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Perovskite Multijunction Solar Cells

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Crystalline silicon based solar cell technology currently dominates the commercial photovoltaic market due to its robustness in terms of manufacturing technology, product reliability, and low manufacturing costs, which have dropped significantly in the last decade fueling the exponential growth in global installations. However, the incumbent technology is based on a single-junction silicon solar cell, which inherently is limited in terms of power conversion efficiency. The maximum practical achievable limit is less than 30% due to sub-bandgap and thermalization losses. The former results from photons with energy less than the bandgap of the semiconductor in the single-junction solar cell that cannot be absorbed by creating electron-hole pairs and the latter from photons with energy exceeding the bandgap that are absorbed but with their excess energy dissipated as heat.

Multi-junction tandem solar cells involve the stacking of solar cells with different bandgaps (highest on the sun-facing side) allowing each cell to absorb different parts of the solar spectrum more efficiently, minimizing sub-bandgap and thermalization losses. The theoretical efficiency limit of multi-junction also increases with the number of junctions from ~45% for double junction to ~51% for triple junction and to ~55% for four-junction tandems. Multi-junction concepts have been implemented for III–V solar cells in the last few decades especially for space applications where the energy conversion efficiency is paramount, outweighing the cost.

As the energy conversion efficiencies of organic–inorganic metal halide perovskite solar cells have followed the fastest improvement trajectory [1], they have been seriously considered as the low-cost contenders for the next-generation multi-junction tandem cell technology [2]. I will give a quick overview of our research at the University of Sydney on perovskite tandem solar cells including our research capabilities for different types of perovskite tandems [3-15], recent efficiency and stability [4-9, 15] results, and research for land and space applications [16-17]..

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