Correlative Probe and Electron Microscopy technology using AFM in SEM

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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 multi-modal sample characterization that would be often unfeasible using each imaging modality separately. It is extremely useful in variety of fields, such as Material science, Nanotechnology, Semiconductors, or Life science.

Correlative Probe and Electron Microscopy (CPEM) represents a hardware correlative technology, enabling simultaneous acquisition of SEM and AFM data, and their seamless correlation into one 3D image. The strength lies in combination of AFM modes (3D topography, electrical, mechanical, and magnetic measurements) and SEM capabilities (fast imaging with wide resolution range, chemical analysis, surface modification, etc.). This technique can be applied using LiteScope 2.0, produced by NenoVision, ensuring the data are collected in the same coordinate system and with identical pixel size which results in 3D complex multi-channel sample characterization.

Above mentioned advantages can be demonstrated on correlative in-situ analysis of $LiNiO_2$ cathode material used in rechargeable batteries. Since the powdered cathode material is prone to immediate oxidation upon air exposure, it would represent a very difficult sample for standard AFM and SEM systems and needs to be analyzed by the AFM-in-SEM approach. The SEM combined with EDX technique provided fast navigation of the AFM probe on the sample, information of elemental composition and material contrast. The AFM LiteScope was used to measure the sample topography and conductive mapping to characterize the changes in the cathode after charge/discharge cycling. Lastly, the correlated CPEM image combines AFM topography with SEM material contrast and provides unmistakable data interpretation.

As we can see, the AFM-in-SEM strategy benefits from the complementarity of both techniques alongside significant savings both in time and resources. In-situ analysis together with CPEM technology opens door to completely new possibilities for advanced data correlation and measurements, in many areas of both research and industry.

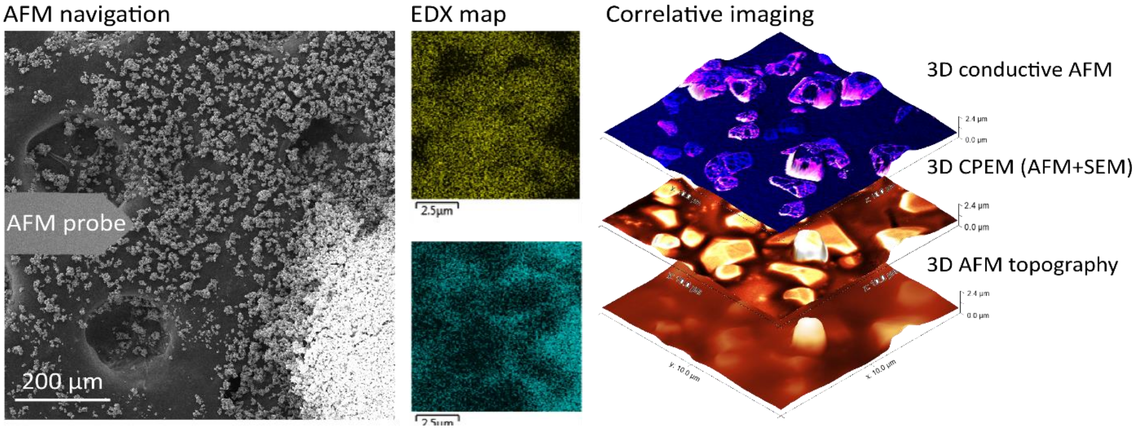

Figure 1: Correlative analysis of $LiNiO_2$ cathode powder: SEM provided fast navigation, elemental analysis (EDX) and material contrast. AFM provided 3D topography and conductivity mapping. The 3D CPEM view merged AFM topography and SEM signal.