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GO-CdS NC Material for water treatment:A Review

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Abstract: In 21st century most important challenges in the global water situation, mainly resulting from worldwide population growth and climate change, require novel innovative water technologies in order to ensure supply of safe drinking water. Providing clean and good water to satisfy human requirement may be a grand challenge of the twenty first century. Worldwide, water system struggles to stay up with the quick growing demand, which is further exacerbated by increase in global climate change, and water quality deterioration. The necessity for technological innovation to change integrated water management cannot be immoderate. Nano technology holds nice potential in advancing water and wastewater through safe use of unconventional water sources. Here we tend to review recent development in nanotechnology for water and waste material treatment.

Index Terms: Nanotechnology Nanomaterials Water and wastewater treatment Water reuse.

I. INTRODUCTION

There has always been an ever increasing demand for safe and clean water all over the world. Various toxic contaminants are detected in drinking water which forms the root cause for many major ailments. The conventional water purification technologies such as winnowing, ,clay vessels, clarification and filtration through plant material, Jempeng stone filter method, horizontal flow coarse media filter, upflow gravel filter,two-stage filter ,upflow/downflow filter etc.have been found to be slow, less effective and environmentally incompatible.

Thus, there is an urgent need to develop an efficient, cost effective and environment friendly technology for water treatment and purification. Developments in nanomaterial sciences can provide solutions to the existing and future water challenges in a significant manner. A rational design of nanomaterials emphasizing on 'design for purpose' can contribute in a big way in creating advanced and more efficient water treatment technologies.

Nanotechnology-enabled water and wastewater treatment promises to not only overcome major challenges faced by existing treatment technologies, but also to provide new treatment capabilities that could allow economic utilization of unconventional water sources to expand the water supply.

Here, we offer an outline of recent advances in nanotechnologies for water and waste product treatment. The potential impact of nanomaterials on human health and system as well as any potential interference with treatment processes are on the far side the scope of this review and so won't be detailed addressed here.

II. ROLE OF NANOPARTICLE .

Four classes of nanoscale materials that are being evaluated as functional materials for water purification:
(1) dendrimers
(2) metal-containing nanoparticles,
(3) zeolites and
(4) carbonaceous nanomaterials.

These have a broad range of physicochemical properties that make them particular attractive as separation and reactive media for water purification.. This would be in particular, immensely beneficial for developing nations like India and Bangladesh where cost of implementation of any new removal process could become an important criterion in determining its success.

Employing inexperienced chemistry principles for the assembly of nanoparticles will result in a good reduction in waste generation, less dangerous chemical syntheses, and an inherently safer chemistry generally. However, to substantiate these claims a lot of quantitative knowledge is needed and whether or not replacement ancient materials with nanoparticles will so end in lower energy and material consumption and hindrance of unwanted or unanticipated aspect effects continues to be receptive discussion. There is also a good discussion concerning the security of nanoparticles and their potential impact on the surroundings. there's fervent hope that applied science will play a major role in providing clean water to the developing countries in associate degree efficient, low cost and property manner. On the opposite hand, the potential adverse effects of nanoparticles can't be overlooked either. for example the chemical action activity of a nanoparticle will be advantageous once used for the degradation of pollutants, however will trigger a poisonous response when preoccupied by a cell. thus this Janus face of nanotechnology will influence be a hurdle in its widespread adoption. but as mentioned before applied science can step during a huge manner in lowering the price and thence become simpler than current techniques for the removal of contaminants from water within the long haul. In this perspective nanoparticles will be used as potent sorbents as separation media, as catalysts for chemistry destruction of contaminants; nanosized zerovalent iron used for the removal of metals and organic compounds from water and nanofiltration membranes.

Water purification is the method of removing undesirable chemicals, biological contaminants, suspended solids and gases from contaminated water. The goal is to supply water suitable for a particular purpose. Most water is disinfected for human consumption (drinking water), however water purification may be designed for a range of alternative functions, together with fulfilling the wants of medical, pharmacological, chemical and industrial applications. Purifying water might scale back the concentration of stuff together with suspended particles, parasites, bacteria, algae, viruses, fungi, further as reducing the quantity of a spread of dissolved and particulate material derived from the surfaces that return from runoff as a result of rain. For these purposes, the nanocomposites could be used by which the small particles can be removed very fast as compared to the simple method.

Ashish Kumar Sahoo, et.al [3] has shown the water treatment process in which they have shown that industrialization and urbanization typically cause the discharge of unhealthy chemicals, specially metallic element (Cd)and lead (Pb) in water which have drawn a worldwide major global concern. Maximum interest has been targeted on semiconductors acting as sensitizers in light-induced redox method for degradation of variety of organic dyes. The corresponding nanocomposites has been investigated separately as photocatalyst in the decomposition of methylene blue in the presence of UV light and also as adsorbents in the removal of Cd(II) and Pb(II) ions in contaminated water. These studies have established that CdS/graphene and ZnS/graphene are effective photocatalyst as well as effective adsorbents in the removal of Cd(II) and Pb(II) ions to an extent of 97 and 99 % by ZnS/graphene and CdS/graphene nanocomposite, respectively, under 1 g L^{-1} of adsorption dose and at pH ~7. Further studies also established Langmuir model befitting for the adsorption of Pb(II) and Cd(II) ions on CdS/graphene and ZnS/graphene, respectively. The presence of interfering ions on extent of Cd(II) and Pb(II) removal has also been reported.

Pawar ,Jin- Yon Lee et. al [5] synthesised RGO-CdS composite material using CBD method in which Graphene Oxide served as the support and Cadmium Sulphate-Hydrate as the starting material. Photocatalytic degradation of the synthesised materials were studied and they showed enhanced photocatalytic activity as compared with CdS nanoparticles.

Wei Lü, JieChen [2] have reported that composite of graphene are made with the combination of large-sized CdS particle by a one pot solvothermal route in which the reduction of graphite oxide into graphene was accompanied by the generation of microsized CdS particles. The structure and composition of the obtained nanocomposites were studied by means of X-ray diffraction, scanning electron microscopy, and transmission electron microscopy. The composites are used to remove the dye from wastewater using the organic dye Rhodomine B as the adsorbate.

Paulchamy B, Arthi G and Lignesh BD [6] have given the breakthroughs in areas such as materials and manufacturing, nanoelectronics, medicine and healthcare, energy, biotechnology, information technology, and national security. One of the crucial bottlenecks for the application of graphene-based systems in materials science is their mass production. Graphene oxide (GO) has been considered widely as a prominent precursor and a starting material for the synthesis of this processable material. It describes the synthesis of Graphene oxide(GO) by both Hummer’s and modified Hummer’s method. This GO acts as a base material for the future application of water purification, super capacitors and as a composite in antibacterial activity, solar cells and coatings.

B. Zeng, X. Chen [7] have given the general method of metal synthesis (Cd, Zn) sulphide nanorods/graphene developed by using microwave technique. It involves photocatalytic degradation of organic pollutant. Here the enhanced photoactivity has been observed. The method approaches towards the fabrication of various one-dimensional semiconductor/grapheme nanocomposites with excellent photocatalytic performance.

Xiaomei Zhao,ShiweiZhou [8] have prepared GO/CdS by one step synthesis in aqueous solution. The as prepared GR–CdSnanocomposite films inherited the excellent electron transport properties of GR. In addition, the hetero nanostructure of the GR–CdSnanocomposites facilitated the spatial separation of the charge carriers, thus resulting in enhanced photocurrent intensity, which makes it a promising candidate for photo electrochemical applications. It was used for the fabrication of an advanced photo electrochemical cyto sensor, based on these GR–CdS nanocomposites, by using a layer-by-layer assembly process. It has showed a good photo electronic effect and cell-capture ability, and has a wide linear range and low detection limit. It could be an efficient platform for many other high-performance photovoltaic devices.

M. Abdel Rafea, A.A.M. Farag, N. Roushdy[9] has done a work in which they have introduced a nano powder. Thin films of different thicknesses of $(Zn_{0.5} – Cd_{0.5})S$ were prepared by dip-coating method onto glass substrates. The X-ray diffraction analysis of the prepared powder and films were performed to investigate the crystalline structure. The dispersion of refractive index was discussed in terms of the single-oscillator model and the important oscillating parameters were determined. The dependence of absorption coefficient on the photon energy was determined and the analysis of the result showed that the optical transition in $(Zn_{0.5} – Cd_{0.5})S$ is allowed and indirect. The thickness dependence of the obtained optical parameters was also considered.

Sandeep Gawande, Sanjay R Thaker[10] introduced a one-pot synthesis of CdS reduced graphene oxide composite via sonochemical reduction of graphite oxide and simultaneous CdS formation. They showed that the composite of RGO nanosheet are densly decorated by CdS nanocomposite, displaying a good combination between RGO and CdS.

Hemant K. Chitte, Narendra V. Bhat, Narayan S. Karmakar, Dushyant C. Kothari, Ganesh N. Shinde[11] reported the synthesis of silver nanoparticles by chemical reduction method. The Ag nanoparticles (AgNP) were characterized using UV-Vis spectroscopy which shows an absorption band at 420 nm confirming the formation of nanoparticles. For any practical application of the silver nanoparticles, it is necessary to stabilize it which can be done by making a com- posite. In the present studies three polymers were chosen such that AgNP could be put to some practical use. Polyvinyl Alcohol (PVA), Polypyrrole (Ppy) and Carboxymethyl cellulose (CMC) are important for use in textiles, electronics and food/drug technologies respectively. Polymeric composites of PVA, PPy, and CMC were prepared by mixing the aqueous solutions of the respective polymers and the colloidal suspension of pre-formed silver nanoparticles.

Suman Devi , PrakashKorake , S.N. Achary , Narendra M. Gupta [12] has given that a series of CdS/Nix nanocomposite photocatalysts, containing ca. 0.6e15 wt% Ni, were synthesized using a one-step hydrothermal method and characterized for their crystallographic, morphological, interfacial, and optical properties. Rietveld refinement of powder XRD data revealed the coexistence of wurtzite (hexagonal) and zinc blende (cubic) phases of CdS in ratios dependent on Ni content. Only a fraction of Ni existed as a secondary phase of NiS while the majority occupied the lattice positions of hexagonal CdS. It reveals that the enhanced CdS photoactivity is not a result of charge transfer between p-type NiS and ntype CdS, Ni-induced visible-region absorbance, or the coating of CdS particles by nonphotoactiveNiS. Instead, the preparation-dependent hexagonal/cubic CdS phase boundaries and particle morphology may play a crucial role. Additionally, certain Ni-doping induced sub-bandgap shallow energy levels contribute to charge carrier separation.

Jessirie Dilag, Hilton Kobus, Amanda V. Ellis [13] has introduced that Current advances in nanoscience have provided the unique opportunity to utilize nanostructured materials to improve the visualization and quality of fingermark development. Here, we show the facile controlled fabrication of CdS/poly(dimethylacrylamide), CdS/poly(dimethylacrylamide-co methyl methacrylate) and CdS/poly(dimethylacrylamide-co-styrene) fluorescent quantum dot nanocompositesfor use as latent fingermark developing agents on non-porous surfaces. First, CdS quantum dots were capped with 2-mercaptoethanol with subsequent immobilization of a carboxylated C12-chain transfer agent (C12CTA) via an ester bond. A surface initiated reversible addition fragmentation chain transfer (RAFT) polymerization was then performed under a controlled system resulting in nanocompositescontaining polymers of low polydispersity. The intrinsic optical properties of the CdS quantum dots were retained throughout the synthetic pathways, which allowed for the successful one-step application andfluorescent visualization of latent fingermarks (fresh and aged) on aluminum foil and glass substrates under UV illumination.

Bin Han, SiqiLiua, Zi-Rong Tang, Yi-Jun Xu [14] have given that CdS nanowires-nitrogen doped graphene (CdS NWs-NGR) nanocomposites have been fabricated by an electrostatic self-assembly strategy followed by a hydrothermal reduction. The CdS NWs-NGR exhibits higher photoactivity for selective reduction of aromatic nitro organics in water under visible light irradiation than blank CdS nanowires (CdS NWs) and CdS nanowires-reduced graphene oxide (CdS NWs-RGO) nanocomposites. The enhanced photoactivity of CdS NWs-NGR can be attributed to the improved electronic conductivity due to the introduction of nitrogen atoms, which thus enhances the separation and transfer of charge carriers photogenerated from CdS NWs. Here work could provide a facile method to synthesize NGR based one-dimensional (1D) semiconductor composites for selective organic transformations, and broaden the potential applications for NGR as a co-catalyst.

Nanocomposites of Graphene/Graphene Oxide with CdS, ZnS or Solid solution of CdS and ZnS can provide new nanostructures with low electron hole recombination and fast electron transfer from CdS semiconductor nanoparticle (donor) to Graphene (acceptor), thus showing enhanced photocatalytic, photovoltaic, electrochemical and optoelectronic properties. Besides, there have been reports of applications of these nanocomposites as an effective adsorbent for the extraction of organic pollutants.

Despite recent progress in studies on promising hybrid materials for photocatalysis, investigations on GO-CdS/ZnS nanocomposites still have a long way to go. Moreover, most of the synthesis techniques for these materials involve complicated and expensive procedures.

Taking these factors into account, it is proposed to investigate the photocatalytic properties of graphene oxide-(Cd_x-Zn_{1-x})S nanocomposite material by the simple and economically viable Chemical Bath Deposition (CBD) method at temperatures below 100° C for applications in water purification. Measurement of photo-catalytic degradation of organic dyes like Rhodamine B and Methylene Blue would be carried out under visible light and the photocatalytic efficiency of the synthesized nanocomposites would be studied. The suitability of these materials for Opto electronic applications would also be investigated.

III. Conclusion

Nanotechnologies have made great improvements for handling water contamination problems and will clearly make further advancements in future. Nanotechnology based treatment has offered very effective, efficient, durable and eco friendly approaches. These methods are more cost-effective, less time and energy consuming with very less waste generations than conventional bulk materials based methods. However certain precautions are to be taken to avoid any threat to human health or environment due to the nanoparticles. The technology should be cost effective.

IV. References.

[1]. Salah Abdul-Jabbar Jassim a,⇑ , Abubaker A. Rashid Ali Zumaila b , Gassan Abdella Ali Al Waly "Influence of substrate temperature on the structural, optical and electrical properties of CdS thin films deposited by thermal evaporation" , Results in Physics 3 (June2013) P.P.173–178

[2]. Wei Lü, Jie Chen, Yao Wu, LianfengDuan, Yue Yang AndXinGe, " Graphene-Enhanced Visible-Light Photocatalysis Of Large-Sized Cds Particles For Wastewater Treatment" (March 2014) P.P 2-7

[3]. Ashish Kumar Sahoo, Suneel Kumar Srivastava, Prasanta Kumar Raul, Ashok Kumar Gupta, RajnishShrivastava," GrapheneNanocomposites Of Cds And Zns In Effective Water Purification" 27 March 2014, P.P 2473

[4]. Amirhossein Hasani,1 Hamed Sharifi Dehsari,2 Ali Amiri Zarandi,2 Alireza Salehi, Faramarz Afshar Taromi,2 and Hanif Kazeroni 3,"Visible Light-Assisted Photoreduction Graphene Oxide Using CdS Nanoparticles and Gas Sensing Properties" 22 December 2014, Volume 2015, Article ID 930306,P.P. 11.

[5]. R.C.Pawar,Jin-Yong Lee,Eun-Jeong Kim,Hyungsub Kim and Caroline Sunyong Lee, "Synthesis of CdS with Graphene by CBD Method and Its Photocatalytic Activity"September 2012,Vol.22,P.P.10

[6]. Paulchamy B, Arthi G And LigneshBd,"A Simple Approach To Stepwise Synthesis Of Graphene Oxide Nanomaterial".Vol-6 P.P 1-4

[7]. B. Zeng, X. Chena," General Method For The Synthesis Of Metal (Cd, Zn) SulphideNanorods/Graphene For Use As A High Performance Photocatalyst ".Vol. 11, No. 2, April - June 2016, P. 559 – 566

[8]. Xiaomei Zhao, ShiweiZhou,Li-Ping Jiang, WenhuaHou, QingmingShen,and Jun-Jie Zhu,"Graphene–CdSNanocomposites: Facile One-Step Synthesis and Enhanced PhotoelectrochemicalCytosensing". Chem. Eur. J. 2012, 18, 4974 – 4981.

[9]. M. Abdel Rafea , A.A.M. Farag, N. Roushdy,"Structural and optical characteristics of nano-sized structure of Zn0.5Cd0.5S thin films prepared by dip-coating method" Journal of Alloys and Compounds 485 (JUNE-2009) P.P 660–666

[10]. SandeepGawande, Sanjay R Thaker," One-pot sonochemical synthesis of CdSgraphene oxide composite and its application for photocatalysticdegredation of methylene blue". Indian journal of chemistry Vol-52A, May 2013, P.P-614-618.

[11]. Hemant K. Chitte, Narendra V. Bhat, Narayan S. Karmakar, Dushyant C. Kothari, Ganesh N. Shinde,"Synthesis and Characterization of Polymeric Composites Embeded with Silver Nanoparticles"World Journal of Nano Science and Engineering, 2012,vol- 2, P.P 19-24.

[12]. Suman Devi , PrakashKorake , S.N. Achary , Narendra M. Gupta," Genesis of enhanced photoactivity of CdS/Nix nanocomposites for visible-light-driven splitting of water" International Journal of Hydrogen Energy · November 2014, P.P 19424-19433.

[13]. Jessirie Dilag, Hilton Kobus, Amanda V. Ellis," CdS/polymer nanocomposites synthesized via surface initiated RAFT polymerization for the fluorescent detection of latent fingermarks" Forensic science international ,May 2013,P.P 105-114.

[14]. Bin Han, SiqiLiua, Zi-Rong Tang, Yi-Jun Xu," Electrostatic self-assembly of CdS nanowires-nitrogen doped graphenenanocomposites for enhanced visible light photocatalysis". Journal of Energy Chemistry vol-24, June 2015, P.P145–156