Polaritonic Metasurface Based on Halide Perovskite

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Exciton-polaritons are half-light, half-matter excitations arising from the strong coupling regime between cavity photons and excitons of semiconductors. Behaving as superlative non-linear photons due to their hybrid nature, exciton-polaritons have been providing a fruitful ground for studying quantum fluid of light and realizing prospective all-optical devices.

In this presentation, we present experimental studies on exciton-polaritons in resonant metasurfaces, which are composed of sub-wavelength lattices of perovskite pillars (see Figure). Room temperature polaritons are demonstrated with a remarkable Rabi splitting in the 200 meV range. We show that polaritonic dispersion can be tailored on-demand. This includes creating linear, slow-light, and multi-valley shaped dispersions [1]. Moreover, we demonstrate that the strong coupling regime between perovskite excitons and photonic bound states in the continuum (BIC) leads to the formation of polariton-BIC that preserves the topological nature of its photonic component [2]. Finally, we observe experimentally the ballistic propagation of polaritons over hundreds of micrometers at room temperature, even with large excitonic components, some up to 75%. This long-range propagation is enabled by the high homogeneity of the metasurface, and by the large Rabi splitting which completely decouples polaritons from the phonon bath at the excitonic energy [3]. Our results suggest a new approach to study exciton-polaritons and pave the way for the development of large-scale and low-cost integrated polaritonic devices operating at room temperature.

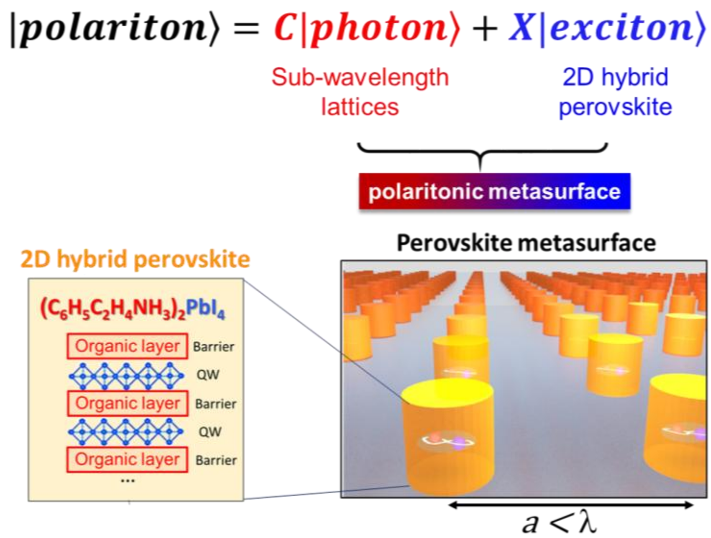

Figure 1: Illustration of polariton metasurface made of sub-wavelength lattices of perovskite pillars

References

[1] Dang el al., Nano Letters 20 (3), 2113-2119(2020)
[2] Dang et al., Advanced Optical Materials 10, 2102386 (2022)
[3] Dang et al., Nano Letters, 38, 11839–11846 (2024)

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