



Light-matter interaction at the single-molecule level probed with STM

Anna Rosławska^a, Tomáš Neuman^a, Shuiyan Cao^a, Benjamin Doppagne^a, Andrei G. Borisov^b, Michelangelo Romeo^a, Michel Féron^c, Frédéric Chérioux^c, Fabrice Scheurer^a, Javier Aizpurua^d, Guillaume Schull^a

^a Université de Strasbourg, CNRS, IPCMS, UMR 7504, Strasbourg, France.

^b Institut des Sciences Moléculaires d'Orsay – UMR 8214, CNRS, Université Paris-Saclay, Orsay, France.

^c Université Bourgogne Franche-Comté, FEMTO-ST, UFC, CNRS, Besançon, France.

^d Center for Materials Physics (CSIC-UPV/EHU) and DIPC, Paseo Manuel de Lardizabal 5, Donostia - San Sebastian 20018, Spain.

Email: roslawska@ipcms.unistra.fr

Abstract:

Light-matter interaction plays a crucial role in the quantum properties of light emission from single molecules. They are usually probed using optical methods, which are, however, spatially limited by diffraction to a few hundred nanometers. On the other hand, scanning tunneling microscopy (STM) routinely reaches picometre spatial scale. Recent works have shown that the tunneling current of an STM can be used to excite the intrinsic luminescence of individual molecules enabling light-matter interaction investigations with unprecedented resolution. Processes that can be addressed involve charging, dipole-dipole interactions or energy transfer between individual chromophores.

Here, we study STM-induced luminescence from phthalocyanine molecules adsorbed on a few-monolayer NaCl film epitaxially grown on Ag(111) substrate. We show how the atomically-confined electromagnetic field at the STM tip apex acts as a “picocavity” for localized plasmons and both enables optical studies with atomic-scale precision and interacts with the emitter [1]. Profiting from that resolution, we investigate a critical mechanism in the photosynthesis process – resonant energy transfer in multichromophoric architectures. We use individual phthalocyanines as ancillary, passive or blocking elements to promote and direct resonant energy transfer between distant donor and acceptor units. Such an approach constitutes a powerful model to study the role of the relative dipole orientation, distance and chemical nature of the chromophores on the efficiency of the energy transfer [2].

References:

[1] Rosławska, A.; Neuman, T. ; Doppagne, B. ; Borisov, A. G.; Romeo, M.; Scheurer, F.; Aizpurua J. ; Schull, G., arXiv:2107.01072.

[2] Cao, S. ; Rosławska, A. ; Doppagne, B. ; Romeo, M ; Féron, M. ; Chérioux, F. ; Bulou, H ; Scheurer, F.; Schull, G., Nature Chemistry, 2021.