

Some structural and substructural properties of nanocrystalline CZTS films obtained by chemical techniques

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$\text{Cu}_2\text{ZnSnS}_4$ (CZTS) thin films were obtained onto the glass substrates at $T_s = 523$ K using a colloidal nanocrystal ink deposited by pulsed spray pyrolysis method, followed by two mild temperature annealing regimes ($T_a \text{const} = 723$ K, $t = 2\text{-}5$ min, $\delta = 1$ min; $T_a = 523\text{-}673$ K, $t \text{const} = 3$ min, $\delta = 50$ K). It is well-known that CZTS films possess the high degree of the secondary phases, complex defects and structural inhomogeneity, thus, the main goal of this work was to investigate the structural and substructural properties of the obtained films. X-ray diffraction analysis revealed that the films were polycrystalline with a tetragonal phase and had the minimum amount of the secondary phases at $T_a = 723$ K and $t = 2$ min. These films showed the texture growth in the [112] direction. The average CSD sizes were $L_{(112)} = 31.9$ nm and $L_{(220)} = 11.3$ nm. The values of the lattice parameters were $a = (0.5420\text{-}0.5444)$ nm, $c = (1.0650\text{-}1.0849)$ nm, $c/a = (1.965\text{-}1.993)$ nm with a weak dependence on the regimes. The optimal conditions for the almost single phase films were found. *Acknowledgments: MES of Ukraine (G.N. 0116U002619, 0115U000665c, 0116U006813)*