ELECTROMAGNETIC WAVE CONFINEMENT IN SUB-WAVELENGTH REGIONS

Aude Barbara
Institut Néel (CNRS-UJF), BP 166, 38042 Grenoble Cedex 9, France

Rough metallic surfaces may present surprising optical properties when the scale of the surface modifications is much smaller than that of the incident light wavelength. Although one could intuitively expected such small scale roughness to be negligible it may nevertheless lead to quasi-total absorb of p-polarized incident light at specific frequencies. The incoming light is trapped in sub-wavelength region thus creating electromagnetic localization effects. Molecules standing nearby such region have their Raman scattering enhanced by several orders of magnitude; it is the SERS effect (Surface Enhanced Raman Scattering). It is today well established that these phenomena are related to the coupling of the incident light with the surface plasmons of the metal, however, a full understanding of the physics involved is still under progress. Beyond the fundamental interest of such studies there are also many applicative motivations since localization of electromagnetic energy at a nanometer scale is an important issue for sub-wavelength optics and/or local optical spectroscopies.

In this presentation we will show that a way to tackle this problem is to consider a rather simple model: rectangular sub-wavelength aperture grooves performed in metallic surfaces. The grooves may be separated in a periodic manner or not. Such approach has permitted to extract some fundamental mechanisms of the light localization at the surface of metals. In particular, we can theoretically predict and experimentally generate up-to-now uncontrolled experimental facts such as wavelength-dependant active sites of field localization (hot spots). Full absorption of visible light by crevasses one or two orders of magnitude smaller than the incoming light was also predicted. This opens a way for an optical confinement in volumes of a few nm^3.