Strong coupling between organic molecules and surface plasmons

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In this talk I will present an overview of the theoretical work developed in our group to understand from a fundamental point of view the phenomenon of strong coupling between organic molecules and surface plasmons. First, I will present the case of a single quantum emitter in close proximity to a 2D metal surface [1] and study under which conditions strong coupling between the exciton mode in the emitter and the propagating surface plasmons supported by a 2D metal surface could emerge. Next I will revisit the case of an ensemble of molecules interacting with a 2D metal surface [2], the system in which strong coupling was firstly observed experimentally.

I will also present the case of organic molecules interacting with the localized surface plasmons supported by a metal nanoparticle [3] and the interplay between quenching and strong coupling in this type of structures. Finally, I will show how exciton conductance in organic materials can be enhanced by several orders of magnitude when the molecules are strongly coupled to a plasmonic mode [4]. I will demonstrate how the formation of a collective polaritonic mode allows excitons to bypass the disordered array of molecules and jump directly from one end of the structure to the other. This finding could have important implications in the fields of exciton transistors, heat transport, photosynthesis, and biological systems in which exciton transport plays a key role.

References

[1] A. Gonzalez-Tudela, P.A. Huidobro, L. Martin-Moreno, C. Tejedor and F. J. García-Vidal, Phys. Rev. B (RC) 89, 041402 (2014).

[2] A. Gonzalez-Tudela, P.A. Huidobro, L. Martin-Moreno, C. Tejedor and F. J. García-Vidal, Phys. Rev. Lett. 110, 126801 (2013).

[3] A. Delga, J. Feist, J. Bravo-Abad and F. J. García-Vidal, Phys. Rev. Lett. 112, 253601 (2014).

[4] J. Feist and F.J. Garcia-Vidal, Phys. Rev. Lett. 114, 196402 (2015).