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EFFECT OF NANOPARTICLES ON THE ANTIBACTERIAL ACTIVITY OF ANTIBIOTICS

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ABSTRACT

In this work, CdS nanoparticles were synthesized via chemical method and its activity on microorganism pathogens was investigated. X- ray Diffraction (XRD), Atomic Force Microscopy (AFM) and UV-VIS transmission spectroscopic analysis were utilized to characterize the crystalline structure, size, transmission spectra of nanoparticles. Diffraction analysis confirms the formation of cubiform and hexangular structures of nanoparticle, The AFM show the formation of combination of nanoparticle with particle size travel 7 – 20 (nm). The CdS nanoparticles improve the antibacterial activity of antibiotic and showed effective repressive activity against the pathogens. that increase as nanoparticles concentration was hyperbolic

INTRODUCTION

Nanoparticles represent a significant category of nanomaterials. Nanoparticles are zero- dimensional, possessing nanometric dimensions altogether the 3 dimensions. The diameters of will vary anyplace between one and a couple of many nanometers. Tiny nanoparticles with diameters a couple of nanometers are corresponding to molecules (Rao *et al*., 2007). Nanoparticles are of nice scientific interest as a result of the exhibit distinctive, fascinating electronically, optical and biological properties and are a perfect size to be used as nanotechnological building blocks. These particles usually show properties intermediate between quantum and bulk materials thanks to their intermediate size and area to volume ratios (Liz-Marzān and Kamat, 2003). Nowadays, metal chalcogenides have a lot of attentions within the field nanomaterials science. Of all II–VI sulfides, sulfide CdS was direct band gap semiconductor, and a promising material thanks to their applications in optoelectronics (Dzhafarov *et al*., 2010), photo catalysts (Huynh *et al*., 2002), photovoltaic cell (Oladeji *et al*., 2000), and nonlinear optical material (Brus, 1991). Especially, they need been extensively exploited to be used in biological systems, living organisms and drugs (Al-Bakri *et al*., 2009). Varied ways are utilized to synthesis CdS Nanoparticles as well as a sol-gel template (Battisha, 2002), microwave – solvothermal route (Murugan *et al*., 2005), hydrothermal reaction (Jinxin *et al*., 2007), laser ablation (Gong *et al*., 2007), chemical bath deposition (Saikia *et al*., 2010) and chemical method (Bhattacharya and Saha, 2008). In this work, CdS nanoparticles was used to enhance the antibacterial activity of antibiotics, Amoxicillin, against completely different infective bacteria: *Escherichia coli, Pseudomonas aeruginosa, Proteus volgaris, Staphylococcus aureus, Streptococcus pneumoniae*

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MATERIALS AND METHODS

CdS nanoparticles Preparation: CdS nanoparticles were synthesized via chemical method, using cadmium nitrate $Cd(NO_3)_2.4H_2O$ and thioacetamide (TA the main points of preparation methodology were delineated in ref. (Khashan, 2013). The structure characterization were performed by X-ray diffractometer (Philips, PW/1710), with monochromatised CuKα radiation of wavelength 0.15418nm. A transmission spectrum was recorded using a Cecile-7200 double beam UV/VIS spectrophotometer equipped by Aquarius Company for the wavelength vary of 200-900 nm. Atomic force microscopy (Advance angstrom Inc. SPM AA3000) was used to characterize surface morphology and particle size.

Antibacterial assay: Completely different infective microorganisms were used: *Escherichia coli, Pseudomonas aeruginosa, Proteus volgaris, Staphylococcus aureus, and Streptococcus pneumoniae.* Muller - Hinton ager was ready. every strain was swabbed onto the ager plates victimization

sterile cotton swabs. Wells of 5 mm diameter were created in every ager plates. Employing a micropipette, 100 µL of various concentration of Amoxicillin (125, 250, 500, and 1000) µg/mL with and while not completely different concentration of CdS nanoparticles (10, 20, 30, 40, and 50) µg/mL were poured onto every well on plate. After, the plates were incubation at 37°C for twenty-four hours. The diameter of the inhibition zones was measured in millimeter, that was demonstrates the efficiency of the antibacterial material.

RESULT AND DISCUSSION

The diffraction pattern of the CdS nanoparticles are shown in Figure(1), peaks were found at 2θ values of 26.5°, 44° and 52°, touching on diffraction from (002), (110) and (112) planes, reflections of the hexangular modification or (111), (220) and (311) reflection of the cubical zinc blend CdS, Also there were shoulders around 25° and 28.3° corresponding to the hexagonal phase in the XRD spectrum.

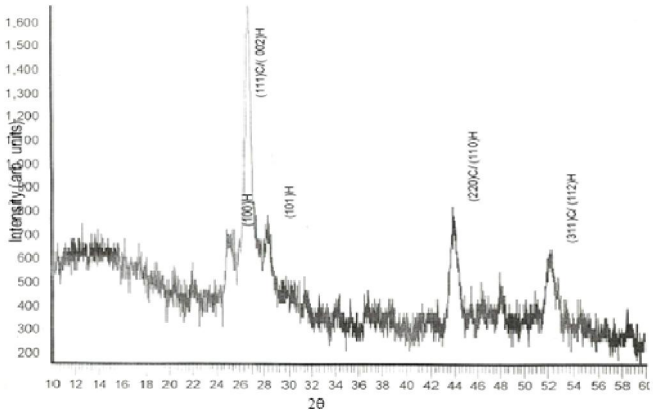

Fig. 1. XRD pattern of CdS nanoparticles

Figure (2) justify the transmission spectrum on CdS nanoparticles, this shows that transmission (T%) reach to 2.5 at short wavelength and this attribute to high absorption of nanoparticles at these wavelength, then the transmission increased as s wavelength increased. It is also observed from spectra a blue shift in band edge (~440nm) as compared to bulk CdS absorption edge (512nm), the amount of blue shift is (82nm). The main reasons for the blue shift are the quantum dimensional effect of the nanoparticles, which induce the wider band gap and the blue shift of the absorption band due to the decrease of particle size, and the surface effect of the nanoparticles, because the large surface force will cause crystal lattice aberration and a small crystal constant.

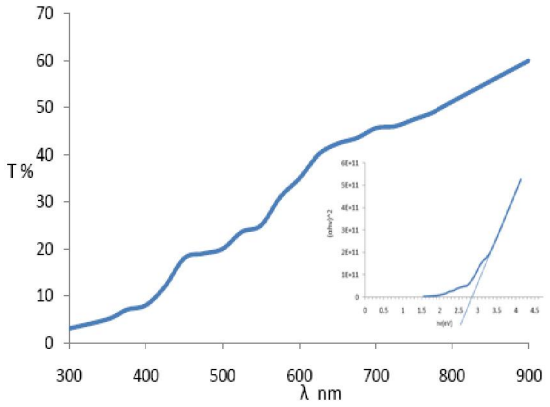

Fig. 2. Optical transmission spectra of CdS nanoparticles

At the same time, the short band length will induce the increase of the bond intrinsic oscillation frequency of nanoparticles, leading the blue shift of the absorption band. Therefore, the nanoparticles size is smaller and the blue shift is more obvious. The energy gaps E_g of CdS nanoparticles is 2.85 eV was calculable victimization Tauc relation (Singh and Chauhan, 2009). The AFM images of CdS nanoparticles was shown in Figure (3), the histogram of size distribution of CdS nanoparticles (Figure (3) b) shows particle size ranging from 7-20 nm.

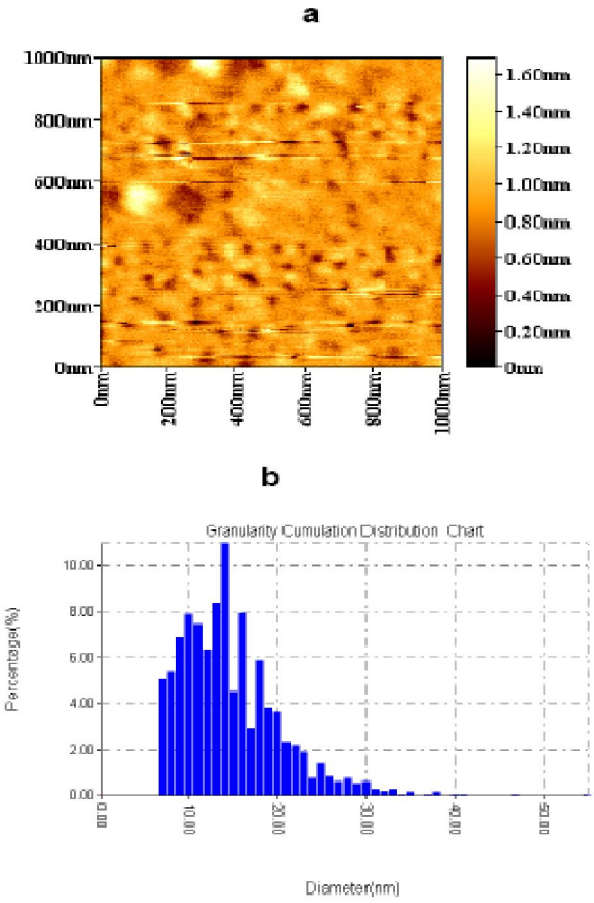

Fig. 3. AFM image of CdS nanoparticles; a) 2D image, b) Histogram of crystal size distribution

the medicinal drug properties of CdS nanoparticles was mixed with normal antibiotics, Amoxicillin , against varied strains of Gram positive and Gram negative microorganism like *E. coli, Pseudomonas aeruginosa, Proteus volgaris, Staphylococcus aureus, Streptococcus pneumoniae*) was studied in Muller Hinton agar. compared with the management, are given in Table (1), the diameters of inhibition zones increased for all the test pathogens, additionally the medicinal drug properties of CdS nanoparticles mixture with antibiotics were over compared with the pure antibiotics. *E. coli* (Gram-negative) microorganism, Table (1a), showed additional inhibition zone than the opposite microorganism as a result of the cell wall nature of the microorganism. Gram negative microorganism having thin simple multilayered lipid materials within the cell wall, the CdS nanoparticles simply enter into microorganism cells; thus, these show high inhibition zone than the opposite bacteria (Kim *et al*., 2007). In all the experiments, the zone of inhibition was higher for CdS mixed with antibiotics than the corresponding pure antibiotics. large area and high penetrating power can be the explanation for the improved activity and c

such nanoparticles may effectively bind to the substrates on the outer membrane and cell membranes of organisms. antibiotics contain active teams which will simply react with nano CdS. The antibiotics get adsorbable on the surface of CdS nanoparticles and thence the antimicrobial teams are available close proximity with a nanoCdS core encircled by antibiotics moieties. A single CdS nanoparticle is encircled by variety of antibiotics moieties and thence these antibiotics capped CdS particle act as one cluster against the microbe organisms. Also, CdS nanoparticles possesses well-developed surface chemistry, chemical stability and applicable smaller size than a microorganism, that makes them easier to interact with the microorganisms. Nanoparticles is additionally able to maintain a constant form and size in solution. it would be that the particles interact with the building components of the outer membrane inflicting structural changes, degradation and at last death. Also, fascinating results spurred out once the CdS nanoparticle concentration was increased. The microbe activity was increased higher as the nanoparticle concentration was increased [Table 1].

Table 1. Antibacterial properties of Amoxicillin & CdS nanoparticles against the various pathogens

a. Staphylococcus

Conc.of NPs µg/mL / Conc. of Amox. µg/mL	Zone of inhibition (mm)					
	0	10	20	30	40	50
0	-	18	19	20	22	23
125	18	20	23	25	26	31
250	25	26	28	30	34	37
500	30	31	33	36	38	40
1000	32	33	35	38	40	42

b. Streptococcus

Conc.of NPs µg/mL / Conc. of Amox. µg/mL	Zone of inhibition (mm)					
	0	10	20	30	40	50
0	-	11	13	15	17	19
125	10	12	15	17	22	25
250	13	18	21	22	25	30
500	15	20	25	27	28	32
1000	17	22	27	30	31	36

c. Escherichia coli (E. coli)

Conc.of NPs µg/mL / Conc. of Amox. µg/mL	Zone of inhibition (mm)					
	0	10	20	30	40	50
0	-	30	32	33	33	35
125	28	32	34	35	37	40
250	35	36	37	37	38	43
500	40	41	42	44	45	46
1000	41	43	44	45	46	48

d. Pseudomonas aeruginosa

Conc.of NPs µg/mL / Conc. of Amox. µg/mL	Zone of inhibition (mm)					
	0	10	20	30	40	50
0	-	18	19	20	22	22
125	18	20	21	23	24	27
250	20	22	24	26	27	29
500	21	24	27	29	31	33
1000	22	25	28	31	34	36

e. Proteus

Conc.of NPs µg/mL / Conc. of Amox. µg/mL	Zone of inhibition (mm)					
	0	10	20	30	40	50
0	-	11	11	13	14	16
125	10	12	13	16	19	21
250	11	14	17	19	21	22
500	13	15	18	20	23	25
1000	15	17	20	21	25	27

As CdS concentration is increased, additional quantity of antibiotics gets adsorbable on the nanoparticle surfaces and clearly this can increase the microorganism activity. Since the amount of antibiotics molecules increase, it'll act additional effectively against the microorganisms. From these observations, it is verified that CdS nanoparticles act as a decent anchor carrying additional quantity of antibiotics effectively on its surface via static attraction between the amine groups of antibiotics and nanoparticles thereby increasing the increased activity.

Conclusion

CdS nanoparticles were synthesized via chemical method using thioacetamide (TA). The XRD pattern confirmed the formation of CdS nanoparticles with hexagonal and cubic phase structure. the particle size of CdS nanoparticles within the vary of 7-20 nm was determined from AFM image, with band gaps 2.85 eV obtained from UV- VIS transmission spectra. As result, it absolutely was shown that a mix of antibiotics and CdS nanoparticles features a profound medicinal drug efficiency against varied strains of Gram positive and Gram negative microorganism a, that efficiency increased as concentration of nanoparticles increased.

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