Ultrabright Photoluminescence Spikes and Step-Wise Photoluminescence Increase from Colloidal Silver Nanoparticles for Patch Nanoantennas

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From all types of plasmonic nanoantennas, the highest Purcell factor with increasing emitter radiative decay rate was obtained with metal plasmonic patch (gap) nanoantennas (a dielectric nanogap with emitters between a metal nanoparticle of a given shape (cube, triangle, etc.) and a metal film. We observed spontaneous intensity spikes up to ∼400–900 kcounts/s, as well as a step-wise several times, increase in photoluminescence from silver nanocubes, typical nanoparticles for patch nanoantennas (see Fig.1). CW, 532 or 633 nm laser excitation was used (∼100 µW incident power with a 1.30 numerical aperture, oil immersion objective). These spontaneous spikes may influence the purity of single-photon emission from single emitters and even prevent photon antibunching. We investigated 100-nm silver nanocubes from nanoComposix protected by a few nanometer layers of polyvinylpyrrolidone (PVP), typically used in patch nanoantennas. Mechanisms of these effects were discussed. They should be taken into account working with silver or other metal plasmonic nanostructures, especially under CW excitation.

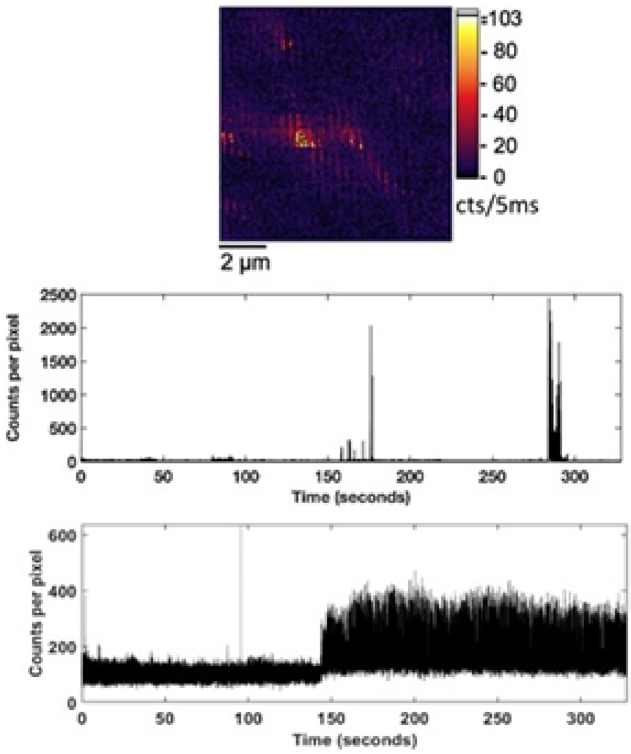

Figure 1: TOP - A confocal microscope image of silver nanocubes' photoluminescence under CW, 633 nm laser irradiation. "Semicircles" and "stripes" indicate a single-emitter behavior of photoluminescent areas. CENTER and BOTTOM - Typical time traces of photoluminescence from silver nanocubes (center figure data were collected from the area of "a semicircle" in the top figure). One pixel corresponds to 5 ms