Monolithic 2-Terminal Perovskite Silicon Tandem Solar Cells

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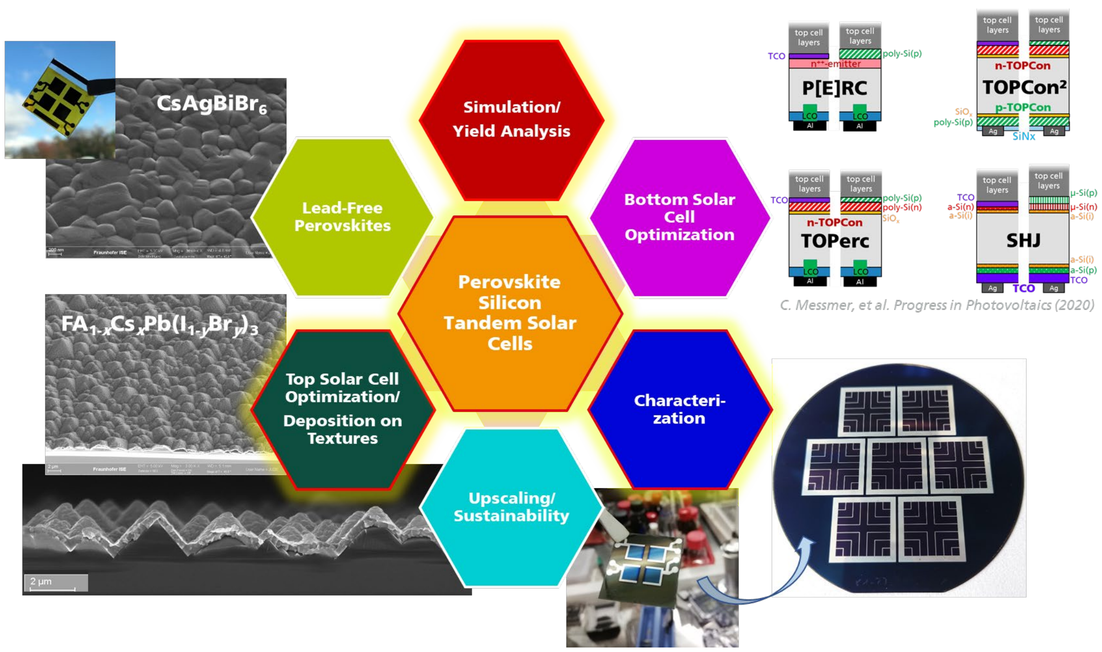
To enable terawatt-scale photovoltaics, resource and cost efficiency are mandatory. Perovskite silicon tandem solar cells can achieve both goals by exceeding the efficiency limit of 29.4% of single junction silicon solar cells [1], with only little additional production costs [2]. We aim for monolithic 2-terminal tandem devices to facilitate module integration and to avoid parasitic absorption in laterally conductive layers.

Starting from a p-i-n perovskite top solar cell with a 1.68 eV absorber on p-type heterojunction silicon bottom solar cells with a pyramidal rear side texture and a planar front [3], we elaborate optimization steps to maximize the photocurrents in the sub-cells and achieve current matching. Supported by optical simulation using transfer matrix formalism [4,5], main process adaptions are addressed, e.g. development of a more transparent front contact layer and fine-tuning the perovskite band gap. Spectral metric analysis [6] – comprising a systematic variation of the illumination spectrum, while keeping the overall irradiance constant – is applied to access the individual sub-cell´s current generation and confirm current matching. A certified current density of 19.6 mA/cm^2 is achieved for optimized tandem devices with planar front. For further current increase and higher energy yield [7], fully textured tandem devices are needed. For this purpose, we investigate the dry/wet hybrid (evaporation and wet processing) route to allow perovskite deposition with tuneable band gap on µm-sized silicon texture.

TOC



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