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Impact Of Annealing Under Minimum And Maximum Se Pressures On The Optoelectronic Properties Of $Cuinse_2$

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Abstract:

$CuInSe_2$ (CIS) and related compounds have proved to be materials with exceptional promise for use as an absorbent layer in thin-film solar cells. Yet, these devices have not reached their peak efficiency limit. This is due in part to a fundamental lack of understanding of the complex intrinsic defect structure in the compound [1-2]. An efficient solar cell requires good collection of photoexcited carriers, and to this effect control of the defect state populations is essential. Numerous experimental investigations have shown that the electrical properties of the compound are dominated by various types of electrically active intrinsic defects associated with deviations from stoichiometry [3].

Photoacoustic spectroscopy has emerged recently as a promising technique for investigating the optoelectronic properties of semiconductors. One of its main advantages, apart from being non-destructive and contactless, it is virtually unique in observing non-radiative defect populations in semiconductors; these are known to be associated with energy loss mechanisms in devices.

The objective of this study is to investigate the impact of changes in the selenium content of $CuInSe_2$ single crystals on their optical properties in the subgap region of the infrared spectrum. A high resolution fully automated near-infrared photoacoustic spectrometer of the gas-microphone type is used for room temperature analysis of non-radiative defect states in as-grown n- and p-type conducting crystals. Samples grown from the melt by the vertical Bridgman technique have been annealed under maximum and minimum selenium vapor pressures in the presence of CIS powder. The absorption coefficient has been derived from photoacoustic spectra in order to establish activation energies for several defect-related energy levels. The results obtained here are compared with similar data obtained from crystals grown with an excess and a deficiency of Se [4]. These results are finally discussed in the light of recent published data.

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