**Coupling effects in arrays of Infrared Gold Nanoantennas**

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Since the resonant excitation of metallic nanostructures by light can yield considerable electromagnetic near field enhancement, the optical properties of metal nanoparticles have been subject of many studies [1]. In particular, interaction between particles in multimers and arrays of nanoantennas modifies and influences the optical properties of the system. The interaction properties depend on the separation distances to adjacent neighbors as well as on the distribution of the particles within the array. These effects have been broadly analyzed experimentally and theoretically in the visible spectral range for many different arrangements of particles [2,3] while only few studies have analyzed the IR range [4], where retardation is especially important.

Here, we report on the effect of coupling in the electromagnetic properties of 2D gold nanorod arrays in the IR range (1–12 μm). We numerically and experimentally investigate the influence of interaction between neighboring antennas along the longitudinal and transversal direction in an ordered rectangular array of wire nanoantennas prepared on a silicon substrate. As an example, we show in Fig.1, the experimental and calculated resonance wavelength, λres vs the rod length *L* for nanoantenna arrays of three different longitudinal separation distances between the antennas, $d_x$. A red shift of the resonance wavelength is clearly observed for small values of $d_x$ (40 nm) while for larger longitudinal separation distances (1μm) the results are almost identical to the non-interacting antennas ($d_x$ = 5μm). This spectral red shift for small $d_x$ can be understood in terms of coupled dipoles that include retardation. Regarding the transversal interaction (not shown here), significant blue shift of the extinction cross-sections and extraordinary broadening can be experimentally and theoretically observed for transversal separation distances, $d_y$ smaller than $\lambda_{res} / n_{substrate}$.

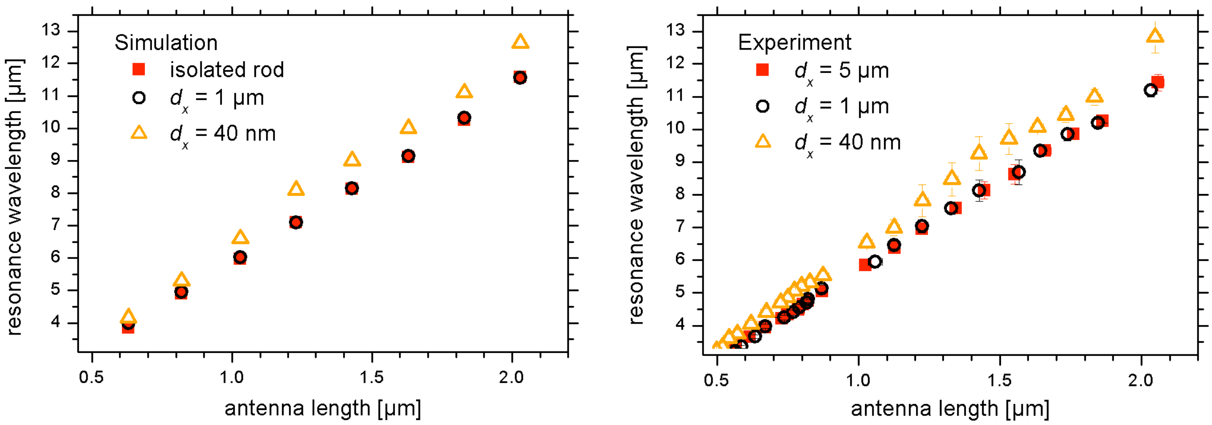


Fig.1: (Top) Calculated and (bottom) experimental resonance wavelength vs. rod length for different longitudinal separation distances between rods $d_x$ .

The modification of optical properties by antenna arrays due to interaction effects can be exploited for sensing applications like surface enhanced infrared spectroscopy (SEIRS) [5].

The sensitivity in SEIRS strongly depends on where the resonant excitation is spectrally located compared to the molecular vibration that is to be enhanced. Therefore, the relation between spectral resonance positions and geometrical properties of the nanostructures, as presented here, is essential for the optimization of sensing devices.

**References**


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