2D materials and perovskite solar cells: toward a reliable and scalable PV technology

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The possibility to produce 2D materials in the form of inks recently allowed their application for the emerging photovoltaic technologies, based on printing deposition techniques and roll2roll production processes. Recently, the use of graphene and 2D materials has been extensive exploited in perovskite photovoltaics, mainly as dopant or interlayer, with the aim to improve device efficiency and long term stability. As a matter of fact, several works claimed the beneficial role of graphene derivatives in enhancing the charge injection/collection when used in cell electrodes.[1] From our side, we demonstrated that the use of graphene flakes as dopant for the mesoscopic TiO_2 photoelectrode has the double role in improving both device power conversion efficiency (PCE) and stability under prolonged light soaking condition.[2] Time and temperature resolved photoluminescence (PL) spectroscopy revealed a strong morphological improvement in perovskite crystals wrapped into the graphene-based mesoporous TiO_2 layer.[3] At the same time, TOF-SIMS and measurements and transient absorption spectroscopy (TAS) pointed out the beneficial role of graphene in preventing iodine penetration within the mesoporous layer by retarding the smaller perovskite crystals degradation at mTiO_2/perovskite interface during the aging tests.[4] The interface engineering strategy based on 2D materials has been even implemented at the counter electrode side by underlining the beneficial role of MoS_2 and its derivatives when used as interlayer at perovskite/spiro-OMeTAD interface.[5] Finally, the proposed 2D engineered structure allowed to efficiently scale-up the perovskite fabrication process from small area devices to large area modules.[6] Remarkably, 2D material engineered modules showed averaged PCE above 13% on 108 cm^2 active area by demonstrating the crucial role of interface engineering in improving the reliability and in pushing the next commercialization of the emerging perovskite technology.

References

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