3D orientation microscopy based on FIB-EBSD tomography: potentials and limits.

S. Zaefferer
Max-Planck-Institute for Iron Research, Düsseldorf, Germany

3D orientation microscopy based on a combination of serial sectioning with a focused ion beam (FIB) and 2D orientation mapping using EBSD on each of the sections is a powerful new tool for materials characterization. The technique allows a comprehensive description of (relatively small) volumes of materials including crystal orientation, crystallographic phase, defect density and, if combined with simultaneous EDS (energy-dispersive x-ray spectroscopy) measurements, elemental composition of every volume-pixel (voxel).The smallest reasonably measurable voxel size (i.e. the spatial resolution) is about 50^3 nm^3. The technique has been shown to work reliably on a large variety of metallic materials with microstructures ranging from recrystallized to heavily deformed state and on single or multi-phase materials.

One particular strength of the technique - besides comprehensive characterization – is the ability to directly deliver numerical input for process simulation as for example deformation and recrystallisation processes.

Although the technique is powerful, it also has a number of serious drawbacks: first of all, it is a destructive technique and therefore does not allow observation of the progress of materials processes at one and the same position. Second, the technique is limited to observation of rather small volumes in the order of maximum 50^3 μm^3. Third, the technique cannot be applied to many materials which show a significant contribution of non-metallic atomic bonding because such materials are too heavily damaged during the ion beam milling. Therefore many intermetallic materials, ceramics or minerals cannot be observed by FIB-EBSD tomography.

The lecture will cover an introduction to the basics of the technique, show an example of combination of observation and simulation and discuss the most critical limitations.