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Nanoscale Optoelectronic Insights into CsPbBr₃: Advanced Characterization of Charge Carrier Dynamics

Cesium lead bromide (CsPbBr₃) has attracted significant attention [1] for its exceptional optoelectronic properties, including high photoluminescence yield [2] and low non-radiative lifetimes [3]. Additionally, its cost-effective synthesis methods [4] make it particularly promising for applications in light-harvesting devices like photovoltaics [5] and radiation detection [6]. However, achieving comprehensive understanding of charge carrier behavior at the nanoscale in CsPbBr₃ remains a challenge.

This study utilizes advanced high-resolution techniques, such as Kelvin probe force microscopy (KPFM), steady-state and time-resolved photoluminescence (PL and TRPL), in combination with aperture-type near-field optical microscopy (a-SNOM), to delve into properties of CsPbBr₃. A novel contribution introduced by our group is the utilization of near-field time-resolved photoluminescence measurements, which we aim to correlate with results obtained from confocal microscopes (far-field approaches such as fluorescence lifetime imaging microscopy, FLIM). KPFM measurements conducted both in darkness and under light exposure show a shift in contact potential difference, suggesting the transport of electrons from the surface. These insights provide valuable information about the spatial variability of electronic properties in CsPbBr₃, pushing the boundaries of nanoscale characterization and supporting the development of next-generation CsPbBr₃ devices. By comparing these near-field and far-field techniques, we seek to establish a comprehensive understanding of the optoelectronic properties of perovskite materials.

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