Stability and Low Light Performance of Mixed Composition Metal Halide Perovskite Solar Cells with Sputtered Nickel Oxide Hole Transport Layers

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Nickel oxide (NiO_x) is one of the few transparent conducting oxide hole transport materials (HTM) suitable for use in perovskite solar cells with inverted (p-i-n) structures. Thin films of this abundant and inexpensive oxide are readily grown by various methods, many of which are readily scalable to large area fabrication. Although devices made with nickel oxide layers tend to show only moderate photoconversion efficiency (PCE)[1], good device stability under operation has been reported.[2]

In this work we examine the stability behavior of mixed composition metal halide perovskite solar cells fabricated with sputtered NiO_x hole transport material. The *J-V* parameters were monitored over 100 h operation at maximum power, in inert atmosphere, under AM1.5G simulated solar radiation. Remarkably, the output characteristics of the devices gradually improved over the testing period, with no hysteresis developing, and exceptionally high fill factor maintained throughout. A fill factor of 0.81 was achieved in stable operation, maintained over a period of more than 50 h.

We also observed that our NiO_x devices had unusually high shunt resistances, both in the dark and under illumination, a property that makes them well-suited for ambient light operation. Examining the light intensity dependence, we found nearly ideal diode behavior extending to 200 lx, with a PCE at 200 lx of 15%.

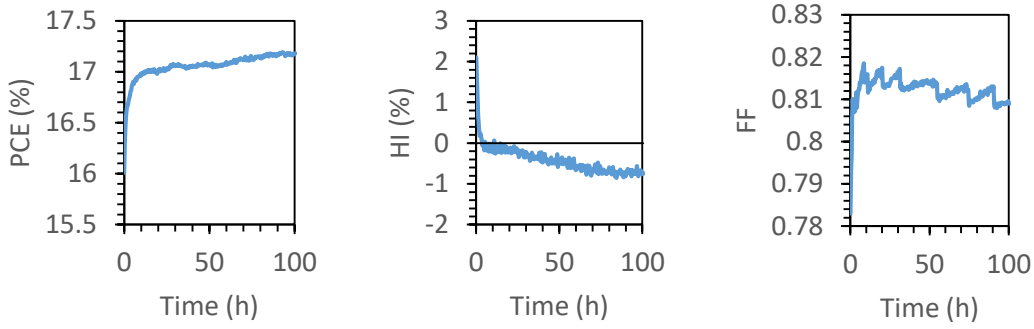

Fig. 1. (left to right) Evolution of photoconversion efficiency (PCE), hysteresis index (HI), and fill factor (FF) of a mixed composition metal halide solar cell with NiO_x hole transport material.

[1] X. Yin, et al., *Sol. RRL* **2019**, *3*, 1900001.

[2] C. C. Boyd, et al., *Joule* **2020**, *4*, 1759–1775.