Plasmon-induced switching of the emission mode of semiconductor quantum emitters

Victor Krivenkov[1]
Adam Olejniczak,[1] Zuzanna Lawera,[1] Dayana Gulevich,[2] Pavel Samokhvalov,[2] Igor Nabiev,[3] Marek Grzelczak,[1,4] Yury Rakovich[1,4,5]

[1]*Department of Polymers and Advanced Materials: Physics, Chemistry and Technology, University of Basque Country (UPV/EHU), and Centro de Fisica de Materiales (CFM, CSIC-UPV/EHU), Paseo Manuel de Lardizabal 5, 20018 Donostia-San Sebastian, Spain*
[2]*National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), 115409 Moscow, Russian Federation*
[3]*Laboratoire de Recherche en Nanosciences, LRN-EA4682, Université de Reims Champagne-Ardenne, 51100 Reims, France*
[4]*Donostia International Physics Center, Paseo Manuel Lardizabal 4, 20018 Donostia-San Sebastian, Spain*
[5]*IKERBASQUE, Basque Foundation for Science, Maria Diaz de Haro 3, 48013 Bilbao, Spain*

Victor.krivenkov@ehu.eus

The formation of weak plasmon-exciton coupling on the nanoscale is a prospective way to overcome some limitations of quantum emitters (QEs) based on semiconductor nanocrystals. Realization of the coupling between plasmon resonance and absorptive transitions of QEs allows for an increase in the efficiency of photoexcitation of QE and thus increases the photoluminescence (PL) intensity. In turn, the coupling of plasmon resonance and radiative transition of QE is a prerequisite for the Purcell effect realization, an increase of the radiative rate, and enhancement of the PL quantum yield (QY). Previously we have shown that these effects may be realized and even combined for the stronger enhancement of both exciton and biexciton PL efficiencies and rates in semiconductor quantum dots (QDs) [1-3]. Moreover, our new experiments show that exciton and biexciton PL efficiencies in perovskite nanocrystals and CdSe/CdS QDs may be enhanced or decreased reversibly by real-time changes in the structure of plasmon-exciton hybrid films (Figure 1). However for initially low-QY nanocrystals we observed an irreversible increase in the PL efficiency even after the total elimination of plasmon-exciton interaction. We explained these effects by the plasmon-induced changes in rates of radiative and nonradiative transitions.

References

[1] V. Krivenkov, S. Goncharov, P. Samokhvalov, A. Sánchez-Iglesias, M. Grzelczak, I. Nabiev, Y. Rakovich, J. Phys. Chem. Lett., 10 (2019) 481-486.

[2] V. Krivenkov, D. Dyagileva, P. Samokhvalov, I. Nabiev, Y. Rakovich, Ann. Phys., 532 (2020) 2000236.

[3] V. Krivenkov, P. Samokhvalov, I. Nabiev, Y. Rakovich, J. Phys. Chem. Lett., 11 (2020) 8018-8025.

Figures

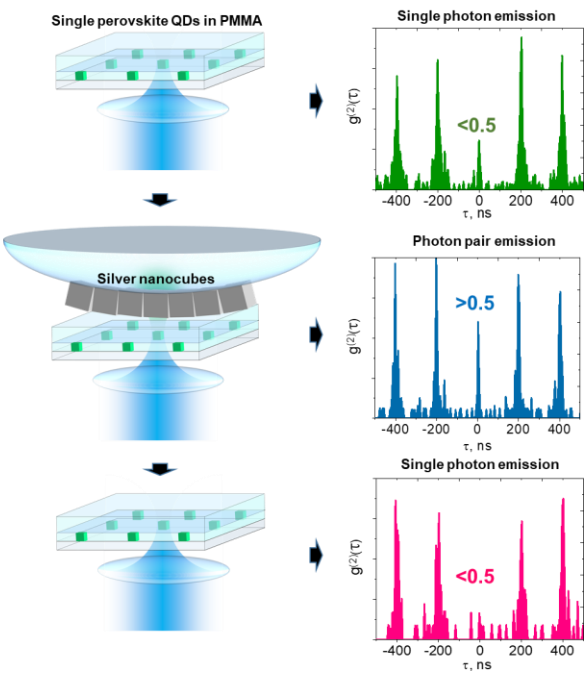

Figure 1: Second-order cross-correlation functions $g^{(2)}$ of the emission from single QD measured in Hunburry-Brown-Twiss geometry, before (green graph), during (cyan graph) and after (pink graph) the interaction with silver plasmon nanocubes.