Low-Temperature Hole-Transport Layers' Investigation for Inverted Flexible Perovskite Solar Cells

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Abstract

Halide perovskite (HP) photovoltaics (PV) demonstrate remarkable efficiency exceeding 26% for terrestrial applications. HP semiconductors demonstrate a unique combination of optical and transport properties in micro-crystalline thin films: diffusion length (>1 μm), lifetime (up to 1 ms), and direct-bandgap structure. The potential of perovskite solar cells lies in their ability to be fabricated on glass or plastic substrates, offering advantages such as lightweight, portability, and suitability for integration on curved surfaces. Although technologies for flexible solar cells based on silicon, cadmium-tellurium (CdTe), and copper-indium-gallium selenide (CIGS) exist, there is no well-developed and widespread approach for perovskite-based flexible solar cells (SC). One of the key challenges in designing flexible SC is the necessity for low-temperature conductive layers due to the limited thermal stability of plastics (< 150 ℃). This demands meticulous fabrication of charge transporting layers and absorber films to maintain high output performance. Particularly, modification of highly efficient hole transporting thin films based on Nickel oxide or application of organic conductive layers can be used. In this work we made a complex investigation for the variation of hole-transport layers with organic conductive material MeO-2PACz deposited by spin coating and explored NiO_x deposition using ion-beam sputtering – the oxidation of dispersed nickel particles, followed by post-treatment annealing at a temperature of 120 ℃. The impact of the HTL type on the output characteristics of flexible solar cells was estimated under the light of a solar simulator. The benefits of the used methods of growth flexible HP solar cells were discussed.

Keywords

Flexible Perovskite Solar Cells, Low-Temperature Manufacturing, Hole-Transport Materials, Ion-Beam Sputtering