Low-Temperature $Hf_xTi_{1-x}O_y$ Electron-Selective Contacts for c-Si Solar Cells

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Abstract :

Carrier-selective contacts have become an emerging solution for reducing the recombination losses at Si/metal interfaces in crystalline silicon (c-Si) solar cells. Transition metal oxides (TMOs) have emerged as highly promising candidates for both hole- and electron-selective contacts in n-type and p-type silicon solar cells. Typically, hole-selective contacts use materials with a high work function such as molybdenum oxide (MoO_x), tungsten oxide (WO_x), vanadium oxide (VO_x), and nickel oxide (NiO_x), while electron-selective contacts utilize materials with a low work function like zinc oxide (ZnO), tin oxide (SnO_2), and titanium dioxide (TiO_2)[1,2]. Recent studies highlight the considerable interest in alloying these materials with other elements, such as $Al_xTi_{1-x}O_y$, to further improve the passivation and carrier selectivity[3].

In this work, we investigate the potential of Hafnium titanium oxide ($Hf_xTi_{1-x}O_y$- HTO) films deposited by atomic layer deposition (ALD) at low temperatures as potential electron-selective contacts for c-Si solar cells. The selectivity, optical and chemical properties and band alignment of HTO with c-Si have been studied. The HTO films demonstrated clear electron selectivity, as indicated by their contact behaviour on n-type and p-type silicon substrates, with ohmic contact formation on n-type silicon and diode-like characteristics on p-type silicon. The band alignment at the HTO/n-Si interface reveals a high valence band offset and a low conduction band offset, supporting efficient electron extraction. Optical analysis confirmed that the HTO films possess high optical transparency, with an estimated band gap exceeding 3.5 eV. These findings highlight the promise of low-temperature ALD-deposited HTO films as effective electron-selective contacts for c-Si solar cells.

References:

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