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Nanoparticle Optics: New Materials, Concepts, and Characterization Methods

RICHARD VAN DUYNE, Northwestern University Department of Chemistry

Nanoparticle Optics is a materials driven subject. The unifying theme in this lecture will be the fabrication of size and shape-tunable, metal nanoparticles using nanosphere lithography (NSL), electron beam lithography (EBL), and chemical synthetic methods. Size and shape tunability leads to an exquisite degree of control over the magnitude and spatial extent of the surface electromagnetic fields that surround optically excited nanoparticles. In turn, this has enabled fundamental new insights into the electromagnetic (EM) field enhancement mechanism underlying both localized surface plasmon resonance (LSPR) spectroscopy and surface enhanced Raman spectroscopy (SERS). This lecture will focus on three topics: (1) LSPR spectroscopy and its application to the development of nanoscale optical biosensors for the study fundamental biological recognition events; (2) Dark-field Rayleigh scattering spectroscopy is used to show that diffractively narrowed plasmon bands can be produced in columnar arrays of Ag nanoparticles, fabricated by EBL, that are spaced by approximately the single particle plasmon wavelength; and (3) the relationship between the LSPR spectrum of Ag nanoparticles and the wavelength-scanned excitation spectra for both surface-enhanced Raman spectroscopy (WS SERES) and second harmonic generation (WS SHGES) is discussed.