

3D Nano Tomography, TEM Lamella Preparation and Automated Nano Fabrication with ORION NanoFab

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ZEISS ORION NanoFab is a unique focused ion beam instrument capable of generating helium, neon, and gallium ion beams. Due to its extremely small helium probe size of $<0.5\text{nm}$ it is being used for high resolution imaging and nanofabrication of structures with feature sizes of less than 10nm . Using the Gallium beam for milling and the Helium beam for imaging we present the first 3D Tomographies done on a helium ion microscope. The datasets show a tightly controlled slice thickness as well as ultra-high lateral resolution. The use of a Neon beam allows for nano-fabrication of structures (i.e. plasmonic devices) well below the size regime of what is usually achieved with a Gallium beam. In order to perform experiments on these structures in the laboratory however, larger numbers are required. This exceeds what can be achieved manually in a reasonable amount of time. We present a software module which is capable of automating almost all instrument functions that an operator has access to. With this graphical scripting capability it is possible to produce multiple structures in an unattended fashion and use off-hours more efficiently.

In traditional FIB-SEM instruments, gallium ions are used for sample modification and popular applications include cross-sectioning, 3D tomography, and TEM sample preparation. For the latter, gallium has the advantage of being fast, but gallium implantation during polishing may lead to a relatively thick amorphous layer and a modification of the chemical and electrical properties of the specimen. In contrast, helium and neon are inert ion species leaving no chemical contamination in the processed sample. This capability in combination with the extremely high precision of the helium and neon beams could enable the fabrication of very thin, high-quality TEM lamellae. In this presentation, we will describe the instrument setup and provide a brief overview of the sample preparation workflow with ORION NanoFab using gallium for coarse milling and neon ions for the final polishing. TEM images of the first set of prepared lamellae will also be shown.