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Scalable, Stable, and Reproducible Roll-to-roll Processed Perovskite Solar Cells

Dechan Angmo[1], Giovanni De Luca[2], Andrew D. Scully[1], Hasitha Weerasinghe[1], Mei Gao[1], Udo Bach[2], Doojin Vak[1]

[1]Flexible Electronics Laboratory, CSIRO Manufacturing, Industrial Innovation Program, CSIRO, Clayton, Victoria 3169, Australia
[2]Department of Chemical Engineering, Monash University, Victoria 3800, Australia
E-mail: dechan.angmo@csiro.au

The record efficiency of laboratory-scale perovskite solar cells has soared to 24%, bringing it on par with inorganic counterparts [1]. The challenge now is to develop an industry-compatible process for perovskite solar cell production that delivers dramatic cost and/or application benefits compared to existing products. A roll-to-roll manufacturing scheme with printing and coating deposition methods on flexible substrates under ambient environment conditions represents the ultimate low-cost and high-throughput production scheme. Perovskite absorber materials are exceptionally well-suited for such a processing scheme owing to their ease of incorporation into solution-based inks and low-temperature annealing requirements. Our progress on upscaling fabrication of planar p-i-n perovskite solar cells will be described in this presentation, including efficiency, stability, and reproducibility results, the latter being a key indicator for upscaling readiness of a given fabrication process. Firstly, a systematic optimization and evaluation of the device materials and structure was carried out using laboratory-scale cells fabricated by spin-coating on glass substrates using the anti-solvent method [2-3], with devices evaluated for efficiency, reproducibility, and stability. Secondly, a bench-top slot-die coater was employed to evaluate and optimize the perovskite absorber material deposition through a facile and reliable hot-deposition process [4]. The slot-die coating hot-deposition method was found to generate completely different perovskite morphology compared with the anti-solvent method, and devices were extensively characterized to unveil how these morphology differences affect opto-electronic properties. The processes developed in this work were then transferred to roll-to-roll coating on flexible substrates where all layers, except the electrodes, were slot-die coated. Scalability and process reliability were evaluated by utilising a flexible PET/ITO substrate patterned to give solar cells of three different areas (0.1 cm^2, 1 cm^2, 10 cm^2) which are processed in-line during a single processing run. This enabled a comparison to be made between the roll-to-roll processed cells and the laboratory-scale benchmark devices, while also enabling evaluation of process reliability for further upscaling.

References:

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