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Performances and Electrical Properties of Vertically Aligned Nanorod Perovskite Solar Cell

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Organolead halide perovskite have attracted much attention over the past three years as the third generation photovoltaic due to simple fabrication process via solution process and their great photovoltaic properties. Many structures such as mesoporous scaffold, planar heterojunction or 1-D TiO2 or ZnO nanorod array structures have been studied to enhance performances. And the photovoltaic performances and carrier transport properties were studied depending on the cell structures and shape of perovskite film. For example, the perovskite cell based on TiO2/ZnO nanorod electron transport materials showed higher electron mobility than the mesoporous structured semiconductor layer due to 1-D direct pathway for electron transport. However, the reason for enhanced performance was not fully understood whether either the shape of perovskite or the structure of TiO2/ZnO nanorod scaffold play a dominant role. In this regard, for a clear understanding of the shape/structure of perovskite layer, we applied anodized aluminum oxide material which is good candidate as the inactive scaffold that does not influence the charge transport.

We fabricated vertical one dimensional (1-D) nanostructured methylammonium lead mixed halide perovskite (CH3NH3PbI3-xClx) solar cell by infiltrating perovskite in the pore of anodized aluminum oxide (AAO). AAO template, one of the common nanostructured materials with one dimensional pore and controllable pore diameters, was successfully fabricated by anodizing and widening of the thermally evaporated Al film on the compact TiO2 layer. Using AAO as a scaffold for perovskite, we obtained 1-D shaped perovskite absorber, and over 15% photo conversion efficiency was obtained. I-V measurement, photoluminescence, impedance, and time-limited current collection were performed to determine vertically arrayed 1-D perovskite solar cells shaped in comparison with planar heterojunction and mesoporous alumina structured solar cells. Our findings lead to reveal the influence of the shape of perovskite layer on photoelectrical properties.

Keywords: AAO, anodized aluminum oxide, perovskite solar cell, organolead perovskite, thermally evaporated Al film