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The role of dielectric function for the control of coupled dipole resonances in dimers of dissimilar metallic nanorods

The position and intensity of plasmon resonances in metallic nanostructures depends acutely on the complex dielectric function of the materials used and, of course, on the geometry, e.g. [1]. Ideally, the material or materials should possess a high DC conductivity and an absence of interband transitions in the visible part of the spectrum. Materials available vary from low-loss (Ag or K) to 'lossy' (Ni or Pt, for example). In general, inclusion of a lossy material in a composite nanostructure would be expected to attenuate any localised plasmon resonances. We have been exploring the effect of dielectric function on the optical properties of dimers of dissimilar metal nanorods and discovered surprising effects when a lossy material is paired with a low loss material: the geometry of the high loss material exerts a controlling influence over the resonance, in particular its frequency. In contrast, variation of the dimensions of the low loss rod for a given length of high loss rod has far less effect. We use calculations based on the Boundary Elements Methods to examine this phenomenon in terms of the underlying complex dielectric functions of the various elements, especially the electric field strength and spectral position of their respective interband transitions. Finally, we show how a range of interesting optical effects could be achieved in such hybrid nanostructures.

References

1. G. Fletcher, M.D. Arnold, T. Pedersen, V.J. Keast and M.B. Cortie, Multipolar and dark mode plasmon resonances on drilled silver nano-triangles, Optics Express, vol.23(14), 2015, pp.18002-18013

Primary author: Mr FLETCHER, Glen (University of Technology Sydney)

Co-authors: Dr ARNOLD, Matthew (University of Technology Sydney); Prof. CORTIE, Michael (University of Technology Sydney)

Presenter: Mr FLETCHER, Glen (University of Technology Sydney)