Effect of the surface engineered silicon quantum dots in hybrid perovskite solar cells

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In this contribution, we will report on implementation of femtosecond (fs) laser surface engineered (SE) Si quantum dots (QDs) in perovskites. We discuss that SE Si-QDs prepared directly in DMF:DMSO colloidal solution is beneficial for room temperature photoluminescence and photovoltaic properties of perovskites hybrids. We investigated the incorporation of SE Si-QDs within two perovskites: formamidinium lead iodide ($FAPbI_3$) and the triple cation perovskite (RbMAFA)PbIBr ($Rb_{0.05}(FA_{0.83}MA_{0.17})_{0.95}PbI_{0.83}Br_{0.17}$). Contrary to as prepared Si QDs incorporated to perovskite [1], we report superior properties of solar cells made from SE Si-QDs and both $FAPbI_3$ and (RbMAFA)PbIBr hybrids. Typical device performance of $FAPbI_3$ with and without SE Si-QDs is plotted statistically in a box plot shown in Figure 1. We observed superior device performance (particularly in J_{SC}) for $FAPbI_3$ SE Si-QDs with power conversion efficiencies exceeding 17 %. We attribute the improved J_{SC} to two possible reasons: increased diffusion lengths observed in perovskite: SE Si-QD hybrids, and/or the reabsorption of carriers. We demonstrate that an introduction of SE Si-QDs in two perovskite absorbers increases overall power conversion efficiency.

[1] C. Rocks, et al., Nano Energy **2018**, 50, 245;

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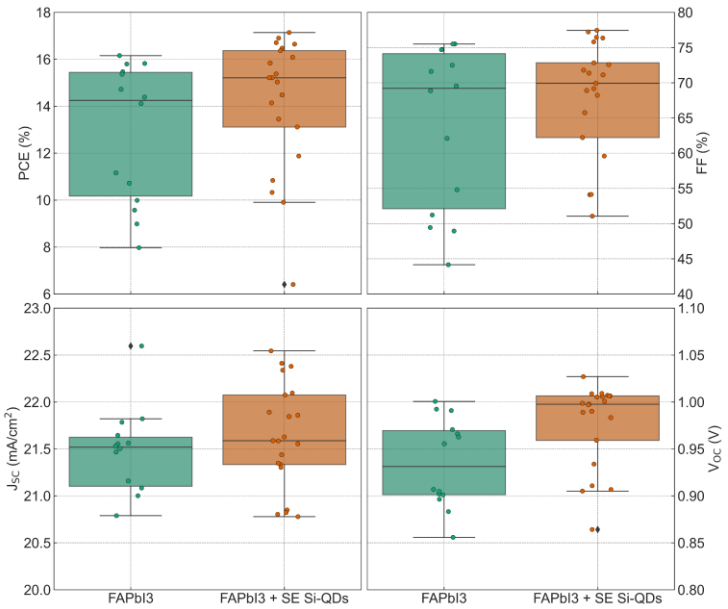

Figure 1: Typical single junction solar cell device performance shown statistically for $FAPbI_3$ and $FAPbI_3$ containing fs surface engineered Si-QDs.