Novel Surface Passivated CsPbCl3 Perovskite Nanocrystals for UV-Photodetectors

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Solution processable UV-Photodetectors have many essential implementations in industrial, defense, and scientific research fields due to their enabling of photoconductive gain. All-inorganic cesium lead halide perovskite (CsPbX3, X = Cl, Br, and I) nanocrystals (NCs) have gained tremendous interest immediately after the pioneering work by Kovalenko's lab. Localized surface trap states on CsPbCl3 NCs is one of the main limitations precluding their optoelectronic applications. Passivation of defect sites provides an auspicious way to improve their emission properties, e.g., photoluminescence quantum yield (PLQY), and colloidal stability. This research aims to demonstrate a post-synthetic surface treatment method using trivalent metal ion salts, YCl3, that passivates those surface traps, making the NCs highly luminescent. Optical and structural characterization tools were used to understand the role of YCl3 on the surface, including the use of Transmission Electron Microscopy, steady-state UV-VIS absorption and photoluminescence (PL) spectroscopy, x-ray diffraction, and time-resolved PL spectroscopy. The PL spectroscopy was further used for the photostability test to check the PL's intensity over 14 days. The passivation approach remarkably enhanced the PLQY up to 60% and stabilized its PL intensity, while preserving the shape, size, crystal structure, and stability of the NCs. The prolongation in the average PL decay lifetime from 0.4 before treatment to 1.7 ns after treatment indicates the effective filling of the surface defects by suppressing the formation of surface non-radiative recombination pathways. These novel surface passivated CsPbCl3 NCs have potential to be utilized in photodetector applications in the future as efficient blue-emitters.

Awards Won:

NASA: Second Award of $750