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TO STUDY THE ELECTRICAL PROPERTIES OF METAL DOPED THIN FILMS WITH TEMPRATURE

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Abstract- The metal doped semiconductor thin films are synthesized by spin coating method. Thin films were annealed in high vacuum furnace with 100^0C, 150^0C and 300^0C temperature in presence of inert gas. Thin films were characterized by SDA with probe station on room temperature. The D.C. electrical resistance of synthesized thin films was analyzed. The composition of Ag increases in CdS with different ratio, thin films varies the order of resistance between 10^8-10^2 ohms with different temperature. The electrical properties of those samples change due to phase transition. The resistivity of thin films decreases with increases concentration of metal percent at particular temperature.

Keywords- Sonication, CdS powder, SD with probe station Cu powder

I. INTRODUCTION

The phenomena of II-VI group compound semiconductor and their solutions are very important for optical, electrical properties and provide valuable information regarding the nature of charge carries, band gap structure, scattering mechanism and resistivity. One of the most significant characteristics of CdS semiconductors that contribute to the high level of experimental interest in these materials is its broad energy gap. It has been shown that the relationship between band gap energy and film thickness is inverse. The four-probe technique was used to assess electrical resistivity at room temperature, and the results demonstrate that CdS films have a high resistance. In several technical fields, including LED, gas detector, photovoltaic, thin-film transistor, and photo catalytic degradation, cadmium sulfide (CdS) is widely employed as a semiconductor with a broad band gap. The CdS has a direct band gap of 2.4 eV at room temperature and it is suitable materials for window layer P-Si / n-CdS type hetro junction solar cells, photovoltaic cells, photoconductor devices. The structure of Cadmium Sulfide (CdS) is solid hexagonal or cubic crystal. CdS is a toxic materials and harmful for human body. In this work the electric conductivity was obtained from the I-V characteristics which were measured along the plane of films using the gap method. The effect of electric conductivity of silver doped CdS. It is well known that semiconductor nanoparticles, optical and electrical characteristics differ greatly from those of the bulk material due to quantum confinement phenomena. Numerous methods have been used to create CdS nanoparticles, which can be categorized into two groups: physical methods and chemical methods. Examples of physical methods include the hydrothermal method, micro-emulsion method, a sol-gel method, chemical co-precipitation method, sonochemical method, microwave irradiation method, wet chemical method, and solvothermal method . Numerous reports on the characteristics of polycrystalline thick or thin film CdS have been published in the literature using a variety of deposition methods, includingchemical vapour deposition, chemical bath deposition, spin coating, thermal evaporation, Spray pyrolysis, thermal evaporation, etc. Despite this, a homogeneous CdS thin layer over a broad area and stoichiometry control are always necessary. In this paper study of the electric properties of thin films prepared by spin coating method with different concentration (x=0.00, 0.01, 0.02). The resistance of CdS thin films calculated at room temperature, 100^0C, 150^0C and 300^0C.

II. SYNTHESIS OF SAMPLE

CdS and metal powder mixed with different wt% percent by sol gel method. Thin films were synthesized by spin coated. Insert table havecomposition of representation of metal doped CdS film.

In a mortar and pestle (grinder), CdS and Ag powder were combined after 30 minutes. Di-chloromethane and propan-2-ol were combined in a 10:1 volume ratio before pure CdS and mixed CdS with silver doping were dissolved in the combined co-solvents. For the doping mechanism, combine CdS with Ag and sonicated at 200V for 20 minutes. The solution was a yellow color. The powder was then thoroughly dissolved by stirring the solution for 1.30 hours at 500 C temperatures in a magnetic stirrer. The solution was optically translucent, quite faintly yellow, and pale black before stirring. Triton X-100 was then added in a modest amount to the solution to create a thin film of meatl /CdS that was uniform and of good quality.

III. DEPOSITION PROCESS OF METAL DOPED CDS THIN FILMS

The size 1x1 cm^2 ITO substrate used a CdS thin film was created utilizing the spin coating technique. Before creating thin films, the ITO substrates were cleaned with acetone and double-distilled water. On clean substrates, the precursor solution for the meatl/CdS composite was spin coated once for 60 seconds at a speed of 2000 rpm. The pure CdS with various concentrations of 1 and 5 weight percent of Ag mixed by this technique was performed. The CdS films were then dried in a vacuum oven for 24 hours at 700 c. The 0-13720C two zone split furnace from Harrier Enterprises is used for the annealing process. Thin film annealed at 100^0c, 150^0c, 300^0c temperature.

Characterizations

The SDA with probe station MicroXacts SPS-2200 system used for I-V characteristics of pure and CuxCdS1-x composite thin films.

IV. RESULT AND DISCUSSION

Electrical studies

Measurement of resistivity is commonly studied by the contact method that includes two-probe method by SDA with probe station and spreading resistance. The simplest and easy to use among these is two–point probe method. It is useful for thin films with high resistivity. In this technique to create a junction between ITO and film surface and dc voltage ‘V’ is applied between two probes with a fixed position and separated by distance ‘d’ (in cm) and the resulting current passing through the sample of known dimensions is measured with a suitable current meter. The D.C resistance of CdS thin films calculated by Ohmic relation.

I-V graph shows that current increases with increasing concentration of cupper in CdS. The resistivity of CdS also decreases with increase silver concentration. Alka Sharma et al studied similar results for CdS.The resistance of each film slowly dropped from 23.55×10^6 Ω down to 1.20×10^6 Ω. The effect of silver concentration on I-V characteristics at 100^0C, 150^0C and 300^0C

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For a sample of uniform dimensions, the resistivity is given by

$$\rho = \left(\frac{AV}{Id} \right) \Omega\text{-Cm}$$

Where 'A' is the cross-sectional area of the sample. The resistivity of thin films are decreases when increases concentration of metal with higher range of temperature. The crystallinity and electrical properties of thin films have improved by increasing temperature

The thermal activation energy Ea can be calculated using the following equation

$$\rho = \rho_0 \exp(- Ea / KT)$$

Where K is the Boltzmann constant, T is the temperature and ρ_0 is the resistivity of the sample at 0 K. The activation energy lies between 0.2 - 0.6 eV range .

V. CONCLUSION

The electrical studies show that the resistance of Cu /CdS composite thin film decrease with increases concentration of silver. The order of resistance rapidly reduced when film annealed at high temperature. The behaviors of thin films change on particular temperature due to undergo phase transition above a particular temperature. The electrical resistivity and activation energy of thin films also reduced with increases concentration as well as temperature.

Reference

[1] D. Raja Reddy, B. K. Reddy, P. J. Reddy, (1983), Electrical property of CdSxSe1-x single crystals, Bull. Matter. Science, Vol. 5, No. 5, 417-423.

[2] Mueller, M. Petruska, M. Achermann, D. Werder, E. Akhadov, D. Koleske, M., Hoffbauer, V.I. Klimov, (2005), Multicolor light-emitting diodes based on semiconductor nanocrystals encapsulated in GaN charge injection layers, Nano Lett. 5, 1039–1044.

[3] M. Iqbal, A. Ali, N.A. Nahyoon, A. Majeed, R. Pothu, S. Phulpoto, K.H. Thebo, M. Iqbal, A. Ali, N.A. Nahyoon, A. Majeed, R. Pothu, S. Phulpoto, K.H. Thebo, (2019), Photo catalytic degradation of organic, pollutant with nano sized cadmium sulfide Mater. Sci. Energy Technol., 2, 41–45.

[4] M.A. Khalid, H.A. Jassem, (1999), Electrical and optical properties of polycrystalline Ag doped CdS thin films, Acta physica hungerica, 73 (1), 29-34.

[5] G. G. Ramteke, A. S. Lanje, D. M. Pimpalshend, (2008), Structural and Optical Performance of ZnS Nanoparticles Synthesized via Chemical Route. International Journal of Scientific Research in Physics and Applied Sciences Vol.6, Issue.3, 69- 74.

[6] D. M. Dhahir, A. J. K. Alrubaie, K. A. Mohammed, A. S. Baron, M. M. Abood, A. H. O. Alkhayatt, (2022), The role of Ag layer in the optical properties of PN junction thin films, Chalcogenide Letters Vol. 19, No. 3, 183 – 186.

[7] D. Kathirvel, N. Suriyanarayanan, S. Prabahar, S. Srikanth, (2011), Structural electrical and optical properties of CdS thin films by vacuum evaporation deposition, Journal of Ovonic Research Vol. 7, No. 4, 83 – 92.

[8] Chunyan W.U., Li Wang, Zihan Zhang, Xiwei Zhang, Qiang Peng, Jiajun Cai, Yongqiang Y.U., Huier GUO, (2016), Synthesis and optoelectronic properties of silver-doped n-type CdS nanoribbons, Front Optoelec-tron, China, 4(2): 161–165

Alka Sharma, Rahul Kumar, Biplab Bhattacharyya, Sudhir Husale, (2016), Hot electron induced NIR detection in CdS films, Scientific Reports, 6:22939.

[9] Jumma mohmad, Jasim M. Abbas, Falah I. Mustafa, (2020), The effect annealing temperature on the physical properties of cadmium sulphide thin films deposited by using thermal evaporation technique, IOP Conf. Series, Materials Science and Engineering 757, 012077.