Nanostructuration of Hybrid Organic-Inorganic perovskite via Thermal Nanoimprint to tailor light-matter interactions for optoelectronic devices

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Hybrid Organic-Inorganic Perovskite (HOP), as direct bandgap semiconductors with excellent absorption and long carrier diffusion length, has recently emerged as a material of choice for a wide range of optoelectronic applications. Recently, several groups have demonstrated that performance of HOP-based devices can be greatly improved via nanophotonic concepts when patterning the HOP into micro/nanostructures. They suggested that nanostructured HOP can lead to light-trapping mechanism for HOP solar-cells, improvement of light-extraction in HOP LEDs, light-matter interaction enhancement for HOP lasers, and very recently the control of photon-exciton strong coupling regime for polaritonic devices. In this work, we develop a <u>direct nanoimprint</u> lithography of a flat HOP layer into nanostructures in the form of subwavelength metasurface lattice. This method have been successfully implemented for both 2D, 3D and quasi 2D HOPs to fabricate large-scale metasurfaces. The nanostructures allows a strong control of light-matter interaction within the perovskite layer. As illustrations, we will present the enhancement of photoluminescence extraction, observation of vortex beam lasing at high oblique angles[1], macroscopic propagation of exciton-polariton at room temperature[2], and enhancement of two photon absorption[3]. Our results pave the way to make low-cost and wafer-size of perovskite devices in which light-matter interaction is tailored in the subwavelength scale.

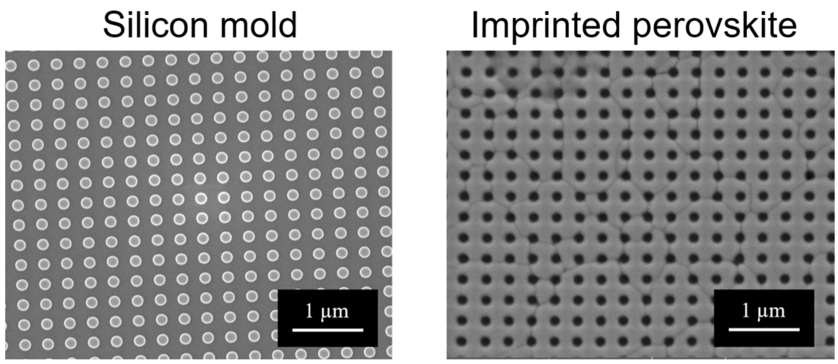

***Figure –** SEM image of the silicon mold (left) and the imprinted HOP (right).*

[1] Mermet-Lyaudoz et al (accepted for Nano Letters), arXiv:2212.10122
[2] Dang et al (in preparation)
[3] Nguyen et al (in preparation)