鉛フリービスマスペロブスカイト太陽電池の電気化学性能に関する研究

Electrochemical performance of Pb-free Bi-based perovskite solar cells

九工大生命体

Chunfeng Lan, Chu Zhang, Tingli Ma*

E-mail: tinglima@life,kyutech.ac.jp

Halide perovskites have many excellent optical properties, such as suitable bandgaps and small effective mass, making them excellent absorption materials for solar cells.[1-3] The power conversion efficiency (*PCE*) of halide perovskite solar cells has sharply increased to 22.1%.. However, they are still facing several serious drawbacks, such as the degradation of perovskite and lead pollutions. Bismuth compounds can be potential candidates to solve the lead-pollution for future perovskite solar cells. Lead-free bismuth compounds, such as Bi_2CrFeO_6, BiI_3 and $A_3Bi_2I_9$ perovskites (A = CH_3NH_3, Cs), have attracted much attention for photovoltaic applications.

We developed a new method to tune the optical properties of lead-free materials by composite the BiI3 and MBI perovskite for solar cell applications. The active layers of $(BiI_3)_{1-x}$(MBI)x showed the gradient in the colors, crystallization and surface morphologies. The introduction of the MBI into BiI3 resulted in a phenomenon of multi-absorption, which affected their photovoltaic performance. Compared with the BiI_3 solar cells and MBI perovskite solar cells, some (BiI_3)1-x(MBI)x composite solar cells exhibited an optimized photovoltaic output. Particularly, the Voc and PCE of the $(BiI_3)_{0.8}(MBI)_{0.2}$ composite solar cells were significantly improved from 0.44 to 0.57 V and from 0.045% to 0.076%, respectively. This phenomenon was mainly attributed to two reasons. One was the enhanced crystallization and improved coverage of BiI_3 after the small amount introduction of MBI, which effectively reduced the recombination. The other was the band bending at the BiI3-MBI interfaces in the composites, which optimized the energy level matching between the absorbing layers and TiO_2 and lead to the more efficient electron injection from the absorbing layers to TiO_2. Our results indicated that the properly-designed composites of lead-free materials with different absorptions and energy levels can be an effective strategy to design new solar cells.

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Reference

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