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DETERMINISTIC FABRICATION OF 3D/2D PEROVSKITE BILAYER STACKS FOR DURABLE AND EFFICIENT SOLAR CELLS

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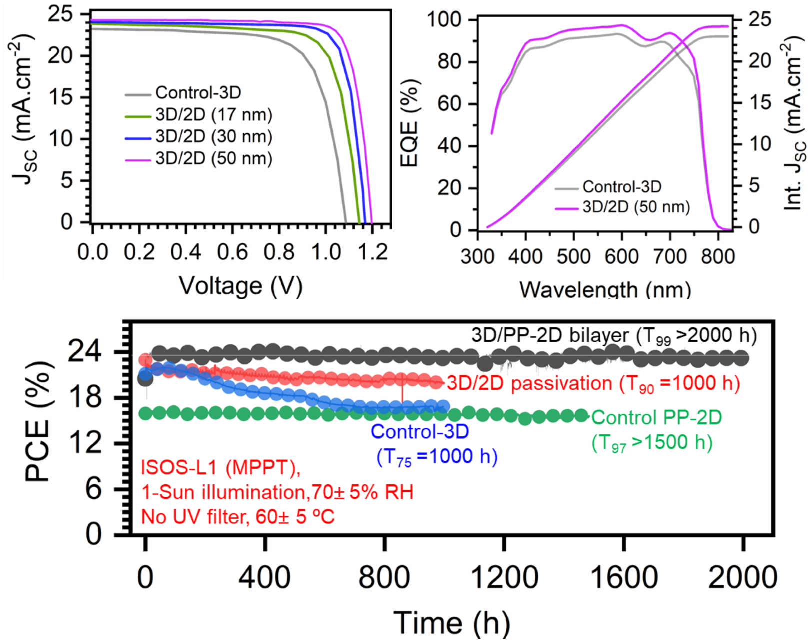
This paper presents a design and fabrication of solution-processed scalable 3D/2D heterostructures for highly efficient and durable conversion of light to electrical energy. Realizing solution-processed heterostructures is a challenge in halide perovskites because of solvent incompatibilities that disrupt the underlying layer. By leveraging the solvent dielectric constant and Gutmann donor number, we grow tunable phase-pure 2D halide perovskite bilayer stacks of the desired composition, thickness, and bandgap onto 3D perovskites without dissolving the underlying substrate. Characterization reveals a 3D-2D transition region of 20 nm, mainly determined by the roughness of the bottom 3D layer. Thickness dependence of the 2D perovskite layer reveals the anticipated trends for n-i-p and p-i-n architectures, consistent with band alignment and carrier transport limits for 2D perovskites. We measure a PV efficiency of 24.5%, with exceptional stability of T99>2000 hours, implying that the 3D/2D bilayer inherits the intrinsic durability of 2D perovskite without compromising efficiency.



Photovoltaic performances and long-term stability *of the 3D|PP-2D HaP bilayer solar cells. Top-left: I-V curves of the champion 3D/PP-2D n-i-p PSCs as a function of the 2D layer thickness. Top-right: External quantum efficiency of the device with and without the 2D layer, showing the absorption and current generation ability of the stack. Bottom: ISOS-L-1 stability measured at maximum power point tracking in ambient condition under continuous 1-sun illumination (55˚C) for an epoxy encapsulated PSC. The initial PCE of the control device is 21%, the 3D|2D passivated device, 22.93%, the 3D|PP-2D bilayer PSC, 23.75% and the PP- 2D perovskite device is 16.3%.*