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**Abstract**

A hermetic encapsulation is required to protect perovskite solar cells (PSCs) from the most common sources of degradation – humidity and oxygen [1]. According to PV standard tests such as IEC61646, photovoltaic devices must be stable at the temperature range of -40 °C to 85 °C and relative humidity of 85 % [2]. Therefore, to achieve the mentioned requirements, the PSCs should be fabricated with thermally stable layers and protected by a long term stable hermetic encapsulation. Laser-assisted glass frit encapsulation has been successfully used to achieve long-term stability for PSCs with n-i-p and HTM-free structures [3,4]. The laser-sealing can be achieved with a single laser beam or dual laser beams. The advanced novel dual laser beam glass frit sealing was previously developed and optimized to hermetically encapsulate n-i-p PSCs at 65 ± 5 °C for a short time of < 60 s [3]. In contrast, for HTM-Free devices the only report is on single laser beam encapsulation at 100 ºC for a long time of 35 min [4]. In this present work, the application of dual laser beam sealing for HTM-free PSCs fabricated with (5-AVA)0.05(MA)0.95PbI3 perovskite is studied. During the laser-sealing process, the cells were subjected to 65 °C for a short time of < 85 s.

The previously reported single beam sealing of HTM-free PSCs at 100 ºC, caused slight decrease in the performance of the devices, due to long thermal exposure during the encapsulation process [4]. In the present work, the average power conversion efficiency (PCE) of the PSCs increased from 6.13 % ± 0.63 % to 6.20 ± 0.40 % after the encapsulation process at 65 °C with dual laser beam method. The improvement of the performance was due to major increase in the *JSC* from 13.84 ± 1.01 to 15.48 ± 1.46 mA cm-2. For FF, there was a slight increase from 0.61 ± 0.02 to 0.62 ± 0.09. However, the *V*oc decreased from 0.72 ± 0.03 to 0.66 ± 0.06. The variations in *V*oc and *J*sc are assigned to re-crystallization of the perovskite absorber at the TiO2 and Carbon layer, respectively. Recrystallization at the carbon contact caused improved charge transfer, therefore increasing the current. However, at the TiO2 scaffold the recrystallization led to the reduction of the *V*oc which was assigned to partial crystal decomposition. In conclusion, this work indicates that a dual laser sealing has a low impact on the performance of the sealed devices. Further stability studies will be taken to prove the hermicity of the sealing.