using optimized protocols

- Comprehensive characterization data demonstrating the precision and reliability of the fabricated standards
- Validation data showing the performance of the standards on different electron and ion microscopes