Innovative Electron Transport Layer for Enhanced Perovskite Solar Cells

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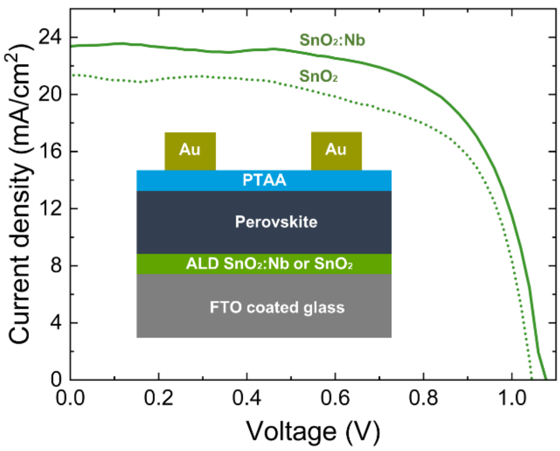
Nb-doped SnO_2 (SnO_2:Nb) film have shown an interesting optoelectronic properties (high optical transparency and electrical conductivity). These makes it to be employed for various applications; as TCO, in fuel cells, photocatalysis, solar cells, gas sensor, and touch screen [1-3]. Reports shown that SnO_2:Nb films prepared by different techniques (such as sputtering, CBD, spin-coating, and solvothermal) has been successfully integrated as electron transport layer (ETL) in *n-i-p* perovskite solar cells (PSC) [4-6]. Even though SnO_2:Nb material shows promising findings, the above-mentioned fabrication techniques are in lack of controlling the thickness, doping concentration, uniformity, and conformality of the thin(ultrathin) films. To overcome these issues, atomic layer deposition (ALD) appears as a promising alternative.

In this context, this work aims to develop SnO_2:Nb thin films by ALD technique and to integrate it in a PSC as ETL. The PSC were fabricated in *n-i-p* architecture with a stack of : transparent conductive oxides (FTO on glass), electron transport layer (SnO_2:Nb by ALD), light absorber (perovskite layer by spin-coating), hole transport layer (PTAA by spin-coating), and top electrode (Au by thermal evaporation). Devices comprising SnO_2:Nb with different Nb concentration, which has been controlled by precursor pulse sequence and cycle ratio during the ALD process [7], were investigated. The different precursor pulse sequence and cycle ratio during the ALD process play a significant role on tunning the optoelectronic properties of the SnO_2:Nb thin films. Consequently, their impacts on the properties of the perovskite layer and on the PV performance of the device were explored.



The fabricated SnO_2:Nb thin films (15 nm) show high surface wettability, which is essential as the perovskite layer deposited on top of it. Despite the SnO_2:Nb thin films have a different doping concentration, it does not show a significant impact on the crystal structure, morphology, and optical property of the perovskite layer. Moreover, SnO_2:Nb layer does not induced a degradation of the perovskite at the SnO_2:Nb/perovskite interface. With controlled Nb doping level, the integration of SnO_2:Nb enhanced the power conversion efficiency of the devices by 1-2% compared to the one with pristine SnO_2. The lowest doping level (<1% Nb) was found to have a positive impact on the device performance with respect to the reference device, whereas the performance decreased as the doping level increase further. To understand the origin of the observed PV performance, dark *I-V*, PL, TR-PL, impedance spectroscopy measurements, and energy band alignments were carried out.

References:

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