Cryo-FIB-SEM: a powerful tool for imaging and structural analysis of sensitive biological samples

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Current trends in electron microscopy are focused on analysis of beam sensitive samples. Studying beam sensitive materials containing water represents one of the most demanding, but also very promising approaches. Low temperature scanning electron microscopy (Cryo-SEM) has become an established technique for capturing and observing such samples close to their natural state. It is a method of choice, where the traditional biological sample preparation (e.g. critical point drying) causes unwanted changes in the sample structure. A Cryo-SEM workflow involves sample fixation using fast freezing to temperatures of liquid nitrogen. The frozen samples are then transferred under vacuum to an SEM chamber equipped with a cryo-stage and observed in high vacuum environment.

A combination of SEM with nanomachining capabilities of Focused Ion Beam (FIB) opens wide range of possibilities. FIB-SEM systems are widely used for their capability of precise cross-sectioning, 3D volume imaging, as well as for routine preparation of ultra-thin TEM specimens. Moreover, FIB can be used for sample ionization, production of secondary ions, which can be analyzed by mass spectrometer. TESCAN integrates Time-of-Flight Secondary Ion Mass Spectrometer (TOF-SIMS) to a FIB-SEM, and thus introduces unique combination of simple navigation over the whole sample with advanced imaging capabilities and acquisition of elemental information from the observed material. This integration considerably extends the possible applications of FIB-SEM workstation. While typical TOF-SIMS analyses requires sample to be introduced into the (ultra) high vacuum, use of cryo stage enables the cryo-immobilized samples to be analyzed, which is of great importance for e.g. chemical mapping of dissolved materials.

The aim of this presentation is to demonstrate the exceptional range of capabilities within single versatile workstation.