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Integrating 3D surface imaging with FIB/SEM microscopy

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With the large amount of current research and development focused on nano wires, carbon nano tubes, and other nano scale materials, imaging these materials has become a large part of the challenges involved.

The two most prominent methods for imaging at the nano scale are Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM). These complimentary methods utilize fundamentally different principles for generating imagery - SEM exploits the interaction of electrons with matter, while AFM is based on physical interaction of a sharp tip with the sample surface.

Both approaches have strengths and weaknesses. The SEM's strength is to quickly generate images with a large range of magnifications, making it easy to locate the area of interest. However, it doesn't yield 3D information, e.g. "invisible" contamination layers. The AFM's main advantage is its ability to obtain 3D information, the downsides are that it is hard to find the target area and image generation is slow.

Combining these two tools into one setup - putting an AFM inside an SEM - gives quick access to a more complete data set. Additionally, FIB-milled or FIB-deposited structures can be characterized using this combination of tools in a FIB/SEM system.

The SFAFM is a small compact solution for in situ AFM experiments. Based on a 4" wafer size platform, with a height of just 10 mm, the system is comprised of an ultra-flat piezo scanner and a next generation three-axis micromanipulator to which a piezo-resistive force measurement cantilever is mounted. These cantilevers can detect deflection without the use of a laser read-out system, making them ideal for in situ applications.

The utility of this combination of tools is demonstrated with several examples where locating the area of interest purely by AFM or light microscopy would have been highly impractical.

Figure 1. SuperFlat-AFM. The load-lockable platform can be mounted into almost any SEM on the market.

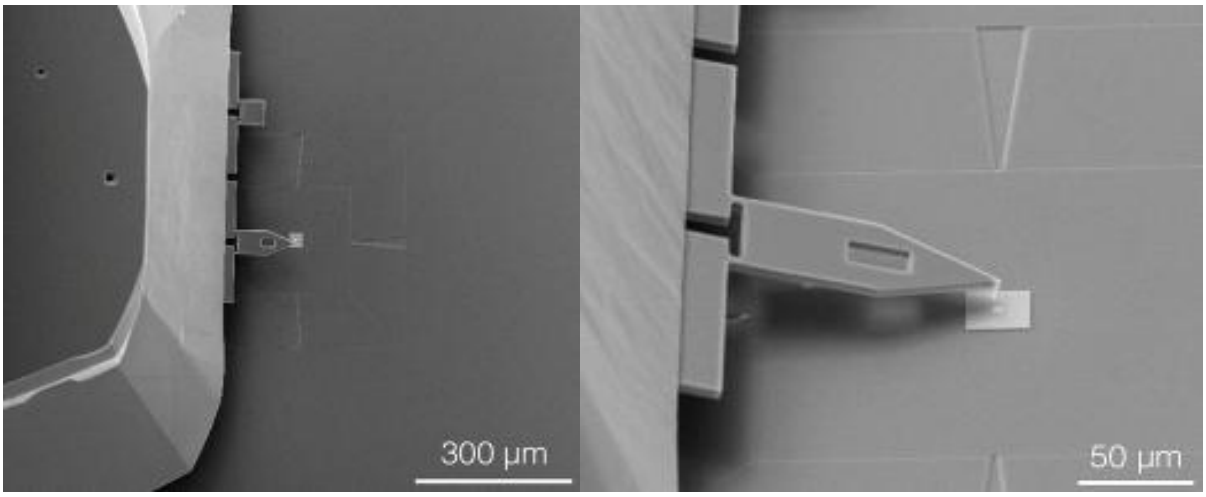

Figure 2. Addressing the target area for AFM inspection is fast and easy using the SEM.

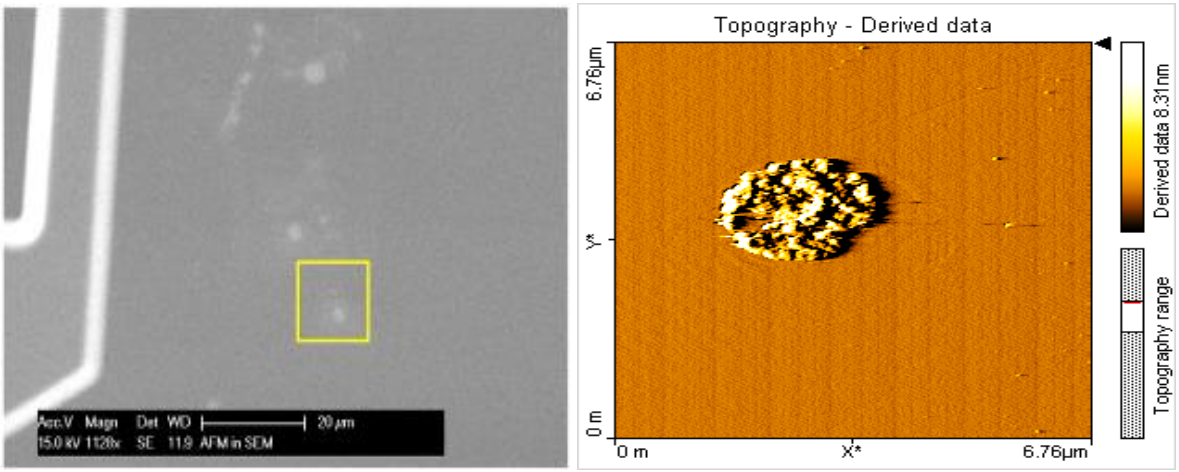

Figure 3. Si surface observation by SEM and AFM characterization of defects. The defects have a height of about 12nm