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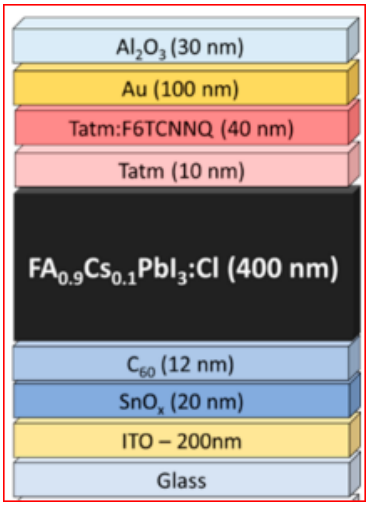
# Tin oxide electron transport layer for solvent-free perovskite solar cell processing

July 25, 2024

Perovskite single junction cells deliver potential efficiencies of 31-33% (assuming 1.5-1.6 eV bandgap). When used in tandem with a single crystalline silicon cell, perovskites cell efficiency increases as high as 45%. Perovskite cells have potential advantages over commercial single crystalline silicon cells such as low temperature, high throughput and low-cost manufacturing, packaged in lightweight and flexible modules. Current research on this developing technology suggests that some of the practical limitations of these cells are: 1) efficient charge transfer within and between layers, 2) stability of the finished cells and 3) manufacturability of the cells.

Efficient perovskite manufacturing requires the development of solvent-free methods. Evaporation and sublimation of perovskite precursors in high vacuum represents a promising path. New research[1] by scientists from University of Valencia and University of Groningen offers a perovskite PV stack in which the efficient and uniform electron transport layer is created through the atomic layer deposition (ALD) (Arradiance GEMStar™) of tin oxide ($SnO_x$) with a thermally evaporated fullerene ($C_{60}$). The combination of large density of $Sn^{2+}$ ions and $C_{60}$ creates an effective charge transfer layer supporting both wide and narrow bandgap materials. The sublimation of formamidine (FA) iodide in rough vacuum, on inorganic PbI-PbCl-CsI scaffold without an anneal (close space sublimation - CSS), produces a high throughput perovskite structure. ALD $Al_2O_3$ encapsulates the device enhancing the stability of the cells.




The combination of ALD and CSS reduces cost and manufacturing complexity for perovskite cells by eliminating all steps with liquid solvents. The ALD-produced films enable effective charge transfer layers and uniform, conformal and impermeable barriers. These critical improvements will enable both efficient and long-life photovoltaic (PV) cells.

Arradiance enables thin-film semiconductor, solar and green energy state-of-the-art ALD solutions. For more information on GEMStar™ Technology, ALD systems or Foundry services, please contact Arradiance.


1. Nathan Rodkey, Inma Gomar-Fernández, Federico Ventosinos, Cristina Roldan-Carmona, L. Jan Anton Koster, and Henk J. Bolink, *Close-Space Sublimation as a Scalable Method for Perovskite Solar Cells,* **ACS Energy Lett**. 2024, 9, 927−933 https://doi.org/10.1021/acsenergylett.3c02794