The fundamental role of two-dimensional materials for perovskite solar modules and panels

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Abstract

Two-dimensional (2D) material are playing an important role in perovskite photovoltaics. Halide perovskite and 2D materials, including 2D perovskites, can be combined to enhance efficiency and stability of solar cells. Beside graphene and related materials, such as graphene oxide and MoS_2, a new perspective class of 2D materials the MXenes, such as Ti_3C_2, demonstrated a beneficial role for interface engineering in perovskite solar cells (PSCs) [1,2]. The use of 2D materials for perovskite photovoltaics does not limit to lab scale cells but it is a milestone in the scaling up of this technology to large are solar modules and panels.

In this talk, I will present the progresses made with 2D materials to improve the performance and the stability of large area perovskite photovoltaics. With a thorough multiscale experimental investigation, we point out that 2D materials can tune interfaces properties, reduce ion migration and modify the work-function of the perovskite absorber and charge transporting layers, all aspects that directly impact on the final efficiency and the stability under accelerated stress tests.
An optimized 2D material strategy has been successful extended from lab-scale cell dimensions to large area module on 25 cm^2, 121 cm^2 till to 210 cm^2 substrate area with efficiency on active area of 20%, 17.2% and 14.7%, respectively. Moreover, the use of 2D materials allows us to reach more than 26% efficiency in a tandem graphene-perovskite/silicon cell [3]. By using 2D materials we realize a solar farm with 0.5 sqm panels obtained with single junction graphene-perovskite sub-modules with efficiency up to 16% (on a substrate area of more than 100cm^2) and panel efficiency exceeding 10%

REFERENCES

[1] Agresti, A., Pazniak, A., Pescetelli, S. et al. Titanium-carbide MXenes for work function and interface engineering in perovskite solar cells. Nat. Mater. 18, 1228–1234 (2019). https://doi.org/10.1038/s41563-019-0478-1
[2] D. Saranin et al. Transition metal carbides (MXenes) for efficient NiO-based inverted perovskite solar cells, Nano Energy 82, 105771, (2021)
[3] E. Lamanna et al, Mechanically Stacked, Two-Terminal Graphene-Based Perovskite/Silicon Tandem Solar Cell with Efficiency over 26%, Joule 4, 865 (2020)