Bruker’s closed electrochemical cells enable a wide range of new electrochemical atomic force microscopy (ECAFM) research. Available for Dimension Icon® and Dimension Edge™ AFMs, the cells have been designed for the widest solvent compatibility and ease of setup, even inside a glove box. In addition, Bruker’s unique ScanAsyst® offers the easiest available in situ liquid scanning with ECAFM, while revolutionary PeakForce QNM® Imaging Mode enables the quantitative collection of nanomechanical property information. In every way, these cells fully leverage the performance and capabilities of the Icon platform and are fully compatible with Bruker’s turnkey 1ppm environmental control. The ECAFM package transforms the AFM into a powerful yet easy-to-use solution for nanoscale electrochemistry research in difficult applications ranging from corrosion to lithium (Li) battery research.

The Most Complete ECAFM Solution

- Delivers widest solvent compatibility, ease of assembly, and long-term-study capability
- Provides easiest in situ liquid scanning and instant quantitative nanomechanical property data
- Enables your most difficult ECAFM research, from corrosion to Li batteries

Li Battery Applications

New applications of Li batteries such as transportation (i.e., electric cars) demand improvements in energy density, power density, and cycle life. The nanoscale structure of Li battery electrodes is understood to be key to achieving the desired simultaneous improvement on all key metrics.
Li Research Challenges

To be relevant, studies of Li battery electrode nanostructure need to take place in situ under realistic conditions. This includes control of the electrochemical potential as well as realistic solvent and gas environment specifically for Li batteries. The chemical nature of Li requires the gas environment to be highly controlled with respect to humidity and oxidizing agents. The control must be maintained continuously from sample assembly through characterization, and must not prevent the AFM from performing at highest resolution.

Design for Electrochemistry

Bruker designed an electrochemical cell for AFM where the sample and solvent is only exposed to Teflon or Kel-F (cell bodies of each material included) and fused silica for structural components and perfluoro polymers for flexible seals. The cup-shaped cell accommodates samples up to 40mm, can be assembled, disassembled, and cleaned elsewhere and easily transported to/from the AFM. It seals upon AFM engage and is proven to enable long-term battery electrode studies over the course of days. Finally, it enables full electrochemical, temperature, and environmental control.

Turnkey Environmental Control

Li battery sample preparation requires the highest level of environmental control and usually takes place in high-end glove boxes where oxygen and water levels are kept below 1ppm. Bruker’s integrated system is engineered such that the AFM provides the highest level of performance while at the same time the environment is maintained at <1ppm oxygen and water (see Bruker datasheet DS091). It provides a seamless workflow from sample preparation to characterization and is fully compatible with Bruker’s EC cell. The cell in turn has been designed specifically to be easy to assemble and use inside the glovebox.

The Best Solution for Li Battery Research

The new closed EC cell integrates with Bruker’s leading AFM technology and turnkey environmental control to provide a complete solution for a wide range of ECAFM applications, and is designed in particular to address all aspects of Li battery research in one seamless package. While electrochemical potential and environment are maintained at the required stringent levels, the highest performance of the industry-leading Dimension Icon and Edge AFMs is maintained.

Bruker’s unique ScanAsyst single-button scan optimization removes the need for cantilever tuning while also eliminating lateral forces and controlling vertical forces at the pN level. This affords the easiest in situ liquid imaging on soft samples.

The results can be seen on the in situ ECAFM images shown here, which reveal fine nanoscale detail on the delicate SEI layer grown and on a Li battery anode. Going beyond topography, Bruker’s unique PeakForce QNM instantly provides material property information as seen in the modulus and adhesion images, revealing the soft nature of the SEI layer and thus providing information about its composition. A highly controlled scratching experiment shows layer thickness and evidence of solvent intercalation in the underlying graphite. All this information was readily revealed using a Dimension Icon with the closed EC cell and turnkey 1ppm environmental control.