Exciton-polariton condensation in bound states in the continuum of plasmonic and dielectric metasurfaces

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We demonstrate the formation of polariton condensates from excitons in organic molecules strongly coupled to symmetry-protected bound states in the continuum (BICs) in different metasurfaces of silicon and silver nanoparticles [1]. Despite the very similar structure of the metasurfaces, condensation occurs in BICs with different characteristics for different materials. For the Si metasurfaces, exciton-polaritons condense in a dispersive electrical quadrupole BIC, whereas for the Ag metasurfaces, condensation occurs in a hybrid magnetic dipole BIC with a remarkably flat dispersion. Surprisingly, the condensation threshold is very similar for Ag and Si metasurfaces despite the unavoidable losses in metals. Our experiments also demonstrate a strong dependence of the condensation threshold on the excitation spot size [2]. For the Si metasurface, the condensation threshold decreases as the excitation spot size increases, achieving thresholds below 3 µm cm^{-2} for spot sizes around 1 mm^2 and condensate lifetimes exceeding 20 ps. We reproduce this dependence in simulations by including a term for the ballistic transport of exciton-polaritons in the rate equations describing the condensation.

These results illustrate the rich possibilities offered by metasurfaces for exciton-polariton condensation and the potential of plasmonic materials for condensation with nanostructures. They also demonstrate the critical role that polariton transport plays in condensation and highlight the relevance of considering the size of the excitation in condensation experiments with extended cavities.

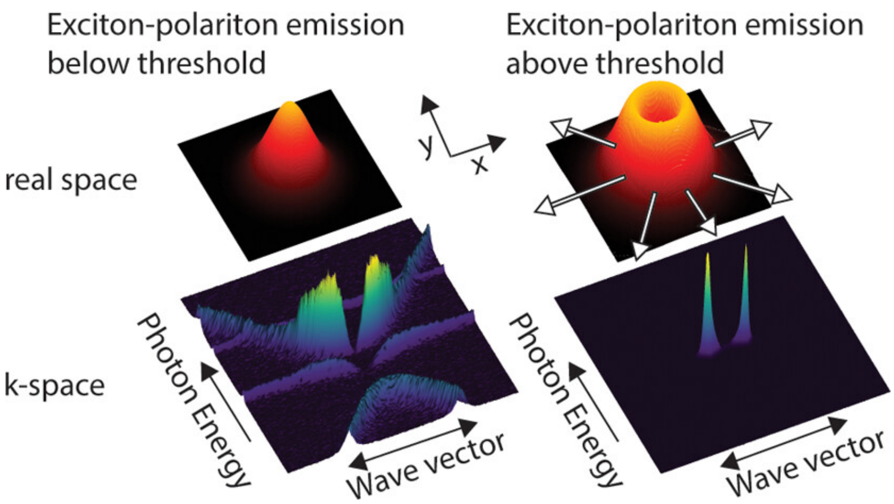

Figure 1: Real space (upper panels) and dispersion measurements (lower panels) of the emission of dye molecules strongly coupled to a metasurface formed by a periodic array of silicon nanodisks, below (left) and above (right) the condensation threshold. Above the threshold, the emission occurs at slightly larger wave vectors than the Γ point, as is apparent from the two emission peaks. Emission at the Γ point is forbidden by the symmetry protection of the BIC. The real space image of the emission above threshold shows a dip at the center that is the result of the propagation of the condensate away from the excitation area.

References

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