Hot spots and confinement in metal nanoparticles and assemblies

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Gold nanoparticles display extremely interesting optical properties, due to their efficient coupling with visible and NIR light, through localized surface plasmon resonances (LSPR). One of the important effects of LSPR is the huge enhancement of the electromagnetic field at the particles surface, which is in turn the main factor behind the so-called surface enhanced spectroscopies (SES) and in particular of surface enhanced Raman scattering (SERS).

It has been predicted that such enhancing ability can be increased at metal surfaces with acute apexes, where LSPR can be strongly confined. Experimental demonstration of this effect has been recently reported, through the colloidal synthesis of so-called gold nanostars, i.e. nanoparticles covered with a significant number of sharp spikes, which display two plasmon resonances, associated to the central core and the spikes themselves. In this talk we shall present a variety of examples regarding the growth of spikes from different gold nanoparticles, as well as their optical characterization (through UV-vis and EELS spectroscopies). Additionally, we have been able to explore the SERS efficiency of these novel nanostructures, through several experiments that demonstrate maximum enhancement when the probe molecules are adsorbed precisely at the tips.

Additionally, examples will be shown of the possibility of creating organized assemblies of metal nanoparticles, with an extremely high density and uniformity of hot spots, in agreement with numerical simulations.