Effect of crystallization strategies on CH3NH3PbI3 perovskite layer deposited by spin coating method: Dependence of photovoltaic performance on morphology evolution

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Effect of Crystallization Strategies on $CH_3NH_3PbI_3$ Perovskite Layer Deposited by Spin Coating Method: Dependence of Photovoltaic Performance on Morphology Evolution

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Absract

In this paper, the effects of humidity, annealing temperature and deposition method including one step method, sequential deposition rout and hot casting technique are investigated on the morphology of perovskite layer. The optimal conditions for deposition of perovskite layers are introduced. Formation and growth of $CH_3NH_3PbI_3$ perovskite crystals by these procedures leads to completely different crystal shapes and sizes and as a result different cell efficiency and environmental stability. Humidity and annealing temperature have great effect on the morphology of perovskite layer in one step method. It was found that in one step method by increasing the humidity from less than 10% to ~40% (during spin coating and annealing the $CH_3NH_3PbI_3$ perovskite) morphology of the spin coated layer evolves from mostly ribbon shape with a large number of voids to layers comprising hollow fibers. However increase of the annealing temperature from 100 to 140 °C results in decreasing the diameter of the formed hollow fibers. In hot casting technique, by controlling the casting temperature, a very compact flat layer including lotus leaf-like morph with fewer pinholes can be created. Cells fabricated using $CH_3NH_3PbI_3$ cuboid crystals grown by sequential deposition rout showed the highest photocurrent and power conversion efficiency (4.8%). However deposited layers via sequential deposition rout and then the cells fabricated using them are not chemically as stable as those prepared by one step method for long time performance due to humidity induced degradation of large crystal of $CH_3NH_3PbI_3$ to smaller size.

Keywords: Crystal growth; Perovskite solar cell; Photovoltaic performance; Spin coating; Morphology evolution.

Introduction

In recent years organic-inorganic hybrid perovskites which have been previously used in field-effect transistors and light emitting diodes [1,2], have found many uses in conversion of photons energy to the electricity [3-9]. Low cost and appropriate energy gap perovskite hybrid materials, especially $CH_3NH_3PbX_3$ (X=Cl, Br, I), have attracted a lot of attention in