Metallic nanoparticles are apt to modify the luminescence yield of fluorophores in their immediate nano-environment. They influence both the nonradiative and the radiative rate. The latter can be tuned that much that even Purcell-like changes of the fluorescence spectra are observable. Besides, nanoparticles have been identified to improve the intrinsic luminescence from gold by several orders of magnitude.

In order to gain deeper insight into the interaction of luminescence and fluorescence with localized plasmons, we investigated a range of gold nanoparticles of complex shape such as bipyramids, stars or sponges. We demonstrate applications of plain and silver-enhanced gold nanostars for random lasing or for increasing the electroluminescence in organic light emitting devices (OLEDs). In the case of random lasing, we have shown that nanostars can support random lasing over a very wide spectral range, spanning almost a full octave from the visible to the IR. As active materials, fluorophores in solution or in a solid matrix may be used, as well as pi-conjugated polymers and quantum dots.

Plasmons can also substantially improve the quantum efficiency of the intrinsic luminescence from gold stemming from the recombination of d-band holes with sp electrons. While the fluorescence yield of extrinsic fluorophores is inherently linked to the hot spots of localized plasmonic resonances just outside the nanoparticles (e.g. at the intimate surface of, or in between two almost touching nanoparticles), we have actually observed an anticorrelation of the intensity of the d-band luminescence with the intensity of the hot spots between two gold nanoparticles. It will be discussed that, instead of the hot spot intensity between two nanoparticles, it is the electric field intensity inside the nanoparticles as well as the spectral dispersion of the gold-intrinsic d-band hole recombination probabilities that matters. Besides, we also observed and simulated gold luminescence supported by higher order plasmonic modes.

In the case of three dimensionally percolated, sponge-like gold nanoparticles, we observe highly polarized light scattering, which excludes the assignment of an effective medium dielectric constant to the nanosponges. In contrast to the scattering response, however, we find far less polarization dependence for the intrinsic fluorescence from small gold nanosponges.