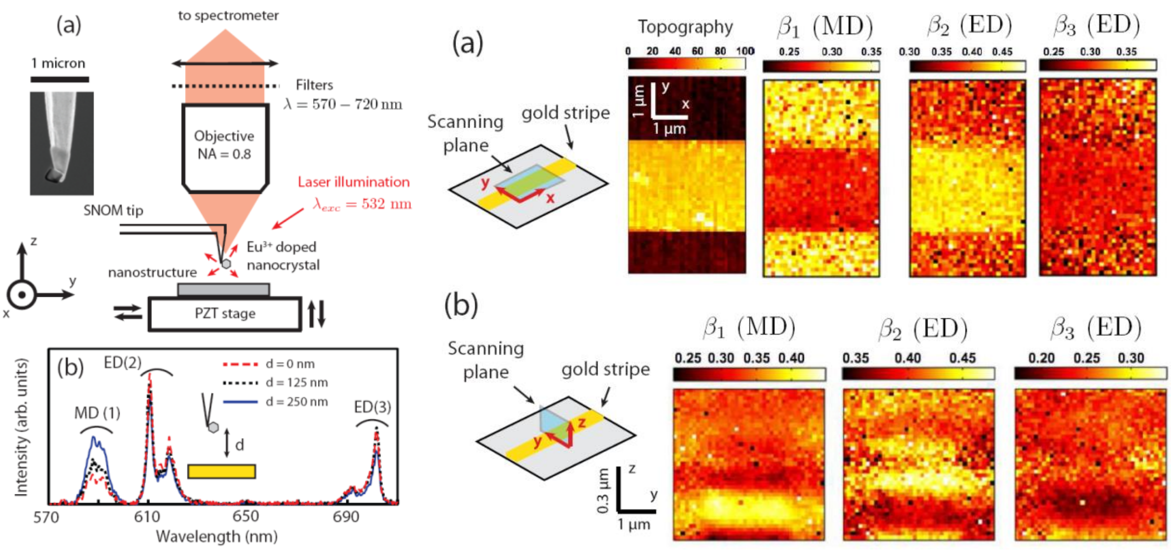
Mapping and Quantifying Electric and Magnetic Dipole Luminescence at the Nanoscale

Usually, in fluorescence experiments, the emission of light often comes from electric dipole transitions. ESPCI researchers from LPEM & Institut Langevin recently studied the emission properties of nanomaterials whose fluorescence comes from transitions that are linked to both electric and magnetic dipoles. They observed that the emission spectrum of such particles can be strongly tuned as a function of their local dielectric/structural environment.

The nanoparticles, synthetized at ENSCP, contain europium ions (Eu3+) inserted in a fluoride crystalline matrix (KYF). When excited in the green, europium ions emit light at different discrete wavelengths between 580nm and 710nm, which originate from electric or magnetic dipoles. The light emitted by a magnetic dipole has a polarization different from the one emitted by an electric dipole. Thus, by approaching the particle from a reflective surface, some fluorescence lines are enhanced or decreased according to their origin.

A single crystalline particle (diameter ~200nm) was glued at the end of a sharp W tip and approached from a gold mirror. As seen in the figure below, the fluorescence peak at 580nm (magnetic-like transition) does not have the same behavior than the ones located at 610nm and 700nm (electric-like transitions). The relative importance of these peaks strongly depends on the distance between the particle and the surface. It is therefore possible to tune the ‘color’ of the particle by changing its distance to the local environment. As another example, the images below show the relative importance of the magnetic and electric-like transitions as a function of the particle position around a gold stripe. At some positions, the magnetic-like fluorescence peak dominates and the particle appears orange. At other positions, the particle exhibits a more red-like color due to the domination of the electric-like fluorescence peak. These results are in excellent agreement with numerical simulations and show that it is possible to tune the spectral properties of nanoparticles in inhomogeneous environments.



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