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Surface Modification of TiO_2 for Efficiency Enhancement in Perovskite Solar Cells

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Surface modification of titanium dioxide (TiO_2) substrates was performed to enhance efficiency of perovskite solar cells efficiency by inserting small organic molecules between TiO_2 electron transporting layer and $CH_3NH_3PbI_3$ perovskite layer. TiO_2 substrates were immersed into a solution of amino propionic acid (APA) or amino benzoic acid (ABA) in order to tune up and improve surface quality which leads to changes in PbI_2 and $CH_3NH_3PbI_3$ perovskite morphology and structure. Fourier transform infrared spectroscopy (FTIR), field-emission scanning electron microscopes (FE-SEM), X-ray diffraction (XRD) and open-circuit voltage-decay (OCVD) were performed to characterize material and device properties. It was found that introduced organic molecules change the PbI_2 precursor morphology which attributes to different trend of efficiency enhancement. Small cracks spreading through PbI_2 film coated on TiO_2/APA were observed. These cracks promote PbI_2 transformation to $CH_3NH_3PbI_3$ perovskite when reacts with CH_3NH_3I. The device with APA treatment show the improvement in power conversion efficiency from 6.23% for untreated TiO_2 condition to 7.78%. In addition, the OCVD analysis revealed that charge carrier lifetime of APA-treated device is significantly longer than that of the untreated device. These imply that this simple surface modification by small organic molecules could improve efficiency of perovskite solar cells.

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