NUMERICAL OPTIMIZATION OF BAND GAP GRADIENT CIGS SOLAR CELLS

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Thin-film chalcopyrite Cu(In_{1-x}, Ga_x)Se_2 (CIGS) Solar cells have become more promising for commercial applications due to recent laboratory advancements, achieving an efficiency of approximately 22%, which surpasses efficiencies most other thin-film solar cells. This study of numerical device simulations has proposed methods to improve the efficiency of thin film CIGS solar cells and analyze the composition gradient shift due to In, Ga diffusion under solar cell fabrication conditions. In CIGS solar cells, the Cu($In_{1-x}Ga_x$)Se absorber layer is the most critical layer that influences the solar cell performance. In this simulation study, several band gap gradients were created by varying compositional ratio of Ga to In in the absorber layer. The band gap gradient optimization was done by using numerical device simulator SCAPS software. The optimum bandgap gradient slope of 0.61 eVµm-1 was obtained with the improved efficiency of 32% and a fill factor of 88.5. The diffusion of In and Ga under fabrication conditions were simulated by COMSOL MULTIPHYSICS software. Taking account of compositional variation of the absorber due to diffusion, the optimum conversion efficiency has dropped to 25%. The simulation results obtained for solar cell performances and elemental gradients reported for high efficiency solar cells shows a good agreement. Considering the effect of diffusion at elevated temperatures during fabrication, this study proposes an optimum elemental flux to be used fabrication of graded band gap CIGS layer.

Keywords: CIGS, Band Gap Gradient, Diffusion