Modular Glove Box system for the NanoWizard® AFM family

AFM measurements are based on the close interaction of a nanoscopic probe with the exposed surface of a sample to be investigated. Typically operated under ambient conditions, AFM can not only provide topographical but also mechanical (stiffness, friction, adhesion), electrical, magnetic, chemical and electrochemical information of the sample on the nanoscale. This makes AFM a versatile tool to characterize and optimize materials, compounds and devices in order to achieve highest performance in real-world applications. However, for many materials such as organic semiconductors, organic photovoltaics (OPVs) and electrodes of lithium batteries, exposure to oxygen and water would result in a degradation of the sample surface due to chemical reactions taking place. Therefore, when in use, these materials are usually sealed and isolated from the outside environment. Accordingly, AFM measurements on such materials require excellent control of the environmental conditions in order to achieve reliable and quantitative results.

Setup Description

For controlling the environmental conditions of AFM measurements, JPK Instruments provides a turnkey solution consisting of a customized glove box system from leading suppliers (see Fig. 1). This comes complete with antechambers, pumps, automatically regenerating purifiers and a custom vacuum-quality feed-through to maintain environmental integrity to allow full functionality of the NanoWizard® AFM and its optional accessories. In order to achieve highest resolution performance of the AFM, active vibration control can be integrated with the system.

As there are different sizes of the glove box system available, these can be fully customized to the needs of the customer. Additionally, the NanoWizard® AFM is fully compatible with all available modes and add-ons provided by JPK within the glove box, thus providing uncompromised AFM characterization experiments of even the most sensitive samples.

When investigating samples such as organic photovoltaic (OPVs) materials, JPK provides an uncompromised solution for the illumination either from the top (with upright optics) or from the bottom (using an inverted optical microscope or the JPK BioMAT™), thus enabling in-situ illumination of the sample while performing AFM measurements.

Fields of Application

There is a broad range of samples which can or should only be investigated under controlled environmental conditions. These include organic semiconductors and lithium battery electrodes (see Fig. 2), where the characterization of electrical and mechanical properties is of great importance. Due to their mechanical properties,
these samples are prone to mechanical damage by the AFM tip while being investigated with standard AFM imaging modes. To overcome this challenge, JPK developed the new QI™ Advanced imaging mode, which eliminates sample damage during mapping of mechanical and conductivity data on even the softest samples.

Other application examples are fuel cell research, electrochemistry, investigation of hydrophilic samples without the covering water layer and experiments which need to be performed at temperatures far below the dew point. Due to the absence of water in the controlled environment, there will be no condensation and freezing on the sample surface influencing the AFM investigations.

Conclusion

In recent times the control of the environmental conditions for AFM measurements has become a major issue, especially for the investigation of organic materials to be used in green and low-cost electronics based on organic soft materials. For such applications, JPK provides a customizable turnkey environmental control solution which is fully compatible with all modes and accessories available for the NanoWizard® AFM. The resulting solution provides flexible high performance AFM measurements under controlled environmental conditions.

Specifications

- Turnkey solution for environmental control of measurements with the NanoWizard® AFM family from JPK
- Option with integrated gas purification
- O₂ and H₂O concentrations ≤ 1 ppm
- Touch screen operation for ease of use
- Flexible antechambers and feed throughs options
- Low acoustic noise level and therefore perfect for AFM operation
- Stable frame support structure with integrated anti-vibration isolation ensures highest AFM performance
- Imaging of mechanical, electrical and electrochemical properties with JPK’s new QI™ Advanced imaging mode
- Combinable with JPK’s standard accessories, e.g. heating, cooling, conductive AFM and electrochemistry
- Different glove box models available from

  - GS GLOVEBOX
  - mBRAUN

Fig. 2: AFM experiments on lithium battery electrode. (a) 3D-topography (scan range: 50 x 50 µm²). (b) Representation of 3D-topography overlaid with color scale of adhesion data (scan range: 10 x 10 µm). (c) Determination of polymer layer thickness by a scratching experiment.