The Impact of Moisture Ingress on Encapsulated Carbon Based Perovskite Cells

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Abstract:

The perovskite cells technology has experienced a rapid development within the last nine years, reaching 25.5% efficiency[1]. For the improvement of the initial instability of the devices, modification of the different layers and interfaces within the cell has been considered. Among the mentioned adjustments, the golden electrode was replaced by carbon, which is a highly hydrophobic material, for the protection of the cells against moisture ingress[2]. However, an additional encapsulation is required, as the perovskite layer is critically sensitive to moisture[3].

The purpose of this work is to investigate the degradation mechanisms due to moisture in carbon based perovskite (c-PSC) cells, when exposed to damp-heat conditions (85% RH / 85 °C). Varied encapsulation concepts were examined, including glass-backsheet and glass-glass structures, with or without edge sealant. Defective devices with glass breakage were also considered, for the evaluation of the moisture ingress. The encapsulant assessed was ionomer, while the backsheet evaluated was a gas barrier polymer film. Polyisobutylene (PIB) with desiccant was applied as edge sealant. The electrical characterisation methods utilised for the assessment of the degradation were J-V measurements, photoluminescence (PL) imaging, light beam induced current (LBIC) mapping and Impedance Spectroscopy under illumination. The results (Figure 1) indicate that the encapsulated, without defects, c-PSC cells reached T_{80} = 1000 hours (time needed for the cell to reach 80% of the initial efficiency).

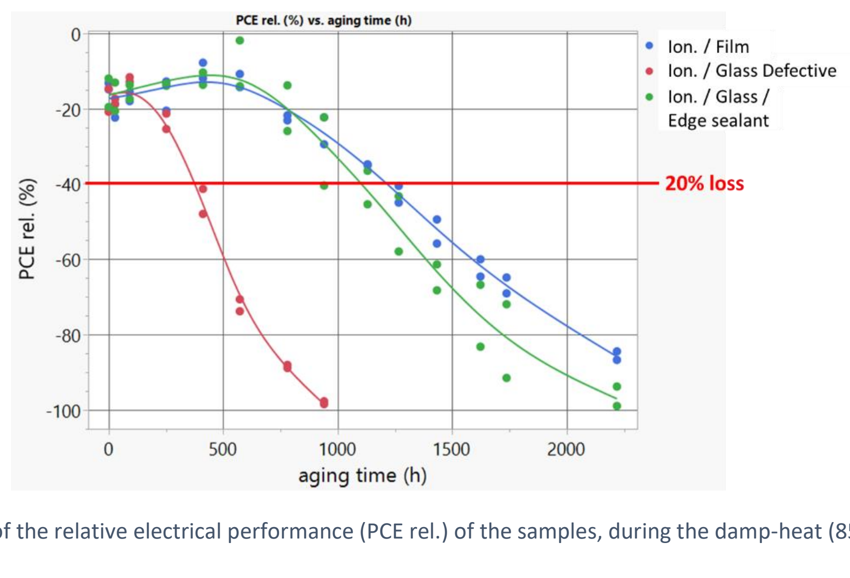

Figure 1 Evolution of the relative electrical performance (PCE rel.) of the samples, during the damp-heat (85% RH / 85 °C) aging.

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[1] NREL, "Best Research-Cell Efficiency Chart." https://www.nrel.gov/pv/cell-efficiency.html (accessed Jan. 26, 2021).

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[3] G. Niu, X. Guo, and L. Wang, "Review of recent progress in chemical stability of perovskite solar cells," J. Mater. Chem. A, vol. 3, no. 17, pp. 8970–8980, 2015, doi: 10.1039/C4TA04994B.