

Extending microstructure characterization from nm to mm scale using the latest multiple ion species plasma FIB integrated with femtosecond laser

Min Wu, Bartłomiej Winiarski and Remco Geurts

Thermo Fisher Scientific, Eindhoven, The Netherlands.

Conventionally 3D X-ray scanning technique such as microCT recovers large sample volume however suffers from relatively low voxel resolution, meanwhile high resolution 3D volume methods such as serial sectioning and imaging using a FIB-SEM can only recover 3D volume in the order of $\leq 40 \times 40 \times 40 \mu\text{m}^3$. Plasma FIB-SEM expands these techniques to volume $\sim 250 \times 250 \times 250 \mu\text{m}^3$ keeping the voxels sizes in the dozens of nm-ranges. Recently, femtosecond Laser PFIB-SEM pushed these 3D techniques further to mm-scale volumes, setting the standards for multi-modal data collection from nm to mm scales and bridge the gap between microCT and FIB-SEM, while maintaining the advantage of high resolution SEM imaging of the cut face.

In this abstract we present the latest development of multiple ion species plasma FIB integrated with femtosecond laser, the Thermo Scientific Helios 5 Laser Hydra system. We address the effects of ultra-short pulse laser ablation and discuss various application usecases using this latest versatile technology. We will also discuss the possibility of laser ablation and slicing materials with multiple ion species under cryogenic conditions using our latest 360° rotatory Aquilos cryo stage, and the newly developed inert gas transfer system CleanConnect.

We will also present the latest automation software from Thermo Fisher Scientific, AutoTEM 5 for lamellae fabrication and Auto Slice & View 5 for 3D serial sectioning and volume reconstruction.

AutoTEM 5 facilitates users to prepare the highest quality S/TEM samples and cross-sectioning with a reliable fully-robotic fashion. It is a unique solution with highly configurable workflow to enable preparation of a wide range of samples for Inverted, Top Down and Planar use cases. The complete in-situ sample preparation workflow features fully automated, unattended multi-site chunk milling, lift-out and final thinning.

Auto Slice & View 5 is the latest generation of Thermo Fisher Scientific's automation software for automated serial sectioning and imaging through a user-defined volume of a specimen. Auto Slice & View 5 provides all necessary features for high precision slicing and imaging through reliable automation, easy setup, monitoring and on-the-fly correction of project parameters. Some of the notable new features include editable job templates to simplify and speed up job setting, rocking beam polishing, and fast and reliable auto functions (auto focus, auto stigmation and auto lens alignment). In addition, a newly developed Spin mill function allows the software to automate sequential milling of large (up to 1 mm) areas. The sample surface is oriented almost parallel to the ion beam and the stage is periodically rotated to a series of pre-defined positions until a full rotation of 360° is fulfilled. Multiple areas for image acquisition could also be configured per every Spin mill site.