Centro de Tecnologia da Informação Renato Archer

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Development strategies for charge transport layers for efficient and stable perovskite-silicon solar cells

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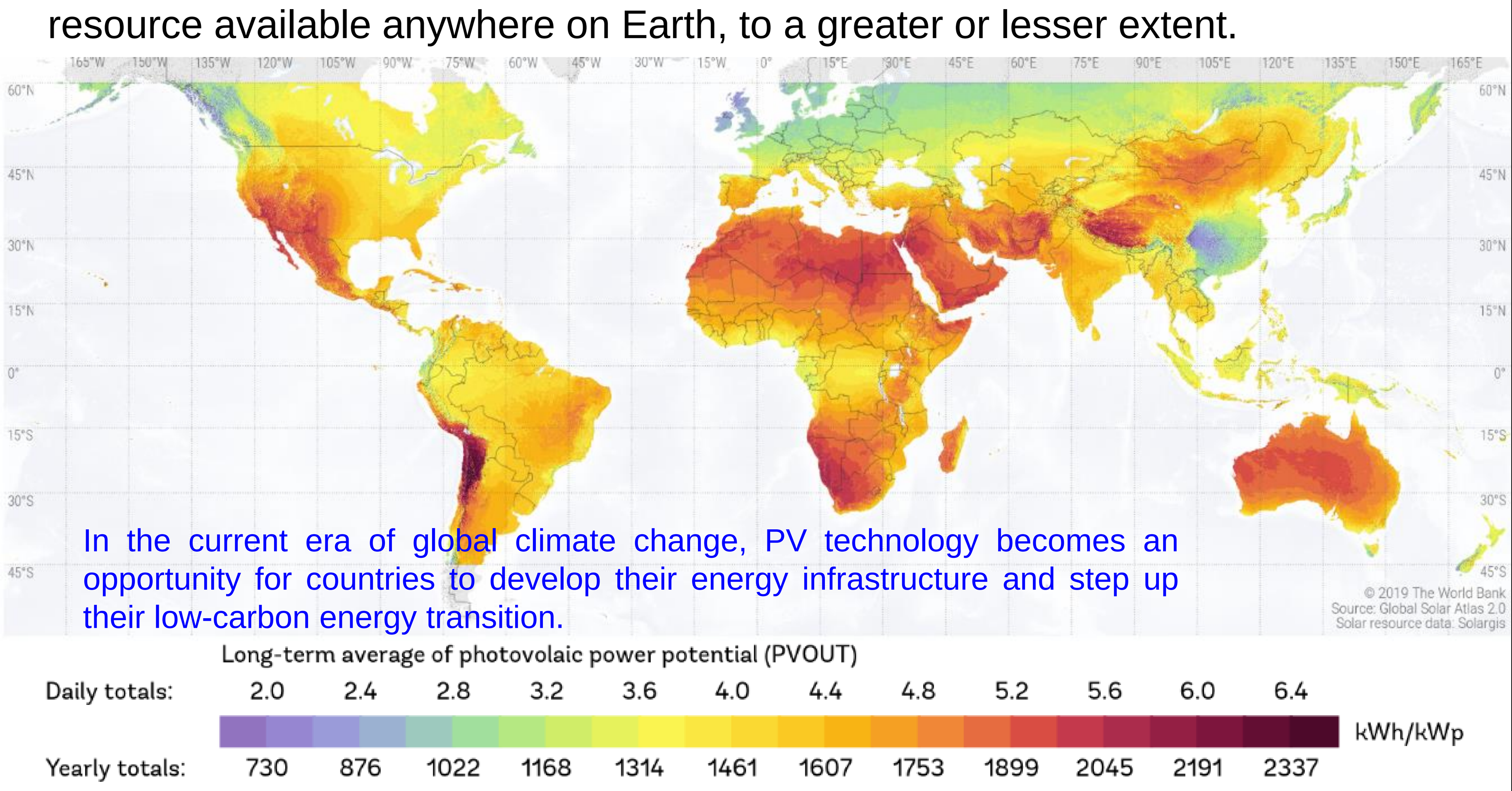
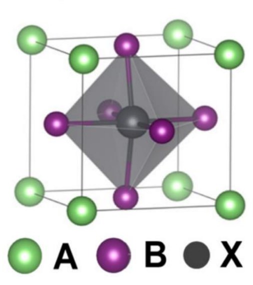
INTRODUCTION AND MOTIVATION

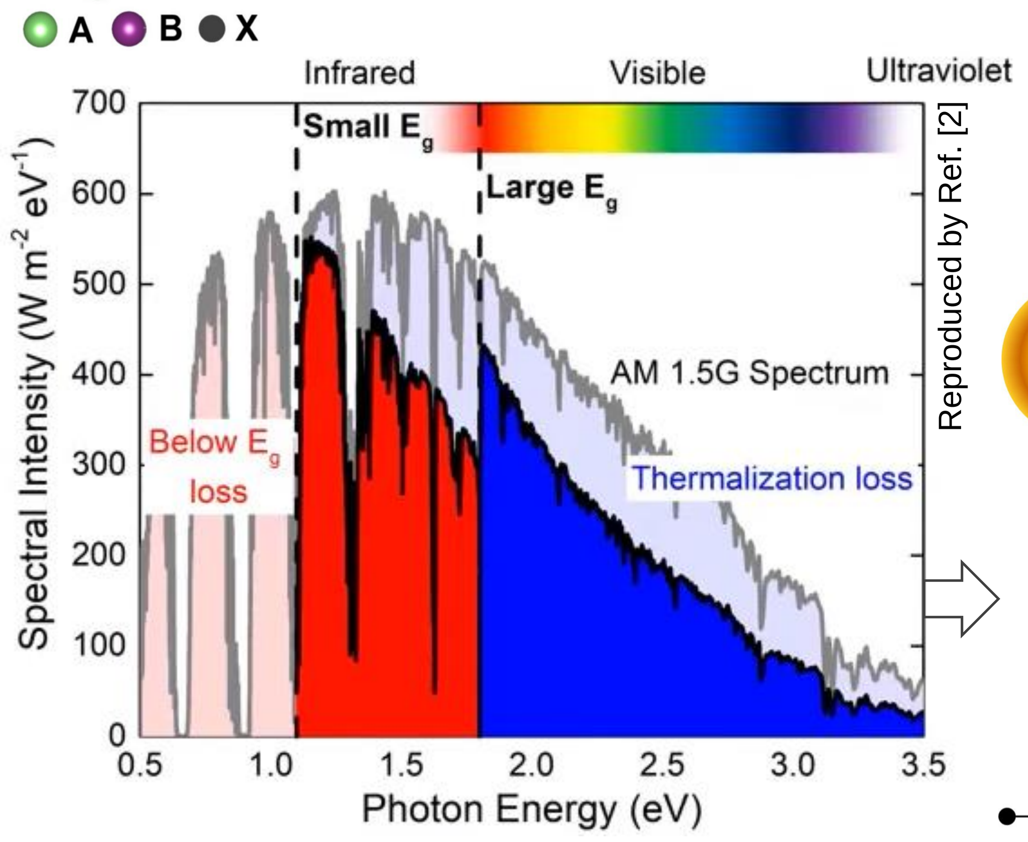
Transition to a sustainable energy future: solar radiation is essentially a free resource available anywhere on Earth, to a greater or lesser extent.

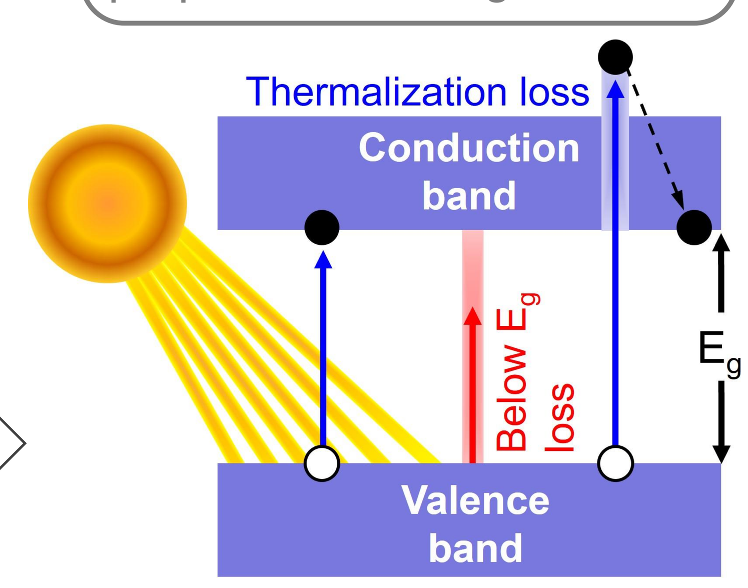




Hybrid organic-inorganic perovskite (HOIP) solar cells: low-cost synthetic routes; photoconversion efficiency > 25%

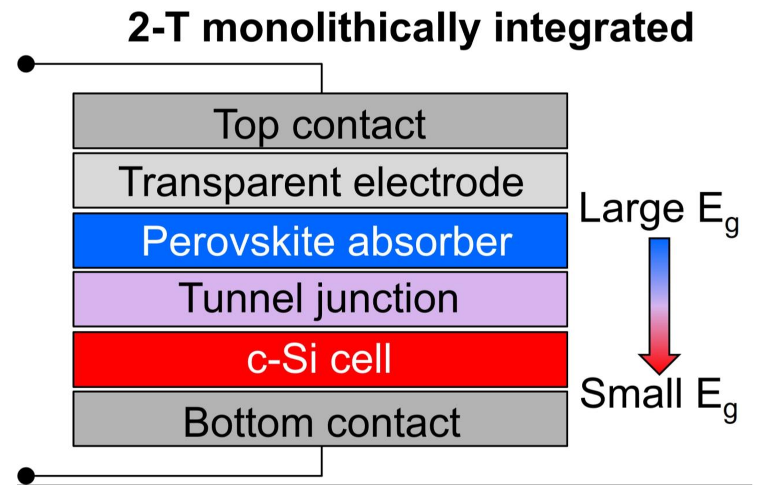
Transport and recombination properties of charge carriers



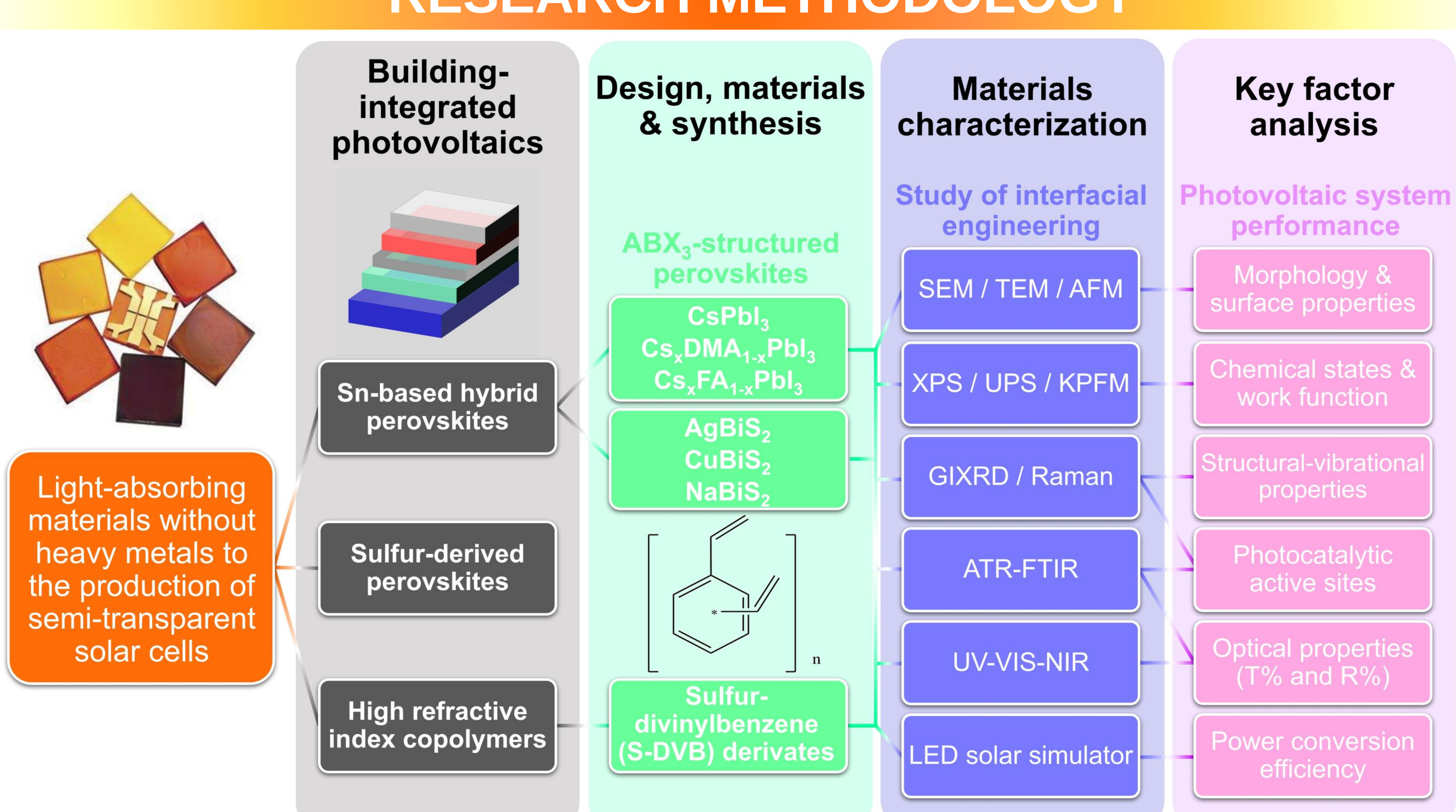


GOALS: Development of hybrid perovskites with a characteristic bandgap of 1.6–1.9 eV and **novel double junction tandem (2-T)** architectures on crystalline silicon cells with optimization of electron and hole transport layers for collecting higher energy photons.

2-T monolithically integrated



RESEARCH METHODOLOGY



❑ Dimethylammonium (DMA) or formamidinium (FA) lead tri-iodide

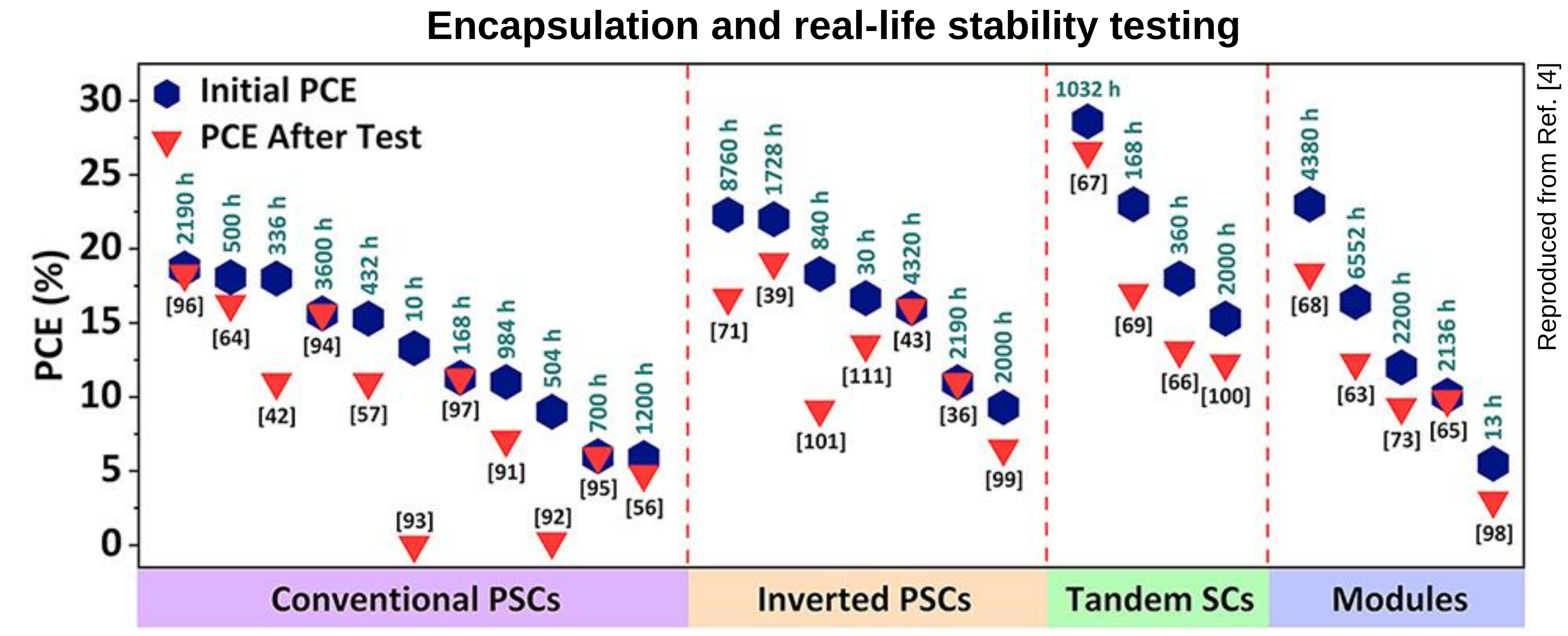
$Cs_xDMA_{1-x}PbI_3$ (x = 0.5-0.7) $Cs_xFA_{1-x}PbI_3$ (x = 0.7-0.9)

❑ **Sn-based HOIP solar cells:** doping will be performed by adding variable levels (1-15 mol%) of $SnCl_2$ to the solution of perovskite molecular precursors.

EXPECTED RESULTS

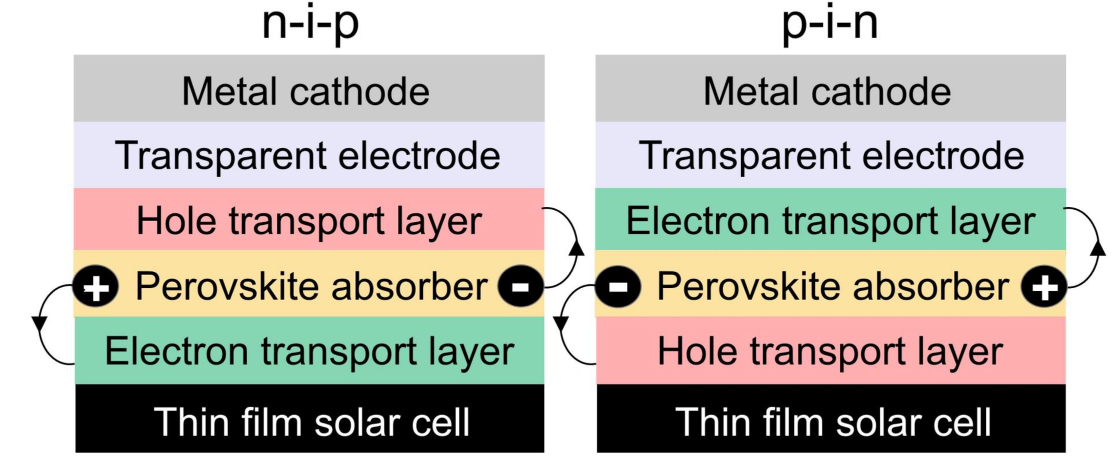
Hybrid perovskites with multijunction configurations are an emerging solar cell technology showing exceptional power conversion efficiency (PCE).

Encapsulation and real-life stability testing

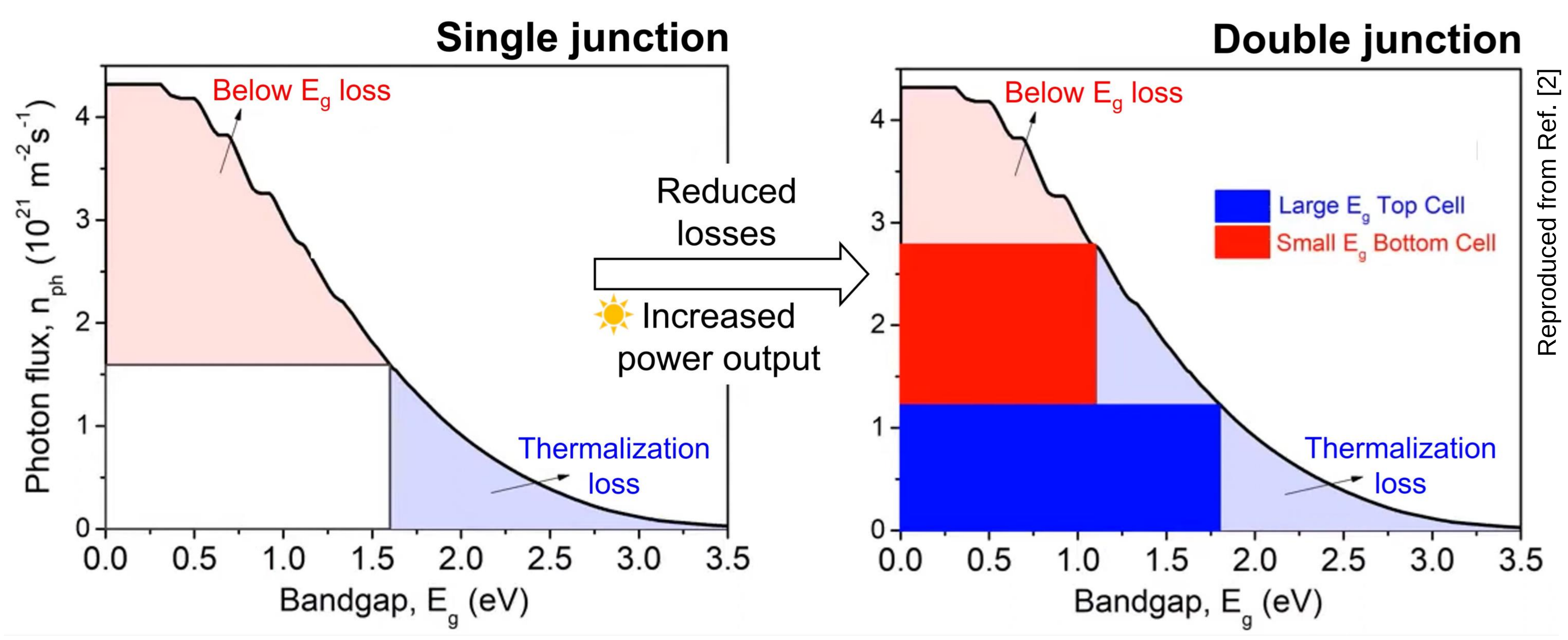


The interface analysis between the perovskite active layer and carrier transport layers is attributed to the mobility, accumulation, trapping, and energy barrier.

Solar PV modules: Planar regular n-i-p / Planar inverted p-i-n



From conventional to suitable integrated system: a trade-off between photon absorption and thermalization losses with respect to the bandgap.



SUMMARY AND OUTLOOK

Improvements in monolithic perovskite-silicon tandem cells can be significantly explored by the synergistic effect of passivation and donor/acceptor layers.

- ► **Dielectric-metal-dielectric (DMD)-based transparent electrodes:** a multilayer structure with visible light transmittance exceeding 90% and low sheet resistance (5–15 Ω/□).
- ► **Paradigm shift in device fabrication:** a new standard methylammonium-free and Pb-free material for perovskite solar cells and characterizations of interfacial charge-separation and charge-recombination processes.
- ► **High performance and stability:** ideal bandgap (~ 1.7 eV) absorbers with PCEs of ~ 25–35% and degradation rates < 0.9% per year.

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