Room temperature polariton nonlinear fluids

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Excitonic polaritons are bosonic quasiparticles arising from the hybridization of a bound electron-hole pair (exciton) and an amplified electromagnetic field (usually cavity photons). Their hybrid light-matter nature has allowed the study of different fundamental phenomena as well as the proposal of plenty of technologically relevant applications. However, the realization of cost-effective and technologically relevant polaritonic devices requires, on the one hand, the exploitation of photonic structures which may offer advantageous topological phenomena, and on the other hand, a profound comprehension of the intrinsic microscopic phenomena underpinning polariton interactions, especially when novel materials with high excitonic binding energy are employed to bring the polariton physics to room temperature.

Here, we present our research activity focused on the investigation of topological properties in photonic waveguides **[1,2,3]**, high finesse microcavities coupled with transition metal dichalcogenides homo- and hetero-structures, as well as single crystals of 2D perovskite **[4]**. We will demonstrate how the presence of polariton interactions in these materials can be exploited to realize proof-of-concept polariton devices that operate successfully at room temperature. Furthermore, we will illustrate how perovskite single crystals, self-sustaining the formation of polaritons, can be grown using microfluidic techniques and controlled dewetting **[5,6]**. These smart and low-cost lithography techniques will enable the formation of self-assembled micro- and nanocrystals with finely controlled shapes and dimensions, which are extremely useful for the development of active polaritonic circuits directly patterned on the final substrate.

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