

CDE4301 Proposal : Fabrication and characterization of electron and ion microscope 3D resolution standards

Proposer details

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Project description:

Microscopes are crucial tools in imaging minute features across diverse research fields such as physics, materials science, and engineering. Modern charged particle microscopes, including scanning electron microscopes (SEMs) and ion microscopes, can achieve resolutions below 1 nanometer. Attaining such a high resolution necessitates precise calibration of the microscope, which involves focusing and adjusting brightness and contrast. However, commercial Calibration targets, defined 3D structures used as reference objects, are essential for ensuring different microscopes deliver consistent results and standardizing equipment performance.

Motivation:

Commercial calibration standards face significant limitations at sub-100nm resolutions due to imprecise edges, poor surface roughness, and substantial edge slope issues.[1] As mentioned the accuracy of the measurement relies on the accuracy of the resolution standards, yet current standards don't always match the pace of device manufacturing technology developments. Existing standards often lack the vertical sidewalls necessary for precise measurements. Current proton beam applications increasingly demand nano dimensional resolution measurements, requiring standards with "a high degree of side-wall straightness" that many commercial options cannot provide. [2]

Objective:

The project aims to create reliable reference structures that ensure consistent calibration across different microscopes, ultimately improving the accuracy and reproducibility of nanoscale imaging in scientific research and engineering applications.

Scope:

To fabricate resolution standards using various lithography techniques, such as laser writing and proton beam writing, to create a fine grid. This process is followed by metallization to produce a metal grid.

Additionally, optimization steps will be incorporated, culminating in a published protocol aimed at facilitating future mass fabrication of resolution standards for fast ion and electron beams.

Deliverables:

1. Creating physical resolution standards for microscope calibration below 1 nanometer
2. Optimizing and documenting fabrication methodology, with aims for future mass production

Reference

- [1] F. Zhang, J. A. van Kan, S. Y. Chiam, and F. Watt, "Fabrication of free standing resolution standards using proton beam writing," *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms*, vol. 260, no. 1, pp. 474–478, Jul. 2007. doi:10.1016/j.nimb.2007.02.065
- [2] Y. Guan and M. Tortonese, "Metrology standards for Semiconductor Manufacturing," *Proceedings. 7th International Conference on Solid-State and Integrated Circuits Technology, 2004.*, 2004. doi:10.1109/icsict.2004.1435075