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Correlative Probe and Electron Microscopy CPEM^{TM} – The Novel Technology for 3D Material Surface Analysis

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The direction of development in scientific instrumentation and analytical methods is the integration of various techniques into a compact apparatus. Atomic Force Microscopy (AFM) and Scanning Electron Microscopy (SEM) are well established and commonly used techniques for imaging the nanoworld. There are many applications of such devices especially in the field of material sciences, nanotechnology, semiconductors, and life sciences.

LiteScope^{TM} AFM produced by NenoVision company 0 is carefully designed for direct integration into many different types of SEM microscopes. It extends the capabilities of both AFM and SEM techniques and offers several benefits like in-situ 3D surface characterization, surface roughness estimation, height/depth profiling, precise AFM tip navigation, measurement of an electric, magnetic or mechanical properties and others at the same environmental conditions during simultaneous measurement. On top of that, it is equipped with a new unique measurement technique CPEM^{TM} for the true correlative imaging which enables direct comparison/correlation of the images acquired by both, SEM and AFM.

Correlative Probe and Electron Microscopy (CPEM^{TM}) is based on a different principle than the traditional approach to combine the SEM and AFM techniques. In the past, both methods were already integrated but used separately. Therefore, the comparison of obtained images was challenging and could be even misleading due to different scanning systems, image distortions, different image resolutions etc.

Using CPEM^{TM} approach, the electron beam is kept still (i. e. point mode, spectroscopy mode) and focused close to the AFM tip, while scanning is done just by a piezo scanner with the sample (Fig. 1). Distance (offset) between the AFM tip and electron beam is constant during the whole measurement. Simultaneous sampling of AFM and SEM signals results in slightly shifted SEM and AFM images. This constant shift/offset is simply subtracted during the post-processing and the resultant images can be composed very easily without any higher order transformations due to their identical coordinate system. Easier data interpretation could be achieved by displaying the AFM image in 3D using the SEM image as an overlay color mask. CPEM^{TM} can accommodate more signals from different SEM detectors (SE, BSE) or related techniques like EBIC or CL. Each signal is then represented by a unique mask and can be used for further image analysis.

Thanks to this new imaging technique, we can precisely combine images from multiple modalities and distinguish differences between material and topography contrast like in Figure 2. In this figure, there is a surface of tungsten with chromium/hafnium particles (W-10Cr-1Hf). From the SEM image itself (Fig. 2a), it is not sure if the different contrast of structures is due to the different material or due to the surface inequality. If there is also information about the real topography given by AFM (Fig. 2b) the speculations can be easily clarified. The data can be processed in Gwyddion 0 open source SPM data analysis software, to obtain 3D CPEM^{TM} view (Fig 2c). LiteScope^{TM} with CPEM^{TM} is a powerful instrument useful to reveal new details of various samples in one shot measurement.

References:

[1] NenoVision, www.nenovision.com (02-22, 2019).
[2] Gwyddion – Free SPM (AFM, SNOM/NSOM, STM, MFM, …) data analysis software, www.gwyddion.net (02-22, 2019).

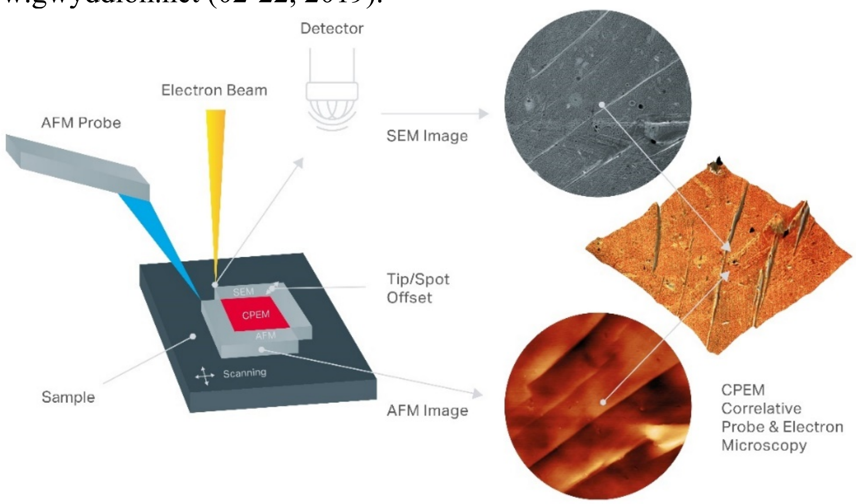
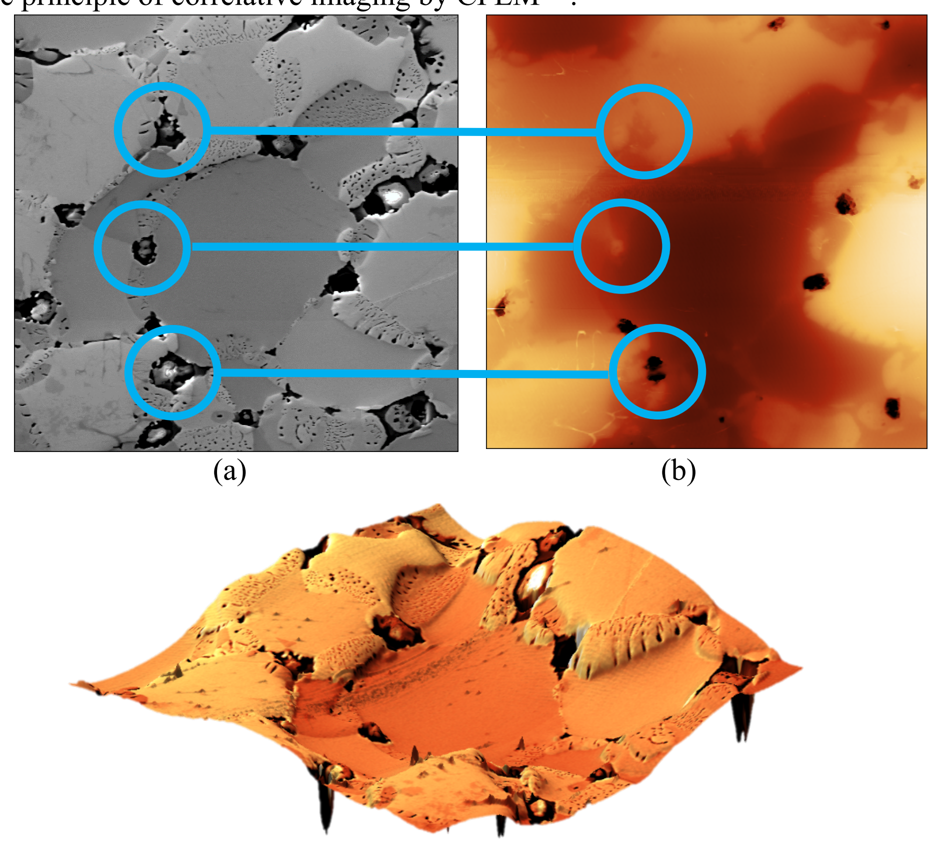


Figure 1. The principle of correlative imaging by CPEM™.



(a) (b)

(c)

Figure 2. Differences between material and topography contrast of tungsten with chromium particles (W-10Cr-1Hf) revealed by CPEM™ technique. Secondary electrons (SEM) (a), topography (AFM) (b) and 3D CPEM™ view of secondary electrons and topography.

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