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Existing Information on CdS Nanoparticles and Nano Crystalline Thin Films

Paresh V. Modh[1] and Kalpesh C. Mevada[2]

R. R. Mehta College of Science,
C. L. Parikh College of Commerce, Palanpur.[1]
Arts & Urban Science College, Mahesana.[2]
Email: paresh_modh@rediffmail.com

Abstract:

Synthesis of CdS nanoparticles and nanocrystalline thin film by chemical bath deposition technique and its characterization structurally. Thermally and microscopically. It is the initial basic introduction about CdS nanomaterials and thin films. This paper provides information about existing chemical, biological routes by which CdS nanoparticles; nanocrystals and thin films can be synthesized. Structure of bulk CdS, properties and applications of CdS nanomaterials and thin films also included.

Nanocrystalline semiconductor materials have been extensively investigated during the last decade, due to their properties which are not present in bulk material. Among all semiconductor materials, cadmium sulfide (CdS) is an important II-VI semiconductor material with a wide band gap energy (Eg = 2.42 eV) [1] and small Bohr radius of 3nm[2] CdS have been extensively studied due to their potential applications such as field effect transistor, light emitting diode, photocatalisis and biological sensors [3-4]

Several approaches and a lot of publication have been devoted to prepare and control the size and shape of II-VI semiconductor nanoparticles and thin film. The nanoparticles of CdS have been synthesized by various routes including ionic [5], and electro deposition [6], screen printing [7] , sputtering [8], spray pyrolysis [9-10] and chemical bath deposition [11].

In recent years, preparation of various low – dimensional CdS nano structures such as nanoparticles, nanowires, nanorods and nanotubes has been intensively studied by using a wide range of synthesis methods [12-13].

Synthesis methods of CdS nanoparticles and thin films.

The deposition of CdS thin film by the Gradient Recrystallization and Growth (GREG) technique using high purity CdS powder. CdS films were grown on Pyrex glass substrates using the following deposition parameters.

450^o -550^o C for The substrate temperature and 650^o -750^o C for the source temperature, then having a thermal gradient between source and substrate of 200^o-300^o C/mm. The used atmosphere was Ar with a total pressure of 0.2-0.5 Torr. Prior to all depositions the system was pumped to 8 x 10^{-6} Torr as the base pressure. The deposition time was 5 min and during this time the source and substrate temperatures remain constant[14].

Synthesis of CdS nanoparticles was performed at ambient temperature by addition of 5 x 10^{-3} M solution of Na_2S to the joint prepared solution of $CdCl_2$ ($CdCl_2$ = 5 x 10^{-3} M) and Pyridine under stirring. In case of chemical doping of CdS with In^{+3} (in fact with In_2S_3), the joint $CdCl_2$ –pyridine solution contained also The necessary quantity of $InCl_3$.The calculated quantity of Na_2S solution was added to this solution to keep stoichiometric ratios of the elements and 10 or 20% weight loading of In_2S_3 in the CdS nanoparticles. The reaction mixtures were kept in dark for 24 h to complete the nanoparticles formation. Then the yellow CdS nanodispersions were dialyzed against $5X10^{-2}$ M water solution of pyridine through cellophane membrane [15].

Nanoparticles of CdS were prepared at room temperature using ethanol as the solvent by dropping 10 ml of NaoH into the mixture of 25 ml of 0.5 M $CdCl_2$. H_2O and 25ml of 0.5 M thiourea, which is kept stirred vigorously using magnetic stirrer for 20 hrs. The role of triethylamine was to stabilize the particles against aggregation. Subsequently the resulting yellow solid product was centrifugalize and washed repeatedly using distilled water. The particles were finally dried at 50^oC for 2 days [16]

Anhydrous $CdCl_2$ (320mg), sulphure powder (50mg) and a stoichiometric amount of sodium borohydride were taken. Tetrahydrofuran was taken as solvent. Sodium borohydride was taken to initiate the reaction at room temperature. The reaction was carried out at 27^o C. The stirring was continued for 16h at a particular speed. [17]

CdCl 0.036 g was dissolved in 50 ml. of diethyl sulfoxide (DMSo) previously purged for at least 30 min with N_2. When CdCl was completely dissolved under vigorous stirring, 0.016 g of sodium 2- ethylhexanoate ($Na(ethex)_2$) ware incorporated - Subsequently 0.12g of Na_2S were dissolved in 5ml of deionized water bubbled with N_2 for 30 min.0.1 ml of this solution was rapidly injected to the cd^{+2} solution. Finally, CdSNps were prepared [18]

Properties of CdS nanoparticles and nanocrystalline thin films.

The properties of CdS nanocrystalline thin films and nanoparticles have been stated below.

- Bulk CdS has a typical wide band gap of 2.42 eV at room temperature
- CdS is a well studied semiconductor because of its stability, easy preparation and distinct band gap that helps to detect a number of optical phenomena[19].
- CdS is an efficient window layer for the fabrication of solar cell structures due

to its high transitivity and low resistivity.

- Both absorbance and band gap increases with decrease in particle size of CdS nanoparticles.
- CdS has an average transmittance of 50% within the optical region and as high as 70% in the near infrared region.

Structure of bulk CdS.

If the carbon atoms in diamond are alternatively replaced with sulphur and cadmium atoms. The cadmium sulphide structure is obtained in this type of structure. The total numbers of valance electrons is four times the number of atoms. Cadmium Sulphide structure is almost identical to the diamond structure except that the two interpenetrating fcc sub lattices are of different atoms and displaced from each other by one quarter of the body diagonal.

The cubic cadmium sulphide structure results when cadmium atoms are placed on one FCC lattice and 5 atoms on the other fcc lattice. The conventional cell of this structure is a cube. There are molecules per conventional cell for each atom, there are four equally distant atoms of opposite kind arranged at a regular tetrahedron .The compounds which have cubic cadmium sulphite structure .CuCl, ZnS, InSb.

Application of CdS nanoparticles and nanocrystalline thin films.

CdS is an important material used in optoelectronics, such as non linear optics, light emitting diodes and lasers.

CdS based quantum dots are used as biomarkers in analysis of biological materials [20]

CdS used as bioorganic detector [21] of proteins [22] or DNA [23-24]

Photo detector, laser, high density magnetic information storage and many others in semiconductor industries.

CdS thin film find applications in large area electronic devices like thin film field effect transistors and solar cells.

Conclusion

CdS nanoparticles and CdS nanocrystalline thin films were successfully synthesized by chemical both depositions at room temperature.

EDAX analysis confirms that the synthesized nanoparticles are of CdS and do not contain any foreign element in them. In case of CdS nanocrystalline thin films we observe some extra elements viz. Si, O, Na and they are due to the amorphous glass substrate used.

Future Prospects :

Synthesis of monodisperse CdS nanoparticles can be tried using inverse miscellar method.

CdS can be dropped with certain impurities so as to improve its luminescence effect.

REFERENCE: BOOKS :

[1] Ch.Barglik-Chory, Ch.Remenyi, H. strohm, G.Muller, J phys. Chem .B. 108 (2004) 7637

[2] R.Banerjee,R.Jayakrisnan ,P.Ayyub, J.phy.Condens. Mat12 (2000) 10647

[3] A.P.Alivisatos, J.Science 271 (1996) 933-937

[4] D.L. Klein, R.Roth, A.K.L.Lim, A.P. Alivistos, J.Nature 389 (1997) 699-701

[5] K.J. Bandaranayake ,G.W. Wen, J.Y. Lin,H.X Jing, C.M. Sorensen, Appl. Phys. Lett.67 (1995) 831.

[6] T.Idamura,J.Muto, Thin solid films 535 (1993) 198.

[7] K. Subba Ramaiah,V.Sundara Raja, Sol.Energy Mater.Sol.Cells 32 (1994) l.

[8] S. Chandra,R.K.Pandey,R.C. Agarwal, J.phys .D Appl.phys.13 (1980) 1757.

[9] B. Thangaruju, P kaliannan, Cryst. Res. Technol. 35 (2000) 71.

[10] M.C. Baykul, A. Balvioglu, Microelectron.Eng.51-52 (2000) 703

[11] P.O. Brien,J McAleese, J.Mater.Chem .8 (1998) 2309.

[12] Y.K Liu, J.A Zapien,C.Y Geng, Y.Y. Shan, C.S.Lee,S.T. Lee, Appl. phys. Lett . 85 (2004) 3241.

[13] S. Kar, B. Satpati, P.V.Sutyam, S. chaudhuri, J.phys.chem. b. 109 (2005) 19134

[14] M.L. Albor –Aguilera,M.A Gonzalez Trujillo, A cruz-Orea, M. Tuhno Velazquez, Thin film solids (2008)

[15] N.M. Osipyonok,A.F singaevsky, Yu.V. Noskoy, Yu.P, Priyatinski, P.S. smertenko, O.P. Dimitriev, A.A. Pud, material science and Endineering B 147 (2008) 254-257

[16] O.S. ponnusamy, K.D Nisha, M Navaneethan, C. Muthamizhchelvan, Synthesis and characterization of Triethylamine capped CdS nanoparticles.

[17] R. Bhattacharya and S. Saha, Pramana J. Physics 71 (2008) 187-192.

[18] M. Quintana, E Perez, Applied surface science 253 (2007) 5781-5784

[19] H. Zhang, D. Yang, X.ma, YY Ji, S. Li, D. Que, Mat. Chem. And Phys. 93 (2005) 65-69

[20] Bruchez, M.Motonne, M.,Jr., Gin,P., et al. Science 281 (1998) 2013

[21] C.M. Niemeyer, Angew. Chem.Int .Ed. 40 (2001) 4128-4158

[22] L. Tan, L.Liu,Q Xie , Y.Zhang and S.Yao, Anal.Sciences 20 (2004) 441-444

[23] R.Mahtab,J.P. Rogers. And C.J.Murphy. J.Am.chem.Soc. 117 (1995) 9099-9100

[24] R. mahtab, J.P.Rogers, C.P singleton and C.J Murphy, J.Am. chem.Soc. 118 (1996) 7028-7032.