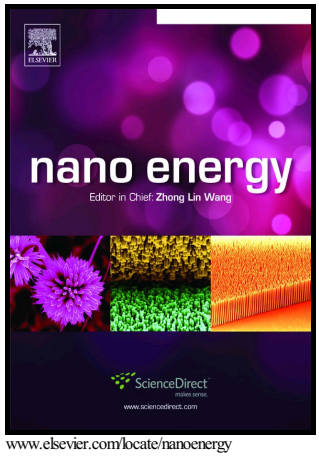

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Abstract

The poor air-stability and reproducibility of perovskite solar cells (PSCs) have prevented the practical applications of the devices that can withstand sustained operation under ambient air conditions. Here, we report all-ambient-air-solution-processed PSCs based on $CH_3NH_3PbI_{3-x}Cl_x$-NiO composite film with inserting Al_2O_3/NiO at the TiO_2/perovskite interface in a cell configuration of FTO/c-TiO_2/mp-TiO_2/Al_2O_3/NiO/$MAPbI_{3-x}Cl_x$-NiO/spiro-OMeTAD/Au. The interface engineering with Al_2O_3/NiO not only improves crystalline quality of perovskite films and enhances charge transport, but also effectively suppresses carrier recombination. This composite-based interface engineering PSCs showed a high power conversion efficiency (*PCE*) of 18.14 % and excellent reproducibility with average 16-18 % *PCE* for 35 devices. More importantly, the devices without encapsulation showed a significant enhancement in long-term air-stability; the device photovoltaic parameters stabilized after 20 days and sustained its stability over 210 days with retaining ~100% of its original V_{oc}, ~94% of J_{sc}, ~91% of *FF* and ~86% of *PCE* in an ambient environment.

***Keywords**:* Perovskite solar cells; $MAPbI_{3-x}Cl_x$-NiO composite; Interfacial engineering; reproducibility; Air stability