# AFM-in-SEM: The Novel Approach to Multimodal, Correlative Microscopy Using CPEM Technology

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Scanning electron microscopy (SEM) and atomic force microscopy (AFM) are two of the most used, complementary techniques for surface analysis at the nanoscale. Thus, combining them by integrating a compact AFM into SEM brings novel possibilities for true correlative microscopy and advanced multimodal sample characterization that would be often unfeasible using each imaging modality separately.

LiteScope™ (Figure 1a) represents a compact AFM, which is designed to be integrated into a large variety of SEMs. In general, the strength of the resulting AFM-in-SEM hybrid system lies in combining the AFM modes (3D topography, electrical, mechanical, and magnetic measurements) with SEM capabilities (fast imaging with wide resolution range, chemical analysis, surface modification, etc.). Further advantages include fast region of interest localization and AFM tip navigation by SEM, and complete sample analysis in-situ conditions, which dramatically facilitates analysis of sensitive samples. Uniquely, LiteScope design enables simultaneous acquisition and correlation of AFM and SEM data by a technique called Correlative Probe and Electron Microscopy (CPEM).

CPEM technology anbles to keep constant offset between electron beam and AFM probe during the image acquisition (Figure 1b), since the scanning movement is conducted by a piezo scanner that carries the sample. This ensures simultaneous data collection in the same coordinate system and with identical pixel size. The resulting 3D CPEM view can combine multiple channels, both from AFM and SEM (Figure 1c), enabling thorough analysis for specific applications.

Above mentioned advantages are demonstrated in Figure 2, showing structural analysis of multilayered $WSe_2$ flakes on Si nanopillars, where a certain shape of the $WSe_2$ monolayer over the nanopillars creates a single-photon emitter. The AFM-in-SEM system enabled to quickly localize the structure of interest on a complex sample. The correlated CPEM image combines AFM topography with SEM material contrast and provides unmistakable data interpretation.

In conclusion, the AFM-in-SEM strategy benefits from the complementarity of both techniques alongside significant savings both in time and resources. Also, it opens completely new possibilities for advanced data correlation and measurements, e.g. in the field of material science, nanostructures, semiconductors or life-science.

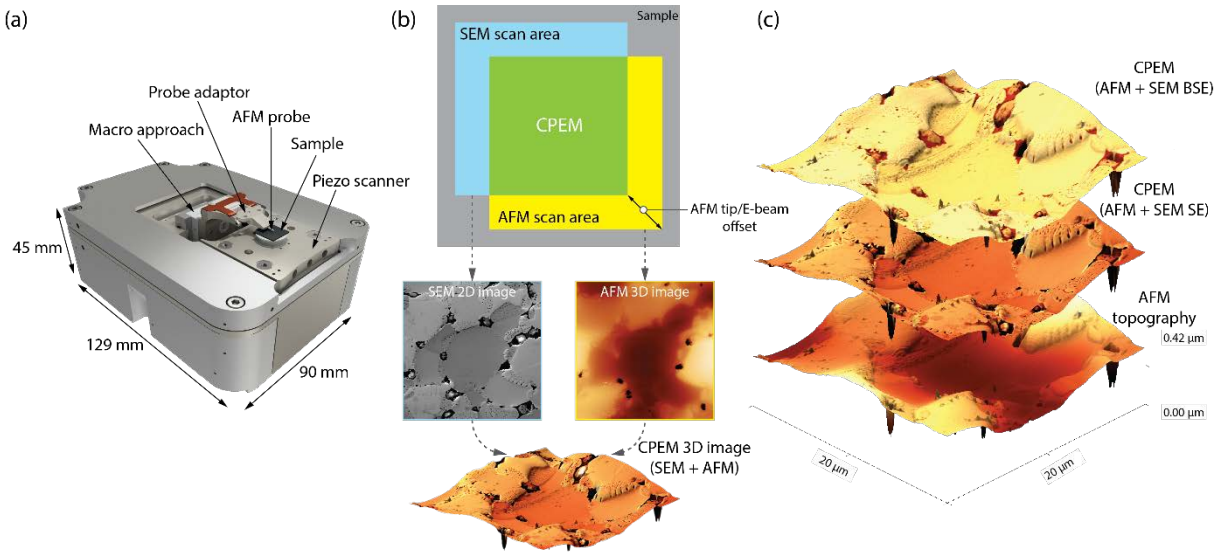


Figure 1: (a) AFM LiteScope, (b) CPEM principle and (c) 3D CPEM view of tungsten alloy consisting of multiple channels (SEM SE and BSE).

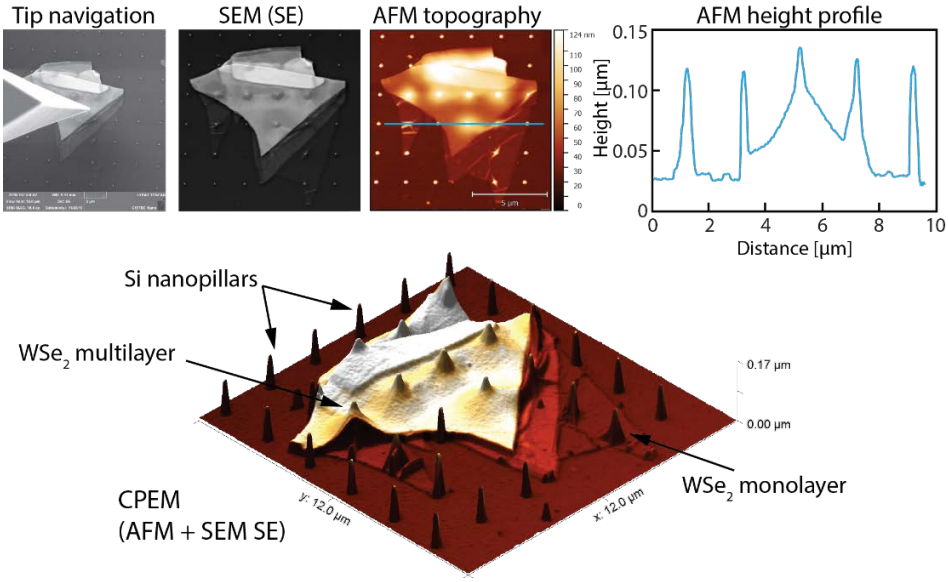


Figure 2: Exfoliated $WSe_2$ flakes on Si nanopillars: SEM overview of the sample and fast AFM probe navigation. The signal from secondary electrons detector (SE), AFM topography with height profile, and resulting 3D CPEM view of merged AFM topography and SE signal.