An autonomous perovskite solar park enabled by 2D materials interface engineering

Emmanuel Kymakis

[1] Department of Electrical & Computer Engineering, Hellenic Mediterranean University (HMU), Heraklion, Greece

[2] Institute of Emerging Technologies (i-EMERGE) of HMU Research Center, Heraklion, Crete, 71410 Greece

kymakis@hmu.gr

Organic–inorganic hybrid perovskite solar cells (PSCs) have revealed their potential as excellent solar energy conversion devices, reaching a power conversion efficiency (PCE) of 25.2%. However, their operational long-term stability, especially at outdoor conditions, remains the main obstacle impeding their commercialization. Engineering approaches to tackle these issues include the incorporation of two-dimensional (2D) interlayers (e.g., graphene and transition metal dichalcogenides) a process applicable also in large-area modules, the optimization of the doping and surface functionalization of 2D interlayers, as well the possibility of integrating passivation layers such as 2D insulators. On top of that, their compatibility with large-scale, solution-processable methods such as sheet-to-sheet and roll-to-roll lay the ground for their direct integration in pilot manufacturing lines, significantly improves the capital expenditure of this technology. In this context, a wide range of 2D materials have been used as replacements for conventional charge transport layers and interlayers not only to improve the charge dynamics of the devices but also to protect the perovskite layer against diffusion of external agents, such as oxygen and moisture and the metal ion migration.
In this talk, I will give an overview of our recent activities on the realization of highly efficient and stable perovskite solar cells and modules. I will give a holistic insight on how the hierarchical placement of 2D materials in all the perovskite device can tune the transport layers work-function, passivate the interface/surface traps and most importantly protect the interfaces, resulting in a simultaneously improvement of the triangle of performance, stability and scalability of the perovskite PVs. Furthermore, I will discuss the implementation of a Solar Park consisting of 2D enabled perovskite 0.5 sqm panels at the Hellenic Mediterranean University campus at Crete, developed under the Graphene Flagship initiative by the Hellenic Mediterranean University, University of Tor Vergata, Bedimensional and GreatCell Solar, in which outdoor field tests are currently performed. The continuous monitoring of the 2D -enabled solar park's performance is providing a better understanding of single panels reliability issues, while the concurrent benchmarking process against commercial PV technologies such as Si, CdTe and CIGS is allowing the assessment of their possible application in future PV system for on-grid electricity generation. I will also directly correlate the electrical measurements of the solar farm with environmental parameters, while at the same time, benchmark their outdoor performance against commercial PV panels installed at the same site. This study is a pivotal information on the commercialization potential of this technology.

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement GrapheneCore3 - 881603"