01 - FIB-SEM nano-tomography for materials science

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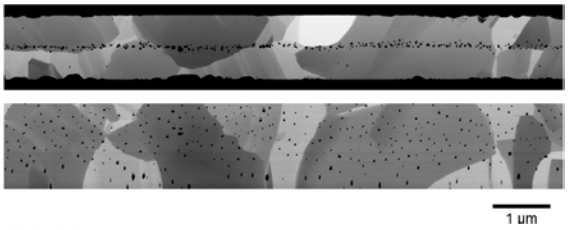
Dual-beam microscopes which combine a field-emission scanning electron column (SEM) and a focused ion beam (FIB) are becoming a standard tool in nanotechnology research and in industry. Here, the FIB allows the machining of an object with an accuracy of a few nm whilst the SEM allows its visualization at nm scale.

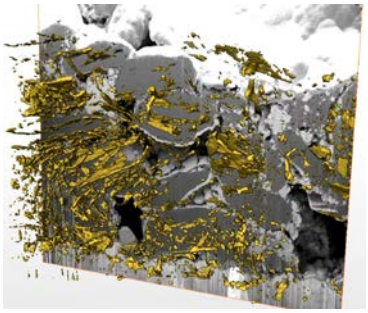
It is commonly used for prototyping and fabrication of nano-devices such as MEMS, photonic arrays or AFM tips. In the semiconductor industry, this is now the standard tool for the preparation of thin (<100 nm) lamella for TEM observations,

Another emerging application of this instrument is the 3D imaging of nanostructures by "slice and view" imaging: a sample is cut slice by slice with the FIB, and each fresh surface is imaged in 2D using the SEM. This technique is robust and versatile: it can be applied to visualize 3D semiconducting or metallic nanostructures, and it is revolutionizing the way biological ultra-structures are imaged in life sciences [1].

(a)



(b) (c)



(a) Zeiss XB 550 dual-beam microscope used in this practical. (b) Nano-porosity revealed in a Cu-Cu direct bonding after annealing. (c) Structure of a C/Si battery anode.

This practical will demonstrate how FIB-SEM nano-tomography can be used to image 3D nano-devices. This will be done on the new Zeiss XB550 microscope installed recently at the PFNC (Plateforme de NanoCaracterisation @ Miatec). We will also discusses the various tools that subsequently allow the extraction of quantitative information from the image stack, and how to visualize them in 3D.

1) M. Cantoni, L. Holzer, *Advances in 3D focused ion beam tomogra*phy, MRS bulletin **39** (2014) 354