Correlative Imaging of Individual $CsPbBr_3$ Nanocrystals: Role of Isolated Grains in Photoluminescence of Perovskite Polycrystalline Thin Films

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Nanocrystalline lead halide perovskite (LHP) $CsPbBr_3$ is a highly promising advanced semiconductor with direct optical transition bright and narrow photoluminescence (PL). In comparison to conventional semiconductors – e.g., Si or Ge – the inherent ionic character of $CsPbBr_3$ allows for cheap and simple large-scale fabrication from chemical solutions [1, 2]. Moreover, decreasing the size of $CsPbBr_3$ nanocrystals (NCs) allows for precise engineering of their optical and electrical response due to the strong quantum confinement effect (QCE).

Here, we explore the role of individual $CsPbBr_3$ nano-sized isolated grains in the PL of polycrystalline thin film by correlative morphological, optical, and chemical imaging. We found a uniform stoichiometry of the grains independent of the grain size and shape. We demonstrate that the PL emission wavelength (Fig. 1a) of individual grains is governed by size-dependent QCE predictable within a simple effective mass model (Fig. 1b) [3]. Observed linear dependence between the PL intensity and the grain volume suggests a negligible role of grain boundaries in the PL dynamics. The understanding of the QCE in individual grains of $CsPbBr_3$ paves the way for their integration into more complex, band gap tunable devices including optical cavities or waveguides.

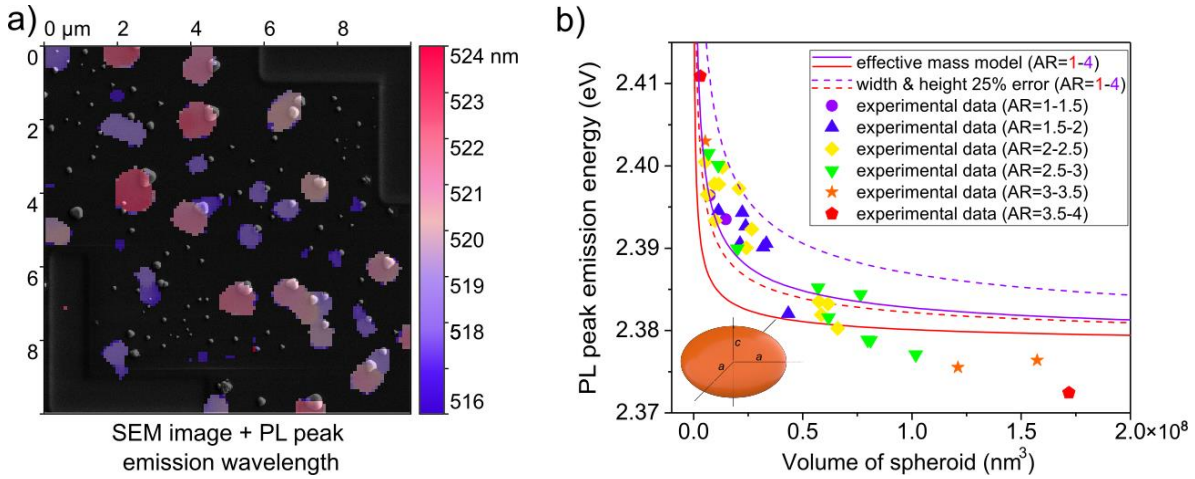

Fig. 1 a) Overlay of $CsPbBr_3$ grains SEM image and PL peak emission wavelength. b) PL peak emission energy of individual $CsPbBr_3$ grains compared to the theoretical QCE model, where a single grain is approximated by spheroid with varying AR.

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[2] G. Raino, M.V. Kovalenko, et al., *Nat. Commun.* **13**, 2587 (2022).
[3] P. Liška, T. Musálek, et al., *J. Phys. Chem. C* **127**, 25, 12404–12413 (2023).