Light-Matter Interaction in Plasmonic Nanocavities

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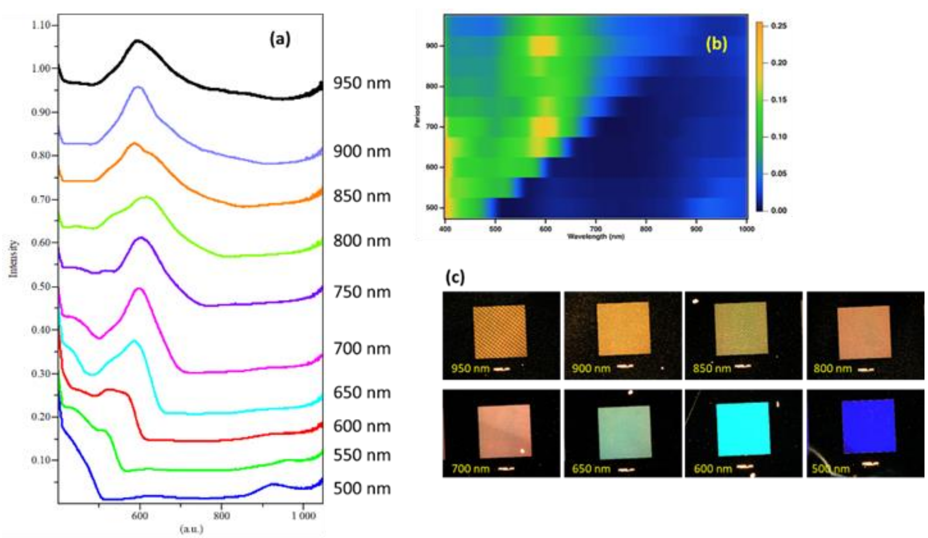
Light-matter interaction typically results from energy exchange between a quantum emitter (dye molecules, quantum dots.. etc.) with electromagnetic field in external resonant cavities. The ability to control the coupling of photons to the collective excitations of the phonon or plasmons can significantly change the quantum emitter properties. Specially engineered coupled systems which promotes the exchange rate of energy faster than other competing relaxation process will lead to the "strong-coupling" regime resulting in the formation of new hybrid light/matter states. Under the strong-coupling regime, novel physio-chemical properties emerge in the hybrid nanostructures with significant implications in polaritonic chemistry. [1] In this poster presentation, we will explore the different regimes of optical coupling exhibited in the periodic arrays of gold nanocube (AuNC) grown atop of a gold mirror. This preliminary design allows us to independently probe the two distinct optical modes, a plasmonic gap mode between the AuNC and the gold mirror surface and a surface lattice resonance mode (SRL) resulting from constructive interference from the scattering of the periodic array.



The nanofabricated AuNC array on Au mirror devices have periodicities range from 500 – 950 nm. These devices exhibit vivid structural colour under dark-field illumination. Reflectance spectroscopy measurements of the array device showed varying degrees of optical coupling that is dependent on the nanostructure geometry, lattice pitch and lattice symmetry. In the device with lowest periodicity, only plasmonic gap modes are observable. When the periodicity reaches 550 nm, two optical modes become visible with the longer wavelength peak corresponds to the plasmonic gap mode and the shorter wavelength peak associated with the lattice resonance mode. These two optical modes hybridize in the device with periodicity greater than 750 nm. Reflectance spectra of the hybridized modes only show a single peak which is the superposition of the two optical modes. Introduction of molecular emitters into the AuNC array will allow us to explore the various regime of the light-matter interactions. [2]

References

[1] Shi, X. Ueno, K. Oshikiri, T. Sun, Q. Sasaki, K. Misawa, H. Nat. Nanotechnol. 13, 953 (2018)

[2] L. Tay and J. Hulse, 2023 Photonics North (PN), doi: 10.1109/PN58661.2023.10222966. (2023).