Development of High Efficiency Robust Perovskite Solar Cells

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Nonrenewable energy sources including coal, oil, natural gas, nuclear and fossil fuels have two big problems as they produce pollution, climate change and nuclear wastes. They will be consecutively exhausted in the future. Thus, it is urgent to find alternative renewable energy sources such as wind, hydro, biofuels and solar energy. Conversion of solar energy into electricity by photovoltaics is one of the most important approaches to solve the energy problem [1].

However the first two generationsof photovoltaics including single crystalline Si solar cells and thin film solar cells have high efficiency and long-term stability, they possess disadvantages. Obtaining highly efficiency silicon solar cells needs expensive purification process. Thin film CIGS solar cells use rarely available indium, while CdTe solar cells use toxic Cadmium.

The third generation of photovoltaics is dependent on nanotechnology as dyesensitized solar cells (DSSCs) and polymer solar cell (PSCs) both use nanomaterials or nanostructures. The highest power conversion efficiencies (PCEs) recorded for DSSCs and PSCs are 13% and 11%, respectively [2-3].

Organic-inorganic hybrid Perovskite $CH_3NH_3PbX_3$ (X = Br, I) was discovered by Miyasaka et al. in 2009. Since then, Perovskite solar cells have gained extensive attention [4]. The most recent development in the organo metal trihalide perovskite (e.g., $CH_3NH_3PbI_3$) solar cells shows great promise as a third generation PV device. Efficiencies up to 17.9% have been reported which are comparable with traditional thin film solar cells including CIGS and CdTe solar cells [2].

The objectives of my research project are to develop high efficiency, robust, and lead-free single junction Perovskite solar cells, integration to polymer solar cells for hybrid tandem Perovskite/polymer solar cells, and better understand device working principles with particular focus on the interfacial charge transport and recombination process. Also, my research will focus on synthesis or modification of transparent conducting polymers (e.g., PEDOT:PSS) that act as hole transport layers.

References

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