24.48%-efficiency Industrial TOPCon Solar Cell with Low-temperature Al 2 O 3 /MoO x Hole-selective Contacts

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Abstract

Thanks to the excellent passivation, high conductivity, low parasitic absorption and simple process, the wide-bandgap doping-free carrier selective contacts have been attracting much attention. In this work, the wide-bandgap high work function of Al $_2$O $_3$/MoO $_x$ stacks were prepared using the low-temperature atomic layer deposition and thermal evaporation technique, respectively, and the interfacial evolution and the elements distribution were examined using high-resolution transmission electron microscopy coupled with energy-dispersive spectroscopy. The passivation and conductivity of the Al $_2$O $_3$/MoO $_x$ stacks were systematical investigated by varying their thicknesses. The high effective minority carriers lifetime of 513 μs and the low series resistance of 0.24 mΩ are realized on the 7nm-Al $_2$O $_3$/5nm-MoO $_x$ and 7nm-Al $_2$O $_3$/3nm-MoO $_x$ stacks, respectively. Benefiting from the excellent surface passivation and conductivity, the industrial size (182×185.3 mm ^{2}) n-TOPCon solar cell with a total area front 7nm-Al $_2$O $_3$/3nm-MoO $_x$ stacks demonstrates a champion power conversion efficiency (PCE) of 24.48%, as well as a short-circuit current density of 41.06 mA cm $^{-2}$, an open-circuit voltage of 721 mV, and a fill factor of 82.66%. This work provides an effective way to enable the PCE over 26.0% and lower the process temperature for TOPCon solar cells with doping-free carrier selective contacts.

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