Structural, electrical and photoelectrical properties of $Cd_xPb_{1-x}S$ thin films prepared by Chemical Bath Deposition method

E. Pentia, L. Pintilie, V. Draghici, G. Sarau, B. Mereu, T.Botila

National Institute of Materials Physics,
Str. Atomistilor 105bis, P.O. Box MG-7,
Bucharest-Magurele, 76900, Romania

It is known that of great interest for IR wavelength telecommunication systems are the materials with the maximum photoconductive signal at 1550 nm. This corresponds to an energy gap of about 0.8 eV. The reason of this study was to see if it is possible to obtain ternary compounds with variable gap by Chemical Bath Deposition method and in such a way, photosensitive films with maximum wavelength around 1550 nm.

$Cd_xPb_{1-x}S$ ($0 \le x \le 1$) thin films were prepared on glass substrates using the Chemical Bath Deposition method. As Pb and Cd precursors were used cadmium chloride $CdCl_2$ and lead nitrate $Pb(NO_3)_2$. The complexing agent was EDTA. A series of ternary compounds $Cd_xPb_{1-x}S$ was deposited (x was increased in 0.1 steps from 0 to 1). The obtained films are mirror like, show a very good adherence to the substrate. To improve the photoelectrical properties the sample were annealed in air and nitrogen. The annealing was performed at temperatures between 100 ^{0}C and 350 ^{0}C. The structure and morphology of the films were analysed by Scanning Electron Microscopy and by X-ray diffraction spectroscopy. The photoconductive properties were investigated in modulated light, using a standard set-up. The structural, electrical and photoelectrical properties of these films are dependent on the value of x. For values of x above 0.5 (high Cd content) the films show a poor crystallinity, with very high values of the dark resistance and weak photoconductivity. For x values below 0.5 (high Pb content) the films exhibit a good crystallinity, with an average dimension of crystallites of about 100 nm. The dark resistance is decreasing with increasing the Pb content, while the photoconductivity increases. The threshold of spectral distribution of photoconductivity is shifted to lower wavelength with increasing the Cd content (Fig.1). This could be an indication that the deposited films are not a simple mixture of CdS and PbS. The electric and photoelectric characterisation had revealed that the properties are dependent on the Cd/Pb ratio. As was expected the band gap value is increasing with increasing the Cd content of the layers. The photoconductivity peak is shifted to lower values of wavelength being about 1800 nm for Cd/Pb ratio of 1:1.

The interesting feature for all compositions in the dark current –temperature dependence is the presence of the current peak centred around 95 K (Fig.2- for $Cd_{0.4}Pb_{0.6}S$).

The presence of such a peak in the dark current versus temperature dependence could be the sign of a phase transition.

To put into evidence the trap levels the Thermally Stimulated Currents and Optical Charging Spectroscopy Methods have been used.

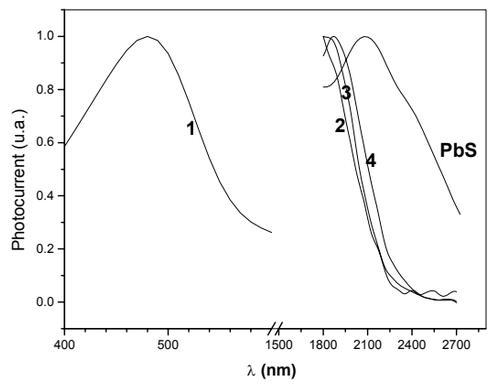

Fig. 1. Spectral distributions of photoconductivity for ternary films with different compositions: (1) $Cd_{0.8}Pb_{0.2}$; (2) $Cd_{0.5}Pb_{0.5}$; (3) $Cd_{0.4}Pb_{0.6}$; (4) $Cd_{0.3}Pb_{0.7}$.

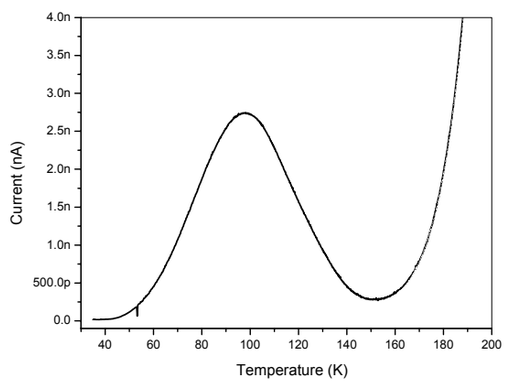

Fig.2. Dark current versus temperature for sample $Cd_{0.4}Pb_{0.6}S$

References

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