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Effect of annealing conditions on optical properties of $CuGa_{0.3}In_{0.7}Se_2$ thin films absorbers for heterojunction solar cells

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Abstract:

In this work, we present results obtained by annealing $CuGa_xIn_{1-x}Se_2$ thin films absorbers in air and selenium atmospheres using photoacoustic spectroscopy for absorbers thin films solar cells. $CuIn_{0.7}G_{0.3}Se_2$ (CIGS) thin films were annealed in two atmospheres: air and selenium atmospheres. These absorbers were deposited on soda lime glass substrates by close-spaced vapor transport (CSVT) technique at 480 °C substrate temperature. The CIGS thin films are polycrystalline with a thickness of about 3 µm, and *p*-type conductivity and were characterized with XRD, SEM, energy dispersive spectroscopy and electrode probe. The changes in the dominant defect states and recombination mechanisms during the various annealing processes are investigated using photoacoustic spectra measured at room temperature by a gas-microphone-type photoacoustic spectrometer in range 810 to 1790 nm with 500 W Xenon lamp radiations and low shopped frequency equal to 10 Hz. We have considered the absorption coefficient for better resolved photoacoutic spectra.

The first process of the annealing was performed under an air atmosphere at 200 °C for 1 h, and the second process of the annealing was carried out using selenium atmosphere at 300 °C for 30 min. The normalized photoacoustic amplitude signal obtained before and after annealing under two atmospheres indicated a significant changes in defects distribution. In the tail of absorption at energies 0,7 to 0,9 eV, several picks are present and associated with impurity to conduction band and valence band to impurity transitions. These deep defect levels were affected by air-annealing atmosphere. In the edge of absorption at energies 0,9 to 1,2 eV, the deep defect levels were affected by selenium-annealing atmosphere.