Applications of one-and two-photon excited SERS

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Surface enhanced Raman scattering (SERS) has become the basis of a whole range of spectroanalytical approaches. SERS in the absence of labels, tags or reporter molecules enables a wide variety of investigations of the interaction of biomolecules with nanostructures. However, all of them necessitate consideration of localization, optical properties, and the potential to interact with the molecules in a biological system, of the SERS-active nanostructures. Another central issue is concerned with the type of information obtained in SERS experiments with cells and tissues, keeping in mind the restrictive condition of a plasmonic nanostructure to be 'nearby'.

If a sample is excited with laser light, different physical processes can be used quasi-simultaneously for its optical and spectroscopic characterization. Non-linear excitation with two photons offers several advantages over one-photon excitation, particularly for the studies of biological objects, mainly related to its lower-energy excitation and the strong confinement of the excitation volumes. Surface enhanced hyper Raman scattering (SEHRS) is the spontaneous, two-photon excited Raman scattering that occurs for molecules residing in high local optical fields of plasmonic nanostructures. As will be discussed, SEHRS can give complementary spectroscopic information resulting from different selection rules and a stronger enhancement due to the non-linearity in excitation. During excitation of the incoherent hyper-Raman scattering, also other nonlinear, coherent optical signals can be obtained from a sample.