Physico-Chemical nanomaterials science

Optical properties of Cu_2ZnSnS_4 thin films prepared by the spray pyrolysis technique

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Quaternary chalcogenides as Cu_2ZnSnS_4 (CZTS), their alloy and related compounds have recently attracted a large attention as promising photovoltaic materials. These compounds consist of the abundant chemical elements which are non-toxic and low-cost in comparison with the current CdTe and $Cu(In,Ga)(S,Se)_2$ based technologies. The perspectives of CZTS as absorber materials for thin films solar cells of the next generation are based on their direct band gap (~1,5 eV), high optical band-to-band absorption ($>10^4$ cm^{-1}). During the last decade the efficiency of CZTS based solar cell has improved significantly, and device conversion efficiencies of over 12,6% have been recently reported [1].

The aim of this work was to investigate the optical properties of the CZTS thin films prepared by the low-cost spray pyrolysis technique.

Thin films CZTS were synthesized using the mixture of the following aqueous solutions: 0.1 M $CuCl_2 \cdot 2H_2O$, 0.1 M $ZnCl_2$, 0.1 M $SnCl_4 \cdot 5H_2O$ and 0.6 M $(NH_2)_2CS$ with the ratio (Cu:Zn:Sn:S) 2:1:1:12. The relatively high concentration of sulfur is required because of its high volatility. Compressed air under pressure of 1.5 bars was used as a carrier gas. The deposition rate was 5 ml/min. The atomizer nozzle was set at the distance of 25 cm from the substrates heated up to the temperature of 288ºC. The band gap E_g of thin films of CZTS was determined from the measurements of the optical transmission and reflectance. The obtained Raman data shows that the CZTS compounds form at the stoichiometric initial ratio of the elements. Based on frequencies of the characteristic Raman peaks, related to fully symmetric vibrations of CZTS [2], the kesterite structure of the samples is established.

1. *Wang W., et., al.* Adv. Ener. Mater.-2014.-**4**, N 7.-P.1-5.

2. *Sheleg A.U., et., al.* J. Appl. Spectr.-2014.-**81**, N 5.-P. 776-781.