Linked nickel oxide/perovskite interface passivation for high-performance textured monolithic tandem solar cells

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INTRODUCTION

Figure 1. (a) Chemical structure and (b) electrostatic potential surface of the N719 molecule; 3D charge density differences of (c) NiO_x surface and (d) perovskite surface obtained by DFT calculations

Sputtered nickel oxide (NiO_x) is an attractive hole-transport layer for efficient, stable, and large-area *p-i-n* metal-halide perovskite solar cells (PSCs). However, surface traps and undesirable chemical reactions at the NiO_x/perovskite interface are limiting the performance of NiO_x-based PSCs. We passivate the NiO_x interface by N719 dye. Benefits of the passivation:

- (i) Concurrent passivation of both surfaces;
- (ii) Preventing perovskite degradation by NiO_x surface;
- (iii) Conformal coverage on textured surface;

SPECTROSCOPIC CHARACTERIZATION

Figure 2. (a) Energy band alignment of charge transport layers and perovskites; (b) fs-TA spectra at different time delays of NiO_x and N719-passivated NiO_x thin films in response to 310 nm optical excitation; (c) TRPL kinetics of 1.60 eV perovskite films on different substrates; and (d) PL image of 1.60 eV perovskite on different substrates.

STABILITY OF TANDEM SOLAR CELLS

Figure 4. (a) For light soaking, devices were encapsulated in between two glasses using butyl rubber. (b) For thermal stability test, devices were kept at 85 °C without encapsulation in an N₂-filled glove box.

DEVICE PERFORMANCE

Figure 3. (a, d) Device layout of *p-i-n* single-junction perovskite solar cells; J-V characteristics of champion (b) 1.60 eV and (c) 1.68 eV perovskite solar cells with pristine and N719-passivated NiO_x; (e) J-V characteristics of champion tandem solar cell with pristine and N719-passivated NiO_x as hole-transport layer; (f) external quantum efficiency of perovskite/silicon tandem solar cell;

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