Numerical Simulation of $Cu(In_{1-x},Ga_x)Se_2$(CIGS) Based Solar Cells with ZnO Buffer Layer and ZnO:F as new window Layer using SCAPS-1D

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Abstract:

The interest in $Cu(In_{1-x},Ga_x)Se_2$(CIGS) thin film solar cells has increased significantly due to its promising characteristics for high performance and low cost. ZnO buffer layer is a prominent candidate to be an alternative buffer layer to so-called toxic cadmium sulphide (CdS) in CIGS based solar cells. Our work focuses on this type of CIGS-based solar cells where CdS is replaced by a ZnO buffer layer. SCAPS-1D software is used to simulate n-ZnO:Al/ZnO:F/n-ZnO(n-CdS) /p-CIGS/Mo polycrystalline thin-film solar cell.
The effect of the [Ga]/[(In+Ga)] ratio (x) for different absorber Doping concentration on the recombination rate is analyzed. A promising result has been achieved with an efficiency of η= (27.57)28.08 % , an open circuit voltage V_{0C}= (0.43)0.48 V, a fill factor FF =(83.43)83.18 % and a current density of short circuit Jsc= (0.75)0.74 mA/cm ^{2}. It is also found that the high efficiency of CIGS absorber layer thickness is 3 µm and the optimum doping concentration was obtained as 2×10^{16} cm^{-3}. Thickness of Fluorine-doped zinc oxide and zinc oxide ZnO:F (ZnO) layer is 200 nm and doping concentration was $10^{18}(10^{17})$ cm^{-3} .

Keywords: $Cu(In_{(1-x)}Ga_x)Se_2$ (CIGS), ZnO:F, SCAPS-1D, Buffer Layer ,Thin film solar cells.