Nanoscale Chemical and Electronic Mapping of Carboxyl Graphene Oxide using TERS

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In recent years, Tip Enhanced Raman Scattering (TERS) imaging made a dramatic progress from "once in a lifetime experience" to a routine everyday characterization tool for nanoscale Raman imaging of various materials. This progress was mainly determined by the advent of new generation of TERS instrumentation, development of advanced TERS imaging modes and availability of highly reproducible commercially available TERS probes with high enhancement factors.

Since TERS is intrinsically a hyperspectral imaging tool, it does not rely on apriori knowledge of the spectral properties of the investigated materials and therefore allows discovery of unexpected Raman peaks and mapping the distribution of their intensities. Cross-correlating the nano-Raman maps with other channels provides by scanning probe microscopy such as the topography, surface potential, conductivity, photocurrent, friction etc, is another powerful tool allowing comprehensive characterization of novel materials at nanoscale.

We'll illustrate usefulness of TERS imaging and cross-correlation of nano-Raman with other SPM channels by probing the distribution of structural defects and chemical groups on a graphene oxide surface. We demonstrate mapping of chemical groups on carboxyl graphene oxide (GO-COOH) surface with an unprecedented spatial resolution of ≈ 10 nm using TERS.

Furthermore, we extend the capability of TERS by in-situ measurement of local electronic properties in addition to the topography and chemical composition at the sample surface. In-situ topographical, electronic and chemical nanoscopy of the GO-COOH surface reveals that the Fermi level on GO-COOH surface increases with increasing ID/IG ratio, enabling correlation of the local defect density to Fermi level at nanometre length-scales for the first time.

Figures

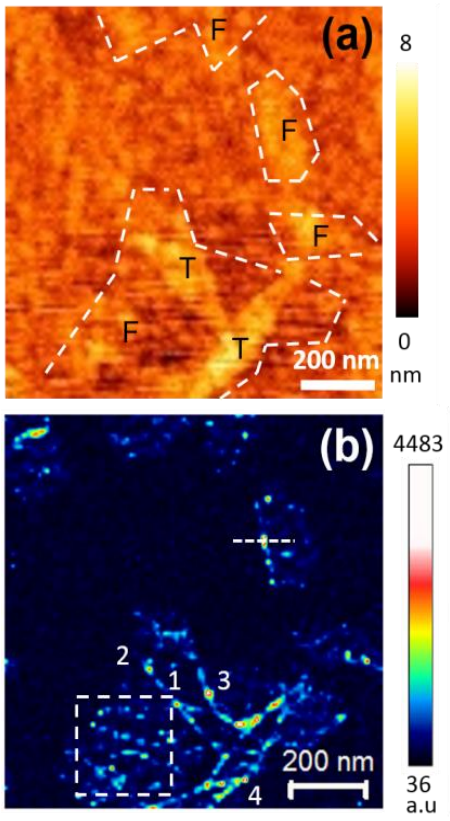

Figure 1: (a) AFM image and (b) high-resolution TERS map of different graphene oxide flakes. The optical resolution is ~ 10 nm.