A SPATIAL MICRO CALIBRATION OBJECT AS REFERENCE FOR 3D MICROSCOPY

Martin Ritter, Matthias Hemmleb
Federal Institue for Materials Research and Testing (BAM)
Unter den Eichen 87, 12205 Berlin, Germany
Email: martin.ritter@bam.de   matthias.hemmleb@bam.de

Heinz Hohenberg
Heinrich-Pette-Institute (HPI)
Martinistrasse 52, 20251 Hamburg, Germany
Email: hohenberg@hpi.uni-hamburg.de

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Electron microscopy has contributed significantly to the understanding of materials and the architecture and processes of life. Modern techniques in scanning electron microscopy (environmental SEM) even offer the possibility of imaging hydrated microstructures while maintaining their original 3D topography.

Photogrammetry is the method of choice for the quantitative 3D reconstruction of SEM or environmental SEM (ESEM) images, since SEM data provide a large depth of focus, a high signal to noise ratio and images can be captured over a wide range of magnification. However, there are several additional 3D micro-range measurement methods that provide specific and supplementary information of structural details, e.g. confocal laser scanning microscopy (CLSM) and scanning probe microscopy (SPM). Our goal is to establish a metric reference frame for the various micro-range measurement methods in order to be able to compare the specific details revealed by each method in a quantitative manner.

We developed a new micrometer sized 3D calibration structure for the calibration of various micro-range measurement methods, e.g. SEM and ESEM in cooperation with FEI Germany. It was fabricated using gas-assisted focused ion beam (FIB) deposition and etching. FIB allows the construction of variously shaped microstructures, in our case a 3 step pyramid in order to allow good visibility even from very angular views when tilted in the SEM. It contains numerous non-symmetrically distributed nanomarkers that serve as well distinguishable reference points at various magnifications. The spatial data of the nanomarkers were obtained by high-precision atomic force microscopy at the Physikalisch-technische Bundesanstalt, Braunschweig. The pyramidal slope structure of the step pyramid allowed the SPM to easily access all the nanomarkers. With the control point coordinates a reference was available for photogrammetric calibration of SEM and ESEM.

Yet, also optical errors of alternative micro-range measurement methods, e.g. confocal laser scanning microscopy (CLSM) and scanning profilometry, can be detected. Thus, a comparative analysis of the microscopic data and their quantitative significance can be accomplished. Analytical statements of specific surface data are substantially increased in their reliability.