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New Directions in Plasmonics: Pushing the Space-Time Limit

RICHARD VAN DUYNE, Chemistry Department Northwestern University

The lecture will begin with the discussion of our efforts to provide a robust existence proof for SMSERS (Single Molecule Surface Enhanced Raman Spectroscopy). Further, fundamental questions such as: (1) what is the largest possible enhancement factor (EF) and (2) what nanostructure produces the largest EF, will be addressed. Our approach to answering these questions involved the development of new tools such as single nanoparticle SERS and single nanoparticle LSPR spectroscopy spatially correlated with high resolution transmission electron microscopy (HRTEM). Recent results using LSPR biosensors to detect molecular binding events and conformation changes will be presented, including discussions of: (1) pushing the sensitivity of plasmonic biosensors towards the single-molecule detection limit, (2) combining LSPR with complementary molecular identification techniques such as matrix assisted laser desorption ionization mass spectrometry (MALDI-MS), and (3) the development of new instrumentation for high throughput plasmonic biosensing, and gas sensing with plasmonic nanosensors. Finally, recent developments showing that for the first time, the revolutionary techniques of surface enhanced Raman spectroscopy and femtosecond stimulated Raman spectroscopy (FSRS) can be combined and substantial progress in tip-enhanced Raman spectroscopy (TERS) will be presented. A UHV-TERS instrument has been constructed with atomic resolution of the surface and sub-molecular resolution of the adsorbate, as illustrated with the copper phthalocyanine (CuPc)/Ag(111) system. We can now foresee the day when it will be possible to combine UHV-TERS and surface enhanced FSRS to enable single-molecule spectroscopy with simultaneous nanometer spatial resolution and femtosecond time resolution.