Morphology Engineering of Low-Temperature Processed Electron Transport Layer for Pursuing High Performance Perovskite Photovoltaic

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Abstract

Perovskite solar cells (PSCs) have become one of the most promising renewable energy converting devices. However, in order to reach a sufficiently high power conversion efficiency (PCE), the PSCs typically require a high-temperature sintering process to prepare mesostructured TiO_2 as an efficient electron transport layer, which prohibits the PSCs from commercialization in the future. This work investigates a low-temperature synthesis of TiO_2 nanocrystals and introduces a novel two-fluid spray coating process to produce a nanostructured electron transport layer for the following deposition of perovskite layer. The temperature during the whole deposition process can be maintained under 150 ^oC. Compared to the typical planar TiO_2 layer, the perovskite layer fabricated on a nanostructured TiO_2 layer shows uniform compactness, preferred orientation, and high crystallinity, leading to reproducible and promising device performance. The detail mechanisms are revealed by contact angle test, morphology characterization, GIWAXS measurement, and SCLC analysis. An averaged efficiency of 19.87% with the champion device showing the efficiency of 21.36% could be achieved. It is worth noting that the temperature for the entire fabrication process can be maintained below 150 ^oC. The efficiency can maintain over 80% of its original value after 3000 hr storage in ambient atmosphere. Our report suggests a low-temperature large-scalable process to obtain high-performance perovskite photovoltaic, paving the way for future commercialization.

Keywords - perovskite, solar cell, TiO_2, spray coating, morphology.