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MICROSCOPY AND MICROANALYSIS LAB

ATOMIC FORCE MICROSCOPY (AFM)

research.hbku.edu.qa

Atomic Force Microscopy (AFM) is a high-resolution imaging technique used to study surfaces at the atomic and molecular levels. AFM can observe surfaces that are too small to be seen with traditional microscopy, such as individual atoms or molecules, and has become a vital tool in the field of nanotechnology.

The AFM probe consists of a sharp tip attached to a cantilever. The tip is brought close to the sample surface, and the cantilever is deflected by the forces acting on the tip as it scans over the surface in a raster pattern. The deflection of the cantilever is measured using a laser beam, and this information is used to construct an image of the surface topography. The sensitivity of the cantilever to atomic-scale forces allows AFM to image surfaces with sub-nanometer resolution.

AFM can measure various properties of the sample, such as mechanical properties, adhesion, and electrical conductivity, which makes it a powerful tool for a wide range of applications in materials science, biology, and nanotechnology.

The HBKU Core Labs offer AFM services to researchers in Qatar. Our state-of-the-art AFM instruments provide high-resolution imaging and accurate measurements of a wide range of sample properties. Our team of experienced scientists and technicians is available to help users with experimental design, data analysis, and interpretation of results. With our AFM services, researchers can gain insight into the structure and properties of materials at the nanoscale level. This can lead to new discoveries and innovations in fields such as materials science, biology, and nanotechnology.

In conclusion, AFM is a powerful imaging technique that can observe surfaces at the atomic and molecular levels. The HBKU Core Labs offer AFM services to support research and development in a wide range of fields, providing access to state-of-the-art AFM instruments and experienced staff. We welcome collaborations with researchers from all disciplines and are committed to supporting innovative research in Qatar.

APPLICATIONS

- Nanoscale surface topography
- Nano-mechanical, nano-electrical, and nano-scale chemical mapping
- Semiconductors
- Optics Polymers

EQUIPMENT AND TECHNICAL SPECIFICATIONS

- ## BRUKER DIMENSION ICON AFM

  The Bruker Dimension Icon AFM (Atomic Force Microscope) is one of the most popular modern AFMs on the market, highly appreciated by industry and academic institutes. It integrates the most recent advancements of the company's industry-leading nanoscale imaging and characterization technologies. Dimension Icon is a very high-resolution scanning microscope used in scanning microscopy (SPM). It is a highly versatile atomic force microscope, suitable for use with a wide range of samples and features. It provides the user with a significant improvement in measurement simplicity, speed, and quality. The Atomic Force Microscope System Bruker Dimension Icon is used for nanoscale surface topography, nano-mechanical, nano-electrical, nano-scale chemical mapping, and morphology measurement. Nanoscale surface topography and morphology measurements of a range of different surface types can be produced with a high resolution by scanning a sharp probe over the sample surface in a relatively short time. In particular, ScanAsyst allows users with limited knowledge to quickly collect high-quality images and data, acquired using PeakForce tapping. Various modes allow topographic, electrical, and mechanical measurements to be taken, often simultaneously.

SCANNER	Lateral range	90 µm
	Vertical range	10 µm
	Lateral noise	less than 0.15 nm RMS (close-loop on)
	Vertical noise	less than 35 pm RMS (close-loop on)
SAMPLE HOLDER	Maximum sample size	210 mm in diameter
	Maximum sample height	15 mm
	Vacuum hold	Yes vacuum sample chuck
OPTICAL MICROSCOPE	Resolution	5MPx (1.6 µm)
	Illumination	control by software
	View field	1,465 to 180 µm
GENERAL	Integral non-linearity	< 0,5 %
	Drift rates	< 200 pm per minute

➢ CAPABILITIES (MODES):

The Dimension ICON can perform many major AFM modes in its standard configuration: Contact, Tapping, Noncontact, and PeakForce with ScanAsyst imaging modes are included, which provides automated image parameter adjustment in PeakForce mode without the need to tune the cantilever, or adjust Setpoint, gain, or scan rate in air or fluid environments. ScanAsyst will adapt to changes in topography by adjusting parameters during the scan. Some of relevant modes are Phase imaging, Piezo Response Microscopy, Force spectroscopy/Microscopy, Electric Force Microscopy, Lift Mode, and Torsional Resistance. The Measurements in liquid environments are also possible.

- **MATERIAL MAPPING**

  The Icon AFM supports the patented PeakForce QNM® Imaging Mode from Bruker, allowing scientists to quantitatively map and differentiate between Nanomechanical characteristics while concurrently imaging the topography of samples at high resolution. This technology works over a very wide range of samples to characterize different types of sample surfaces with a topographic imaging ranging from sub-nm to several microns in height. Phase imaging may also be used to qualitatively identify different phases of material by their surface properties. This technology operates over an extremely wide range (1MPa to 50GPa for modulus and 10pN to 10μN for adhesion) to characterize a large variety of sample types

- **ELECTRICAL CHARACTERIZATION**

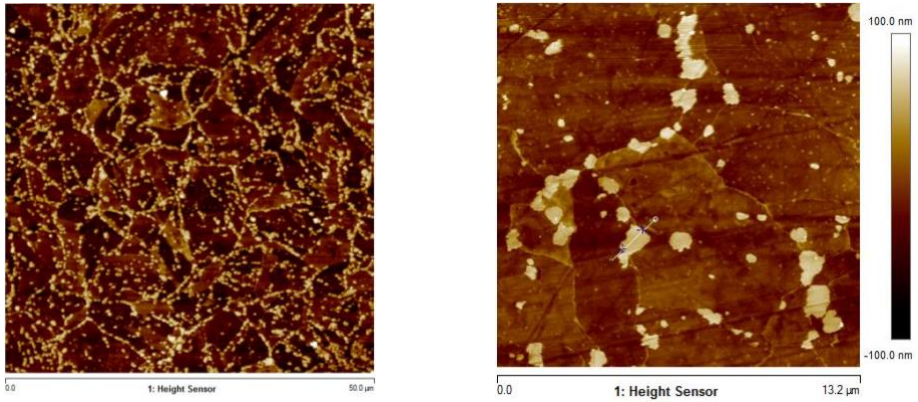
  Proprietary modes enable electrical characterization at the nanoscale with greater dynamic range and sensitivity. These investigations can be combined with other methods, like tunneling AFM (TUNA), and torsional resonance TUNA, which use PeakForce mode to give high-resolution conductive AFM images on fragile samples such as nanotubes and nanoparticles that are

not possible to obtain with normal contact mode C-AFM.

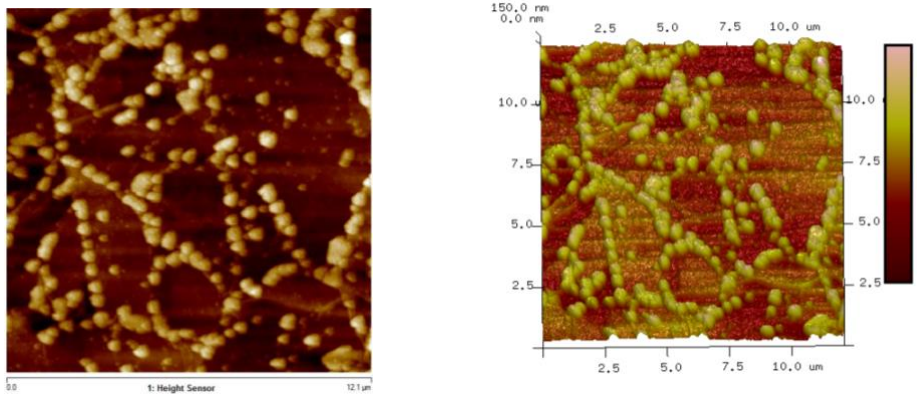
- **NANOINDENTATION**

  Nanoindentation investigates the hardiness of hard and soft samples. The typical indentation force range available with our instrument is 1-100 μN with a resolution of less than 0.5 μN. The diamond tip mounted to the end of the cantilever has a tip radius of less than 12 nm to ensure good imaging resolution and nanometer-scale indents.

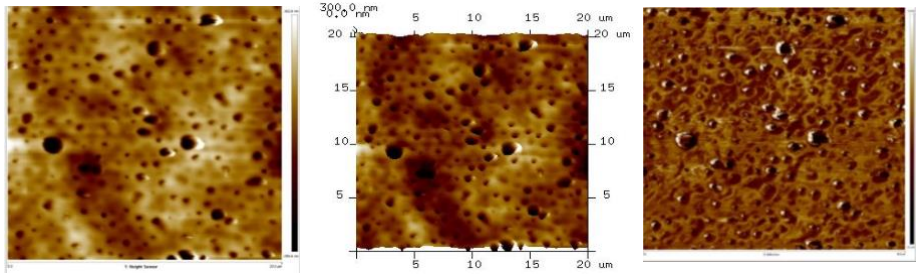
EXAMPLES OF WORK DONE



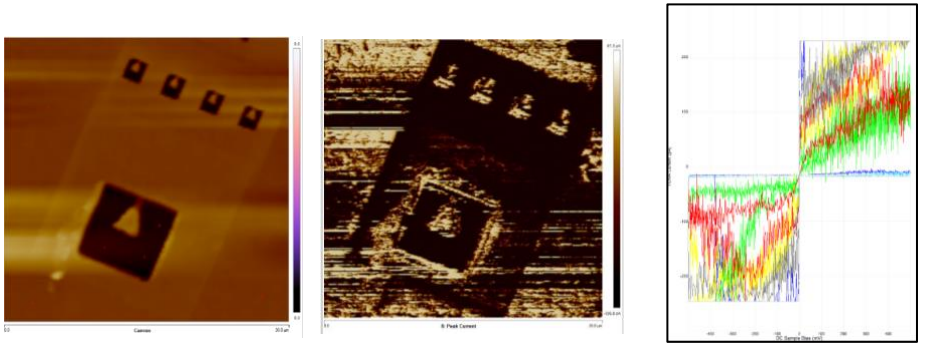
Stainless Steel polished and etched imaged using the ScanAsyst Mode for Topography analysis



Stainless Steel polished and etched showing carbides formation along the grain boundaries. The image was then visualized in 3D using the NanoScope software

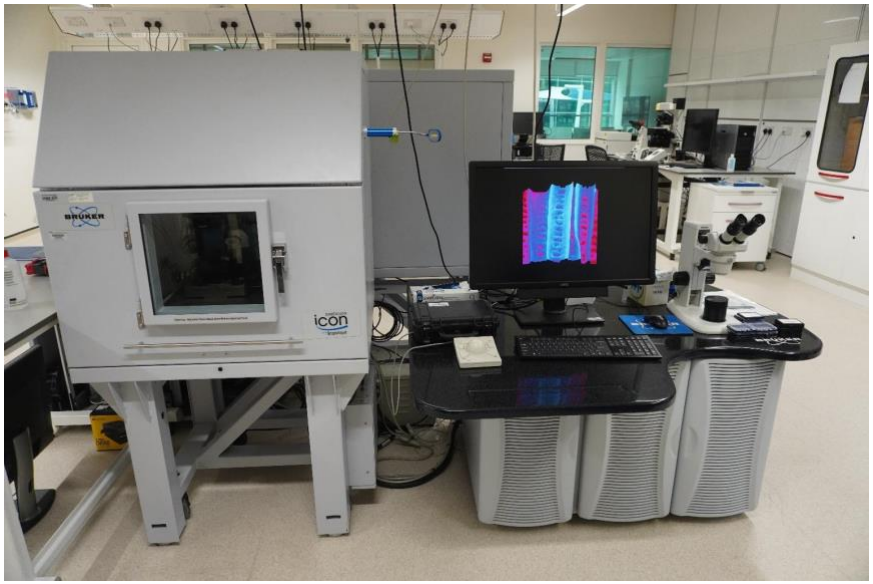


Polysulfone membrane showing the pores distribution on the surface. Using PeakForce QNM mode the topography as well as other mechanical properties such as the adhesion could be characterized.



Using PeakForce Tuna the electrical properties of Antennas structures was mapped and the IV curves were extracted from different points.

PICTURES OF EQUIPMENT



Bruker Dimension Icon AFM