$Cd_{1-x}Hg_xS$ THIN FILMS OBTAINED BY CHEMICAL DEPOSITION METHOD

M. Fukarova – Jurukovska, M. Ristov
Institute of Physics, PMF, Skopje

Abstract:

The proposed method of chemical deposition is very simple and economic one and enables prodicing $Cd_{1-x}Hg_xS$ thin films. It is shown that the energy gap at these thin films can be varied from 2,45 to 2,306 by variation of the concentration of Hg.

INTRODUCTION

Semiconductor thin films are usually prepared by evaporation(1,2,3) spraying(4) and other methods, but of all of these, the chemical deposition method is the simplest and most economic(5,6). The chemical deposition has been successfully applied for the preparation of CdS, CdSe, PbSe thin films.

Solid solution or alloy of semiconductors are particular interest due to the possibility of changing their properties. The alloys $Cd_{1-x}Hg_xS$(6,7), $Zn_{1-x}Cd_xSe$(8), $Cd_{1-x}Pb_xS$(6), have been prepared by various methods and variations in properties such as energy gap and flatband potential have been a function of the composition.

The proposed method of chemical deposition(5), which has been found effective for CdS(5), $Cd_{1-x}Zn_xS$ preparation was applied for $Cd_{1-x}Zn_xS$ thin films with x = 0,0 – 0,30.

EXPERIMENTAL PROCEDURE

Semiconductor thin films $Cd_{1-x}Hg_xS$ prepared by this method were deposited on microscopic glasses. Each $Cd_{1-x}Hg_xS$ film was deposited as following: in a glass was prepared the solution (1-x), 0,1M complex $CdCl_2$ and x, 0,1M complex HgJ_2 where x was changed at 0,0; 0,05; 0,1; 0,15; 0,20 and 0,30. The complex solution was prepared by adding $Na_2S_2O_3$ to $CdCl_2$ and HgJ_2. This solution was kept at room temperature.

In another glass, with a volume of 200 ml, 0,1M thiourca and 5 – 10 ml, 2M NaOH was slowly warmed to the temperature of 80 – 90°C. Then good cleaned substrat is dipped in the first and after that in the second solution for 1 – 2 s in each of them. After each fifth dipping of the substrat in one of the solutions, the film was cleaned by water to remove the deposited powder from the surface. The film quality (plan parallelity) and its thickness were checked by color of the interference curves of equal thickness.

RESULTS AND DISCUSSION

The optical energy gap was determined for 6 thin $Cd_{1-x}Hg_xS$ films with different composition (changing x = 0,0 – 0,30). It is carried out by the method$^{(5,7,9)}$ applying experimental data for the function of the transparency and frequency. So, in our case, the function T(%) = f(λ) for $Cd_{0,85}$ $Hg_{0,15}S$ is presented in Fig. 1, and the graphically determined energy gap Eg is presented in Fig. 2. It can be seen that the curve in Fig. 1 has not interference maximum and minimum, which is usually used to determine the film thickness, therefore it was carried out by the gravimetric method. The density of the deposited material for each film was determined by the percentage values of Hg and Cd in the solution.

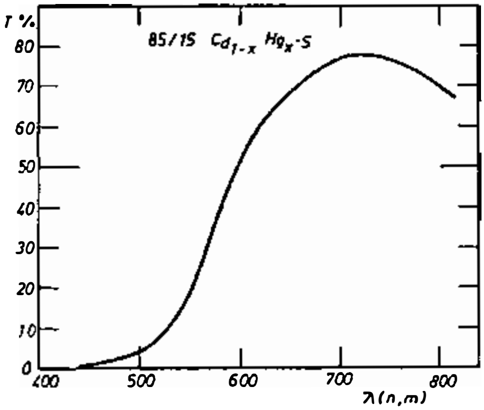

Fig. 1.

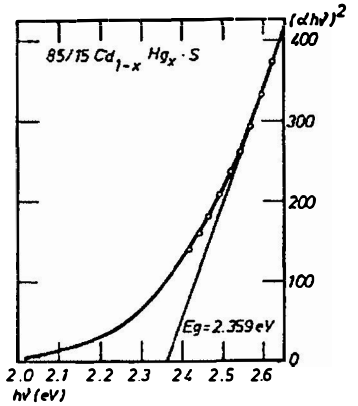

Fig. 2.

Presented in Table 1 are the thickness values d for each $Cd_{1-x}Hg_xS$ film and their energy gap Eg$^{(9)}$:

Table 1

1-x/x	d(μm)	Eg(eV)
1/0	0,695	2,450^5
0,95/0,05	0,620	2,442
0,90/0,10	0,608	2,390
0,85/0,15	0,580	2,359
0,80/0,20	0,667	2,306
0,70/0,30	0,736	–

For the film x = 0,30, the value Eg (Table 1) it was not calculated what was the result of the poorly defined absorption edge.

The optical energy gap Eg as a function of composition in the solution per x for all $Cd_{1-x}Hg_xS$ films is presented in Fig. 3. The curve (Fig. 3) slowly decreases from 2,42eV^{12,5} for CdS to 1,8eV$^{(12,13)}$ for HgS cited in the literature.

The composition of the alloys was determined by the atomic absorption spectrophotometry and the obtained results are summarized in Fig. 4. It is evident that the concentration of Hg in the film is lower than that in the deposition solution. Also, Figure 4 shows that the results lie at the line with a slope 0,685 which was calculated by the least squares method.

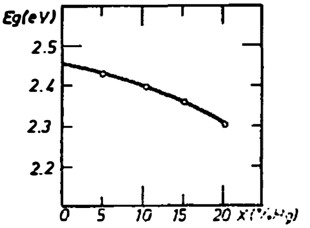

Fig. 3.

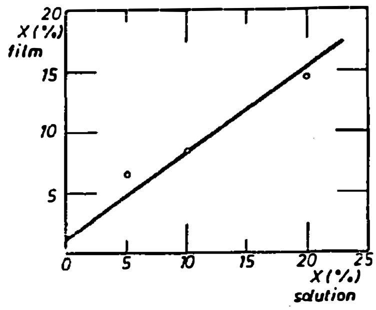

Fig. 4.

The structure of the deposited material ($Cd_{1-x}Hg_xS$) of thin films was checked by the x-ray defraction analysis, carried out for $Cd_{0,5}Hg_{0,5}S$ films (Fig. 5) and showed that it was policrystaline.

All the films show a good photoconductivity, possessing both fast and slow component. In order to examine the dependence of the conductivity on the concentration, it was measured by resistance the R for all deposited films at light flux θ = 30 lx, and the dependence on the composition x is presented in Fig. 6. This Figure shows that the resistance decreases with x (relative content of Hg in the films). It proves that the concentration of the donors in the films is increased by the concentration of Hg.

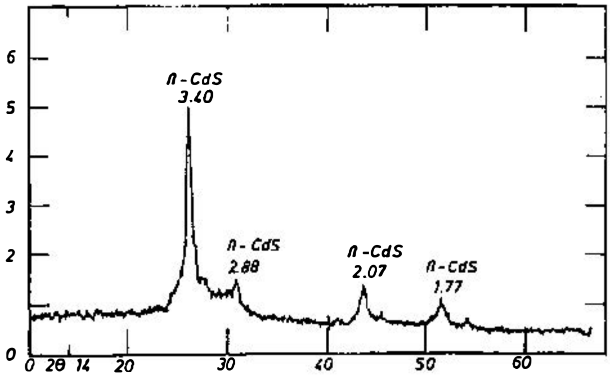

Fig. 5.

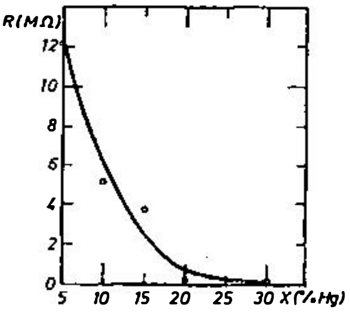

Fig. 6.

CONCLUSION

In this paper it is shown that the proposed method of chemical deposition is simple and economic and it can be used successfully for the preparation of $Cd_{1-x}Hg_xS$ thin films. It is shown that the energy gap, Eg, of these films can be varied from 2,45 to 2,306 by varying the concentration of Hg from 0 to 30%. The x-ray defraction analysis showed that the deposited material was of policrystaline structure.

REFERENCES

1. Kazmenski, L. L., W. B. Berry, C. W. Allen, J. Appl. Phys., 43 No. 8 (1972).
2. Lakova M. S., R. R. Stefanov, D. J. Dimova, S. K. Kanev, Bulg. J. Phys., 8 (1981) 4.
3. Wilson, J. B., J. Woods, J. Phys., Chem. Solids, 34 (1973) 171.
4. Gupta, B. K. and coll. Thin Solid Film, 48 (1978) 153.
5. Fukarova – Jurukovska, M., M. Ristov., M. Mitrovski, Bulletin of the Association of Phys. of SR of Macedonia (in Macedonian) (1984).
6. Skyllas – Kazacos, M., J. F. McCann, R. Arruzza, Appl Surf. Sci. 22/23 (1985) 1091-97.
7. Fukarova – Jurukovska, M., M. Ristov, Annual Proceedings of Physics (in Macedonian) T. 35 (1985) 41.
8. Russak M. A., J. Reichmann, J. Elektrochem. Soc. 129 (1982) 542.
9. Uhanov, JU. I., Opticeskie svoistva poluprovodnikov, Nauka, Moscow, (1977).
10. Aljunovic, Lj., V. Gotovac, D. Krpan, J. Eng. Phys. XXV (1983) 50.
11 Sathays, S. D., A. P. Sinha, Thin Solid Films, 37 (1976) 15.
12. Ugaj, JA. A., Vovedenie v hemiju poluprovodnikov, „Vi > aja Skola”, Moscow, (1975).
13. Fiziko-hemiceskie svoistva poluprovodnikovih ve > estv, Nauka, Moscow, (1979) 51.