Strong Coupling between Surface Phonon-Polaritons and Surface Plasmon-Polaritons

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Resonantly excited plasmonic nanostructures confine electromagnetic radiation on the nanoscale and therefore enhance the light-matter interaction, which can be used to increase the signature of excitations in the infrared. Here we discuss the coupling between surface phonon-polaritons and localized surface plasmon-polaritons. We perform infrared (IR) spectroscopy of metal nanoantennas placed on SiO_2 layers of different thickness. Due to strong coupling between the plasmonic excitation of the antennas and the surface phonon-polaritons of the thin SiO_2 layers a splitting of the plasmonic resonance is found. Although the phonon-polaritons themselves are dark excitations under normal illumination, they strongly interact with plasmon-polaritons as we detail for a planar SiO_2 layer underneath the nanostructures. The observed splitting can result in a transparency window, corresponding to suppression of antenna scattering, respectively “cloaking” of the antenna. [1,2]

Furthermore, we investigate the coupling of localized surface plasmon-polaritons to localized surface phonon polaritons of SiO_2 ultra-fine dust particles. In agreement with numerical calculations, we show that particles with deeply sub-wavelength dimensions can be characterized by far-field infrared spectroscopy. [3] Our experiments reveal a detection limit, in terms of a particle diameter of less than 20 nm, corresponding to a ratio of the diameter to the vacuum wavelength below 0.002. Our approach offers the possibility to analyse infrared bands from tiniest particles and thus guides the way toward dust sensing devices based on surface enhanced infrared absorption (SEIRA).

References:

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