Advances in 3D Microscopy and Micro-Analysis using DualBeam Technology

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An understanding of the 3 dimensional structure of matter is vital in characterizing its properties. Until recently the underlying nature of materials has had to be extrapolated from 2-demensional surface information or by involved sample preparation techniques and the use of several imaging and analytical instruments. However, DualBeam, a unique combination of a SEM and FIB (focused ion beam), has enabled users to straightforwardly cut a cross section into a sample using the FIB and directly view the underlying structure revealed on the cross section with the SEM (fig. 1). Furthermore, by accurately cutting a series of cross sections with the FIB and sequentially imaging with the SEM a stack of coherent images can be obtained that can then be used to reconstruct, in 3 dimensions, the sample's structure. A further application of this is to use the electron beam combined with an additional detector, for example an X-ray detector, to gather analytical data from each cross section (or slice) of the sample. By combining the imaging and analytical data in 3D a detailed understanding of the sample can be built up [1,2].

This sectioning and 3D reconstruction already enables a sample to be characterized far more quickly and in greater detail than was possible before (for example by serially polishing or cutting a sample ex-situ). But more fundamentally, by analyzing material in 3D down to the order of 10nm an understanding of the material that was very difficult or impossible to obtain previously can now be realized.

This presentation will explore some of the recent advances made in 3D-imaging and show examples of where combining x-ray analytical data with 3D-imaging (figures 2 and 3) can reveal unique aspects of materials such as samples with embedded precipitates or gun shot residue particles.

References

[1] F. Lasagni et al, Three-dimensional characterization of 'as-cast' and solution-treated AlSi12(Sr) alloys by high-resolution FIB tomography, Acta Materialia 55 (2007) 3875–3882.
[2] M. Schaffer et al, Block lift-out sample preparation for 3D experiments in a dual beam focused ion beam microscope, Microchim Acta 161 (2008) 421–425.

[3] K. Scott, Nanoparticle detection in biological systems – FIB EDS approach, FLAVS-FSM Annual Joint Symposium, March 10-11, 2008, UCF, Orlando, FL (Invited)

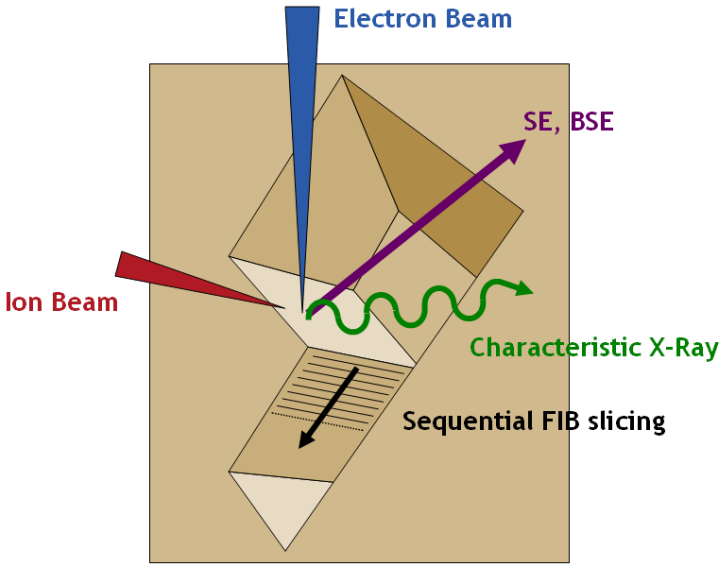

Fig. 1: Principle of sequential FIB slicing and EDS mapping in a DualBeam

Fig. 2: Example of automated sequential FIB slicing and EDS map collection a standard Al stub for electron microscopy. The volume analyzed is 20 x 16.6 x 20.3 μm^3.

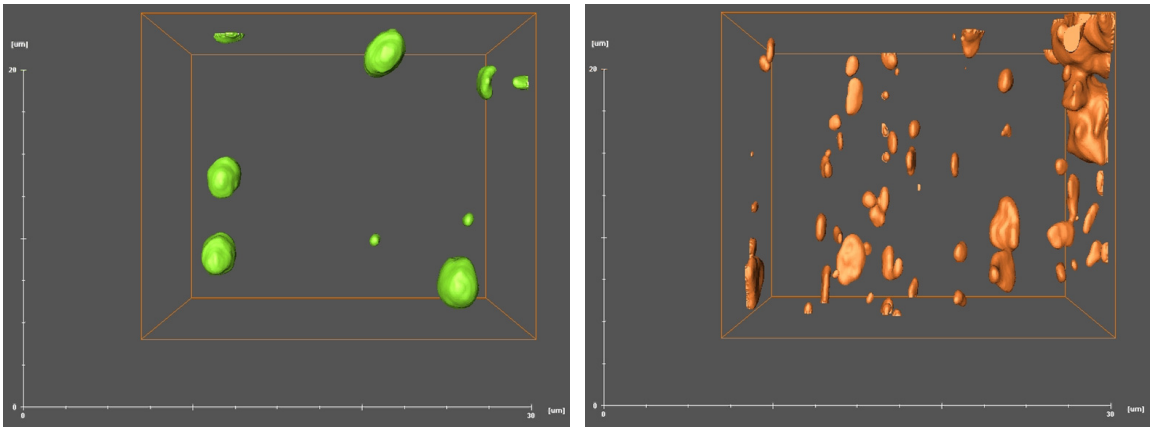

Fig. 3: 3D chemical reconstruction of the Al stub 20 x 16.6 x 20.3 μm^3 volume, revealing the Bi (left) and Cu (right) inclusions.

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