Gold 2018
July 15-18, 2018 - Paris, France

Abstracts 2

Tip-Enhanced Optical Spectroscopies: Correlated Nanoscale Raman, Photoluminescence and SPM techniques.

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Tip Enhanced Raman Scattering (TERS) combines Raman spectroscopy with scanning probe microscopy (SPM). The increase of the Raman signal is due to a strong electromagnetic field enhancement at the SPM tip apex related to localized surface plasmon resonance (LSPR) excitation. Since the original proposal and the initial demonstrations 18 years ago, the past decade has seen extraordinary development in TERS activity. Comparison of SPM physical information and Raman chemical images provides unique surface information, making TERS a valuable technique for surface analysis.

We will start this lecture with an introduction of near-field optics providing some background material on the basic physical concepts underlying Tip-enhanced Raman spectroscopy. We will see how the histories of optics with the discovery of evanescent waves, scanning probe microscopes and plasmonics converge to make possible the nanoresolution with TERS.

Then, specifics of the TERS setup that enable fast, high pixel density chemical imaging will be discussed. We will describe the innovative integration of spectroscopic and microscopic technologies that brings high-throughput optics and high-resolution scanning for high-speed imaging without interferences. The latest developments in TERS probes that provide reliable solutions for researchers alike to easily get started with nanoscale Raman spectroscopy will be also presented.

Thanks to those latest instrumental developments, we will finally present new nano-imaging capabilities. Tip-enhanced optical spectroscopies (TEOS) such as TERS (tip-enhanced Raman spectroscopy) and TEPL (tip-enhanced photoluminescence) provide a unique capability for the characterization of diverse 0D, 1D and 2D materials (graphene, TMDCs like MoS_2, WS_2, WSe_2 etc.). We demonstrate the power and importance of the cross-correlation of nanoscale hyperspectal imaging with data from other scanning-probe techniques such as topography, surface potential, conductivity and photocurrent. We also discuss how we have extended this technique to other nano-materials as well as semiconducting nanostructures and bio-materials.