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A COMPARITIVE STUDY OF EFFICIENCY OF CdS-SWCNT, AND NiO-SWCNT NANOCOMPOSITES FOR DEGRADATION OF METHYL VIOLET

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ABSTRACT

Cadmium sulphide (CdS), and nickel oxide (NiO) nanoparticles were synthesized by chemical precipitation method. The CdS nanoparticles were characterized by Field Emission Scanning Electron Microscope (FESEM), EDAX (Energy Dispersive Analysis of X Rays), and UV-Vis spectrophotometric methods, and NiO nanoparticles by X-ray Diffraction (XRD). Cadmium sulphide-Single Wall Carbon Nanotube (CdS-SWCNT), and Nickel oxide-Single Wall Carbon Nanotube (NiO-SWCNT) composites were prepared separately and tested for their efficiency in degradation of methyl violet dye. The results shows that CdS-SWCNT got better efficiency compared to NiO-SWCNT.

Keywords: CdS-SWCNT composite, NiO-SWCNT composite, FESEM, UV-Vis spectrophotometry, dye degradation.

I. INTRODUCTION

Pollution is the majour cause for the imbalance of the nature. One important kind pollution is the ground water pollution by industrial dyes. Most of the dyes are non-degradable and inhibit the aquatic biota by blocking the penetration of sun light to the aquatic system [1-7]. Dyes are the most polluting constituents in industrial wastewateras the presence of even very low concentrationsof dyes in effluent is highly visible and degradationproducts of these textile dyes are often carcinogenic [8]. Due to the complex chemical structure of the dyes often it is difficult to treat [9]. Nanomaterials exhibit significantly mechanical, electronic, magnetic, thermal, catalytic properties, and optical properties in comparison with their bulk counterparts, and have extensively attracted interests [10, 11, 12].Nano remediation has been most widely used for ground water treatment with additional extensive research in waste water treatment [13]. Metal oxide nanoparticles have got the potential for the degradation of dyes [14].

In this research work we have focused on the comparison study of the composites of CdS-SWCNT, and NiO-SWCNT for the effective degradation of methyl violet.

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II. EXPERIMENTAL PROCEDURE

The chemicals employed in the present study are nickel nitrate, sodium hydroxide, cadmium nitrate, sodium sulphide, methyl violet, ethanol, glucose (from Merck, India), methanol (from Fisher Scientific, India), SWCNT (from Ad-nano, India).

Synthesis of NiO nanoparticles: The Nickel oxide nanoparticles were produced by chemical precipitation method [15]. Two separate solutions were prepared; one a solution of 8.7 g of nickel nitrate in 60 mL of deionized water.The other contains a solution of 3.0 g sodium hydroxide in 150 mL of deionized water.1 g of surfactants is added to sodium hydroxide solution. The sodium hydroxide solution was added drop wise into the nickel nitrate solution on vigerous stirring at 1000 rpm at 30°C.The resultant light-green solution was filtered, and then washed with deionized water and ethanol for several times and was dried at 50°C for 24 hours, then calcinated at 450°C for 2 hours. The surfactants were removed after the synthesis processes by continuous washing and filtering.The obtained NiO nanoparticles were characterized by XRD.

Synthesis of CdS nanoparticles: The Cadmium sulphide nanoparticles were also produced by the simple chemical precipitation method [16].Two separate solutions were prepared; one of the solution taking 1.54 g of cadmium nitrate in 50 mL of deionized water. The other contains a solution of 0.39 g sodium sulphide in 50 mL of deionized water. The sodium sulphide solution was added drop wise into the cadmium nitrate solution with vegerous stirring at 1000 rpm at 30°C in order to avoid the agglomeration of the particles. 50 ml of 0.1 M glucose was added to the cadmium sulphide solution as a capping agent. The resultant yellow solution was filtered, and then washed with deionized water and ethanol for several times followed by methanol to remove the impurities and other byproducts.The filtrate was then dried at 100°C for 20 minutes using a hot plate.

Preparation of NiO-SWCNT nano composites: The carbon nanotubes used are single walled carbon nanotubes (SWCNT) with the purity greater than 95%.The SWCNTs are heated to 350°C for 2 hours before composite preparation to remove the impurities.The nickel oxide - single walled carbon nanotubes nanocomposites were prepared by taking nickel oxide nanoparticles and carbon nanotubes in equal proportion. The crucible containing the mixture is placed in a furnace at 400°C for 2 hours in order for the solid state reaction to take place to form the composite.

Preparation of CdS-SWCNT nano composites: The cadmium sulphide - single walled carbon nanotubes nanocomposites were prepared by taking nickel oxide nanoparticles and carbon nanotubes in equal proportion. The crucible containing the mixture is placed in a furnace at 450°C for 2 hours in order for the solid state reaction to take place to form the composite.

Dye degradation test procedures: The stock solution of the preferred dye (methylene violet) was prepared by taking 0.2g of methyl violet dye and dissolving it in 100 mL of distilled water. The absorbance range for this stock solution was measured by using UV-Vis spectrophotometry. Then 0.5mL of the prepared dye solution was taken and to this NiO-SWCNT, and CdS-SWCNTnanocomposites were added, separately. The absorbance reading of this solution was taken for every five minutes for half an hour using UV-Vis spectrophotometer. The above procedure was repeated with 1.0 mL stock solution of the dye and with NiO-SWCNT composite.

XRD patterns were recorded by using Bruker D2 phaser instrument. FESEM and EDAX were done using ZEISS Sigma FESEM 300 with EDS geometry of ZEISS Sigma 500, and UV-Vis spectrophotometry (Systronics, India).

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III. RESULTS AND DISCUSSIONS

XRD analysis:

The prepared NiO nanoparticles were characterized using XRD. The characteristic x-ray diffraction pattern of NiO nanoparticles, generated in a typical XRD analysis provides a unique "fingerprint" of the crystals present in the sample.The peaks positions are readily indexed as (111), (200), (220), (311), and (222) crystal planes of the NiO (Fig. 1). All these diffraction peaks can be perfectly indexed face centered cubic (FCC) crystalline structure peak position, both in peak position and in relative intensity of the characteristic peaks, which is in accordance with that of the standard spectrum [17].

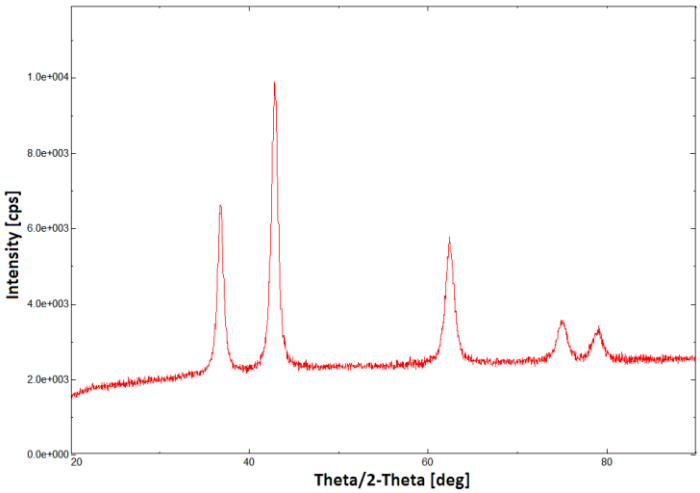

Figure 1: XRD peaks obtained for NiO nanoparticles

FESEM:

The synthesized CdO nanoparticles were characterized by FESEM (Fig. 2). The FESEM image obtained shows the average size of the synthesized cadmium sulphide nanoparticles as 19 nm. The size was calculated using Image J software were the size of individual sphere was calculated. Same procedure was repeated and average value of five particles is taken.

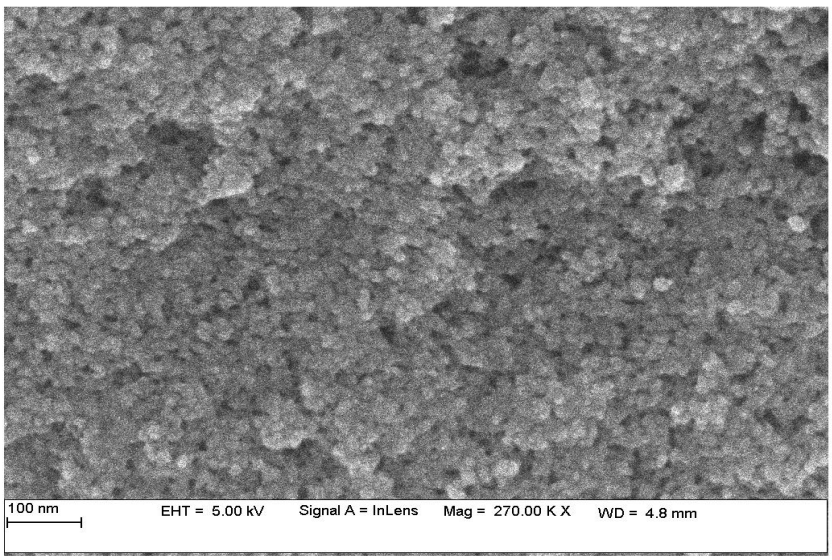

Figure 2: FESEM image ofCdS nanoparticles

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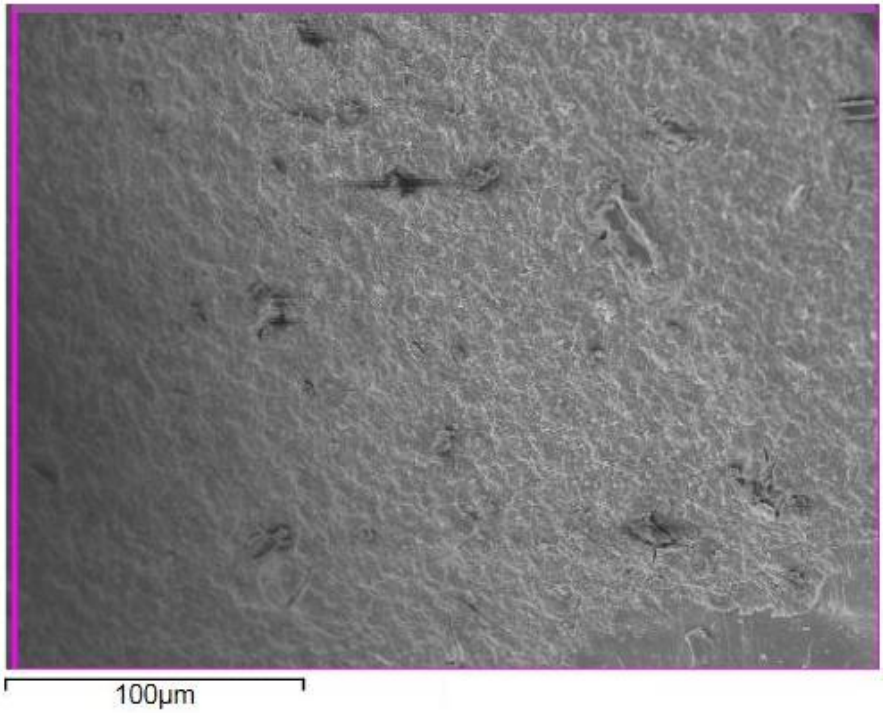

Figure 3: EDAX Image of CdS

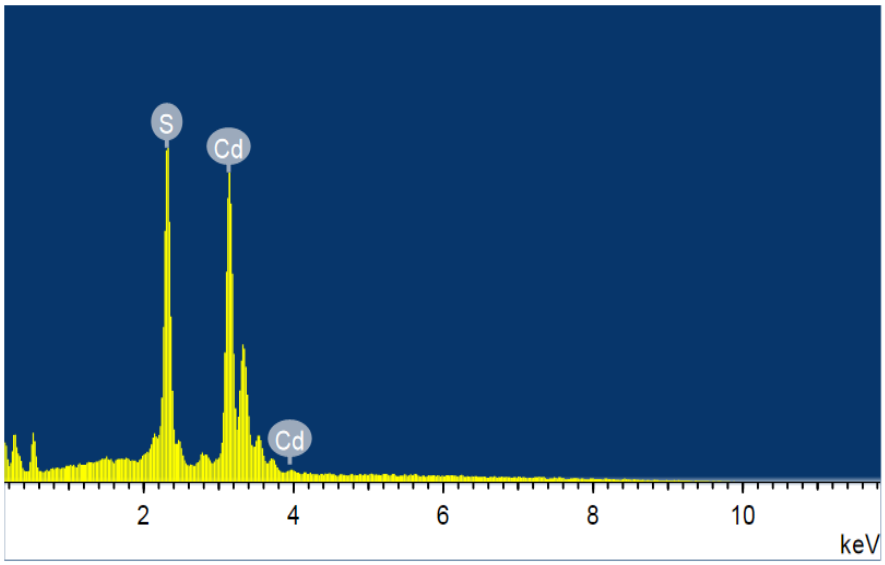

Figure 4: EDAX composition analysis of CdS

Table 1: EDAX chemical composition analysis

Element	Composition (%)	Weight (%)
Cd	53.84	6.95
S	46.16	1.70

EDAX:

EDAX was done on the CdS nanoparticles. The EDAX image and composition analysis graph is shown in Fig 3, and Fig. 4 respectively. From EDAX the composition of the mixture was analyzed (Table 1). EDAX result shows the composition and weight of cadmium and sulphate in the nanoparticles synthesized. It shows that CdS composition is more i.e, 53.84% and sulphate as 46.16%.

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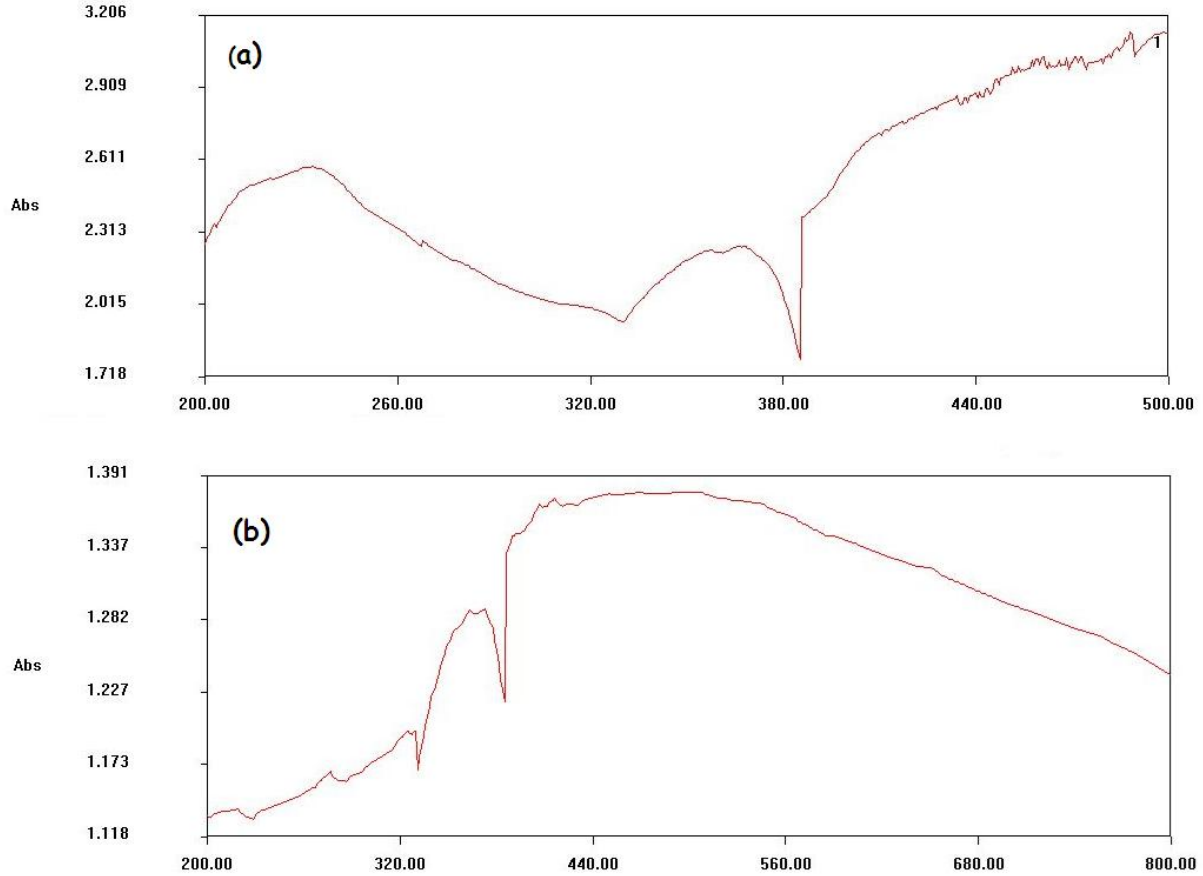
UV-Vis Spectroscopy:

UV-Vis absorption and transmittance spectrum of the synthesized CdS nanoparticles was measured (Fig. 5 (a)). The reading shows that the absorbance of CdS nanoparticles is nearly 460-490 nm.

Dye degradation test on addition of NiO-SWCNT nanocomposite: The UV-Vis spectrophotometric analysis were done for the methyl violet dye (Fig. 5 (b)), the mixture of 0.5 mL methyl violet and NiO-SWCNT composite immediately after mixing (Fig. 5 (c)), the mixture of 1.0 mL methyl violet and NiO-SWCNT composite immediately after mixing (Fig. 5 (d)), and 0.5 mL methyl violet and CdS-SWCNT composite immediately after mixing (Fig. 5 (e)). The solution was changed from blue colour to colourless solution and the absorbance was considerably decreased for every 5 minutes (Fig. 6 (A), (B), and (C)).

From the UV-Vis Spectrophotometric study results for 0.5 mL and 1.0 mL for both NiO-SWCNT nanocomposites and CdS-SWCNT nanocomposites it was observed that, in case of addition of NiO-SWCNT nanocomposites to both 0.5 mL and 1.0 mL of stock dye solution, the absorbance decreases with time indicating the degradation of dye.On addition of CdS-SWCNT nanocomposites to 0.5 mL of stock dye solution, the absorbance decreases faster with time as degradation occurs faster.Comparing these, both yields similar results but the rate of degradation is faster in CdS-SWCNT nanocomposites when compared to NiO-SWCNT nanocomposites.



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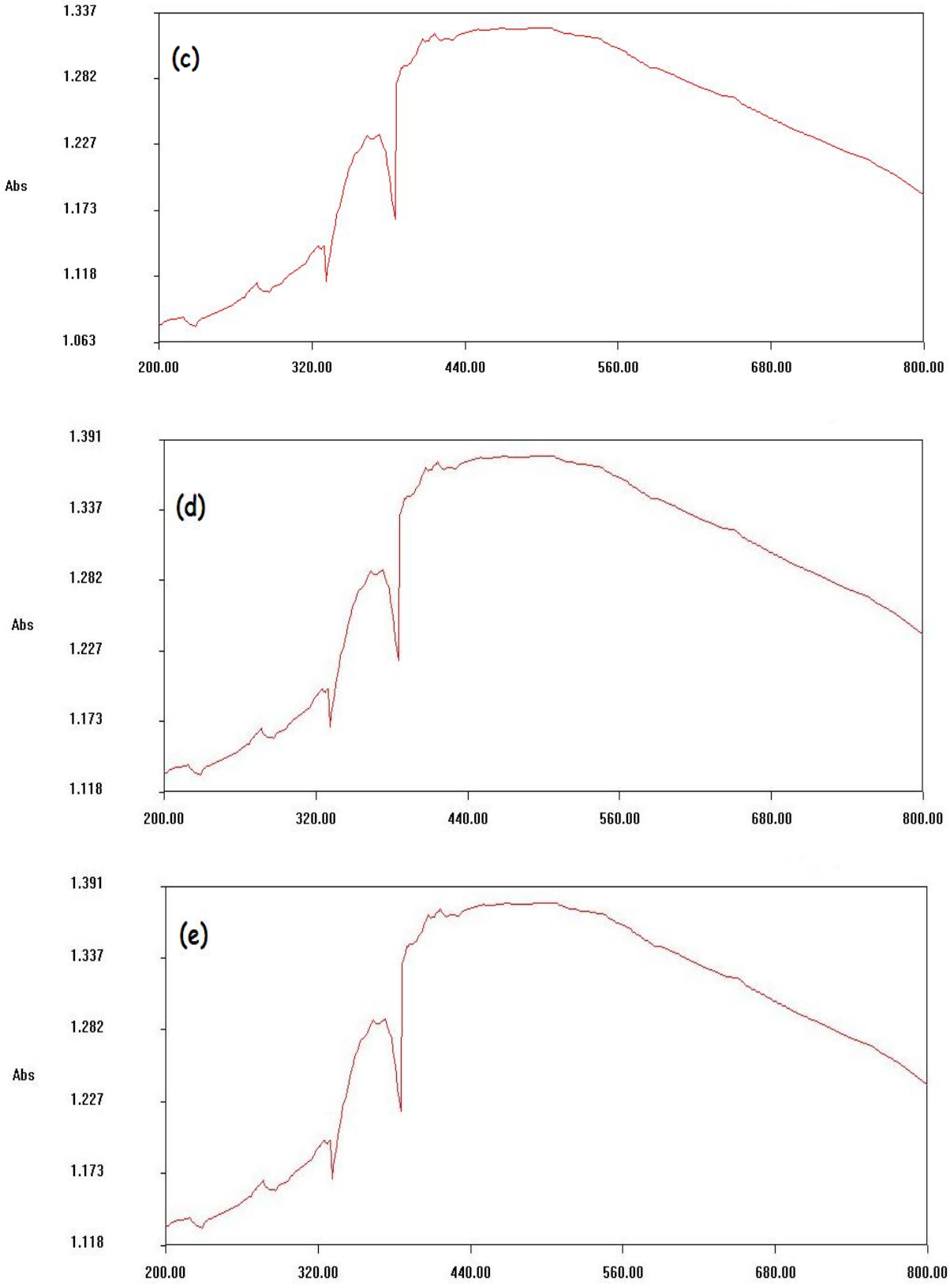

Figure 5: UV-Vis spectrophotometry images for (a) CdS nanoparticle, (b) Methyl violet, (c) 0.5 mL methyl violet and NiO-SWCNT composite, (d) 1.0 mL methyl violet and NiO-SWCNT composite, (e) 0.5 mL methyl violet and CdS-SWCNT composite.

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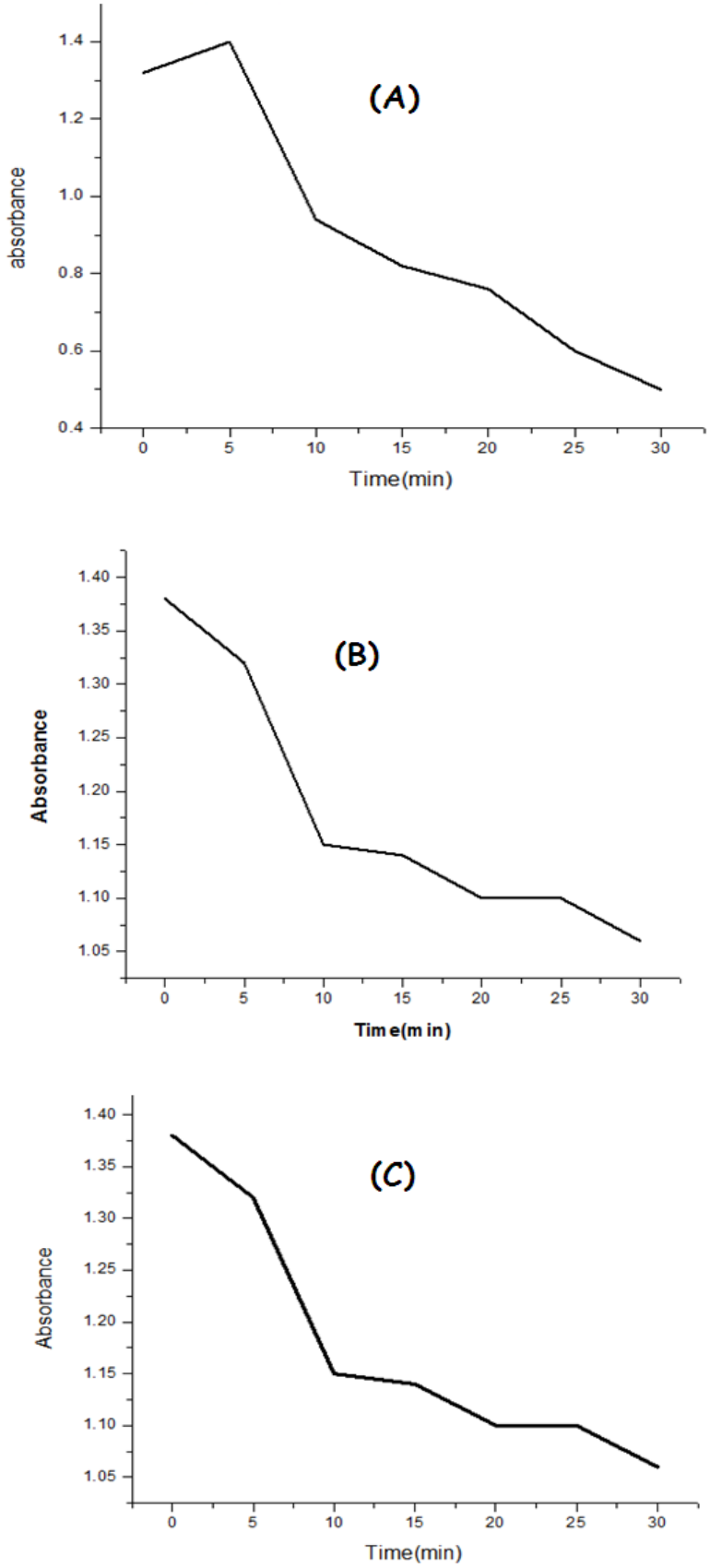

Figure 6: Time vs absorbance graph (A) for 0.5 mL methyl violet and NiO-SWCNT composite, (B) 1.0 mL methyl violet and NiO-SWCNT composite, (C) 0.5 mL methyl violet and CdS-SWCNT composite.

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VI. CONCLUSION

Cadmium sulphide (CdS) nanoparticle were synthesized by chemical precipitation method and confirmed by FESEM, EDAX, and UV-Vis spectrophotometric methods. NiO nanoparticles were synthesized and characterized by XRD. The prepared nanocomposites of NiO-SWCNT, and CdS-SWCNT were used to study the degradation rate of methyl violet. From the UV-Vis Spectrophotometric study results for 0.5mL and 1.0 mLof both NiO-SWCNT nanocomposites and CdS-SWCNT nanocomposites it was observed that, in case of addition of NiO-SWCNT nanocomposites to both 0.5 mL and 1.0 mL of stock dye solution, the absorbance decreases with time indicating the degradation of dye. On addition of CdS-SWCNT nanocomposites to 0.5 mL of stock dye solution, the absorbance decreases faster with time as degradation occurs faster. Comparing these, both yields similar results but the rate of degradation is faster in CdS-SWCNT nanocomposites when compared to NiO-SWCNT nanocomposites.

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