Area: Perovskite solar cells.

ECO-FRIENDLY BISMUTH HALIDE, AG-BI AND CU-BI BASED LIGHT ABSORBING MATERIALS FOR LEAD FREE PEROVSKITE SOLAR CELLS

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Hybrid organic-inorganic lead halide perovskite based solar cells have attracted enormous research attention due to its exceptional optoelectronic properties such as long carrier diffusion length, ambipolar charge mobility, photon recycling capability, direct band gap etc., and sky rocketing efficiency with recent record of 22.1% certified efficiency. Despite of several advantages, lead perovskite suffers from long term stability and upon degradation; lead iodide (one of its starting material), which is highly toxic, is exposed to human environment resulting in severe damage to human’s reproductive and nervous system. Tin (Sn) based perovskites solar cells have been shown to exhibit moderate performance. However, the rapid oxidization of Sn, from +2 to +4 oxidation state when exposed to environment and self doping effect limits its further use. Also, toxicity concern of Sn based perovskite has been raised. Therefore use of alternate eco-friendly perovskite/non-perovskite materials having similar optoelectronic properties with that of lead perovskite is of utmost importance.

Recently use of methylammonium iodobismuthates (MBI) in photovoltaic devices has shown promising stability when exposed to environment but the efficiency is far behind its lead based counterparts. Interestingly bismuth iodide (BiI₃) is one of the precursor materials which are used in the synthesis of MBI and it belongs to layered heavy metal semiconductor group and possesses interesting optoelectronic properties. Also, the band gap of BiI₃ (~1.73 eV) is smaller than MBI (~2.1 eV) indicating its suitability for single junction and/or tandem solar cell. This present talk will discuss about the use of bismuth halide as a light absorbing material and its optoelectronic properties. Also, we present tuning of morphology and crystal orientation with the processing temperature in mesoporous TiO₂ structured configuration device and its effect on photovoltaic performance as shown in Fig. 1. We also highlight the use of several silver bismuth (Ag-Bi) and copper bismuth (Cu-Bi) based perovskite materials, its optoelectronic, physiochemical properties and its suitability in device architecture. We will present the results of our ongoing assessment for these new Ag-Bi and Cu-Bi based materials in aspects of short-circuit current (Jsc) improvement and cell stability against moisture, preservation, heat and light illumination.

Figure 1: Current density-voltage characteristic curve of BiI₃ processed at different temperature.