Graphene Interface Engineering for the industrialization of Perovskite Photovoltaics

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Hybrid Metal-Organic Halide Perovskite such as $CH_3NH_3PbI_3$ (MAPI) have opened up new directions to fabricate cost effective and high efficient photovoltaic (PV) devices. Many factors can influence the efficiency and stability characteristics of Perovskite Solar Cells (PSCs). In particular, interfaces can influence layers deposition, charge recombinations and compound intermixing/diffusion, representing a critical aspect for scaling up activities aiming to exploit at industrial level perovskite photovoltaics. In this perspective, bidimensional (2D) nanomaterials, such as graphene and related materials can play a primary role owing to their 2D nature and the large variety of 2D crystals, whose complementary opto/electronic properties, can be on-demand tuned by chemical functionalization and edge modification. The so called Graphene Interface Engineering (GIE) has shown to be extremely effective in PSC technology both at lab cells (small area) level and at large area (module) level. We demonstrate the use of graphene and 2D materials as an effective way to control the morphology [1] and to improve stability and efficiency [2,3]. By dispersing graphene flakes into the mesoporous TiO2 layer and by inserting graphene oxide (GO) as interlayer between perovskite and Spiro-OMeTAD layers, we demonstrate a PCE exceeding 18% with a two-step MAPI deposition, carried out in air.[2] Further optimization of the 2D interface layers could promote the efficiency above 20% with a strong improvement of the stability. The proposed approach has been exploited for the fabrication of state-of-the-art large area perovskite modules with a PCE of 13.7% (active area exceeding 100 cm^2) paving the way to an industrialization phase compatible with standard fabrication processes [4]. In this respect, the Spear Head project "Solar Farm" of the Graphene Flagship will make use of the GIE for a pilot-line fabrication of Graphene-Perovskite modules to demonstrate the feasibility of the approach in the realization of PV panels..

References

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[3] A. Agresti et al. ACS Energy Lett. 2017, 2, 279−287
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Figures

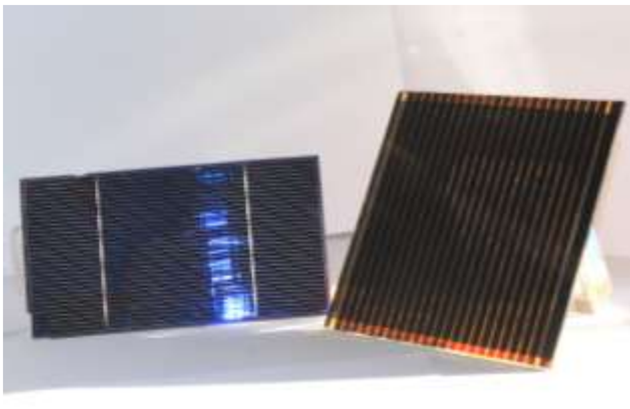

Figure 1: comparison between silicon solar cell (left) and graphene-perovskite solar module (right)