Monitoring Electrochemical Processes in a Safe Environment – from Metal Layers to Batteries

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For over two decades, scanning probe microscopy (SPM) has provided scientists a unique tool to study *in situ* electrochemical (EC) processes with atomic/molecular resolution. Nowadays, with the boom in alternative power sources using batteries, and the increase of interest in corrosion of lighter, thinner and more complex layer materials, surface studies under electrochemical potential control have found a new revival. New discoveries continue to be reported as the research boundary expands wider and deeper. While the field steadily advances, the requirements for electrochemical scanning probe microscopes also become greater.

Experiments under controlled environment have been considered critical for many surface studies – if you just think of lithium-based batteries, highlighting the oxygen-elimination capability of a standard environmental chamber. This is one of the main prerequisites for successfully studying structural changes during charging/discharging processes, or any morphological changes during electrochemically controlled processes.

Examples presented range from studies of metallic and molecular layers under electrochemical and environmental control (temperature, solvent, atmosphere), electro-polymerization of poly-electrolytes using cyclic voltammetry, up to studies of "real-world" samples like corrosion studies on steel alloys or applications in non-aqueous battery technology (lithium- and tin-based substrates [1] or graphite [2]), see figure 1.

In summary, several techniques and examples will be shown that demonstrate the capabilities of electrochemical SPM for topographical imaging on the nanometer scale and simultaneously modifying a surface under potentiostatic and environmental control.

References

[1] I.T. Lucas, E. Pollak, R. Kostecki, Electrochem Commun 11 (2011), 2157.
[2] Samar Basu (Bell Telephone Laboratories), Re-chargeable battery, U.S. Pat. No. 4,304,825 (1981).

Figures

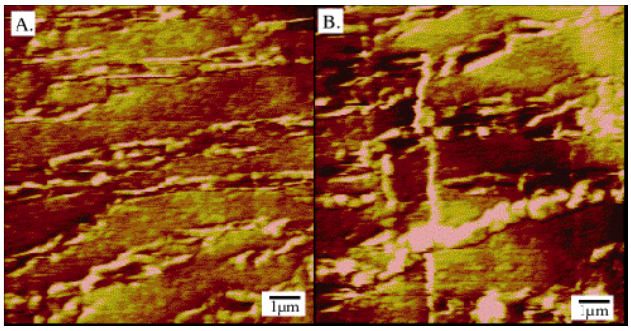

Figure 1: Illustrating morphological changes on a lithium film in non-aqueous electrolyte.
(A) 10µm topography image of a proprietary lithium foil in electrolyte solution.
(B) The same area after 40 consecutive potential sweeps mimicking charging/ discharging processes, where several cracks in the surface become apparent.