The effects of different electron transport layer materials on the photovoltaic properties of flexible and printed perovskite solar cells

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One of the promising photovoltaic devices for converting power is perovskite solar cells (PSCs). To date, PSCs have achieved a certified power conversion efficiency (PCE) of 25.7%. This is due to the unique properties of perovskites, such as low-temperature solution processing and the use of various deposition methods to print thin perovskite films on different types of rigid and flexible substrates. These features of perovskites afford large-scale production of cost-effective and fully printable and flexible PSCs (FPSCs). However, there is a number of urgent problems and tasks that need to be addressed to transition the manufacturing of FPSCs from laboratory to industrial scale.

This work is dedicated to fabricate PSCs on the surface of flexible polyethylene terephthalate with a layer of transparent conducting indium-tin-oxide (PET/ITO) using a slot-die coating method and studying the effect of different electron-transporting layers materials on the performance of FPSCs. Fabrication of partially printed (printing the main functional layers and applying the top metallic electrodes by thermal evaporation) FPSCs with the architecture PET/ITO/ETL(SnO_2 or PCBM)/Perovskite($MAPbI_3$)/HTL (Spiro-OMeTAD)/Au is carried out using a slot-die coater (NanoRoll, FOM Technologies, Denmark). All three device functional layers are printed in air with the temperature and relative humidity of 18-21 °C and ~27%, respectively. After the completion of the device fabrication process, the photovoltaic properties of printed FPSCs are studied. As a result, printed FPSCs with the PCEs of 11.7% using SnO_2 and 8% using PCBM are obtained. According to statistical data, on average the FPSCs with SnO_2 ETL yield a PCE value of 7.68%, whereas the device with PCBM ETL shows around 6% for a PCE value.

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