ARRADIANCE *Sneak Preview*

Crystallization Modulation and Holistic Passivation Enables Efficient Two-Terminal Perovskite/CuIn(Ga)Se_2 Tandem Solar Cells

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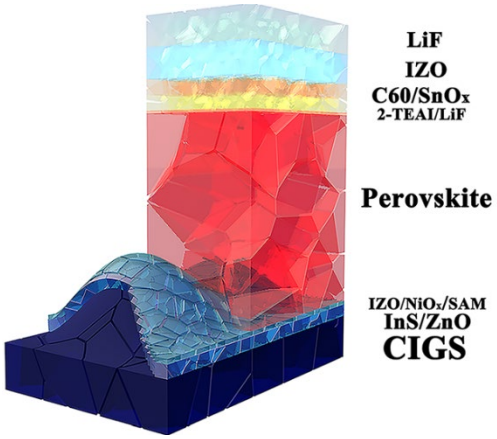
CIGS (Copper Indium Gallium Selenide) thin-film solar cells offer the potential for lightweight, flexible, and low-cost solar energy. However, their adoption has been limited by limited power conversion efficiencies (PCE), typically around 20%, compared to approximately 24% for commercial crystalline silicon solar cells. One promising strategy to overcome this performance gap is to develop tandem solar cells that stack a perovskite (PVK) layer on top of the CIGS absorber. This tandem cell harvests a broader spectrum of sunlight, boosting overall efficiency.

A recent study presents a cost-effective and scalable approach to fabricate high-efficiency two-terminal (2-T) tandem PVK/CIGS cells. A major technical barrier in achieving efficient devices has been the irregular, rough surface of CIGS films, making it difficult to grow uniform, defect free PVK layers. These surface-related issues contribute to poor interface quality, incomplete coverage, and a higher incidence of performance-limiting defects.

The researchers used two strategies to improve the PVK film quality: 1) they promoted hydrogen bonding in the PVK precursor solution to slow crystallization, and 2) they added a layer to reconstruct and passivate the surface of the PVK films.

A critical enabler in the tandem cell design is atomic layer deposition (ALD). ALD was used to deposit a highly conformal 20 nm layer of SnO_2 as an electron transport and passivation layer above the perovskite/C60 stack. ALD's unique ability to uniformly coat the rough surface of the CIGS is essential in improving the interface quality and reducing shunt pathways, which are particularly prevalent on rough surfaces and cause significant device performance degradation.



Integrating these material and process strategies, researchers achieved a record-high PCE of **24.6%** in 2-T PVK/CIGS tandem solar cells. This narrows the performance gap with leading silicon technologies and highlights a viable path forward for advancing CIGS-based photovoltaics using tandem architectures and precision thin-film processing (ALD).

Arradiance enables ALD on many types of substrates, including those with limited thermal budgets or rough surfaces. For more information on Arradiance Technology, ALD systems or Foundry services, please contact Arradiance.

[1] *Crystallization Modulation and Holistic Passivation Enables Efficient Two-Terminal Perovskite/CuIn(Ga)Se₂ Tandem Solar Cells,* ***Nano-Micro Letters. 2024****, 17:8* https://doi.org/10.1007/s40820-024-01514-1