MULTI-JUNCTION SOLAR CELLS

Losses at large

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In a decade, perovskite solar cells have achieved power conversion efficiencies comparable to silicon and other thin-film photovoltaic (PV) devices. Even more interestingly, perovskite cells work particularly well when coupled to these PV technologies in multi-junction solar cells. Lab-scale perovskite–silicon tandem cells have reached an efficiency of 28.0%, outperforming both perovskite and silicon single-junction devices. Similarly, perovskite–copper indium gallium diselenide (CIGS) tandems have reached a record efficiency of 24.6%, although on devices that are less than one square centimetre in area. A key challenge is to translate these efficiencies to large-scale commercially relevant modules. Now, Manoj Jaysankar and colleagues in Belgium and Germany have investigated the factors at play in the efficiency loss when upscaling perovskite–silicon and perovskite–CIGS tandem solar cells from 0.13 cm^2 to 16 cm^2.

The researchers identify three loss factors: resistance, dead area and inhomogeneity. Resistive losses, associated with semi-transparent electrodes, and dead-area losses, due to a reduction of the active area on device patterning, are predominant for device areas up to 4 cm^2 and can be avoided using highly conductive and transparent electrodes and laser patterning. Inhomogeneity losses, which mainly arise from the variation in uniformity of the perovskite layer, instead become the key loss factor for larger areas. Despite the losses incurred on upscaling, the researchers show that tandems still enable higher efficiency than the individual single-junction devices for all the areas explored. These findings underpin the need for coating and deposition techniques that improve the layer homogeneity on scales relevant to the commercialization of perovskite-based single- and multi-junction PV technology.

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