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Strong coupling in metallic nanoparticle dimers studied in aberration-corrected electron microscopy

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Metallic nanoparticles have attracted considerable attention over the last decade due to their plasmonic properties. They exhibit localized surface plasmon resonances (LSPR) at particular excitation frequencies depending on the size, shape, material. The synthesis and properties of these particles have been extensively studied and there are a wide variety of applications in medical tagging, sensing, and optical coupling [1]. As we move toward nanoscale devices it becomes critically important to be able to understand and measure not only bulk properties, but also the resonances of individual and small groups of nanoparticles. Photoemission electron microscopy (PEEM) is a promising candidate for evaluating the systems due to its noninvasive measuring mechanism and nonlinear response to surface plasmon excitation. Our home-built aberration-corrected PEEM has proved to be a powerful tool for characterizing plasmonic responses and has been used to observe propagating surface plasmon polaritons and patch antennas [2]. Here we report observation of avoided level crossing due the hybridization of the dipolar dimer mode and the single nanoparticle substrate mediated mode in 45nm silver nanoparticle dimers on an indium tin oxide substrate with interparticle gaps range from 2nm-8nm. The results indicate that interparticle coupling can quantitatively be studied on the nanometer scale in PEEM.

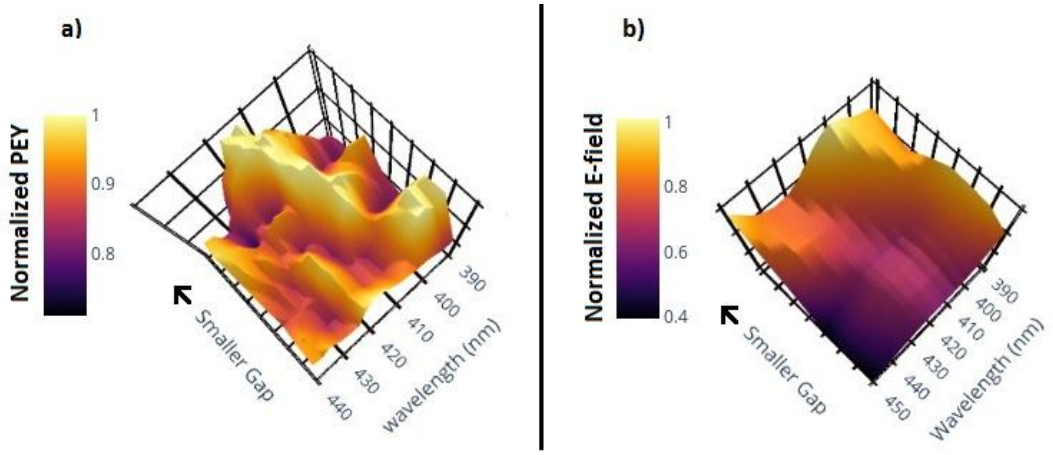

Figure 1. (a) The normalize Photoemitted Electron Yield as a functions of wavelength is plotted for silver nanoparticle dimers on ITO with varying gap size between particles ranging from 2nm-8nm (b) Simulation in COMSOL Multiphysics of the normalized electric field at the surface of silver nanoparticle dimers on ITO with of varying gap size between particles ranging from 2nm-8nm. Avoided level crossing is observed between the dipolar dimer mode and the single nanoparticle substrate mediated mode.

References

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[2] R. C. Word, and R. Könenkamp, J. Ultramic, 180 (2018), p. 43.