Progress in Halide Perovskite Solar Cells

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The general formula AMX_3 of inorganic-organic hybrid perovskite materials (A: organic cation, methylammonium (MA) or formamidinium (FA), M: metal, X: halide anion, Br, I) exhibits beneficial properties for high-performance photovoltaic systems such as a suitable band gap (1.5 - 1.4 eV), high absorption coefficient (10^4 - 10^5 cm^{-1}), low exciton binding energy (< 50 meV), and long charge-carrier diffusion length (~175 μm). In addition, these materials exhibit easy crystallization at low-temperature by solution processing, resulting in their low cost. Based on above distinct properties of perovskite materials, we have designed a new photovoltaic platform for efficient perovskite solar cells (PSCs). The performance has been remarkably increased to more than 22 % by introducing a mediator to retard the rapid crystallization between organic cations and PbI_2, and manipulate the chemical composition of the perovskites via solvent engineering, intramolecular exchange process, and defect engineering, making these routs attractive for attaining low-cost and high-performance devices. Although perovskite solar cells have improved efficiency in the short term, a variety of problems such as long-term stability, the use of non-toxic materials, and large-area modularization must be addressed for commercialization. In this presentation, I will introduce our progress to improve the efficiency and long-term stability of PSCs.