Interaction and coherence of a plasmon-exciton polariton condensate

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Hybrid particles of excitons in semiconductors and cavity photons, called polaritons, have shown fascinating phenomena including Berezinskii-Kosterliz Touless transitions [ref] and Bose-Einstein Condensation (BEC) recently observed at room temperature in organic-based microcavities [1]. In this context, a promising route for the exploitation of polariton physics at the nanoscale is offered by the Surface Lattice Resonances (SLRs) arising from the coherent radiative coupling of diffractive modes, propagating in the plane of an array of metallic nanoparticles, with the localized surface plasmons (LSP) of each individual naostructures [2]. The SLR systems showing a high electromagnetic (EM) field enhancement are characterized by a strong suppression of losses (higher quality factor) with respect to individual nanoparticle LSPs, at the expense of a less confined electromagnetic field (larger mode volume) [3].

By strongly coupling molecular excitons to a SLR in a 2D array of silver nanorods (NRs), we demonstrate the formation of an out-of-equilibrium plasmon-exciton-polariton (PEP) condensate with an extended spatial coherence over distances longer than the excitation spot. This is proved by time resolved experiments which evidence the picosecond dynamics of the condensate and a sizeable blueshift, thus measuring, for the first time, the effect of polariton interactions in plasmonic based cavities. These findings are very promising for studying properties of quantum fluids at room temperature with ultrafast dynamics, thus opening the way towards future plasmon-exciton-polariton based condensates and devices.

References

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[3] Todisco, F. et al., ACS Nano, **10**, 11360–11368 (2016).

Figures

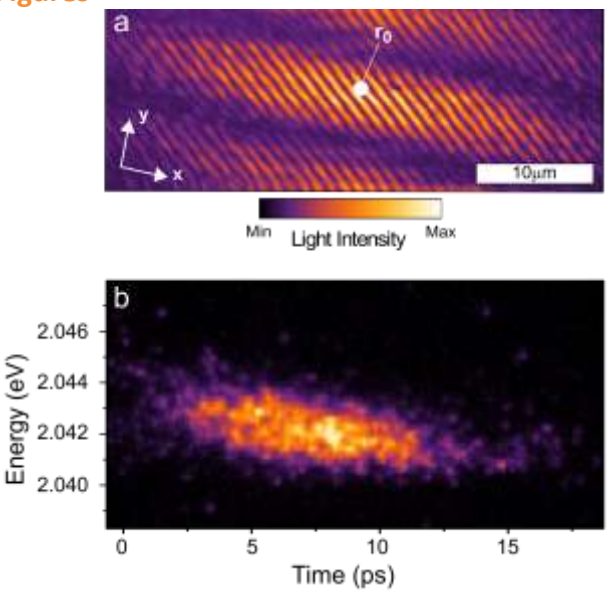

Figure 1. (a) Experimental interferogram of two-dimensional spatial coherence of the PEP condensate. (b) Time- and energy-resolved PL above PEP condensate threshold.