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Analysis of Synthesis Techniques and Properties of II-VI Semiconducting Compounds: A Review

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Abstract: This paper provides a review focusing on synthesis techniques, various structures and the effect of capping agent on the size of semiconductor nanocrystalline materials. These semiconductor nanoparticles have potential applications in light-emitting diodes, small film transistors, solar cells and photoconductive devices. Compared to most bulk materials, these nano particles have unique properties. If the particle size of these semiconductors becomes smaller than the Bohr excitonic radius, quantum size effects occur and subsequently band gap of the material increases. Capping agents have an important role to play in particle size reduction. Keeping this in view, researchers have explored several new substrates and methods of synthesis using different capping agents for these materials. Some recent contributions of authors about new techniques and properties of nano materials and their use in a variety of fields are also discussed.

Keywords: Synthesis, capping agent, nanomaterials

I. INTRODUCTION

Nano crystalline materials have attracted many material researchers due to their enhanced properties when compared to that of bulk materials. They are becoming increasingly interesting for optoelectronics and photonics. The electronic and electrical properties of such materials show a remarkable change as the particle size approaches that of its excitonic Bohr radius and then electrons and holes are subject to the effects of quantum confinement [1, 2] due to their wide range in volume, which has led to the formation of higher regions. Nanoscale semiconductors show exciting electro-optical structures and stimulating behavior [3]. As the size of the nanocrystal decreases, the strength of the initial solid state decreases, following the quality following the performance of the particle-box. This effect of the dependence on the size and emergence of the electronic structure separates from the continuous levels in the valence and conduction bands of the semiconductor effect in bulk is caused by quantum confinement. [4]

Semiconductor nano materials have a wide band gap with Eg = 2.4 to 3.7 eV at 300 K. As Compared to bulk materials and melting point, electronic absorption, gap strength, crystal structure, and other structures properties of these nano particles (CdS, CdSe, ZnS, ZnO, and TiO2-NP) are also affected by size [5 - 7]. These synthetic nano particles can be used in the fields of electronic and photovoltaic devices [8], [9], catalysis, molecular diagnostics and interfacial electron transfer [10]. This detailed review shows some areas, which have not been adequately addressed so far. Various integration routes have been used over the past few years to accommodate these structures. They can be adjusted to customized sizes and structures such as increased durability, surface area, magnetic properties, optical and catalytic properties. This study includes the various techniques for the synthesis, structure and application of these nanomaterials in various fields and the effect of capping agent in size.

II. DIFFERENT METHODS

There are various methods for synthesis of Nanomaterials like Chemical Precipitation method, Hydrothermal method, Sol-gel method, Chemical Bath Deposition (CBD) method, Biosynthesis method. One method for synthesis of Nano Material is chemical co-precipitation method. Nanoparticles were synthesized with different sizes by chemical precipitation method [14]. Another method is hydrothermal method, in which nanoparticles with good crystallinity were prepared by hydrothermal method [15] in micro emulsion composed of polyoxyethylene laurylether/water/cyclohexane/butanol. This method is used to improve the photo-luminescent property of the nanoparticles. Nanocomposites have also been synthesised by sol-gel method, and such prepared nanocomposites show much higher and more stable activity for photoluminescence (PL) properties. Nanocrystals are successfully grown in porous silicon (PS) sol-gel method [16]. The most common procedure for the synthesis of Cadmium sulphide is a chemical bath [17] where Nano Material is deposited on the glass substrate and thus a thin film is prepared. The film size is almost full when the deposition time is more than 90 min.

Although nanomaterials can be produced using a variety of traditional physical and chemical processes, it is now also possible by biological processes. Recent studies show the preparation of nano materials by biological method [18] or green synthesis. In this method, plant extract is used as a stabilizing/ reducing agent with less hazards towards environment, They can be easily scaled up, are stable, economically viable and suitable for large scale production.

III. DIFFERENT PROPERTIES OF NANO MATERIAL

Different properties of nanomaterials are presented in table no.1. There are various uses of nano materials such as solar cells, such as pigment, antireflection coating and others of great interest. Different synthesis methods and properties of nanomaterial have been reported by many researchers and this review would help in further investigations on this material [19].

Table 1: Different Properties of Semiconductor Nanomaterials

S. No.	Name of Materials	Properties				Ref.
		Optical Properties	Structural Properties	Electrical Properties	Band Gap	
1	CdS	λ= 200-700 nm (wavelength)	hexagonal structures	photo voltage is higher and photocurrent is lower	2.45eV	20
2	ZnS	λ= 570 nm (wavelength)	hexagonal structures	operating at 40 kV and a current of 30 mA	3.54eV	21
3	CdSe	λ= 500-650 nm (wavelength)	hexagonal structures	operating at 40 kV and 40 mA	3.7eV	22
4	ZnO	λ= 420-500 nm (wavelength)	hexagonal structures	operated at 35 kV and 20 mA	3.37eV	23
5	TiO_2	λ= 360-720 nm (wavelength)	tetragonal structures	operated at 42 kV and 120 mA	3.05eV	24

IV. EFFECT OF CAPPING AGENT ON SIZE

Capping agents are a basic component in the synthesis of nanoparticles with controlled size and well-defined shape. These results will be given in the construction of a metal-ligand interphase, its distinctive structures that deal with catalytic behavior. Therefore, understanding the structure of this interphase is critical to the use of a suitable nanocatalyst structure. This table provides an overview of the effect of capping agents on the size and structure of these substances [25].

Table 2: Effects of Capping Agents on size of nano materials-

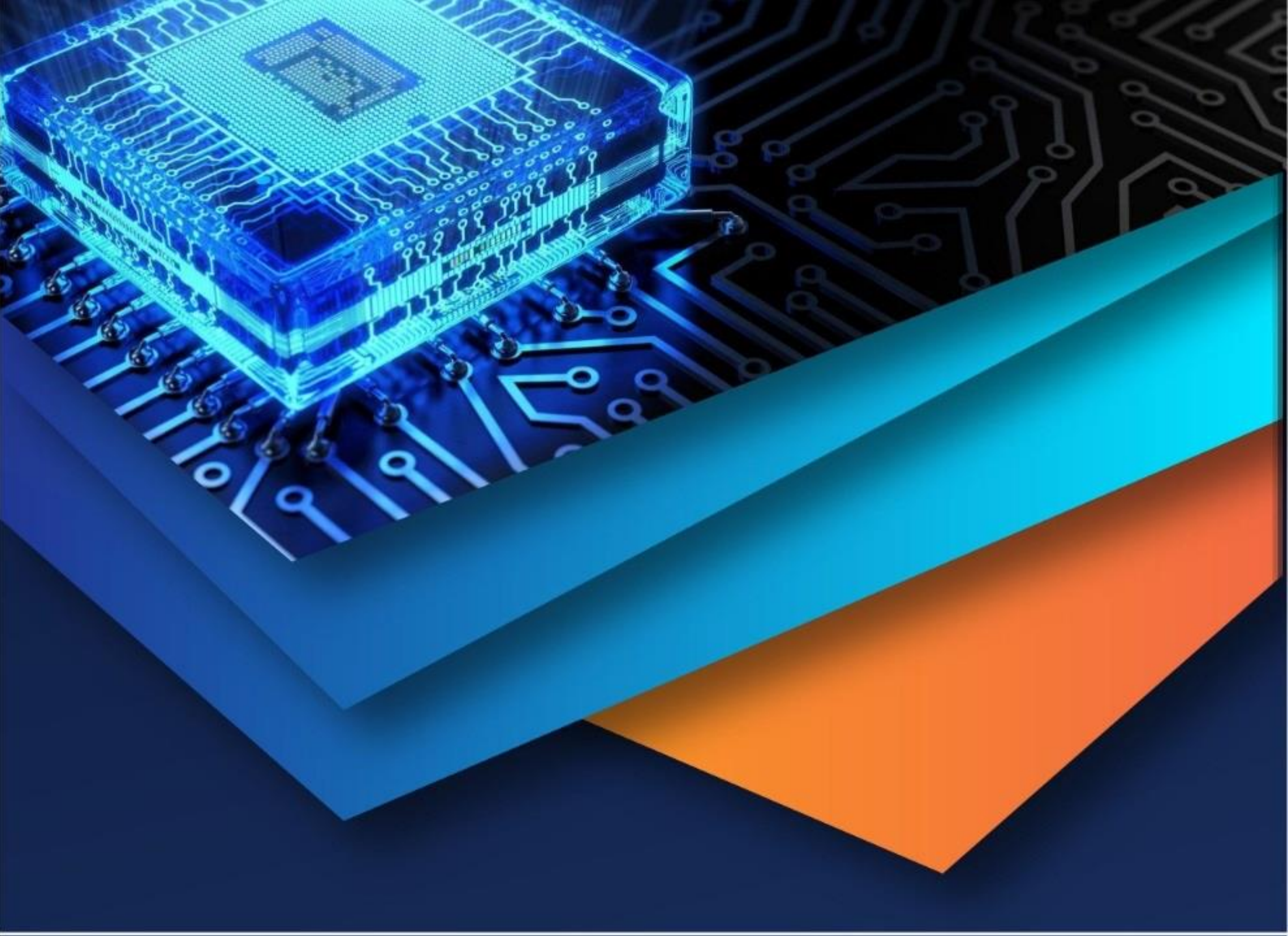
S. No.	Name of Materials	Capping Agents			Ref.
		Mercaptoethanol	Thioglycerol	PVP	
		Size	Size	Size	
1	CdS	4nm	2.8-5nm	3.8nm	26,27,28
2	ZnS	1.80-2.45 nm	1.85-2.44 nm	1.95-2.28 nm	29,30,31
3	ZnO	18-20nm	2.6-3.3nm	32nm	32,33,34
4	CdSe	3.5nm	1.9nm	74.68 nm	35,36,37
5	TiO2	7.4 nm to 20 nm	9.50-26.14 nm	29.20-49nm	38,39,40

V. CONCLUSION

A review on different synthesis methods, properties and effects of capping agent of nanomaterial is presented in this article. The different types of techniques used to synthesis nano materials and the various reported structures are also discussed.

REFRENCES

[1] L.E. Brus , J Chem. Phys. 90 (1986) 2555.
[2] G. Wakefield, H.A. Keson, P.J. Dobson, J.L. Hutchison, J. Phys and Chem. of Solids 60(1999) 503.
[3] N. Lopez, W.Janssens, B.S. Clausen, Y.Xu, M. Mavrikakis, T. Bligaard and J.K Norskov, J. Catal. 223 (2004) 232.
[4] T.Kippeny, L.A Swafford, S.J Rosenthal, J.Chem.Edu. 79 (2002) 1094.
[5] Alivisatos, A.P., 1996 "Perspectives on the physics chemistry of semicoductor nanocrysts" J. Phys. Chem. 100 (31), 13226–13239.
[6] Banerjee, R.; Jayakrishnan, R.; Ayyub, P.: Effect of the Size-Induced Structural Transformation on the Band Gap in CdS Nanoparticles. Journal of Physics: Condensed Matter 2000, 12, 10647-10654.
[7] Roduner, E.: Nanoscopic Materials: Size-Dependent Phenomena; Royal Society of Chemistry, 2006.
[8] Gogotsi, Y.: Nanomaterials Handbook; CRC Taylor & Francis Group, LLC: United States of America, 2006.
[9] Liu, J., Sheina, E., Kolawlewski, T. and Mccullough, R.D. (2002) Angewandte Chemie International Edition, 41, 3259.
[10] Greenham, N.C., Peng, X.G. and Alivisatos, A.P. (1996) Physical Review B, 54,17628. http://dx.doi.org/10.1103/PhysRevB.54.17628
[11] G. Bawendi, C. Murray, D. J. Norris, J. Am. Chem. Soc.115, 8706 (1993).
[12] T. Vossmeyer, L. Katsikas, M. Giersig, I. Popovik, K. Diesner, A. Chemseddine, A. Eychmüller, H. Weller, J. Phys.Chem. 98, 7665 (1994).
[13] J. R. Lakowicz, I. Gryczynski, Z. Gryczynski, C. J. Murphy,J. Phys. Chem. B. 103, 7613 (1999).
[14] Borra Rajesh Kumar, Varra Rajagopal Reddy, V.Rajagopal Reddya, T.Subba Rao, "Preparation And Characterization Of Cds Nanoparticles By Chemical Co-Precipitation Technique", Vol. 8, No. 3, P. 177 – 185, (2011).
[15] Mohammed H. K.Al-Mamoori,Dunia K. Mahdi, Saif M.Al-Shrefi, "Synthesis And Spectroscopic Study Of Cds Nanoparticles Using Hydrothermal Method", Technologies And Materials For Renewable Energy, Environment And Sustainability, 978-0-7354-1675-8, (2018).
[16] Zhang Hong-Yan, "Effects Of Post-Annealing Treatment On The Structure And Photoluminescence Properties Of Cds/Ps Nanocomposites Prepared By Sol-Gel Method", Optoelectronics Letters Vol.12 No.2, (2016).
[17] Dilip Maske, "Growth And Characterization Of Cds Thin Films By Chemical Bath Deposition",International Journal Of Scientific And Research Publications, Volume 6, Issue 6, 264 Issn 2250-3153, (2016).
[18] K. R. Kanude1, Preeti Jain, "Biosynthesis Of Cds Nanoparticles Using Murraya Koenigii Leaf Extract And Their Biological Studies", International Journal Of Scientific Research In Research Paper . Multidisciplinary Studies E-Issn: 2454-9312 Vol.3, Issue.7, Pp.5-10, P-Issn: 2454-6143, (2017).
[19] K.Gowthamanb, P.Gowthamana, M.Venkatachalama, M.Sarojaa, M.Kutraleeswarana, S.Shankara P.Thamarai Selvanb, "Review On Structural, Optical, Luminescence And Electrical Properties Of Cadmium Sulfide", Iaetsd Journal For Advanced Research In Applied Sciences Volume 5, Issue 1, Jan/2018 Issn No: 2394-8442
[20] Sebastiano Campisi , Marco Schiavoni, Carine Edith Chan-Thaw and Alberto Villa "Untangling the Role of the Capping Agent in Nanocatalysis: Recent Advances and Perspectives", Catalysts 2016, 6, 185; doi:10.3390/catal6120185
[21] Seyed Mohammad Taheri OTAQSARA , Mohammad Hassan YOUSEFI and Ali Azam KHOSRAVI, "Optical characterization of Fe3+ doped CdS nanoparticles synthesized by wet-chemical route", Turk J Phys 35, 341 – 347. c T¨UB˙ITAK doi:10.3906/fiz-0911-40, (2011)
[22] KR Kanude and Preeti Jain, "CdS Nanoparticles: Green Synthesis Method and Capping Agent's Effect on its Crystallite Size", Journal of Chemical and Pharmaceutical Research, 9(6):86-89, 2017
[23] L. Saravanan, S. Diwakar, R. Mohankumar, A. Pandurangan and R. Jayavel, "Synthesis, Structural and Optical Properties of PVP Encapsulated CdS Nanoparticles ", Article in Nanomaterials and Nanotechnology · DOI: 10.5772/50959, November 2011
[24] Abbas Rahda, "Effect of 2-mercaptoethanol as capping agent on ZnS nanoparticles: structural and optical characterization", Journal of nanostructure in chemistry Rahdar; licensee Springer. © 2013
[25] A. Rahdar, "Effect of 1-Thioglycerol as Capping Agent on ZnS Nanoparticles: Structural and Optical Characterization", International Journal of Science and Engineering Investigations vol. 1, issue 2, March 2012
[26] R. Ashok Kumar, K. Geetha and P. Prabukanthan, "Synthesis of Mn2+ Ions Doped ZnS Nanoparticles using PVP, TOPO and CTAB as Capping Agent and their Characterization", International Journal of Applied Science and Mathematics Volume 2, Issue 5, ISSN (Online): 2394-2894
[27] SHRIWAS S ASHTAPUTRE1, APARNA DESHPANDE, "Synthesis and analysis of ZnO and CdSe nanoparticles", Vol. 65, No. 4— journal of physics pp. 615–620, October 2005
[28] Shabana Nazneen, Roselin Polugari, Shailaja Raj and Prerana Singh, "COMPARATIVE STUDY ON EFFECT OF DIFFERENT CAPPING AGENTS ON THE ANTIMICROBIAL ACTIVITY OF ZNO NANOPARTICLES" , IJPSR (2015), Vol. 6, Issue 9
[29] Shingo Tachikawa, Atsushi Noguchi, Takeharu Tsuge, Masahiko Hara, Osamu Odawara and Hiroyuki Wada, "Optical Properties of ZnO Nanoparticles Capped with Polymers", Materials 2011, 4, 1132-1143; doi:10.3390/ma4061132
[30] MANOJ E WANKHEDE, SHAUKATALI N INAMDAR, APARNA DESHPANDE, "New route for preparation of luminescent mercaptoethanoate capped cadmium selenide quantum dots", Bull. Mater. Sci., Vol. 31, No. 3, June 2008, pp. 291–296. © Indian Academy of Sciences.
[31] Avinash Singh, V S Tripathi, "acile and green synthesis of 1-thioglycerol capped CdSe quantum dots in aqueous solution", Article in Materials Chemistry and Physics · May 2018
[32] A. Jafar Ahamed, K. Ramar, P. Vijaya Kumar, "Chemical Synthesis of CdSe Nanoparticles by using Hydrazine Monohydrate as A Reducing Agent" , J. Environ. Nanotechnol. Volume 5, No.3 pp. 29-33 ISSN (Print): 2279-0748 ISSN (Online): 2319-5541 doi:10.13074/jent.2016.09.163198, 2016
[33] Lingling Liu, Wenhong Fan, Huiting Lu & Wei Xiao, "Effects of the interaction between TiO2 with different percentages of exposed {001} facets and Cu2+ on biotoxicity in Daphnia magna", 1Scientific RepoRts | 5:11121 | DOi: 10.1038/srep11121
[34] N Rab, F K Chong , H I Mohamed and W H Lim, "Preparation of TiO2 nanoparticles by hydrolysis of TiCl4 using water and glycerol solvent system", IOP Conf. Series: Journal of Physics: Conf. Series 1123 012065 doi :10.1088/1742-6596/1123/1/012065, 2018
[35] I.Sharan Kumar, Mridula Polasa, Ch. Shilpa Chakra, K. Venkateswara Rao , "Preparation And Characterization Of Titanium Dioxide Nanoparticles By Olyvinylpyrrolidone Hydrothermal Processes", International Journal Of Multidisciplinary Advanced Research Trends Issn : 2349-7408 Volume Ii, Issue I, February 2015



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