Fully-ambient-processed Mesoscopic Semitransparent Perovskite Solar Cells by Islands-structure-$MAPbI_{3-x}Cl_x$-NiO Composite and Al_2O_3/NiO Interface Engineering

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We present fully-ambient-processed stable and mesoscopic semitransparent PSCs by non-continuous islands-structure-$CH_3NH_3PbI_{3-x}Cl_x$-NiO nanoparticles composite and interface engineering by inserting Al_2O_3/NiO at between TiO_2 and MAPbI3-xClx-NiO/ composite layers in a device configuration of FTO/c-TiO2/mp-TiO2/Al_2O_3/NiO/islands-structure-$MAPbI_{3-x}Cl_x$-NiO/spiro-/Au. Except for the islands-structure-MAPbI3-xClx-NiO capping layer, a uniform and thicker and transparent TiO2/Al2O3/NiO/MAPbI3-xClx composite layer is formed, which can effectively reduce photocurrent density loss and interface recombination. The composite film of average visible transmittance (AVT) was ranged from 18% to 56% and the corresponding device PCE changed from 17.51% to 12.47%, and showed an excellent air stability over 270 days under ambient condition. Finally, we achieved semitransparent device of PCE = 10.06%, corresponding to AVT = 27%.