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Synergistic Interfacial Engineering Enables High-performance Perovskite LEDs for High-Speed Visible Light Communication

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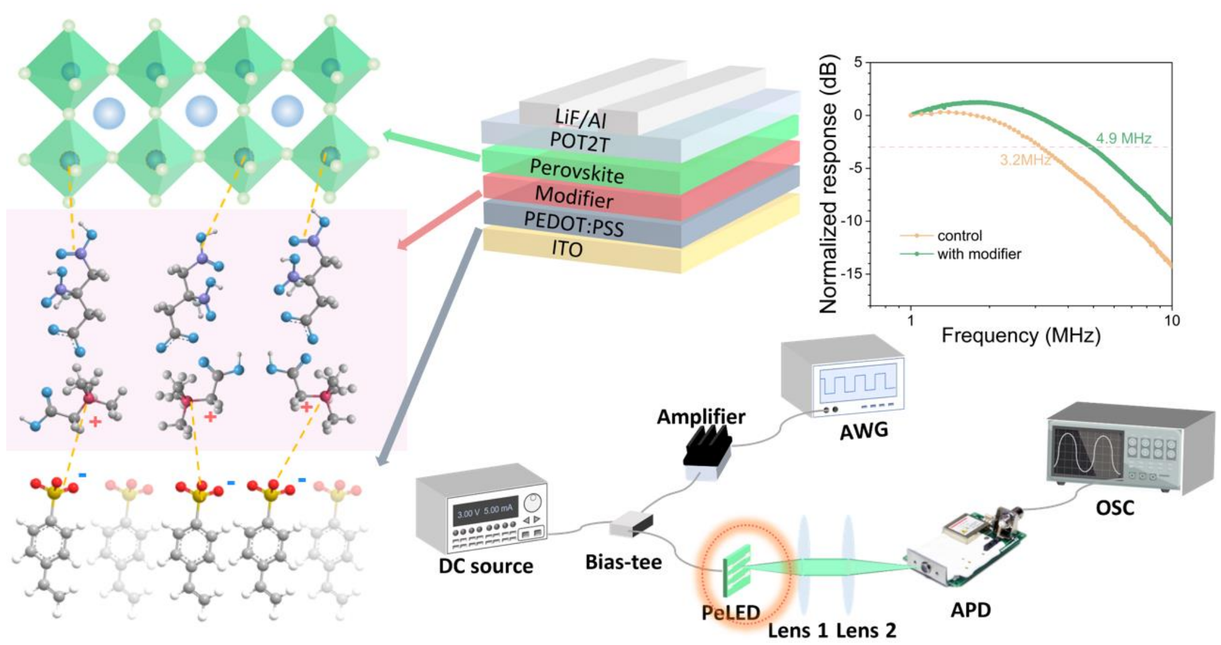
INTRODUCTION & AIM

- **Background**: Metal halide perovskite light-emitting diodes (PeLEDs) are promising emitters for visible light communication (VLC) due to their excellent optoelectronic properties and cost-effective fabrication.[1]
- **Challenge:** Practical application is limited by interfacial defects, charge imbalance, and RC delays, restricting modulation bandwidth.[2]
- **Aim:** Develop a multifunctional interfacial strategy with betaine citrate (BC) and methanol to suppress defects and balance charge injection, enabling high-speed PeLED-based VLC.

METHOD



- **Interfacial Strategy**

Introduce zwitterionic betaine citrate (BC) on PEDOT:PSS.BC passivates Pb^{2+} defects and lowers hole injection barrier.

- **Methanol Treatment**

Removes insulating PSS, enriches conductive PEDOT, and improves interfacial contact.

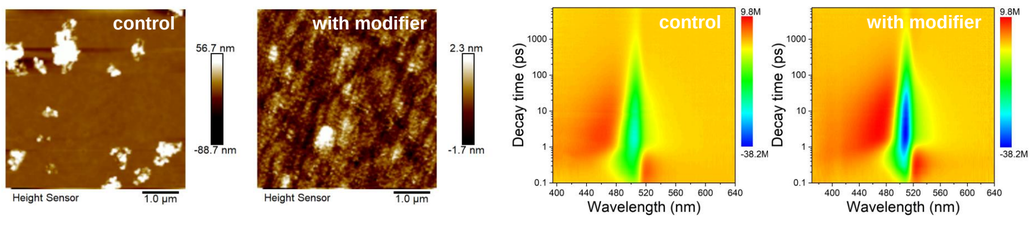
- **Device Fabrication**

Standard green PeLEDs fabricated on BC/methanol-modified PEDOT:PSS.Characterized by morphology, optical, and electrical measurements.

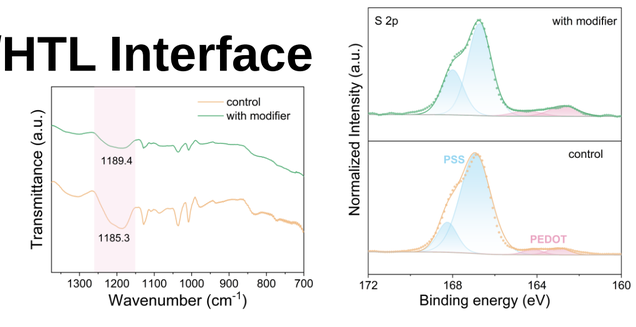
- **VLC application**

RESULTS & DISCUSSION

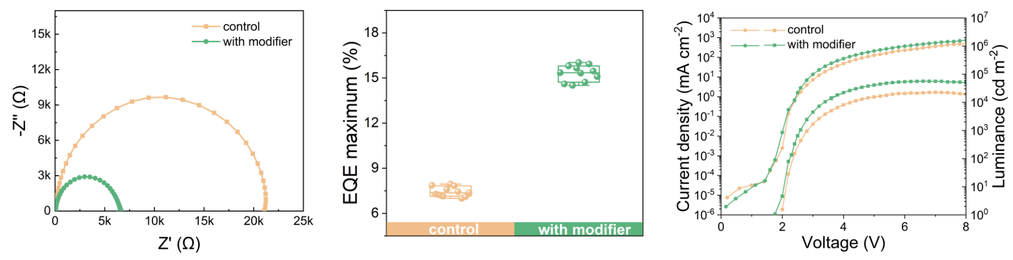
- **Optimization of Film Quality**



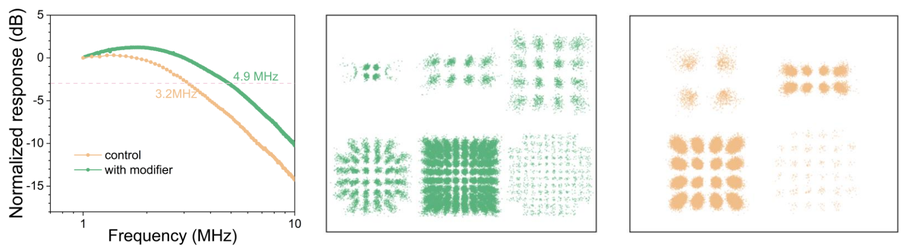
- **Investigation of Interfacial Interactions at the Perovskite/HTL Interface**



- **Improvement of Electrical Properties and Electroluminescent Performance**



- **Advancement of Modulation Bandwidth and VLC Performance**



CONCLUSION

We developed a multifunctional interfacial engineering strategy that simultaneously passivates defects, optimizes energy alignment, and enhances charge injection, leading to outstanding optoelectronic performance. The modulation bandwidth increases from 3.2 MHz to 4.9 MHz, achieving a maximum data rate of 55.56 Mbps, revealing the mechanisms governing PeLED-based VLC and highlighting the potential of PeLEDs as next-generation light sources for high-speed optical communication.

REFERENCES

[1] Liu, X. K.; Xu, W.; Bai, S.; Jin, Y.; Wang, J.; Friend, R. H.; Gao, F. Metal halide perovskites for light-emitting diodes. Nature Materials 2021, 20 (1), 10-21.
[2] Ren, A.; Wang, H.; Zhang, W.; Wu, J.; Wang, Z.; Penty, R. V.; White, I. H. Emerging light-emitting diodes for next-generation data communications. Nature Electronics 2021, 4 (8), 559-572.