High Performance Quasi-2D Ruddlesden-Popper Perovskite Solar Cells

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Abstract:

Quasi-2D Ruddlesden-Popper perovskites (RPPs) materials have attracted enormous attention due to their great stability and structural diversity.[1] Although photovoltaic devices based on these materials have experienced a dramatic increment in power conversion efficiency (PCE),[2] their current performances are still lower than traditional 3D perovskite devices.[3] In this study, we report an inverted quasi-2D Ruddlesden-Popper perovskite solar cell (PSC) employing an organic spacer 4-Fluoro-Phenethylammonium (4FPEA). To enhance PCE, an optimal concentration of self-assembled monolayer (SAM), [2-(3,6-dimethoxy-9H-carbazol-9-yl) ethyl] phosphonic acid (MeO-2PACz), was utilized to improve the wettability of poly [bis (4-phenyl) (2,4,6-triMethylphenyl) amine] (PTAA) hole transport layer. Meanwhile, the good band alignment of PTAA/MeO-2PACz/4FPEA quasi-2D perovskite minimized recombination loss at interface, considerably improving charge transport efficiency and device performance. Accordingly, the champion quasi-2D device based on $(4FPEA)_2(MA)_3Pb_4I_{13}$ with a PCE of 17.41% was successfully obtained, compared to the control device without MeO-2PACz treatment, which achieved an efficiency of 15.13%. Moreover, the optimized device also showed good performance under indoor illumination. The maximum efficiency of 31.15% and 28.39% were exhibited under 1000 lux and 500 lux 6500K LED illumination, respectively. This proposed optimization offers new insights into the quasi-2D Ruddlesden-Popper PSCs for indoor application.

Conflicts of Interest

There is no conflict of interest.

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