Leveraging 2D Materials to Boost Perovskite Photovoltaic Performance and Durability

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The vast library of two-dimensional materials presents a unique opportunity to optimize the interface properties of perovskite solar cells. In this presentation, we will discuss the implementation of 2D materials in perovskite cells, modules, and panels, with a specific emphasis on a novel class of 2D materials called Titanium Carbide MXenes (e.g., Ti3C2). These MXenes not only possess outstanding chemical and mechanical properties but also provide a broad range of work function (WF) tunability based on their surface termination. The WF can vary from approximately 2 eV for OH-termination to around 6 eV for O-termination.

By fabricating well-exfoliated Ti3C2Tx MXenes with a relatively low WF (~3.7 eV), we demonstrate the ability to modify both the perovskite absorber and electron transporting layer (ETL) WFs. This approach has been applied to both nip [1] and pin [2] cell structures, as well as large-area modules.[3] We reveal that MXene interface engineering employed on the n-side of the pin cell (NiO/perovskite/C60/BCP/Cu) significantly enhances the cell's stability, with a T90 exceeding 2000 hours under continuous light soaking at the Maximum Power Point (in ambient conditions) and a T80 exceeding 1000 hours under thermal stress (85 °C).[4]

This strategy of leveraging a combination of 2D materials to boost the performance and stability of perovskite technology has been extended to panels (nine panels of 0.5 sqm each) tested for over a year in a Solar Farm in Crete. The outcomes of this outdoor trial in a real-world environment will be presented, and the performance and stability will be thoroughly examined. [5]

References

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