

Surface- and Tip- Enhanced Raman Spectroscopy: basic principles and applications

Pietro G. Gucciardi

CNR-IPCF, Istituto per i Processi Chimico-Fisici, Viale F. Stagno D'Alcontres 37, Messina, I-98158, Italy.

Abstract

Surface- and Tip- Enhanced Raman spectroscopy (SERS, TERS) take advantage of the peculiar optical properties of metal nanostructures to amplify the tiny Raman scattering signal of molecular compounds by several orders of magnitudes. This allows one to make sensors (SERS) with sensitivity that, in specific conditions, can reach the single molecule, and to tailor (TERS) the spatial resolution of optical microscopes down to the nanoscale, i.e. well beyond the limit imposed by diffraction. The spectacular capabilities of SERS and TERS are made possible by the excitation of localized surface plasmon resonances (LSPR) in metal nanoparticles, i.e. collective oscillations of the conduction electrons, that make them behave as antennas for light, or optical nanoantennas (NAs). The resonant excitation of LSPRs in NAs leads to a strong amplification and spatial confinement of the electromagnetic fields at nanometric length scales. In the last decade it has been shown that extreme light confinement can occur at sub-atomic level, in what are called picocavities. Picocavities can be exploited to highlight quantum effects in plasmonics or to reach atomic scale resolution in TERS experiments. In this talk we will review the basic principles of SERS and TERS and highlight the most recent developments in the field of plasmonics and its applications.