

Solution-processed SnO₂ quantum dots electron transport layer for flexible printed perovskite solar cells

Muhammad Salman Kiani^{1*}, Zhandos T. Sadirkhanov¹, Alibek G. Kakimov¹, Annie Ng², and Askhat N. Jumabekov^{1**}

¹*Department of Physics, Nazarbayev University, Nur-Sultan 010000, Kazakhstan*

²*Department of Chemical Engineering, Nazarbayev University, Nur-Sultan 010000, Kazakhstan*

* E-mail: muhammad.kiani@nu.edu.kz , ** E-mail: askhat.jumabekov@nu.edu.kz

Flexible perovskite solar cells (PSCs) fabricated on lightweight plastic substrates have many excellent potential applications in emerging new technologies including wearable and portable electronics, the internet of things, smart buildings, etc. To fabricate flexible PSCs, all functional layers of devices should be processed at low temperatures. One of the best metal oxide materials to employ as the electron transport layer (ETL) in PSCs is tin oxide. One of the limitations of its use in flexible electronics is its high annealing temperature, which is unsuitable for heat-sensitive flexible substrates. Herein, the preparation and application of SnO₂ quantum dots (QDs) as an ETL for flexible PSCs are demonstrated.

SnO₂ QDs have been synthesized via a solvothermal method and processed to obtain aqueous and printable ETL ink solutions with different QD concentrations. PSCs are fabricated using a slot-die coating method on flexible plastic substrates. For this purpose, a vectorSC (FOM Technologies, Denmark) coating system has been used. All the functional layers including ETL are deposited at room temperature with annealing temperatures < 150 °C. Morphological analysis confirms the uniformity and crystallinity of SnO₂ QDs ETL. The thickness of the SnO₂ QDs ETL is observed to be around 25 nm. The solar cell performance and spectral response of the obtained devices are characterized using a solar simulator and an external quantum efficiency measurement system. The ETL ink solutions with 2.0 wt.% SnO₂ QD concentration yielded a high average power conversion efficiency (PCE) of 7.23 % along with 10% PCE for the champion device. The work presented in this paper can be used in the future for the synthesis of SnO₂ QDs and also for its use as an efficient ETL for rigid as well as heat-sensitive flexible substrates.

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