# Quantum Charge Effects in Nanoparticulate Plexcitonic Systems

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Gold and silver nanoparticles (NPs) have been studied extensively in the last decades for their localized plasmonic properties ranging in the UV/visible spectral range of the electromagnetic spectrum. It is thus well known that the size and shape of the NPs are important for plasmonic effects. Far less knowledge is yet available about near field interparticle interactions in ordered assemblies of plasmonic NPs (Fig. 1) that generally trigger additional dominant collective effects. The field of nanoparticle plasmonics can benefit from a further coupling of the plasmon resonances with excitons from light irradiated semiconductor materials, in particular QDs such as CdE (E = S, Se, Te,…), ZnO or $Cu_xO$ nanostructures, etc. In fact, hybrid metal NPs-semiconductor materials are the subject of active experimental and theoretical investigations [1]. The present project aims at bringing new insights into excitonic/plasmonic interactions in large assemblies of bi-particulate NP-QD networks.

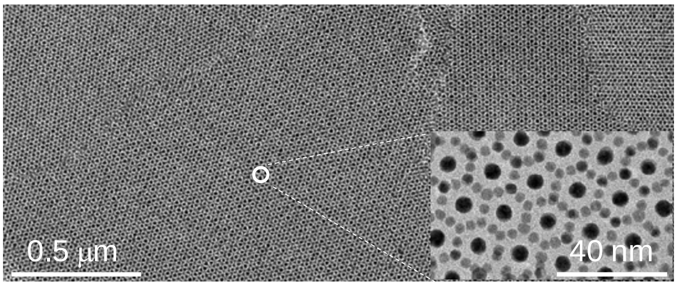


Fig 1 An example of our binary particulate networks

The project has two major objectives. The first is to further develop an existing atomic force-based technique called PiFM [2] to detect excited electronic states in individual QDs, while the second is, to investigate the electron distribution in individual QDs in interaction with individual plasmonic mNPs. This is to be done with both macroscopic (UV-Vis, …) and microscopic (PiFM-based) approaches. A particular attention will be payed to systematically couple the QDs and the mNPs through a precise chemical synthesis and functionalization of both the NPs and the QDs [3]. The project includes therefore experimental and theoretical aspects and notions in solid-state physics, optics, electronic effects, and chemistry, are needed. Knowledge of physics and chemistry of materials, oxide films, metal nanoparticles, as well as scanning probe techniques can constitute an important asset for the development of the project.

[1] K. Tanaka, E. Plum, J.Y. Ou, T. Uchino, and N. I. Zheludev, Phys. Rev. Lett. 105, 227403 (2010).
[2] T. Tumkur, M. Hurier, M. Pichois, M. Vomir, B. Donnio, J.L. Gallani, and M.V. Rastei, Phys. Rev. Appl. 11, 044066 (2019).
[3] For a mesomorphic network, see: B. Donnio, et al., Adv. Mater. 19, 3534 (2007); J. Am. Chem. Soc. 138, 10508 (2016).