## Physico-Chemical Nanomaterials Science

# Effect of pressure changes during sulfurization on formation of thin film $Cu_2ZnSnS_4$ solar cell absorber

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$Cu_2ZnSnS_4$ (CZTS) is a promising light absorber material for the production of thin film (TF) solar cells due to its desirable direct optical gap of 1.5 eV and large band-to-band optical absorption coefficient (~$10^5$ $cm^{-1}$). All constituents of CZTS used to utilized in processing are non-toxic and abundant in the earth crust with contrast to well studied CdTe and $Cu_2In(Ga)S(Se)_2$ absorbers. The conversion efficiency record of CZTS-based TF SCs reaches value of 12.6% [1] that it is not enough for industrial production. The aim of this work was to investigate the structure properties of CZTS TF grown by a two-step synthesis at different pressure in vacuum chamber.

Obtained samples were measured by Energy-Dispersive X-ray spectroscopy (EDX) equipped inside a scanning electron microscope (SEM). All samples are Cu-poor and Zn-rich, the deviation of stoichiometry by S and Sn is immaterial. The structural properties of the CZTS were explored using the μ-Raman spectroscopy in backscattering configuration. From the Raman spectra we estimated the degree of the kesterite structure disordering. The phases forming during processes were studied using X-ray diffraction (XRD) spectroscope. On the XRD-spectra of all samples present weak peak at 29° that confirms the presence of a small amount $Cu_2S$ and CuS in the structure of CZTS thin films. We can resume that the most stoichiometric sample was created by sulfurization at pressure of argon 450 mbar. It was evidenced by the presence of the most intense peaks characteristic of CZTS. The influence of pressure in vacuum chamber on the CZTS thin films formation was investigated. Raman-spectra suggests that the high pressure facilitate to create more ideal kesterite structure.

**1.** *Wang W., Winkler M.T., Gunawan O., Gokmen T., Todorov T.K., Zhu Y., Mitzi D.B.* Device characteristics of CZTSSe thin-film solar cells with 12.6% efficiency // Adv. Energy Mater.-2014.-**4**, N 7.- P. 1-5.