Perovskite and Quantum Dot Light Emitters for Next-Generation Realistic Displays

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In this talk, I will present my research to overcome fundamental limitations of light-emitting nanomaterials including metal halide perovskites and colloidal inorganic quantum dots (QDs) for their display applications.

Before 2014, room-temperature electroluminescence from metal halide perovskites was considered as almost impossible due to strong exciton dissociation at room temperature and some other reasons. We have solved this problem by identifying fundamental efficiency-limiting factors and developing two novel strategies: (1) *In-situ* fabrication of perovskite nanocrystals based on crystallization control[1] and (2) introducing quasi-2D structures with ligand-like A-site cations (Ruddlesden-Popper phase).[2,3] Those strategies led to a world-first breakthrough in brightness and efficiency of perovskite light-emitting diodes (LEDs) at room temperature, which was >20,000 times higher than control and even comparable to those of organic LEDs and QD LEDs. These works greatly stimulated PeLED research and totally changed the paradigm of display industry that focused only on organic or QD emitters.

On the other hand, precision patterning of perovskites and QDs is a critical step to fabricate displays incorporating high-color-purity color filters and LED subpixels in form of RGB matrix. However, high-resolution patterning of solution-processed perovskite and QD layers is fundamentally challenging because conventional patterning methods cannot simultaneously meet the requirements of high resolution, pattern uniformity, high throughput, and high PLQY. To overcome this challenge, we developed a direct, scalable, and nondestructive route for high-resolution patterning of QDs and QLEDs.[4] A specially designed nanocrystal ink, "photopatternable emissive nanocrystals (PEN)", consists of gradient core/shell QDs (or colloidal perovskite nanocrystals) and photosensitive additives which enable photochemically activated reactions leading to *in-situ* ligand exchange or ligand crosslinking in the QD films. Uniform electroluminescence patterns with features size down to 1 μm were demonstrated while preserving the structural, electronic and emissive properties of patterned light emitters.

References

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