Hysteresis effect reduction in printed and flexible perovskite solar cells with SnO_2 quantum dot-based electron transport layers

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With a power conversion efficiency (PCE) of more than 25%, perovskites solar cells (PSCs) have shown an immense potential application for solar energy conversion. Owing to lower manufacturing cost and facile processibility via printing techniques, PSCs can easily be scaled up to an industrial scale. Printed and flexible PSCs fabricated on lightweight plastic substrates are forecasted to make several viable commercial applications in emerging new technologies such as smart buildings, wearable and portable optoelectronics, the internet of things, and automobile industry [1,2]. The PCEs of flexible and printed PSCs have been improving steadily with the advcnacment and optimisation of printing techniques and processes. SnO_2 is frequently used as an effective ETL material for printed and flexible PSCs due to its excellent electronic and optical properties as well as its exceptional chemical stability [3]. In this work, a synthesis and application of SnO_2 quantum dots (QDs) to prepare ETLs of printed and flexible PSCs is demonstrated. SnO_2 QDs are synthesized via a solvothermal method and processed to obtain aqueous and printable ETL inks [4]. Printed and flexible PSCs are manufactured using a slot-die coating technique employing thin plastic substrates with a transparent condcutive oxide layer (see Figure 1).

Devices are printed in an ambient atmosphere at 25 °C and relative humidity of 40-60%. The printed SnO_2 QDs ETLs are subsjected to UV-light treatment for different time durations and then used to print the remaining device layers except for the top metallic contacts. The behaviour and performance of the obtained devices are investigated using standard characterization techniques. It is found that the UV-treated devices have improved perfromance and reduced hystersis. The underlying reasons for these changes are investigated employing both experimental and theoretical analysis methods. The obtained results provide with a valuable understanding of the effect of SnO_2 QD-based ETLs and their processing on the behaviour and performance of printed and flexible PSCs.

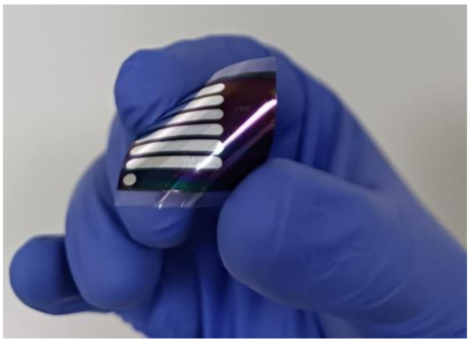

Figure 1. Photograph of a printed and flexible perovskite solar cell with SnO_2 QD-based ETL.

References

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