INFLUENCE OF ZINC CONCENTRATION ON STRUCTURAL AND OPTICAL PROPERTIES OF POLYCRYSTALLINE CZT THICK FILMS OBTAINED BY THE CLOSE SPACED SUBLIMATION

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The single crystals of $Cd_{1-x}Zn_xTe$ (CZT) ternary semiconductor are widely used for the X and gamma rays radiation detectors. It could be explained by the fact that band gap of this material can be adjusted over a wide range from 1.46 to 2.26 eV by the changing of Zn concentration. Introduction of zinc atoms may substantially increase resistivity of CZT and hence detector performance. On the other hand it may lead to decreasing in crystal quality due to deformation of crystal lattice. Also the nonuniformity in Zn volume distribution is one of the key problems of CZT crystal growth technology. The necessity of obtaining the low cost large-area uniform CZT wafers for X-ray imaging detectors lead to usage of thick films CZT instead of bulk crystals.

This paper reports results of studying of effect of zinc concentration on structural and optical properties of $Cd_{1-x}Zn_xTe$ thick films. Also the possibility of obtaining of high-quality thick polycrystalline CZT films with high Zn concentration (x>0.1) will be established.

The CZT films were deposited on Mo coated glass substrates by co-evaporation of the pure CdTe and ZnTe powders from independent sources using close spaced sublimation method (CSVS). Temperature of CdTe evaporator was $T_{e(CdTe)}$ =893 K, temperature of ZnTe evaporator was $T_{e(ZnTe)}$ = 993 K, substrate temperature was T_s=673 K. With the purpose to obtain CZT films with different Zn concentration the mass ratio of CdTe to ZnTe powder has been varied.

The X–ray diffraction (XRD), low temperature photoluminescence (PL) and Raman spectroscopy were used in order to study properties of CZT films.

XRD studies have shown that films were single-phase and contain a cubic phase of CdZnTe. Calculations of microstructural parameters, such as coherent scattering domains size and microstrains indicate decreasing of crystal quality with increasing in Zn concentration. In particular significant deterioration of crystal lattice was observed in films with zinc concentration higher than 30%.

The PL spectra of the samples show bound-exciton and donor-acceptor emission bands as well as broad band due to presence of dislocation. The clear observation of dominating A^0X bands on PL spectra of the samples with zinc concentration up to 30% indicates fairly good crystal quality of the samples. The analysis of defect band of PL spectra confirms XRD results which reveal deterioration of the crystal lattice of CZT comparatively with CdTe.

Room-temperature Raman spectra of CZT films with different Zn concentration, obtained with a 785 nm laser excitation wavelength, include only CdTe and ZnTe-like longitudinal (LO) and transverse (TO) optical phonons modes. In order to carry out detailed phase analysis and hence to study spatial distribution of Zn atoms in samples we preformed surface Raman mapping of the ratio of ZnTe(LO_1) to CdTe(LO_1) modes intensities. As it was found, surface distribution of zinc atoms is rather uniform for all samples.

The in-depth study of CZT samples by XRD, PL and Raman show that CSVS method allow to obtain sufficiently uniform and high-quality thick films with Zn concentration up to 30%. Further increasing in x value lead to non-uniform Zn distribution and monotonically decreasing of films crystal quality.

Our studies provide a way to obtain thick polycrystalline $Cd_{1-x}Zn_xTe$ films deposited on a Mo coated glass substrate by means of CSVS with large Zn concentration suitable for application in X-ray detectors.