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| **Title:** | The significance of bilayer window (CdS:O/CdS) on the performance of CdTe thin film solar cells | | |
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| **Abstract:** |  |
| Ultrathin and compact CdS:O/CdS bilayer window in CdTe solar cells has higher potential for enhanced *p*-type doping, reduced Te diffusion, and improved power conversion efficiency (PCE) compared to traditional single-layer CdS or CdS:O windows. In this effort, we used a two-gun RF sputtering equipment to deposit compact CdS:O (∼50 nm)/CdS(∼50 nm) bilayers onto the borosilicate and ITO-coated glass substrates at low temperature (≤250 °C). Intriguingly CdS:O/CdS bilayers retain its hexagonal {0002} preferential orientation but with around 10.58 % optical bandgap (Eg) increment compared to CdS (Eg ≈ 2.32 eV) of equal thickness (∼100 nm). Close-spaced sublimation (CSS) technique was used to deposit the CdTe thin film onto the CdS and CdS:O/CdS layers at 650 °C. The effect of CdS and CdS:O/CdS layers on the microstructural and morphological features of CdCl2-treated CdTe films were critically analyzed in revealing a promising {0001}/{111}-like partial-epitaxy presumably due to the preferential cubic CdTe growth along the <111> orientation. The CdTe films grown over a CdS:O/CdS layer exhibited smaller average crystallite and grain sizes than those grown over a single CdS layer. An essential finding was the formation of an optimal intermix layer of CdSxTe1-x, particularly evident in the CdTe films grown on the CdS:O/CdS bilayer. To comprehensively explore the effect of CdS:O/CdS window layers on PCE, complete CdTe solar cells were fabricated using three different window layers: CdS, CdS:O, and CdS:O/CdS, which are all considered as rudimentary as no layer optimization was performed. Notably, CdTe solar cell that incorporates the CdS:O/CdS bilayer window exhibited the most promising performance among all the tested rudimentary cells and corroborated the numerically simulated findings conducted by the SCAPS-1D simulator. | |