

AGING STUDY OF ENCAPSULATED CARBON-BASED PEROVSKITE SOLAR CELLS UNDER DAMP-HEAT CONDITIONS

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Abstract

Recently, organometallic hybrid perovskite materials, such as MAPbX_3 ($\text{MA} = \text{CH}_3\text{NH}_3^+$, $\text{X} = \text{I}$) are experiencing a real progress for solar cell applications. Due to particularly interesting properties: adaptable band gap, high crystallinity, high charge transport capacity and high thin film efficiency, these materials have the potential to exceed the performance limits of current technologies. They also combine a low cost and processing versatility. Among alternative device structures, carbon-based perovskite solar cells (CPSCs) look highly promising due to their low cost and abundantly available materials (TiO_2 , ZrO_2 , carbon black and graphite powders), cost-efficient scalable fabrication methods and the inherent high stability. A one step $\text{CH}_3\text{NH}_3\text{PbI}_3$ perovskite solution was pipetted to infiltrate mp- TiO_2 /mp- ZrO_2 through a thick porous carbon layer^{1,2}. In order to reveal their maximum photovoltaic performance, these devices should be matured under humidity and temperature. This step lasts of approximately 100-150 h improves of the cell's performance. To further investigate their stability, aging campaigns at 85°C/85%RH have been conducted during 1000h. The macroscopic observations show an inhomogeneous degradation of the perovskite layer, the interfaces and the electrodes, mainly located at these edges². This inhomogeneity probably results from the pipetting process used to infiltrate the perovskite. This was confirmed by the variation of PV parameters during aging, which showed an important decrease in performance close to 50% after 1000h of aging. In this study a basic encapsulated system based on glass and a surlyn gasket was used, enabling the humidity permeation up to solar cells and inducing probably an accelerated degradation of devices. Thanks to dedicated characterization techniques, such as laser beam induced current (LBIC) measurements and photoluminescence imaging, the local performances have been correlated to the degradation inhomogeneity. The modifications of perovskite layer have been evaluated with others more common techniques (X-Ray diffraction, UV-Vis absorption and photoluminescence spectroscopy). Thanks to this multiscale approach, a degradation mechanism could be proposed highlighting the role playing by the maturation step. Today, others technological solutions are tested such as the inkjet printing for the perovskite infiltration and more advanced encapsulation system, to improve the stability of these PV devices.

References

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