

Study of light-induced charge transfer effect in organometal halide perovskite photodetector by in situ x-ray absorption spectroscopy

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Abstract

The investigations in the novel layered Methylammonium lead halide perovskite-based solar cells is fundamental to fully exploit the possibilities of application. One-step spin coating procedure successfully deposited 500nm MAPbI₃ polycrystalline thin film on a glass substrate by controlling the coating speed. Au film was deposited as electrodes on to the typical MAPbI₃ flake photoconductive device by thermal evaporation in order to make a well physical (metal-semiconductor) contact and to improve the device performance. An insulating, transparent, and low photosensitive PMMA protective layer covered the easily decomposable hybrid perovskite film. The device showed good photoresponse under 1 sun (100mW) illumination. The estimated bandgap 1.6 eV from the UV-Visible measurements and the observed internal electric field from the PL spectral response agrees well with the early reports. The mechanism of the photoelectron reactions and interactions of charge-carriers was analyzed based on the in situ X-ray absorption spectroscopy (XAS) technique, which clearly shows that the Methylammonium and I ions simultaneously participate in the charge transfer effect with a slight lattice distortion of the octahedra. Moreover, the C and N K-edge XAS revealed the electronic structural properties and discovered the mobile electron in the organic Methylammonium layer that would play a key role for efficient charge extraction and electron transport under 1 sun illumination of the organometal halide perovskite photodetector flake. The overall results from the in situ XAS study demonstrate a different perspective from the currently existing knowledge on these kinds of photovoltaic material and is expected to be a viable candidate for the application.