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RESEARCH HIGHLIGHT

Efficient and stable weakly space-confined perovskite LEDs

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https://doi.org/10.61109/cs.202511.151

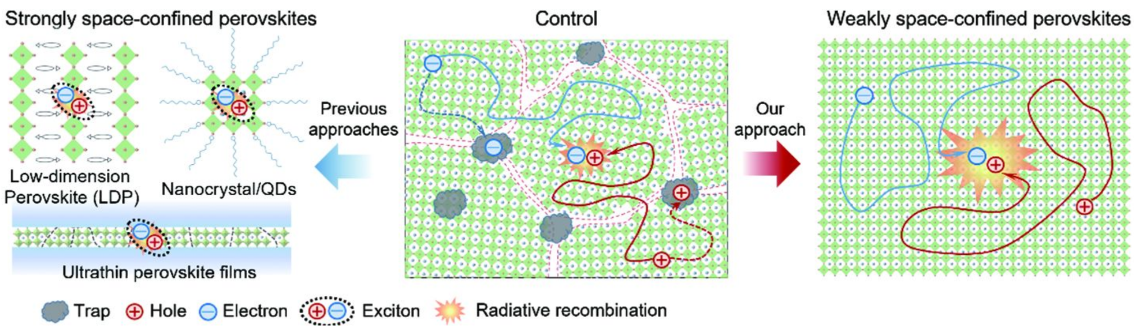
Citation: Z. Xiao, Efficient and stable weakly space-confined perovskite LEDs, *Coshare Science* **03**, 04 (2025)

Author introduction

Zhengguo Xiao is a Professor in the Department of Physics at the University of Science and Technology of China (USTC). He earned his Ph.D. from the University of Nebraska–Lincoln in 2015, followed by a postdoctoral appointment in the Department of Electrical Engineering at Princeton University from 2015 to 2018. In March 2018, he joined USTC as a faculty member. His research centers on novel semiconductor-based optoelectronic devices, with particular emphasis on perovskite solar cells, LEDs, and photodetectors. Notably, his group has published pioneering work on perovskite light-emitting diodes (LEDs) with excellent device performance for optoelectronic applications.

Highlights

- Developed high-efficiency, stable PeLEDs using a weak space-confinement strategy to enhance both efficiency and lifetime
- Introduced HPA and NH_4Cl into $CsPbBr_3$ precursors to control crystallization, yielding high-quality films with large grains and few boundaries
- The weakly confined PeLEDs achieved 22% EQE, 1.16×10^6 cd m^{-2} brightness, and a 1.85×10^5 h lifetime, marking a major advance in stability and brightness



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Efficient and stable weakly space-confined perovskite LEDs

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Abstract We focused on developing high-efficiency and stable perovskite light-emitting diodes (PeLEDs), with particular emphasis on exploring a new approach to improve the efficiency and lifetime through a "weak space-confinement" strategy. Although the conventional "strong space-confinement" strategy can improve emission efficiency, it also leads to severe Auger recombination and ion migration, resulting in low brightness and poor device stability of perovskite LEDs. Moreover, the commonly used organic ligands in such systems exhibit poor thermal stability and cannot withstand Joule heating during device operation, thereby limiting the long-term stability. To overcome these challenges, hypophosphorous acid (HPA) and ammonium chloride (NH_4Cl) were introduced into the $CsPbBr_3$ precursor system to regulate the crystallization process. This approach yielded highly crystalline perovskite films with large grain size and low grain-boundary density. The weakly space-confined perovskite films show suppressed Auger recombination, reduced ion migration, and enhanced thermal stability. Based on this design, the fabricated green PeLEDs achieved an external quantum efficiency (EQE) of 22%, a maximum brightness of 1.16×10^6 cd m^{-2}, and an extrapolated lifetime of 1.85×10^5 hours at 100 cd m^{-2}. These results represent a significant breakthrough in both brightness and stability, providing a promising pathway toward the practical application of perovskite LEDs.

Keywords perovskite light-emitting diode, weakly space-confined perovskite, stability, high brightness

Acknowledgments:

We acknowledge support from the National Key Research and Development Program of China (2022YFA1204800), the National Natural Science Foundation of China (62 175 226, 62 234 004, 52 302 201), the University Synergy Innovation Program of Anhui Province (GXXT-2022-009), the China Postdoctoral Science Foundation (2022M723006), and a fellowship from the China National Postdoctoral Program for Innovative Talents (BX20230353).

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Submitted: 21 October 2025; Accepted: 21 November 2025; Published Online: 28 November 2025

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