Air-Stable, Hole-Contuctor-Free High Photocurrent Perovskite Solar Cells with $CH_3NH_3PbI_3$-NiO Nanoparticles Composite

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Here, we report an air-stable, hole-conductor-free (HCF), high photocurrent PSC based on $CH_3NH_3PbI_3$-NiO nanoparticles ($MAPbI_3$-NiO NPs) composite. The composite solution contains highly dispersed NiO NPs in solution of CH_3NH_3I (MAI) and PbI_2 in dimethylformamide. By introducing the $CH_3NH_3PbI_3$-NiO composite into the active layer, the HCF-PSCs with FTO/c-TiO_2/mp-TiO_2/$MAPbI_3$-NiO/Au architecture have been fabricated under ambient conditions. Compared to the power conversion efficiency (PCE) of $MAPbI_3$-based HCF-PSC (i.e., 5.43%), the $MAPbI_3$-NiO NPs composite-based HCF-PSC showed a high PCE of 12.14 %. More interestingly, the composite-based HCF-PSCs without encapsulation showed remarkable air stability with retaining ~90 % of its original PCE and ~94% of both Jsc and FF for 60 days under ambient environment. XPS and IR spectra analysis revealed that Ni-O, Pb-O, C-O, Ni-N and N-NiO bonds attributed to strong chemical interaction between NiO and $MAPbI_3$ molecules enhance the air stability of $MAPbI_3$-NiO composite based HCF-PSCs.