Trapping Single Molecules on a Au (111) Surface Investigated by Tip-enhanced Raman Spectroscopy

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Single-molecule surface-enhanced Raman scattering (SM-SERS) was first observed in 1997 and it becomes one of the few methods available for detection of single molecules with spectroscopic finger-print. Although over one decade has passed, some conflicts in understanding of the phenomena associated with SM-SERS still exist. For example, the enhancement (varies from 7 to 14 orders of magnitude) necessary for SM-SERS detection and whether chemical enhancement is involved in SM-SERS are still not conclusive. The intrinsic problems associated with SERS, such as the low spatial resolution, complicated structures of SERS substrates, the molecule movement and migration in the hot spots, make the phenomenon even complex.

Tip-enhanced Raman scattering (TERS) is enhanced by the strong LSPR in the nanogap formed by the metallic tip and the substrate, and it has been demonstrated with a single molecule sensitivity. We demonstrate here that the topological image and the Raman signature of single molecules can be simultaneously obtained by STM-based TERS. Isolated single MGITC molecules was prepared over the alkane thiol template pre-assembled on a Au (111) surface. The STM images (left panel in Fig.1) reveals some isolated spot of the size of MGITC molecule. The TERS signal of the isolated single molecules shows characteristic peak of MGITC, but with clear different features from that of the multi-molecules, especially in the region marked in the dashed rectangle (right panel in Fig. 1).

Figure 1. (Left) An STM image from single MGITC molecules captured in the thiol template on a Au (111) surface. (Right) TERS spectra from single MGITC molecule (A) and multi-molecules (B).

References: