Study of novel ZnMgO buffer layer in CZTS solar cells

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Abstract:
Quaternary kesterite semiconductor CZTS is a promising material for low cost thin-film solar cells due to the suitable optical band-gap energy of about 1.45 eV, high absorption coefficient (>10^4 cm^{-1}) and abundance of constituents [1]. The Mo/CZTS/CdS/ZnO/Al structure with a CdS buffer layer enabled recently 12.6% record conversion efficiency [2]. A Zn_{1-x}Mg_xO thin film is an excellent material for photovoltaic applications and one of potential candidates as an alternative of CdS buffer layer. The large and variable band gap [3.3 – 4 eV] with controllable conduction-band offset allows improved performances of cell [3]. Device modeling and simulation have been carried out by numerical approach using SCAPS-1D code [4]. Result of CZTS based solar cells including this alternate buffer layer (with x= 0.1) showed an improvement in efficiency which increased from 11.09% (with conventional CdS buffer layer) to 11.58% (with ZnMgO buffer layer).

In this work, thin films of Zn_{1-x}Mg_xO have been deposited using the chemical spray pyrolysis method. The effects of Mg-compositions in range of (0 - 25%) on the structural, optical and electrical properties were investigated. The films prepared at x=10% showed good crystallinity and surface morphology. The average transmittance of the films was found to be ~80% in the visible range with band gap of 3.4eV, for the Mg content to x =10%. The films exhibited high resistance (~20 kΩ/o) that can be lowered to acceptable values by Ga or Al doping.

Keywords: ZnMgO, CZTS, spray pyrolysis, modeling and numerical simulation, nano-buffer layer.

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