Light coupling into planar waveguides by plasmonic nanoparticles

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Coupling of light into a thin layer of high refractive index material by plasmonic nanoparticles has been widely studied for application in photovoltaic devices, such as thin-film solar cells. In numerous studies this coupling has been investigated through measurement of e.g. quantum efficiency or photocurrent enhancement.

Here we present direct optical measurements of light coupling into a waveguide by plasmonic nanoparticles [1]. We investigated the coupling efficiency into the guided modes within the waveguide by illuminating the surface of a sample, consisting of a glass slide coated with a high refractive index planar waveguide and plasmonic nanoparticles, while directly measuring the intensity of the light emitted out of the waveguide edge. These experiments were complemented by transmittance and reflectance measurements. We show that the light coupling is strongly affected by thin-film interference, localized surface plasmon resonances of the nanoparticles and the illumination direction (front or rear).

In addition, we investigated polarization-dependent light coupling into a planar waveguide by ellipsoidal plasmonic nanoparticles (Fig. 1). In this case, the 1 mm thick glass substrate acted as a waveguide. We found that by adjusting the direction of polarization, one may choose which of the plasmonic modes is coupled into the waveguide.

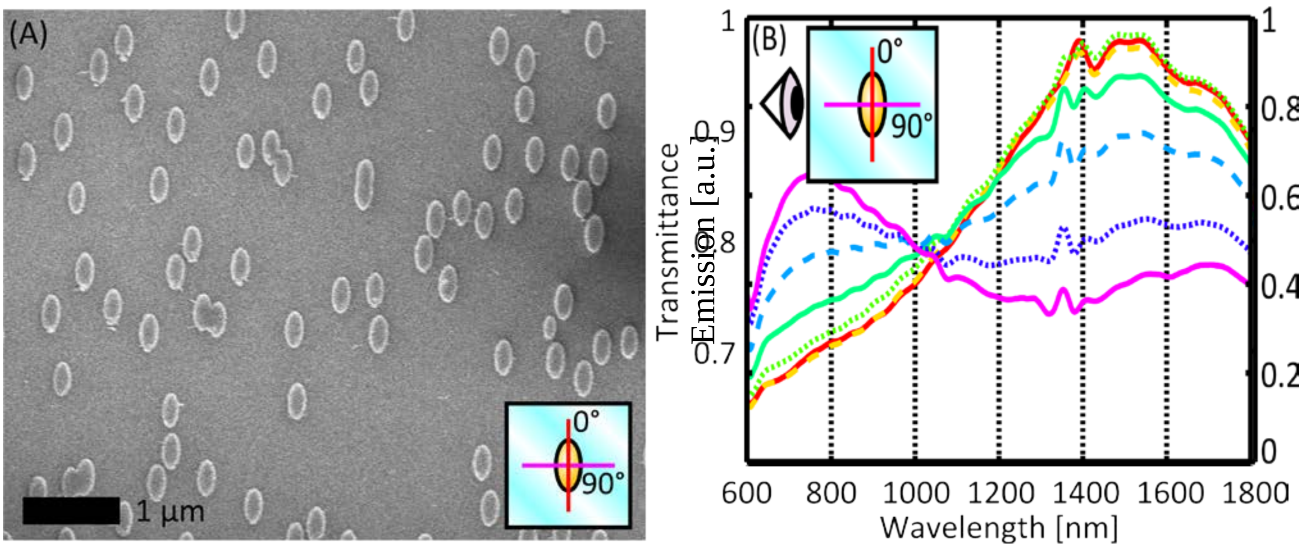

Figure 1. *SEM micrograph of the ellipsoidal gold nanoparticles **(A)** and spectra measured from the edge of the substrate/waveguide with various polarizations of the incident light **(B)**. The plasmonic resonances of the particles are at around 1400 nm and 700 nm for the 0 and 90 degree polarization directions, respectively.*

[1] A. M. Pennanen and J. J. Toppari, Opt. Express, vol. 21 Suppl 1, no. S1, pp. A23–35 (2013).