

Improved Morphology in Sequential Deposition of the Inverted Type Planar Heterojunction Solar Cells Using Cheap Additive (DI-H₂O)

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Abstract : Hybrid halide Perovskites with the general formula ABX₃, where X = Cl, Br or I, are considered as an ideal candidates for the preparation of photovoltaic devices. The most commonly and successfully used hybrid halide perovskite for photovoltaic applications is CH₃NH₃PbI₃ and its analogue prepared from lead chloride, commonly symbolized as CH₃NH₃PbI_{3-x}Cl_x. Some researcher groups are using lead free (Sn replaces Pb) and mixed halide perovskites for the fabrication of the devices. Both mesoporous and planar structures have been developed. By Comparing mesoporous structure in which the perovskite materials infiltrate into mesoporous metal oxide scaffold, the planar architecture is much simpler and easy for device fabrication. In a typical perovskite solar cell, a perovskite absorber layer is sandwiched between the hole and electron transport. Upon the irradiation, carriers are created in the absorber layer that can travel through hole and electron transport layers and the interface in between. We fabricated inverted planar heterojunction structure ITO/PEDOT/ Perovskite/PCBM/Al, based solar cell via two-step spin coating method. This is also called Sequential deposition method. A small amount of cheap additive H₂O was added into PbI₂/DMF to make a homogeneous solution. We prepared four different solution such as (W/O H₂O, 1% H₂O, 2% H₂O, 3% H₂O). After preparing, the whole night stirring at 60°C is essential for the homogenous precursor solutions. We observed that the solution with 1% H₂O was much more homogenous at room temperature as compared to others. The solution with 3% H₂O was precipitated at once at room temperature. The four different films of PbI₂ were formed on PEDOT substrates by spin coating and after that immediately (before drying the PbI₂) the substrates were immersed in the methyl ammonium iodide solution (prepared in isopropanol) for the completion of the desired perovskite film. After getting desired films, rinse the substrates with isopropanol to remove the excess amount of methyl ammonium iodide and finally dried it on hot plate only for 1-2 minutes. In this study, we added H₂O in the PbI₂/DMF precursor solution. The concept of additive is widely used in the bulk- heterojunction solar cells to manipulate the surface morphology, leading to the enhancement of the photovoltaic performance. There are two most important parameters for the selection of additives. (a) Higher boiling point w.r.t host material (b) good interaction with the precursor materials. We observed that the morphology of the films was improved and we achieved a denser, uniform with less cavities and almost full surface coverage films but only using precursor solution having 1% H₂O. Therefore, we fabricated the complete perovskite solar cell by sequential deposition technique with precursor solution having 1% H₂O. We concluded that with the addition of additives in the precursor solutions one can easily be manipulate the morphology of the perovskite film. In the sequential deposition method, thickness of perovskite film is in μm and the charge diffusion length of PbI₂ is in nm. Therefore, by controlling the thickness using other deposition methods for the fabrication of solar cells, we can achieve the better efficiency.

Keywords : methylammonium lead iodide, perovskite solar cell, precursor composition, sequential deposition

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