# Ligand-Assisted Halide-Exchange Engineering Toward Highly Stable White Perovskite Quantum Dots Applications in Wearable Displays

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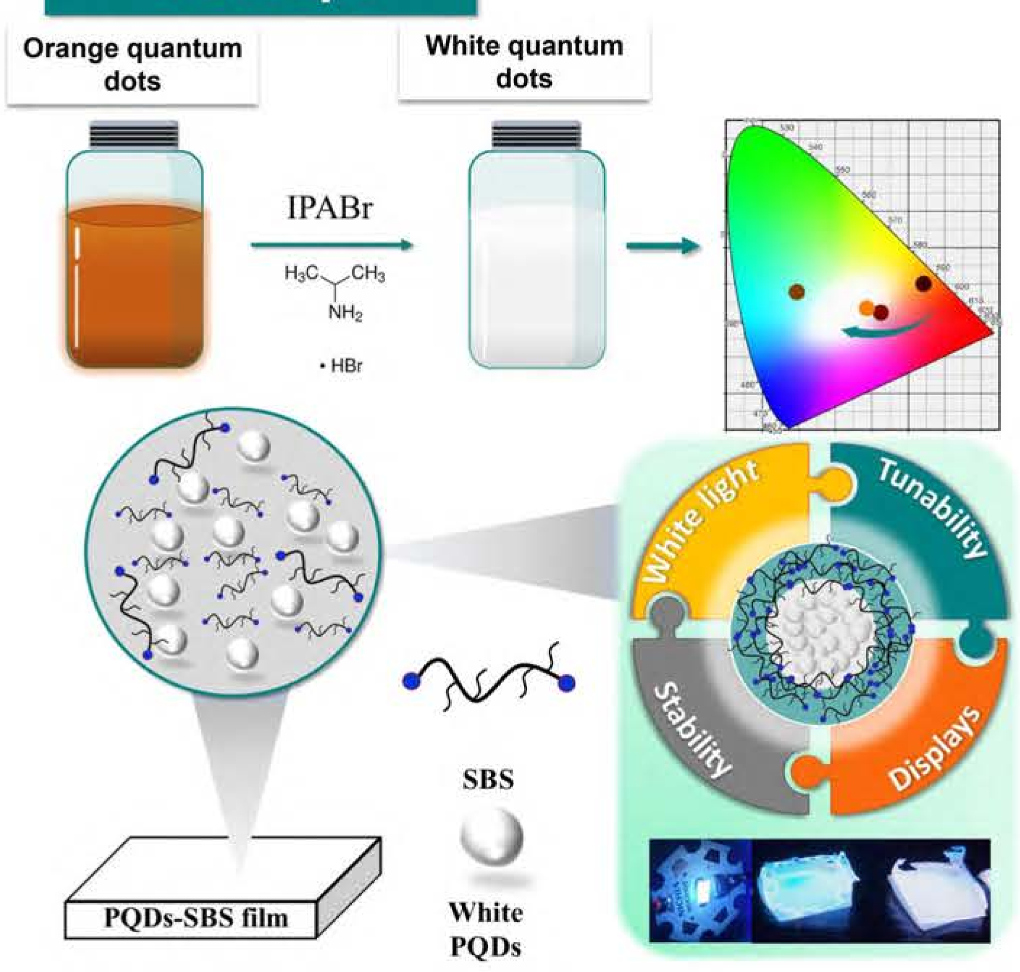
## Introduction

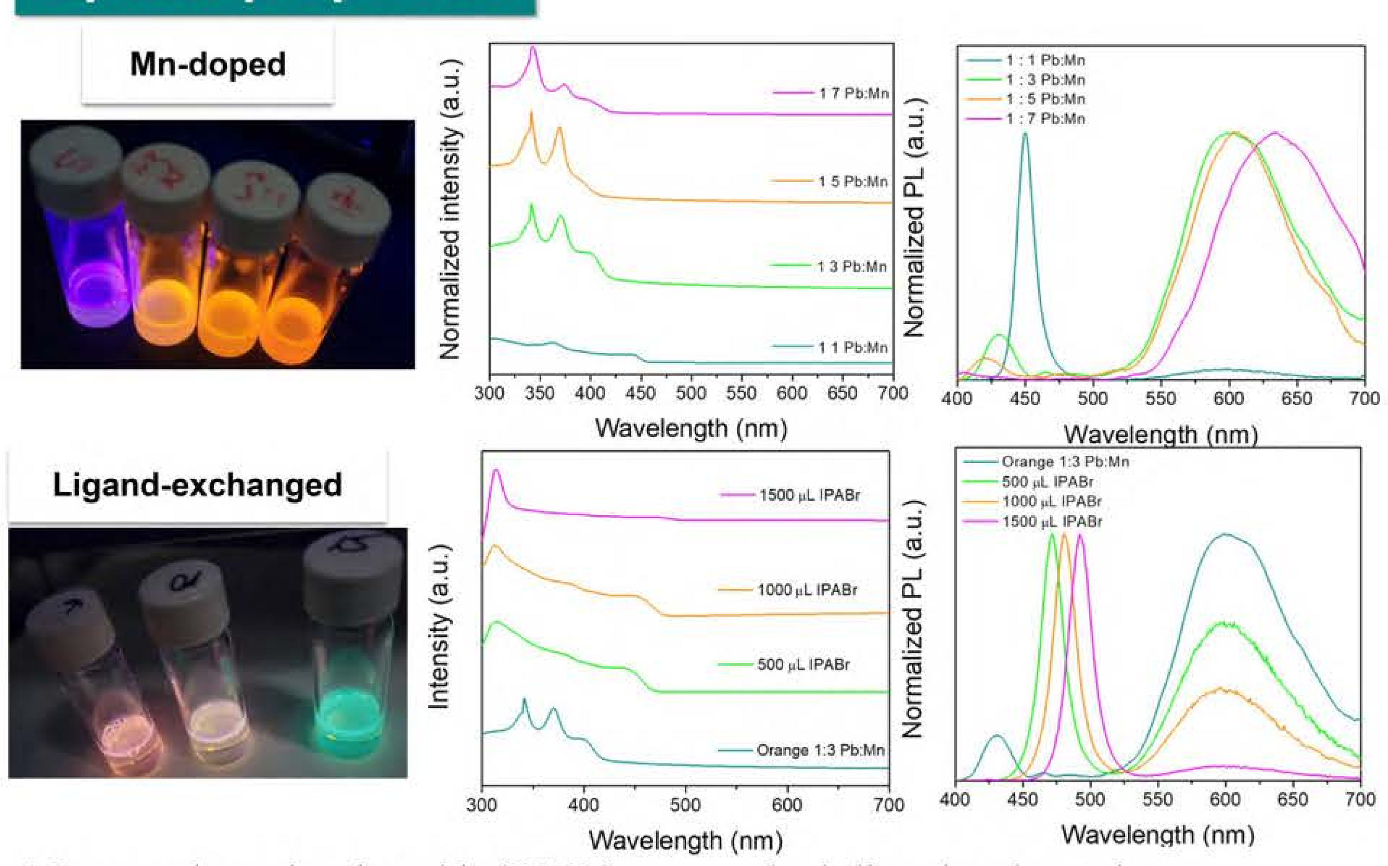
Conventional perovskite-based white light-emitting diode (WLEDs) often rely on the use of a multiphase, corrugated perovskite or a complex multilayered LEDs architecture to achieve WLEDs. However, such approaches result in significant energy loss, instable perovskite spectral behavior and increased non-radiative recombination pathways. By contrast, the development of single white emitter with dual emission has garnered a large attention due to the facile tunability of both perovskite host and impurity dopant emission. Herein, we employed a short-branched ligand isopropylammonium bromide (IPABr) to facilitate a rapid ligand exchange process in manganese-doped perovskite quantum dots on achieving white light emission while maintaining high perovskite stability, both driven by manganese and IPABr. Furthermore, a poly(styrene-butadiene-styrene) matrix was employed to mitigate rapid and detrimental structural changes in the perovskite thin-film resulting in a more stable emission profile. As a proof-of-concept, our composite material was employed for the fabrication of a multicolored backlight display and a cool-white LEDs with robust emission. These findings offer promising prospects for perovskite-based WLEDs advances.

## Research

### Concept

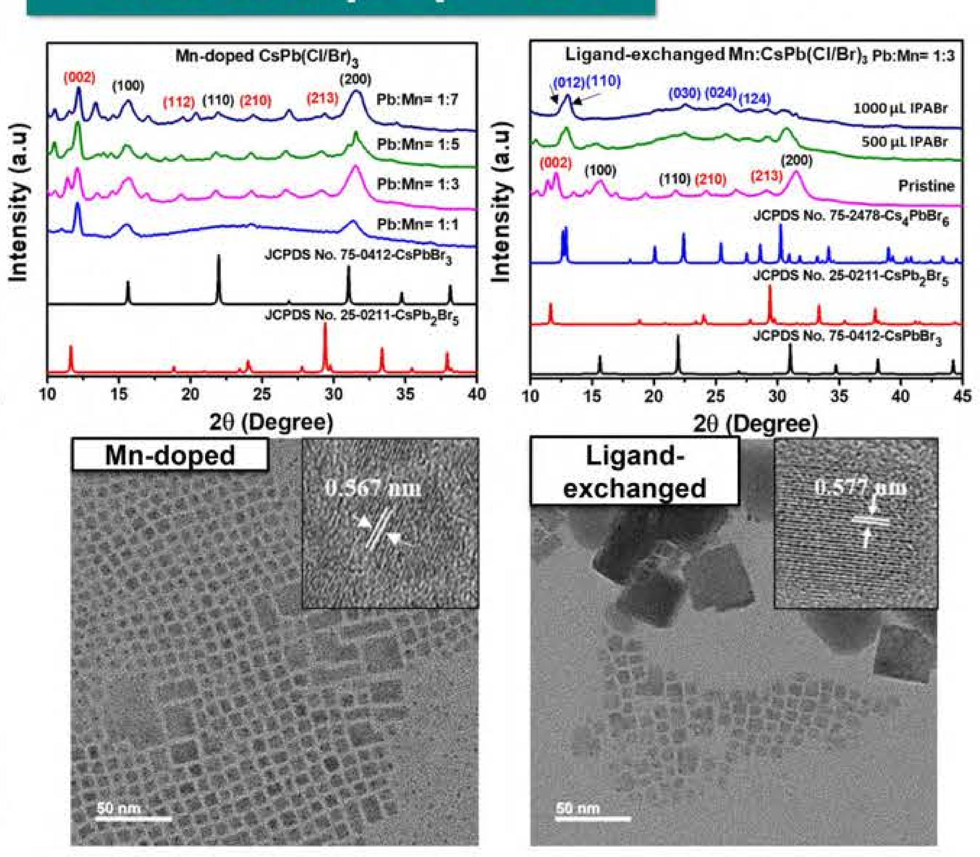



### Optical properties



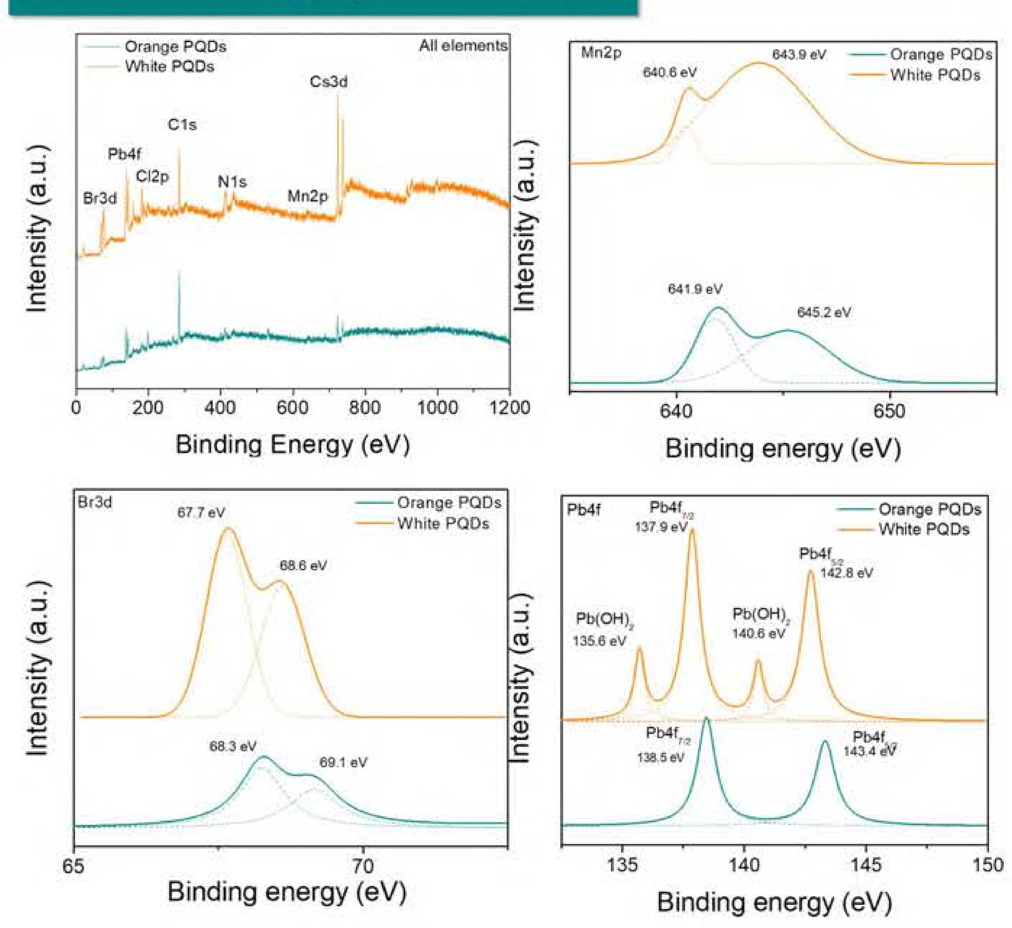

A Isopropylamonium bromide (IPABr) post-synthesis ligand exchange into a Manganese-doped perovskite quantum dot solution facilitate bromide exchange to obtain spectrally white perovskite quantum dot

### Structural properties

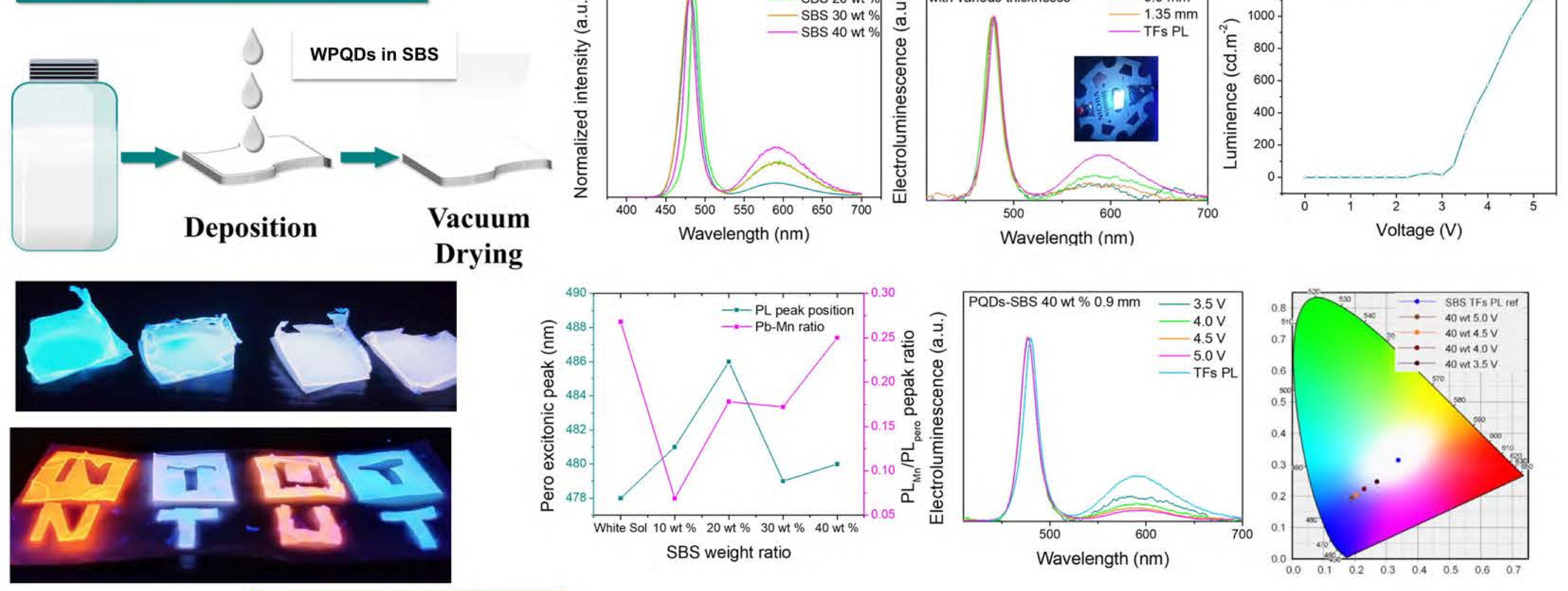



During ligand exchange, the perovskite not only undergo halide exchange but also profound structural change that result in significant ramification for its behavior

### XPS




### Applications




## Conclusion

Herein, we have introduced a two-step synthesis to fabricate a white single-emitter perovskite. First, we have observed that the thermodynamic behind Mn doping drives the final position and intensity of both perovskite excitonic and Mn emission. Second, the usage of a short-branched ligand carrying halide function enabled the fine tuning of the perovskite excitonic peak while maintaining a quantifiable Mn emission to attain white light. It has been observed that both Mn and amine ligand have a significant influence onto the perovskite structure and its white emission. The transformation of the perovskite phase from a Mn:CsPb$_2$(Cl/Br)$_5$-type with Mn:CsPb(Cl/Br)$_3$-type perovskite to Mn:CsPb(Cl/Br)$_3$-type and local Mn:Cs$_4$Pb(Cl/Br)$_6$-type presence enable to overcome the Mn-induced doping thermodynamic limit. The conservation of the perovskite white light emission was aided by SBS to mitigate environmental-induced perovskite degradation. As a proof-of-concept, we have fabricated a multicolored backlight display as well as a cool-white LED. The observed color shift is indicative of the challenge ahead for the obtention of highly sustainable single white emitter. We believe our material open the paths for the facile design and fabrication of more stable perovskite single white emitter.

**References**

1. Benas Jean-Sebastien, *PhD dissertation*, **2023**, National Taipei University of Technology, Taipei, Taiwan (R.O.C)