Evaluating the performance of various back-contact designs in perovskite solar cells

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Perovskite solar cells (PSCs) are a highly promising technology in the field of photovoltaic research due to their ability to achieve high (>25%) power conversion efficiencies (PCEs). A typical architecture of PSCs involves a sandwich structure, where a perovskite layer is situated between thin electron and hole transporting layers [1-5]. In recent years, a new back-contact design has been proposed as an alternative architecture for PSCs to further boost their light-harvesting capability and ultimately increase the device efficiency [1-5].

Various designs of back-contact architecture for back-contact perovskite solar cells (BC-PSCs) have been proposed in recent years [1-5]. Based on the design of back-contact electrodes, BC-PSCs can be classified into three main categories: 1) BC-PSCs with quasi-interdigitated electrodes (hereon indicated as quasi-interdigitated back-contact (QIBC) PSCs) [1, 6-9], 2) BC-PSCs with flat-interdigitated electrodes (hereon indicated as flat interdigitated back-contact (FIBC) PSCs) [3, 10], and 3) BC-PSCs with interdigitated electrodes (hereon indicated as interdigitated back-contact (IBC) PSCs) [2, 3, 11].

Back-contact design for the architecture of devices is a promising approach to develop high-performance perovskite solar cells. Here, numerical simulation methods are used to investigate device properties of BC-PSCs with the quasi-interdigitated, flat-interdigitated, and interdigitated electrode designs. The results highlight the principal differences in the designs of the electrodes, and provide an investigation and analysis of the impact these electrodes have on the photovoltaic properties of their BC-PSCs. The effect of the perovskite photoactive layer electronic properties on the performance of BC-PSCs is also investigated. It is revealed that while PSCs with the QIBC design can potentially produce PCEs well above 25%, PSCs with the FIBC and IBC are more tolerant to electronic imperfections in the perovskite layer and can produce PCEs higher than those in devices with the QIBC. Manufacturing and prospective use of electrodes with the QIBC, FIBC, and IBC in developing PSCs are discussed based on the experimental standpoint.

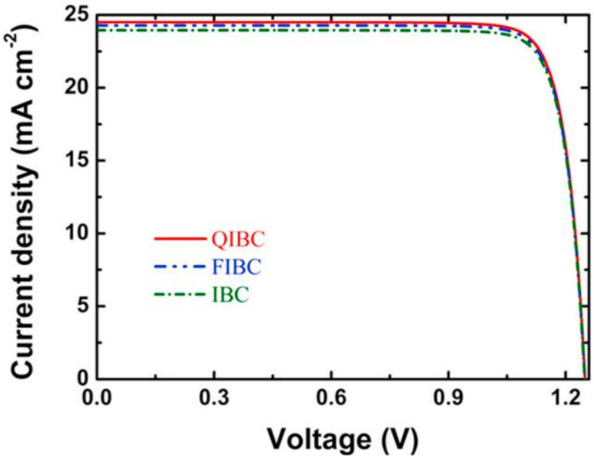

Figure 1. Comparison of the J-V curves of QIBC (red), FIBC (blue), and IBC (olive) PSCs.

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