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Tunable Fano resonance due to interaction between molecular vibrational modes and a double-continuum of a plasmonic metamolecule[1]

EDWARD OSLEY, CLAUDIU BIRIS, PAUL THOMPSON, RAHAM JAHROMI, NICOLAE PANOIU, PAUL WARBURTON, University College London — We have fabricated and characterized a plasmonic system comprised of an array of asymmetric cross-shaped apertures in a metallic film coated with poly(methyl methacrylate) (PMMA). The apertures (called plasmonic metamolecules) produce localized surface plasmon (LSP) resonances that can be tuned by varying the polarization of incident light. Arrays of these nano-scale apertures, designed to have resonances at infrared wavelengths, were fabricated using electron beam lithography and argon ion milling of a gold film. Filling the apertures with PMMA allowed its C=O bond resonance to interact with tunable LSP modes. The transmission, reflection and absorption spectra of the system were measured using FTIR. Coupling between the LSPs and the C=O bond is shown to produce a Fano resonance that can be tuned in situ. The system was investigated theoretically using (a) rigorous electromagnetic calculations and (b) a quantum mechanical model that describes the interaction between a discrete state (the C=O bond) and multiple continua (the LSPs of the plasmonic metamolecule). We demonstrate that the predictions of the quantum model are in good agreement with the experimental data and show that the model allows an intuitive interpretation, at the quantum level, of the plasmon-molecule coupling.

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