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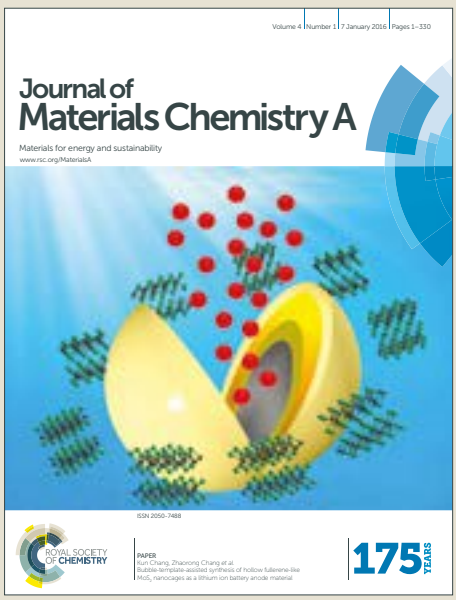

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TiO_2 Embedded Structure for Perovskite Solar Cells with Anomalous Grain Growth and Effective Electron Extraction

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Abstract

The structure of the perovskite solar cells (PSCs) is either mesoporous or planar. Here, a novel structure for highly-efficient and stable PSCs is proposed, i.e., the embedded structure, which combines the advantages of the mesoporous and planar structures. The embedded structure utilizes TiO_2 nanoparticles embedded perovskite ($CH_3NH_3PbI_3$) film as the absorption layer. The presence of TiO_2 nanoparticles in perovskite film could improve the electron extraction, and promote the formation of a compact perovskite layer with large grains. Consequently, the performance of the PSCs is significantly improved with the efficiency increasing from 16.6% for planar structure to 19.2% for the embedded structure, which is the best performance of the $MAPbI_3$-based PSCs. Furthermore, the TiO_2 embedded perovskite films present better long-term stability than the pristine perovskite films, and the corresponding PSCs, which have no any other chemical modifications, also show excellent stability with efficiency keeping approach 80% (for average) or 90% (for the best) after being exposed in air for 28 days without encapsulation.

Introduction

Organic-inorganic halide perovskite solar cells (PSCs) possess the advantages of low-cost and high performance, especially the power conversion efficiency (PCE).[1-6] The outstanding performance of the PSCs both relies on the perovskite itself and the device structure. The structure of the PSCs is either mesoporous or planar, according to with or without mesoporous scaffold layer. [7, 8]