Application of The Correlative Probe and Electron Microscopy (CPEM) in Advanced Sample Surface Analysis

NenoVision

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LiteScope™ – Atomic force microscope for SEM

LiteScope is an atomic force microscope (AFM) carefully designed for easy integration into a wide range of scanning electron microscopes (SEM). Both of these techniques are often used for imaging the nanoworld in fields of material sciences, nanotechnology, semiconductors or life sciences. Nevertheless, correlative imaging by these two techniques is very challenging due to the differences in coordination systems, spatial resolution, scanning nonlinearities, and other effects, which cannot be simply corrected by post-processing.

A novel approach of LiteScope equipped with patented Correlative Probe and Electron Microscopy (CPEM™) technology overcomes these problems and enables simultaneous correlative measurement of the analyzed sample.

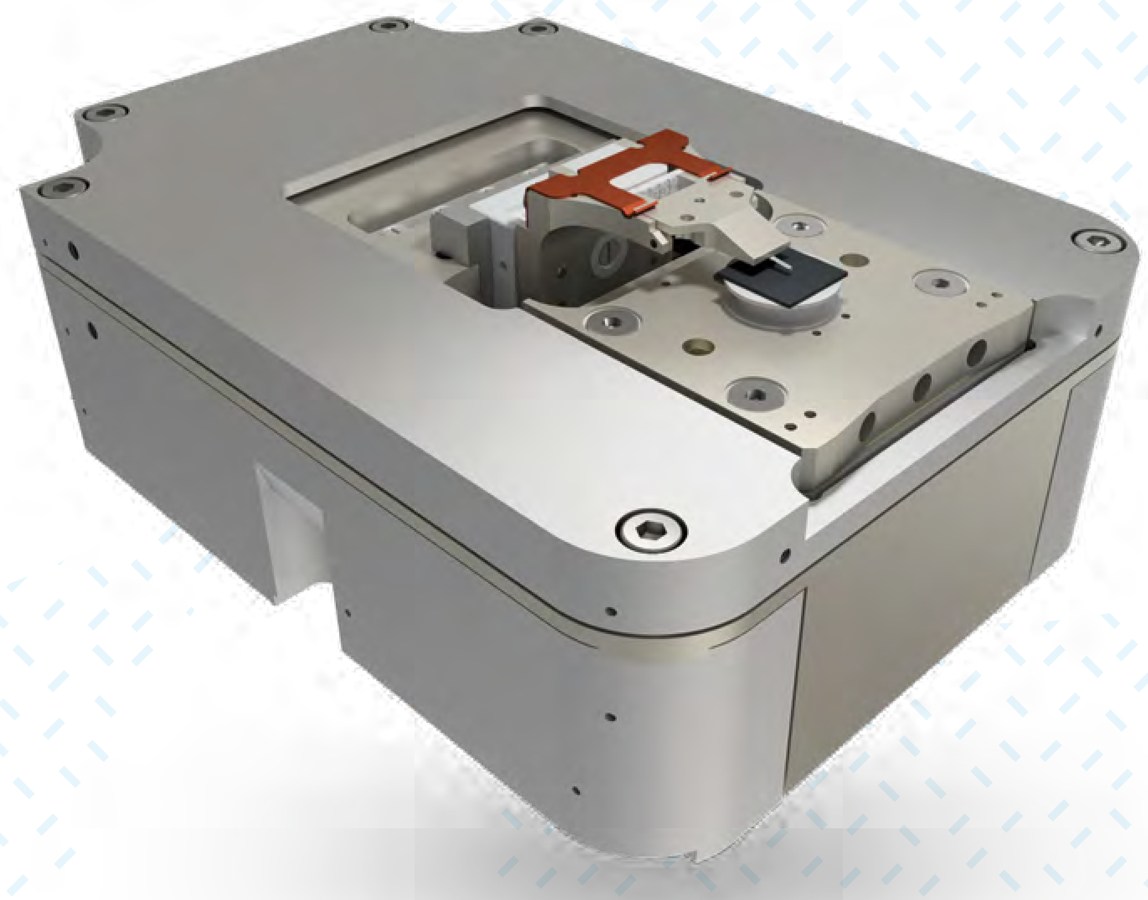


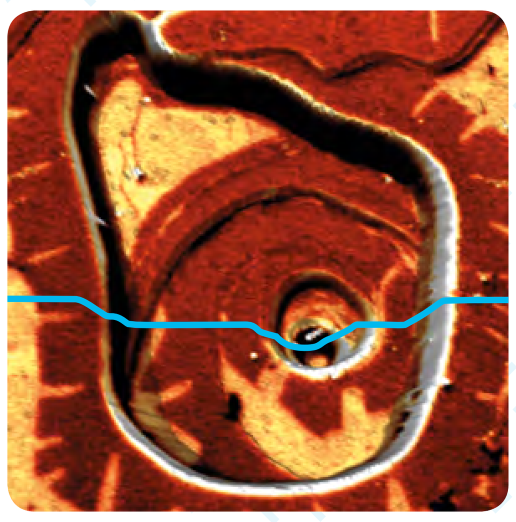
Fig. 1 NenoVision LiteScope™
– atomic force microscope designed for the application of CPEM

Why AFM-in-SEM?

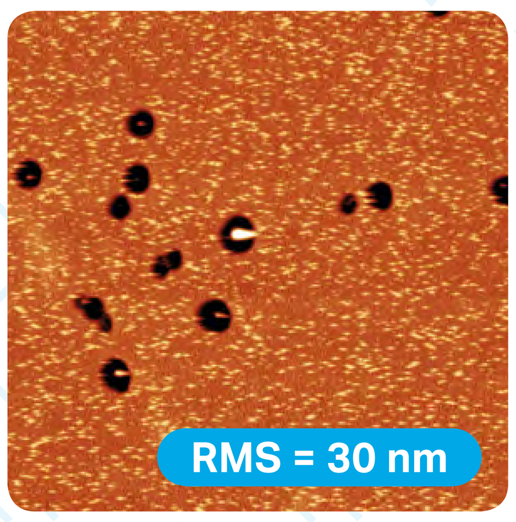
LiteScope with CPEM technology provides complex sample analysis including surface topography, roughnes, hight/depth profiling or local conductivity using different replaceable and commercially available probes.

Precise AFM tip navigation

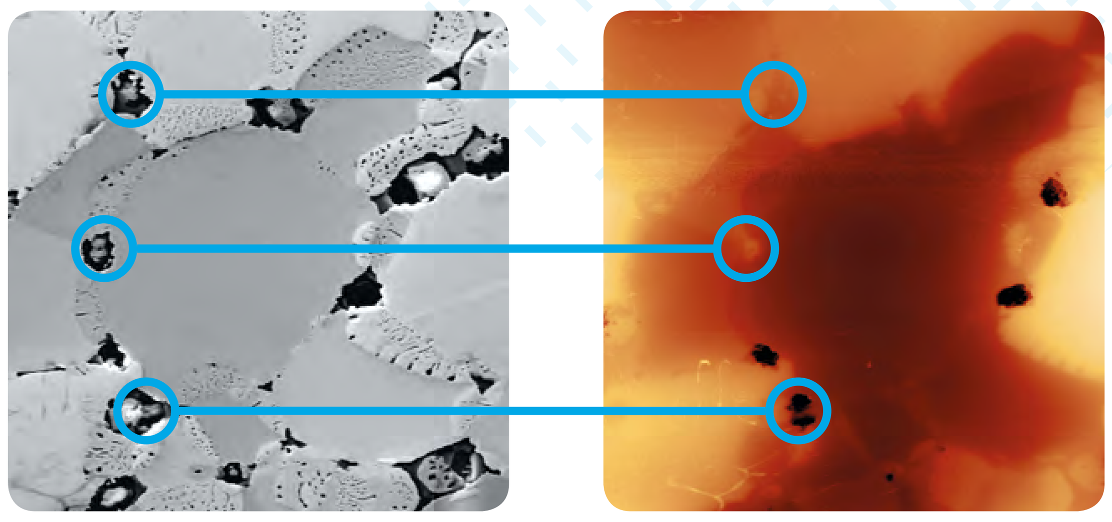
In-situ 3D profiling



Roughness measurement



Material vs. topography contrast



CPEM – principles

CPEM enables simultaneous surface characterization of a region of interest by SEM and AFM at the same time and in the same coordinate system. The electron beam is focused close to the stationary AFM tip. Subsequently, the scanning is provided by the piezo scanner with a mounted sample. Neither the e-beam nor the AFM probe is moving during CPEM image acquisition. Simultaneous sampling of SEM and AFM signals with known constant offset and identical pixel size ensures that the analysis is performed on the same surface at the same time and can be directly used for correlative imaging.

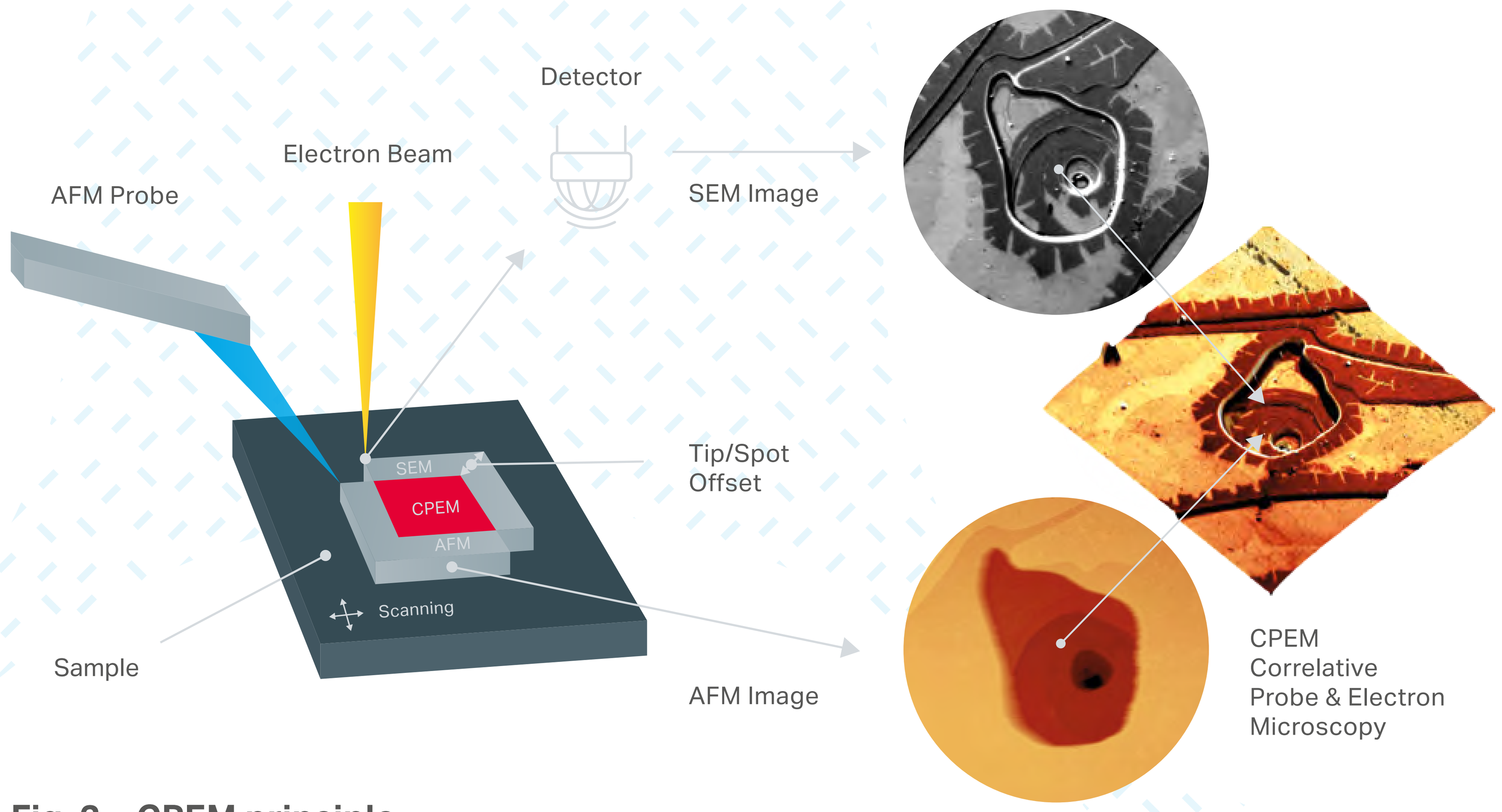


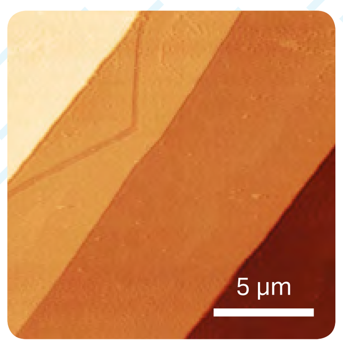
Fig. 2 CPEM principle

> CPEM technique can combine and directly correlate several different signals from AFM and SEM (topography, cAFM, SE, BSE, CL, EBIC, etc.) to obtain comprehensive information about the sample.

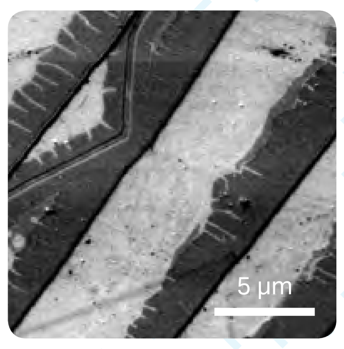
Application example

Using CPEM, images of graphene layers on SiC were obtained. Graphene was prepared by thermal decomposition of SiC, thus when silicon atoms evaporate from the surface, the remaining carbon atoms form the graphene layers.

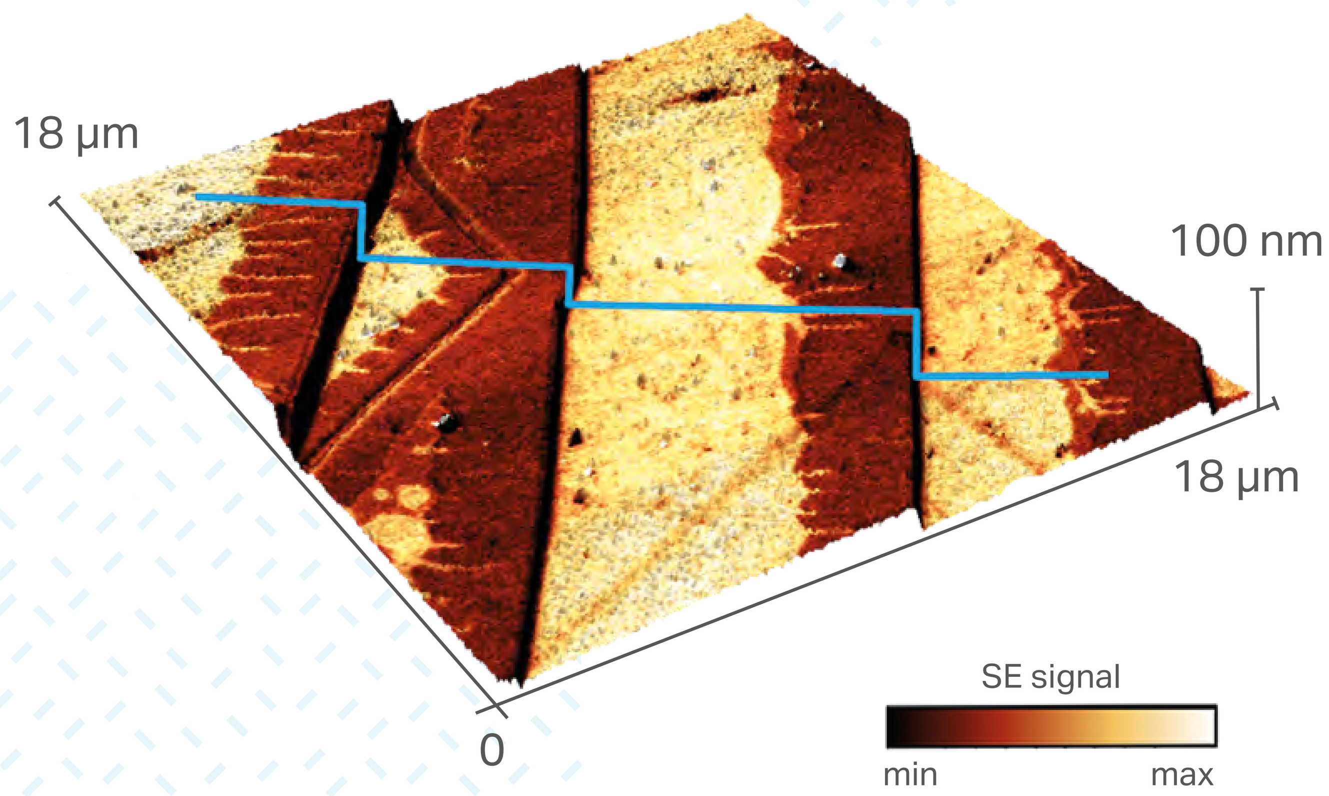
AFM image



SEM image



3D CPEM view



The analysis showed that graphene layers start to grow from the edges of the SiC substrate and then continue to grow on the surface of the terraces. Presumably, it is due to the larger area leading to higher evaporation of silicon atoms. After some time, multiple layers start to grow from the edges. Thanks to this method number of graphene layers can be detected. Moreover, based on the SEM image itself, it is uncertain if there are steps or if it is only due to the material contrast.

Because the graphene growth is not uniform across the sample, it would be impossible to get this result using AFM and SEM separately.

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