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## PAPER

# Light-induced effects on crystal size and photo-stability of colloidal CsPbBr<sub>3</sub> perovskite nanocrystals

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## Abstract

CsPbBr<sub>3</sub> perovskite nanocrystals (PNCs) have been synthesized using the hot injection method. The CsPbBr<sub>3</sub> PNCs exhibit a high photoluminescence quantum yield (PLQY) of 73%. A comprehensive study of UV light interaction with the CsPbBr<sub>3</sub> PNCs was performed. SEM images, photoluminescence spectra, x-ray Diffraction and PLQY measurements were obtained for different time of UV exposure. The exposure to UV light modifies the crystal size (from 10 × 10 nm to 12 × 95 nm) and morphology (change from nanocubic to nanorods form). The XRD spectra show a change from tetragonal to cubic crystalline structure. In addition, the interaction of UV light modifies the optical properties of the PNCs by varying the photoluminescence. The material remains stable for a period of 1 h, however, with exposure to UV light, the PNCs show a decrement in QY from 73.3% to 46.6% after 30 days. These results indicate that light-induce variation in morphological and photo-stability of CsPbBr<sub>3</sub> PNCs.

## 1. Introduction

All inorganic halide perovskite materials have attracted attention due to their higher power conversion efficiency [1–4], excellent optoelectronic properties [5–9] and economic feasibility [10]. The typical structure of an all inorganic perovskite material is ABX<sub>3</sub>, where A corresponds to an inorganic cation which can be cesium (Cs<sup>+</sup>) and rubidium (Rb<sup>+</sup>) [11–15], B is a large inorganic cation usually Pb<sup>2+</sup>, Sn<sup>2+</sup>, or Bi<sup>3+</sup> [16–18], and X is a smaller halogen anion like chloride (Cl<sup>-</sup>), bromide (Br<sup>-</sup>) or iodide (I<sup>-</sup>) [4, 19]. Also, the all-inorganic halide perovskites has been of great interest as emissive component in light emitting diodes (LEDs) [20, 21]. Recently, Kovalenko *et al* reported all-inorganic CsPbX<sub>3</sub> based perovskite nanocrystals (PNCs) having high photoluminescence (PL) [22]. These perovskite-based nanocrystals exhibit a PL quantum yield of ~80% [23, 24]. Perovskite based nanocrystals have recently been introduced in Resistive Switching Memories, solar cells and LEDs [24–30]. A maximum efficiency of over 10% with a high open circuit voltage of 1.23 V has been reported for CsPbI<sub>3</sub> based PNCs [31]. Recently, De la Rosa's group used CsPbX<sub>3</sub> PNCs as an interface engineering material by incorporating it in between the perovskite film and hole-transporting material (HTM) leading to improved hole extraction. The device provided a power conversion efficiency of ~15% for PNCs with an appropriated band gap alignment [27, 32]. However, PNCs suffer from poor stability due to the interaction of ligands in the colloidal solution. The stability of the nanocrystals increase the optical properties and at the same time enhances the surface passivation on the surface of nanocrystals [33].

The surface passivation plays an important role in quantum dot sensitized solar cells by increasing the electron injection, with reduction in a recombination process which has been extensively studied by our group [34–37]. Similar phenomenon can be observed in perovskite solar cells; the interfacial passivation of TiO<sub>2</sub> and the perovskite surface results in enhanced charge carrier transport along with reduction in the recombination process [12, 27]. Additionally, the need of surface passivation has also been proved for light emitting diodes (LEDs) to increase their external quantum efficiency [38].