

Brightening perovskite LEDs with photonic crystals

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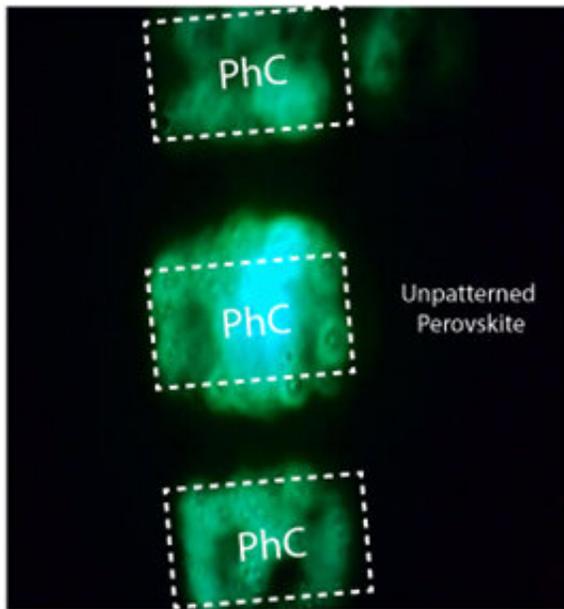


Fig. 1 Photoluminescence image of photonic crystal (PhC) and unpatterned perovskite thin film. Credit: Nanyang Technological University

All inorganic cesium lead halide perovskite semiconductors exhibit great potential for nanolasers, light emitting diodes and solar cells due to their unique properties, including low threshold, high quantum efficiency and low cost. However, the high material refractive index of perovskite semiconductors hinders light extraction efficiency for photonic and illumination applications.

Very recently, an NTU team lead by Assoc. Prof. Wang Hong, demonstrated high [light](#) extraction efficiency of perovskite photonic crystals fabricated by delicate electron-beam lithography. The perovskite photonic crystals exhibit both emission rate inhibition and light energy redistribution simultaneously.

They observed 7.9-fold reduction of the spontaneous emission rate with a slower decay in perovskite photonic crystals due to the photonic bandgap effect (PBG). 23.5-fold emission intensity enhancement was also clearly observed as a result of light energy redistribution from 2-D guided modes to vertical direction in perovskite photonic crystals thin films, indicating a high intrinsic light extraction efficiency.

This observation is the second largest extraction efficiency with two-dimensional photonic crystals in comparison with that of silicon. There is an emission inhibition, but since the light is improved by the direction coupling, the emission image in Fig. 1 shows a significant brightness in [photonic crystals](#) (PhC) comparing with that in unpatterned films.

The combination of inhibiting undesirable emission by redistributing light energy into useful modes offers a promising approach in various applications for perovskite, including [solar cells](#), displays and photovoltaics. The study is published in *ACS Photonics*.

More information: Songyan Hou et al. Concurrent Inhibition and Redistribution of Spontaneous Emission from All Inorganic Perovskite Photonic Crystals, *ACS Photonics* (2019). [DOI: 10.1021/acsp Photonics.8b01655](#)

Provided by Nanyang Technological University

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