Abstract:

Glasses and granular materials are ubiquitous examples of disordered systems, having many poorly in recent years, graphene has been attracting massive attention due to its unique mechanical and electric properties, with great potential in the next generation of devices, ranging from sensors, drug/chemical delivery, to electronic devices and display devices. Scanning probe microscopy (SPM) has been widely used to study graphene since its discovery. The applications are mainly in determining the number of layers by thickness measurement and morphological changes under different treatments. Mechanical, electrical properties and surface chemistry of graphene have direct influence on its applications. However, it is beyond traditional SPM's capabilities to quantify these properties with nanometer resolution. In traditional SPM, local contact is neither known nor well controlled, making measurements unrepeatable, which plagues its applications in mechanical and electric properties measurement.

With the invention of Peak Force tapping technology, where a force-distance curve is measured at each point, superior probe-sample interaction is achieved. In conjunction with new probes development, quantitative measurement on mechanical properties and electric properties are achieved with sub-nanometer spatial resolution, even atomic resolution on crystalline materials. In this article, we will report the technological developments and case studies on simultaneous quantitative measurements of potential/work function, mechanical properties and surface chemistry on different graphene surfaces. This information is critical for growth mechanism and applications of graphene in different devices.

Plasmonics of graphene directly affects its applications in different fields, including electronic devices, lighting devices and display. Direct observation of plasmonic behavior in graphene is highly demanded by many scientists and engineers. By utilizing metal tip enhancement of infrared light, we implemented a scattering type scanning nearfield optical microscope (SNOM) by coupling an infrared laser beam a metalized SPM probe and detecting near-field optical signal by higher harmonics extraction. With this setup, we have succeeded in observing plasmonic propagation in graphene while mapping mechanical and electric properties simultaneously.