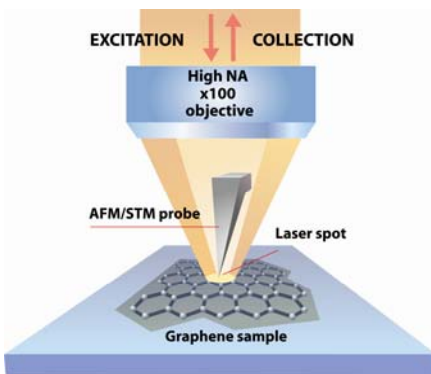


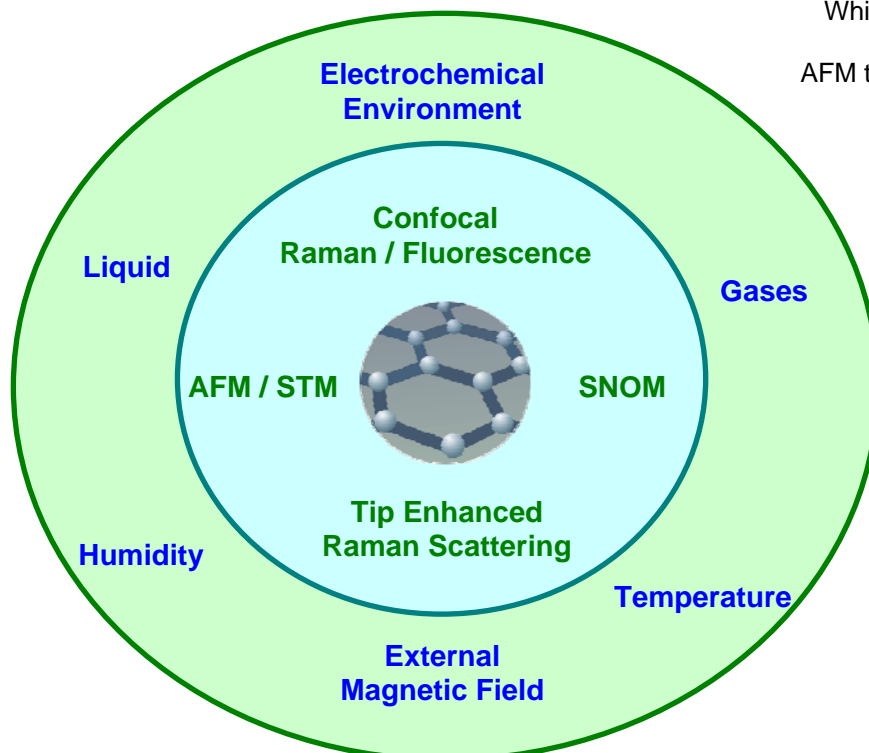
Graphene digest

Graphene Studies by Different Optical, AFM and Spectroscopy Techniques

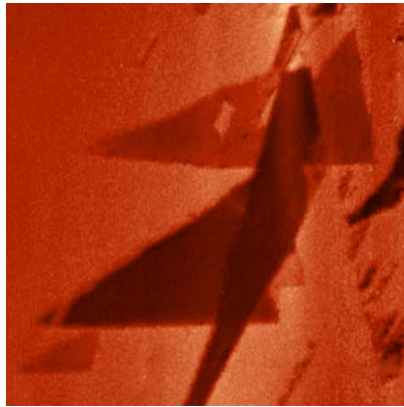
Combination of *Atomic Force Microscopy (AFM)*, *Raman / Fluorescence / Rayleigh microscopy* and *Scanning Near-Field Optical Microscopy (SNOM)* provides unique opportunities for Graphene investigation. Different *AFM techniques* allow one to study mechanical, electrical, magnetic and even elastic properties of Graphene flakes. Studies of local work function, conductivity, capacitance, piezoresponse and many other surface properties are also available. At the same time, *Raman microscopy* (available *simultaneously* with AFM) provides information about flake thickness, structural uniformity, presence of impurities and defects etc. Additionally, *Rayleigh imaging* and SNOM measure local optical properties of the sample providing further information about flake structure. Importantly, most of the measurements can be performed under environmental control: at variable humidity and temperature, in controlled atmosphere, in liquid and even (in some configurations) in electrochemical environment and at the external magnetic field.



White light image of the graphene flake with AFM tip and Raman laser



Graphene Studied by Various Optical, AFM and Spectroscopy Techniques – All in the Single Experiment. (Si/SiO₂ substrate)



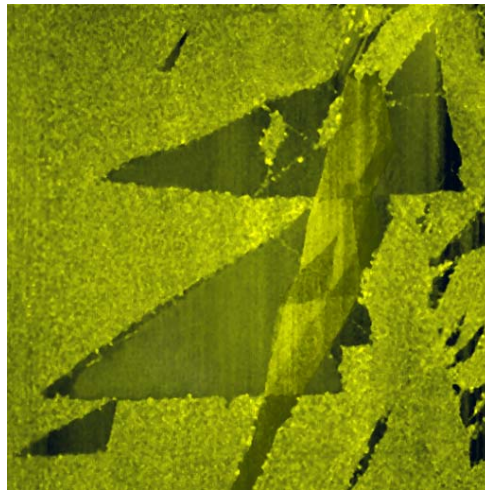
Electrostatic Force Microscopy



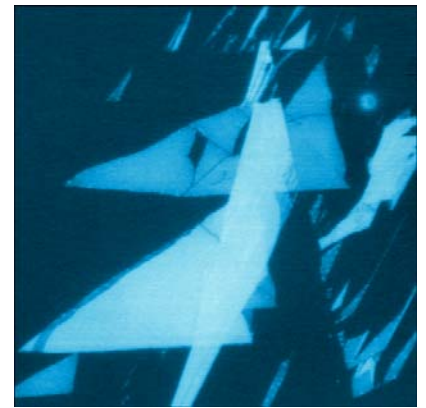
Force Modulation Microscopy



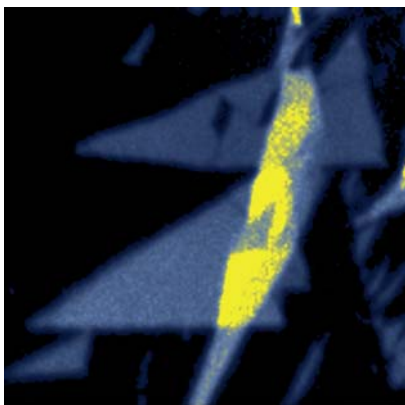
Lateral Force Microscopy



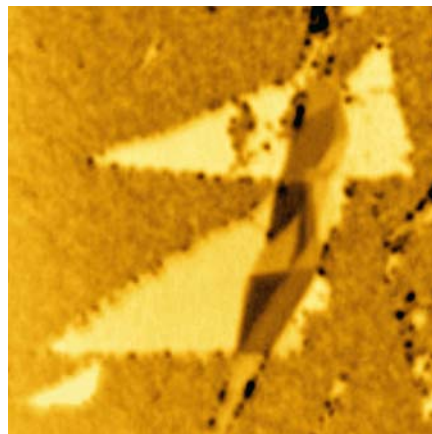
AFM Topography
Size: 30*30 μm



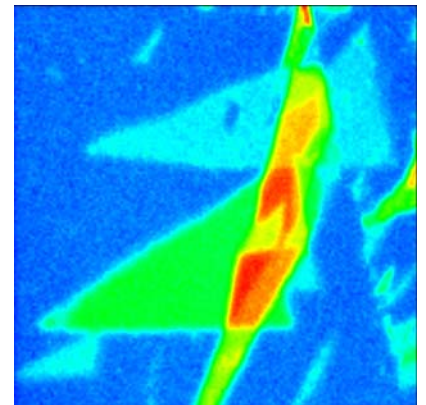
Scanning Kelvin Probe Microscopy



Raman Map,
Mass Center of 2D (G') Band



Confocal Rayleigh Microscopy
(473 nm laser)



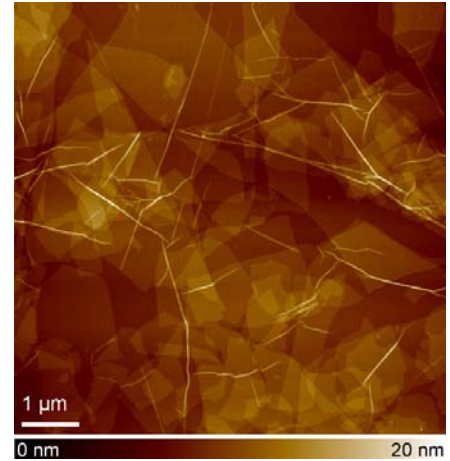
Raman Map, G-band Intensity

*Data courtesy:
E.Kuznetsov, S.Timofeev,
and P. Dorozhkin (NT-MDT Co.)*

Further Insight into Graphene and Graphite Structure Can Be Obtained with Other Very High Resolution SPM Techniques

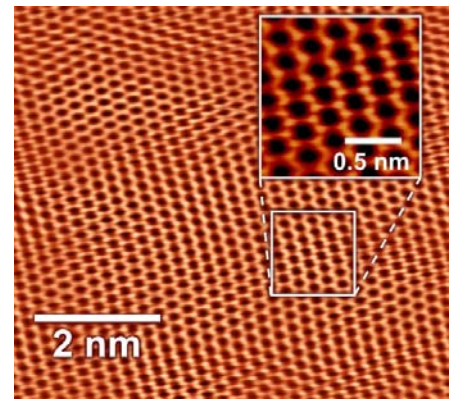
High-Resolution Imaging of Single-Layer Graphene

The high-resolution image was taken by AFM and shows an assembly of single-layer, functionalized Graphene sheets on a surface. Some of the sheets are many square micrometers large. The thickness of each sheet is less than 1 nm.



Atomic-Resolution Lattice Images of Graphite

The picture shows a graphite (HOPG) sample that was imaged by scanning tunneling microscopy (STM). The scan range of the entire image is less than 7 nm. Excellent atomic resolution is achieved.



*Image courtesy:
Dr. Hannes Schniepp (The College of William & Mary, USA)*

NTEGRA Spectra provides the opportunity to carry out all the measurements by the same instrument, on the same sample during the same experiment. It is possible to obtain AFM / Raman / Fluorescence / Rayleigh / maps exactly from the same area during one sample scan. All AFM and spectral data analysis are performed with the same software.

Modes

- AFM (mechanical, electrical, magnetic properties and nanomanipulation – more than 30 modes)
- Confocal Raman Imaging and Spectroscopy
- Confocal Fluorescence Imaging and Spectroscopy
- Scanning Near-Field Optical Microscopy
- Tip Enhanced Raman and Fluorescence Microscopy (TERS, TEFS)
- White Light Microscopy and Reflected Laser (Rayleigh) Confocal Imaging



Controlled environment

- Temperature
- Humidity
- Gases
- Liquid
- Electrochemical environment
- External magnetic field