Hybrid silicon quantum dots perovskites blended solar cells.

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Silicon quantum dots (Si QDs) owing to their small size (<10 nm) possess high photoluminescence efficiency (> 50 %) and size-tunable energy gap over a wide-range of solar spectra. Si QDs have marked advantages over other QDs possessing carrier multiplication, as some of these materials contain toxic elements (lead or cadmium), and others rely on elements that are in limited supply (e.g. Indium). In addition, free standing and colloidal dispersible Si QDs can be easily used for the design of new hybrid materials. Recently perovskites showed to be an attractive blending material for Si QDs particularly due to their ease of processing, band alignment, long carrier diffusion lengths and low nonradiative recombination rates. In this contribution we present comparative studies on the blending of Si QDs with zero-dimensional methylammonium iodo bismuthate (CH3NH3)3(Bi2I9) (MABI) and the most common methylammonium lead iodide (MAPbI3) perovskite. We show that both MABI and MAPbI3 perovskite can be well blended with Si QDs and allow successful coupling of their unique opto-electronic properties. Independently both composites MABi/Si QDs or MAPbI3/Si QDs films were incorporated into solar cells by showing improvements in PV performance and stability. We have assessed the influence of structural MABI and MAPbI3 dynamics over the optoelectronic properties of Si QDs. In particular, in the case of MAPbI3 perovskite, the rather wide bandgap of Si QD (2 eV) and the favorable position of HOMO and LUMO levels allows the formation of novel type-I heterojunction whereby the possibility of effective carrier extraction is demonstrated. Our investigations suggest that solar cells based on type-I alignment can offer great opportunities for QD-based solar cell developments and present a model material for future nanostructured composite third-generation photovoltaics. The specific implementation of Si QDs with two types of perovskites also appears to present synergies that can be tuned to enhance both QD and perovskite key features in general.