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Quasi-2D Perovskite Light-Emitting Diodes with Enhanced Chirality-Induced Spin Selectivity via Mixed Chiral–Achiral Spacer Engineering

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INTRODUCTION

Quasi-2D perovskites are promising for circularly polarized luminescence and spin light-emitting diodes due to their strong spin-orbit coupling and tunable structures. However, challenges remain in achieving high dissymmetry factors and efficient performance due to limited chirality transfer and poor optical properties. In this work, we incorporate the bifunctional achiral spacer 2-phenoxyethanamine ($POEA^+$) into quasi-2D perovskites, creating a mixed chiral and achiral system. $POEA^+$ passivates defects, enhances optical properties, and facilitates efficient chirality transfer. The optimized films exhibit a CPL peak at 701 nm with a dissymmetry factor of 5.4×10^{-3} and LEDs with 4.22% external quantum efficiency.

METHOD

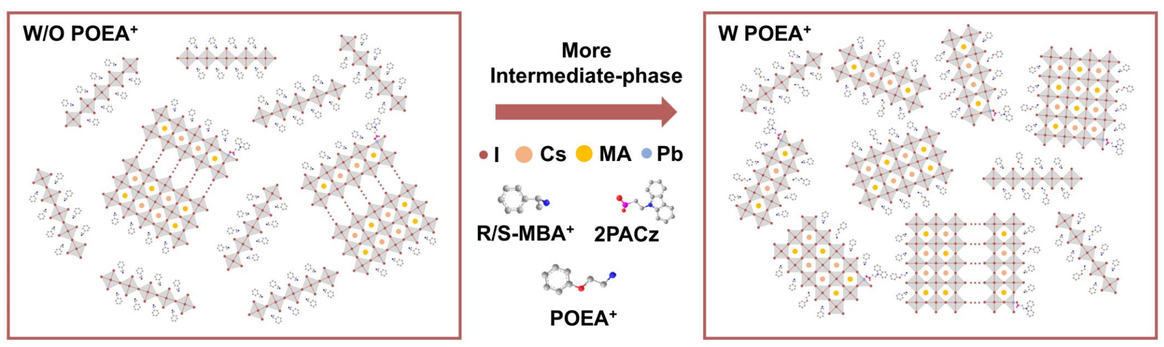
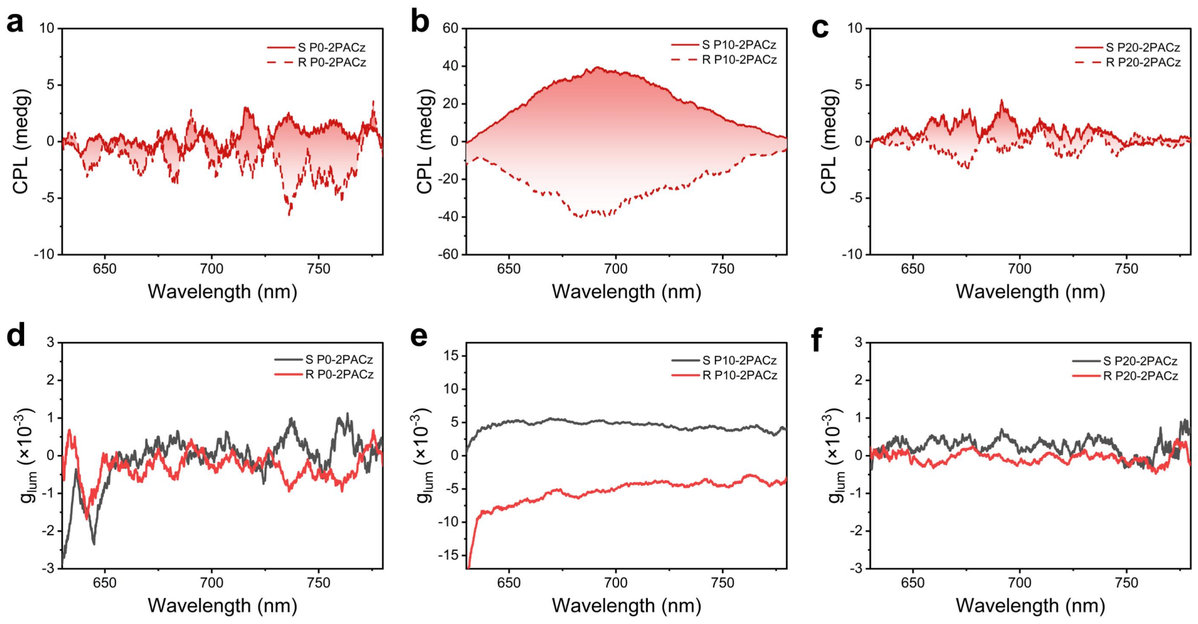


Figure 1. Schematic illustration of the phase distribution in $POEA^+$- quasi-2D perovskites.

- Perovskite precursor preparation
- Device fabrication

RESULTS & DISCUSSION



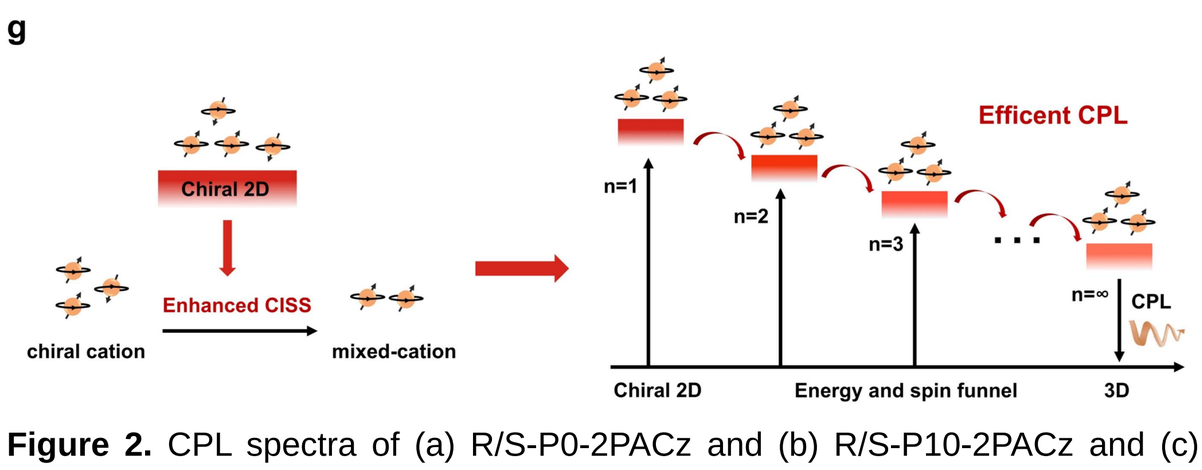


Figure 2. CPL spectra of (a) R/S-P0-2PACz and (b) R/S-P10-2PACz and (c) R/S-P20-2PACz films. g_{lum} spectra of (d) R/S-P0-2PACz and (e) R/S-P10-2PACz and (f) R/S-P20-2PACz films. (g) Schematic illustration of energy and spin funneling process that spin-polarized carrier from chiral n = 1 phase to high n phase.

- The introduction of POEA+ suppresses the formation of the n = 1 phase and significantly promotes the generation of intermediate phases, which is beneficial for achieving a narrow phase distribution.
- POEA+ not only improves the quality of perovskite films, but also enhances the chirality. Strong opposite CPL was observed at the center of ~701 nm with a maximum $|g_{lum}|$ of 5.4×10^{-3} for R/S-P10-2PACz films.
- LEDs based on the optimized film demonstrate a high external quantum efficiency of 4.22%, demonstrating great potential for application in spin-LEDs.

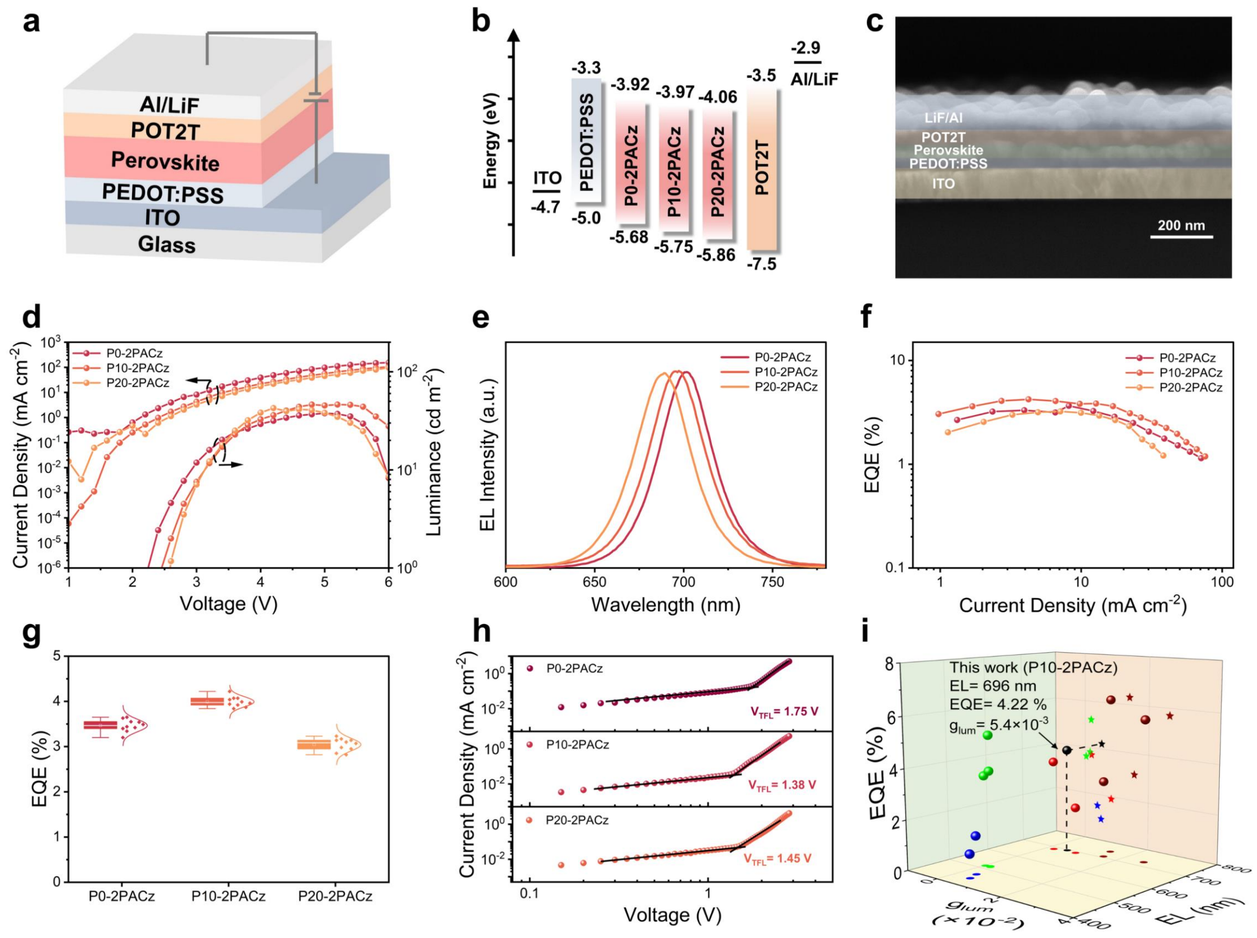


Figure 3. Structure and electroluminescence performance of quasi-2D perovskites based on $(R\text{-}MBA_{1-x}POEA_x)_2(MA_{0.4}Cs_{0.6})_{n-1}Pb_nI_{3n+1}$ (x=0, 0.1, 0.2) perovskites: (a) device structure, (b) energy levels, (c) cross-sectional SEM for devices, (d) J-V-L curves, (e) normalized EL spectra at 4.4 V, (f) EQE-J curves, (g) the peak EQE statistics of quasi-2D LEDs and (h) J-V curves of electron-only devices. (i) Comparison of spin-LED performance between this work and previously reported studies.

CONCLUSION

In conclusion, we have demonstrated that the incorporation of a bifunctional organic spacer cation, $POEA^+$, into quasi-2D perovskites containing only chiral spacer cations can significantly improve optical properties of perovskite film and enhance the CISS effect.

REFERENCES

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