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A Study of Antimicrobial Activity of High Fluorescent Cadmium Telluride Nanoparticles

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Abstract: In this work CdTe was synthesised at low temperature in an aqueous medium using mercaptopropionic acid (MPA) as capping agent in the absence of inert atomosphere. The optical studies demonstrated the formation of CdTe nanoparticles (NPs). Scanning electron microscope revealed the presence of CdTe NPs. Antimicrobial activity was also tested against the gram positive bacteria Escherichia coil and Klebsiella Pneumoniae as well as gram positive bacteria Bacillus subtilis, salmonella typhi and the effect was more pronounced with gram negative bacteria.
Keywords: Nanocrystal, fluorescent imaging, photoluminescence, antimicrobial.

Introduction:

Nanotechnology is becoming an area of increasing research, considerable attention has been paid for II-VI semiconductor nanoparticles over the past decade(1-6). Among various II-VI semiconductor nanoparticles, CdTe is extensively used because of strong fluorescence, high absorption coefficient, ideal band gap, low cost, easy preparation and greater stability. CdTe has been focussed in numerous field owing to its potential applications in photovoltaics, optoelectronics devices, photo detectors, photo chemical cells (7-11). CdTe NPs can also be used as fluorescent tags, biomarker, bio imaging, and drug delivery systems in target regions (12-14). Chemical approaches are the best popular method for the production of CdTe NPs .CdTe NPs show excellent physical and chemical properties and may vary based on size, shape, distribution, morphology and environment (15). In this article we report on the aqueous synthesis of MPA capped CdTe NPs under normal atmosphere and utility of CdTe NPs in biological applications. Our studies explore the influence of CdTe NPs on Gram positive and Gram negative bacteria.

Experimental Procedure:

CdTe Capped with MPA Nanoparticles

Cadmium Choloride of 0.1g was dissolved in 50 ml of demineralised water for 30 minutes under magnetic stirring. Add 0.2g of trisodium citrate dehydrate in the mixture. After 30 minutes 0.5 ml of MPA is added gradually and the PH level of the solution was readjusted to 7.5 using NaOH, then 0.25g of NaHTe and 0.5g of Sodium borohydride was added successively in the solution. The mixture was refluxed at 90˚C and stirred vigorously for several hours. The obtained colloidal solution was washed repeatedly with ethanol and centrifuged at 5000 rpm.

Figure (1)

Antibacterial assay:

The antibacterial activities of the Gram positive and gram negative bacteria using CdTe QDs were determined using the agar well diffusion method. 250ml of sterilized Muller Hinton agar (MHA) was poured into petri plates and allowed to solidify four bacterial test cultures were inoculated by the aseptic swabbing plate method. Then, with the help of a sterile cork borer, wells were cut measuring 0.9cm in diameter. About 0.25µl, 50µl, 75µl, 100µl of CdTe QDs were carefully dispersed into the bored holes for the test samples. 100µl of deionized water was placed in the center as a control. The plates were incubated at room temperature for 24 hours. The presence of Zone of inhibition around each well was indicative of antibacterial activity.

Result and discussion:

UV-Visible spectrum

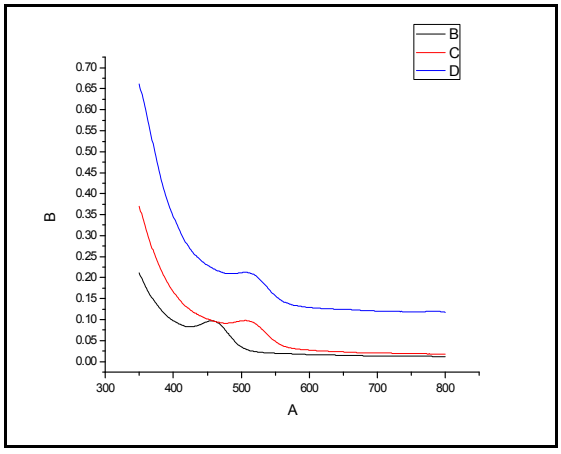

Figure (2)

The above synthesized MPA capped CdTe nanoparticles were carried out by UV –Visible absorption studies. The figure (2) depicts the absorption spectra of Nanoparticles for different refluxing time. The absorption was found in the range of 430 nm to 564 nm. The peak wavelength of the sample B, refluxed at 4 hr was 454nm.The peak was shifted to 516nm for the sample C and D, refluxed at 16 hr and 25 hr.This increase in wavelength is due to an increase in the nucleation of particles. The bandgap was calculated as 2.4ev, which was greater than the bulk CdTe(1.5ev) .This reveals the reduction of grain size.

Photoluminescence Studies:

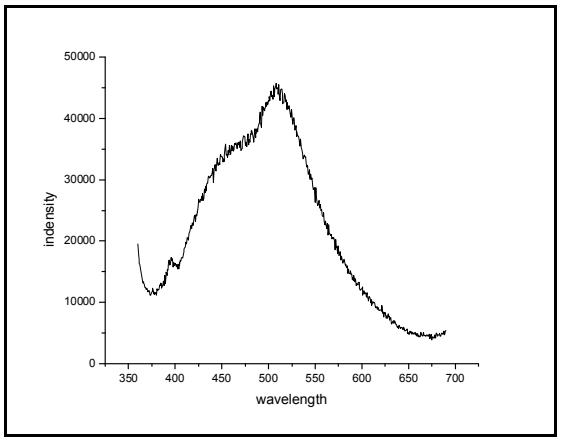

Figure (3)

The Photoluminescence Spectrum of the MPA capped CdTe sample was examined. The figure (3) shows the maximum Photoluminescence intensity in the wavelength range of 510nm-679nm.There is a weak deep trap emission over the wavelength of 510nm – 679nm.This may be due to the non radiative decay of trapped electrons or holes. The trapped electrons are the surface atoms of the NPs and they differ from the bulk.

Scanning Electron Microscope:

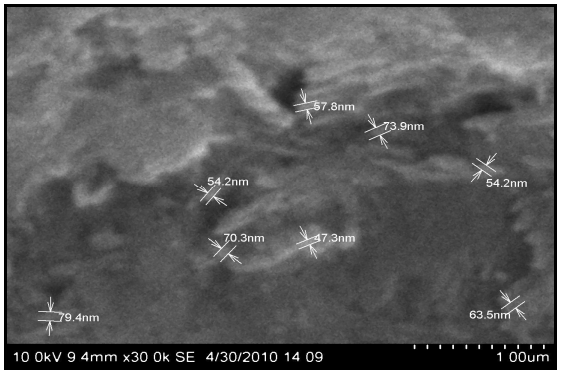

Figure (4)

Figure (4) shows the SEM image of MPA capped CdTe NPs. The surface morphology of as prepared sample with different grain sizes was observed.

Fluorescence:

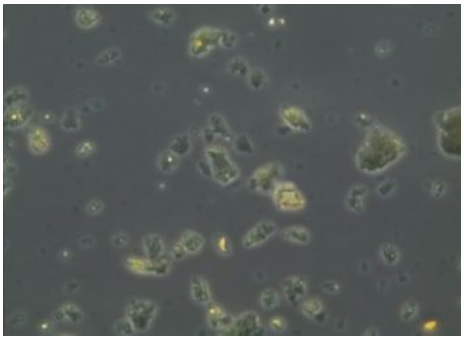

Figure (5)

Figure (5) reveals the Presence of Fluorescence in the MPA capped CdTe nanoparticles. The fluorescence intensity was enhanced depending on the size of the CdTe nanoparticles under the excitation of UV light.

Antimicrobial activity Results:

The antimicrobial Properties of as synthesized CdTe Nanoparticles at different concentrations were investigated using Gram Negative bacteria (Escherichia coli and Kleibsella Pneumoniae) as well as the Gram Positive bacteria (Bacillus subtillis, Salmonella Typhi) as Test Organism. The Bacterial Effect of CdTe Nanoparticles was determined by measuring the diameter of the inhibition Zone in Gel diffusion tests. Bacterial sensitivity was found to vary depending on the concentration and the microbial species. Gel diffusion tests revealed greater effectiveness of about 15 mm inhibition zone in the MPA capped CdTe Nanoparticles with Gram negative bacteria, particularly in Escherichia coli compared to other Test organisms. Escherichia coli exhibited maximum susceptibility to MPA capped CdTe Nanoparticles at 100µl concentration. As the concentration of MPA capped CdTe Nanoparticles increases, the inhibition Zone Range was found to be increased by 0.5mm approximately in all the samples. The difference in sensitivity can be attributed due to the differences in their cell membrane structure which interfers with CdTe Nano particles binding, leading to Reactive Oxygen Species (ROS) generation or the direct oxidation of cell lipids and proteins.

Table: I Antimicrobial activity of various bacteria using different concentrations of CdTe Nanoparticles.

S.No	Selected clinical pathogens	Zone of inhibition (mm)			
		25µl	50µl	75µl	100µl
1	Bacillus subtillis	12	12.5	13	13.5
2	Escherichia coli	13	14	14.5	15
3	Salmonella typhi	10	11	12	14
4	Klebsiella pneumoniae	11	12	13	15

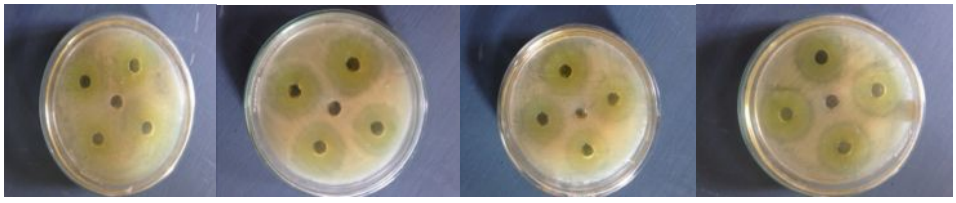

Figure (6)

Conclusion:

Aqueous MPA capped CdTe NPs could be successfully synthesized at low temperature. The surface morphology was recorded using SEM. Particle size was in the range of 50-70 nm. The Photoluminescence spectra showed the possibility of disorder. Fluorescence spectra confirmed the usage of CdTe as Fluorescent labels. The inhibition zone range indicated that Gram negative bacteria achieved highest antimicrobial activity than gram positive bacteria. This CdTe NPs resist Microorganisms Strongly.

References:

1. Sun.Y.H, Liu.Y.S, Vernier.P.T, Liang.C.H, Chong.S.Y, Marcu.L, Gundersen.M.A, Nanotechnology 17, 4469 (2006). doi: 10.1088/0957- 4484/17/17/031
2. Zhang.Y, He.J, Wang.P.N, Chen.J.Y, Lu.Z.J, Lu.D.R, Guo.J, Wang.C.C, Yang.W.L, J. Am. Chem. Soc. 128, 13396 (2006). doi: 10.1021/ja061225y
3. Alivisatos.P, Nat. Biotechnol. 22, 47 (2004). doi:10.1038/nbt927
4. Medintz.I.L,Uyeda.H.T, Goldman.E.R, Mattouss.H, Nat. Mater. 4, 435 (2005). doi: 10.1038/nmat1390

5. Michalet.X, Pinaud.F.F, Bentolila.L.A, Tsay.J.M, Doose.S, Li.J.J, Sundaresan.G, Wu.A.M, Gambhir. S.S, Weiss.S, Science307, 538 (2005). doi:10.1126/science. 1104274
6. Parak.W.J, Pellegrino.T, Plank.C, Nanotechnology 16, R9 (2005). doi: 10.1088/0957-4484/16/2/R01
7. Seleverstov.O, Zabirnyk.O, Zscharnack.M, Bulavina.L, Nowicki.M, Heinrich.J.M, Yezhelyev.M, Emmrich.F, ReganA. Bader.R.O, Nano Lett. 6, 2826 (2006). doi: 10.1021/nl0619711
8. Kim.N.H,Y.-o.Choi and W.-.Lee.S, Electronics letters(2010).DOI:10.1049/d.2010.1135
9. Sungjee Kim,Brent fisher,Hans jurgen,Eisler and Moungi Bawendi,*J. Am. Chem. Soc.*, 2003, *125* (38), pp 11466–11467. doi: 10.1021/ja0361749
10. Uematsu.T,Kitajima.H, Kohma.T,Torimoto.T, Tachibana.Y and Kuwabata,Nanotechnology 20 (2009). doi:10.1088/0957-4484/20/21/215302
11. Ke Sun, MilanaVasudev, Hye-son Jung, Jianyong Yang, Ayan Kar, Yang Li, Kitt Reinhardt, Preston Snee, Michael A. Stroscio, Mitra Dutta, Microelectronics Journal 40 (2009) 644-649. doi:10.1016/j.mejo.2008.06.033
12. Li Zhou, Chao Gao, Xiaozhen Hu, and Weijian Xu,APPLIED MATERIALS & INTERFACES, VOL. 2.NO.4. 1211-1219.2010.doi:10.1021/am9009296.
13. Liyuan Chen, Chengliang Chen, Ruina Li, Ying Li and Songqin Liu,Chem. Commun., 2009, 2670-2672,The Royal Society of Chemistry 2009.doi: 10.1039/b900319c
14. Pan Sun, Hongyan Zhang, Chang Liu, Jin Fang, Meng Wang, Jing Chen, Jingpu Zhang, Chuanbin Mao, andShukun Xu, Langmuir. 2010 Jan 19; 26(2): 1278– 1284.doi: 10.1021/la9024553
15. Vaclav Kubat, Zdenek Losos, Zdenek Travnicek, Josef Novosad,Inorganic Chemistry Communications, 38 (2013) 8-10,http://dx.doi.org/10.1016/j.inoche.2013.10.003

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