

Intrinsic formamidinium tin iodide nanocrystals by suppressing the Sn(IV) impurities

D. Dirin^{1,4}, A. Vivani², M. Zacharias³, T. Sekh^{1,4}, I. Cherniukh^{1,4}, M. Aebli^{1,4}, A. Wiczorek⁴, S. Siol⁴, M. Kovalenko^{1,4}, M. Bodnarchuk^{4,4}

¹ETH Zurich, ²Università dell'Insubria, Italy, ³Univ Rennes, INSA Rennes, France, ⁴Empa - Swiss Federal Laboratories for Materials Science and Technology

Lead halide perovskites successfully advance toward applications in solar cells, light-emitting devices, and high-energy radiation detectors. Recent progress in understanding their uniqueness highlights the role of optoelectronic tolerance to intrinsic defects, particularly long diffusion lengths of carriers, and highly dynamic 3d inorganic frameworks. This picture indicates that finding an analogous material among non-group-14 metal halides can be very challenging, if possible at all. On the other hand, a judicious choice of chemistry made it possible to noticeably increase the performance of formamidinium tin iodide perovskites when integrated into thin-film photovoltaic devices. The main challenge with this material originates from the easiness of the trap states generation, which is typically ascribed to the oxidation of Sn(II) to Sn(IV). In this work, we describe the synthesis of colloidal monodisperse FASnI₃ NCs, whereby thorough control of the purity and redox chemistry of the precursors allows the concentration of Sn(IV) to be reduced to an insignificant level, to probe the intrinsic structural and optical properties of these NCs. Intrinsic FASnI₃ NCs exhibit unusually low absorption coefficients of $4 \cdot 10^3 \text{ cm}^{-1}$ at the first excitonic transition, a 190 meV increase of the bandgap as compared to the bulk material, and a lack of excitonic resonances. These features are attributed to a highly disordered lattice, distinct from the bulk FASnI₃ as supported by structural characterizations and first-principles calculations.

