Ambient Temperature Graphene Paste for Large-Area Carbon Perovskite Solar Cells: Towards Wafer-Like Concepts

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Perovskite Solar Cells (PSCs) have recently shown a power conversion efficiency (PCE) exceeding 25% [1]. In order to enter the market, it is mandatory to upscale the PSC technology to large-area substrates (> 100 cm^2) by means of industrial manufacturing methods. In this context, PSCs using carbon-based counter electrodes (C-CEs), namely carbon perovskite solar cells (C-PSCs), promise to provide a viable cost-effective device configuration while mitigating instability issues, such as gold ion migration toward either the hole-transporting layer (HTL) or the perovskite [2] in the conventional PSCs. In this work, we propose efficient printable C-PSCs fabricated by depositing a low-temperature-processed graphene-based carbon paste atop prototypical mesoscopic and planar n–i–p structures. Small-area (0.09 cm^2) mesoscopic C-PSCs reach a PCE of 15.81% [3]. The proposed graphene-based C-CEs can be applied to large-area (1 cm^2) mesoscopic devices and low-temperature-processed planar n–i–p devices, exhibiting PCEs of 13.85 and 14.06%, respectively [3]. These PCE values are amongst the highest reported for large-area C-PSCs in the absence of back-contact metallization or additional stacked conductive components or a thermally evaporated barrier layer between the charge-transporting layer and the C-CE. In order to fabricate large-area devices, the addition of metal grids allows the PCE of wafer-like area solar cells to get closer to that of small-area devices [4]. From this perspective, we present a proof-of-concept of metallized miniwafer-like area C-PSCs (substrate area = 6.76 cm^2, aperture area = 4.00 cm^2) that achieve a PCE on active area of 13.86% and a record-high PCE on aperture area of 12.10% [3]. First, this result proves the metallization compatibility with our C-PSCs for the realization of large-area PSCs. Secondly, monolithic wafer-like area C-PSCs represent feasible all-solution-processed configurations that are more reliable than prototypical perovskite solar modules based on the serial connection of subcells [5]. In fact, their fabrication does not involve laser ablation-based patterning techniques for subcell separation. Meanwhile, monolithic wafer-like PSCs intrinsically mitigate hysteresis-induced performance losses and hot-spot-induced irreversible material damage caused by reverse biases in serial perovskite solar module configurations

References

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Figures

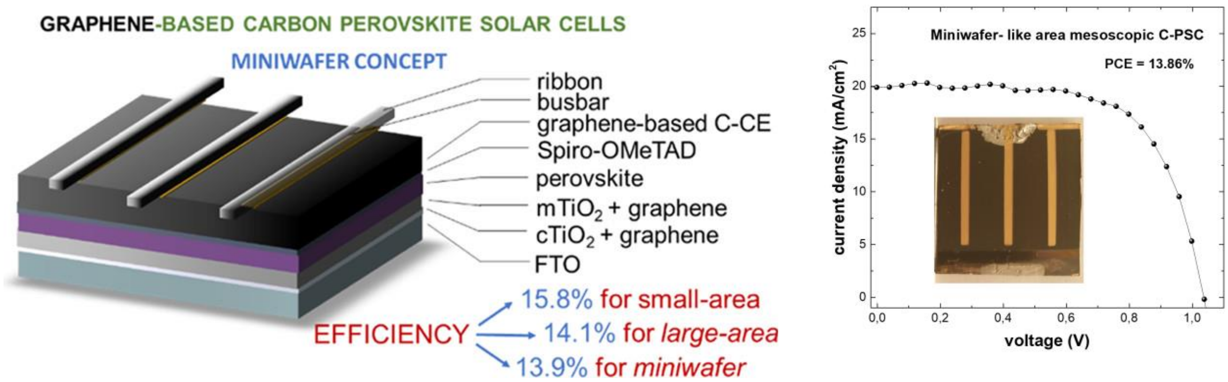

Figure 1 (left): schematic of wafer-like PSC; **(right)** J-V characteristic of the proof-of-concept miniwafer PSC.