Engineering of a Novel Low-Cost Hybrid Perovskite Material for Modulating LED Devices

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The light-emitting diode (LED) has shown an increase in its applications compared to traditional forms of lighting due to its energy efficiency and positive environmental impact. Commercial semiconductors (silicon and gallium arsenide) used in manufacturing LEDs exhibit complex processing, leading to high production costs. One of the most emerging photoelectric materials are metal halide perovskites, attracting considerable attention owing to their exceptional optoelectronic properties, availability, and their raw materials' ability to be processed at low temperatures, significantly reducing production costs and speed. Thus, this project aimed to engineer a novel low-cost perovskite material that can modulate light emissions in LEDs. The effect of halide (I^-, Br^-, Cl^-) content on the bandgap and emission peak wavelengths was studied. The precursor solution was prepared in a nitrogen atmosphere containing the perovskite raw materials in anhydrous DMF/DMSO to obtain the desired compositions. Perovskite films were fabricated in a spin coater and then annealed. PL, EL, UV-Vis, XRD, and SEM were used to characterize the films. As the atomic radius of the halide decreases the absorbance onset was gradually blue-shifted. The results displayed the successful achievement of three primary emissions for white LEDs; 632 nm, 534 nm, and 467 nm for red, green, and blue, respectively. Additionally, the FWHM was at most 46 nm, indicating high color purity. These outcomes showcase the effective adjustment of the bandgap to aquire precise wavelengths for thermodynamically stable perovskite-based LEDs. This cost-effective hybrid perovskite shows high potential to fabricate a white LED device from a single layer for conventional lighting applications and high-resolution color displays.

Awards Won:
King Abdulaziz &amp
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