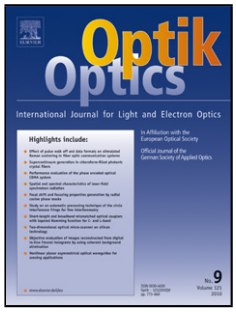

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Laser operation by kesterite chalcogenide nanocrystals

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Abstract

We demonstrate a possibility to vary structural, morphological and optoelectronics parameters for kesterite Cu_2ZnSnS_4 nanocrystalline films using external laser beams at 1540 nm, and 770 nm or 1064 nm, and 532 nm. The illumination is performed both by single mode laser beams as well as by bicolor coherent treatment. The principal changes were observed for the density of electronic states in the valence band, third-order nonlinear optics, surface states. The energy density of the fundamental laser beams was continuously varied up to 250 J/m^2. The role of photo-thermal and phonon anharmonic contributions play here crucial role. The maximal changes of the electronic density of states and effective masses were achieved during simultaneous illumination by 1540 nm/770 nm Er: glass laser coherent bicolor laser beams. This result correlates well with the occurrence of the optical interference gratings, the formation of the nanocrystallites and surface morphology.

Keywords: Chalcogenides; Semiconducting nanocrystallites; AFM; TEM; Third-harmonic generation; Density of states

1. Introduction

The considerations of optical methods for the Cu_2ZnSnS_4 (CZTS) are a chalcogenide semiconductor with direct band gap varying within the range 1.4 eV–1.6 eV. [1]. Recently, CZTS was explored as materials for a solar cell with principal benefits – an absence of toxic