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Synthesis, Characterisation and Photocatalytic Activity Of Cadmium Sulphide

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ABSTRACT

Cadmium sulphide (CdS) was synthesized by reaction between cadmium acetate and sodium sulphide. The CdS particles were characterized by IR spectroscopy and UV-DRS. The photocatalytic activity of CdS was tested for degradation of methylene blue, rhodamine B and malachite green as well as photocatalytic reduction of malachite green in presence of EDTA and ascorbic acid as reductants. The catalyst showed high activity for the photocatalytic reduction of malachite green in presence of EDTA.

KEYWORDS: *Cadmium sulphide, UV DRS, photocatalytic activity*

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I. INTRODUCTION

Cadmium sulphide is an important semiconductor with a band gap of 2.42 eV and possessing various important physical and chemical properties. Cadmium sulphide has been used as catalyst for various photocatalytic reactions. CdS has been widely used for the photocatalytic degradation of dyes[1-4] and organic molecules[5,6]. Kothari et al.[7] have studied photoreduction of malachite green over CdS catalyst in presence of ascorbic acid and EDTA as reductants. In the present investigation CdS has been synthesized by precipitation method and its photocatalytic activity was tested for degradation of methylene blue, rhodamine B and malachite green as well as photocatalytic reduction of malachite green in presence of EDTA and ascorbic acid as reductants.

II. EXPERIMENTAL

Preparation of CdS: 250 ml of 0.5 M sodium sulphide was added dropwise with stirring to 250 ml of 0.5 M cadmium acetate. The solution turned yellow indicating formation of CdS. The solution was further stirred for 4 hours. The solution was filtered and the solid was washed with double distilled water and dried in an oven at 60 °C. The resulting solid (CdS) was yellow in colour. The solid was finely powdered using an agate mortar and pestle.

Characterisation Methods: IR spectrum of CdS was recorded using Shimadzu IRPrestige-21 FTIR in the range of 4000–400 cm^{-1}. The UV DRS spectrum of CdS was recorded using UV2450 Shimadzu UV-Visible spectrophotometer.

Photocatalytic Activity: The photocatalytic activity of CdS was tested for the degradation of methylene blue, rhodamine B and malachite green dyes. The photocatalytic reduction of malachite green was also studied in presence of ascorbic acid and EDTA.

Photocatalytic degradation of methylene blue, Rhodamine B and malachite green: The photocatalytic reaction was carried out with CdS catalyst suspended in 100 ml of dye solutions in a 250 ml beaker in sunlight. All experiments were conducted at room temperature in air. The initial concentrations of MB, RhB and MG were 50 µmol/l, 50 µmol/l and 60 µmol/l respectively. The weight of catalyst taken was 0.1 g, 0.1 g and 0.2 g for MB, RhB and MG respectively. At definite time intervals, an aliquot of the dye solution were withdrawn from the reaction vessel and absorbance was measured using a Shimadzu mini1240 UV-Vis Spectrophotometer at a wavelength of 650 nm, 500 nm and 620 nm for MB, RhB and MG respectively.

Photocatalytic reduction of malachite green in presence of ascorbic acid and EDTA *:*The photocatalytic reduction of malachite green in presence of ascorbic acid and EDTA was carried out with 0.2 g powdered CdS catalyst suspended in 100 ml of reaction mixture in a 250 mL beaker in sunlight. All experiments were conducted at room temperature in air. Malachite green solution concentration was 60 µmol/l and ascorbic acid and EDTA concentration was 30 µmol/l. At definite time intervals, an aliquot of the reaction mixture were withdrawn from the reaction vessel and absorbance was measured using a Shimadzu mini1240 UV-Vis Spectrophotometer at a wavelength of 620 nm.

III. RESULTS AND DISCUSSION

Figure 1 shows IR spectrum of CdS catalyst and the corresponding IR band assignments are shown in Table 1.

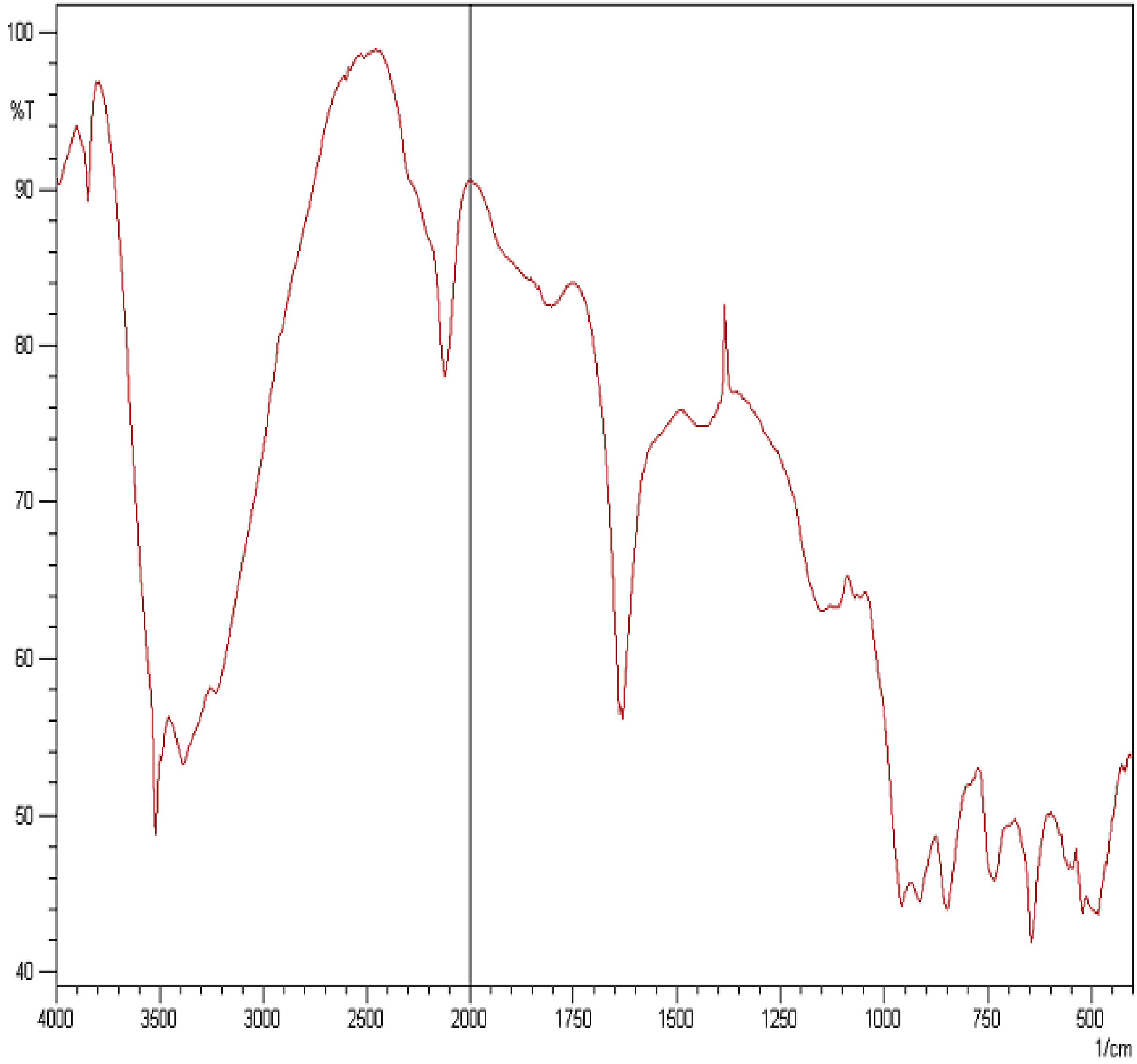

Figure 1. IR spectrum of CdS

Table 1. IR Assignments

Frequencies (cm^{-1})	Intensities	Assignments
3550	Strong	O-H stretching of adsorbed water on surface of CdS
1625	Strong	Bending vibration of water
650 740	Medium Weak	Cd-S stretching

The UV DRS spectrum of CdS is shown in Figure 2.

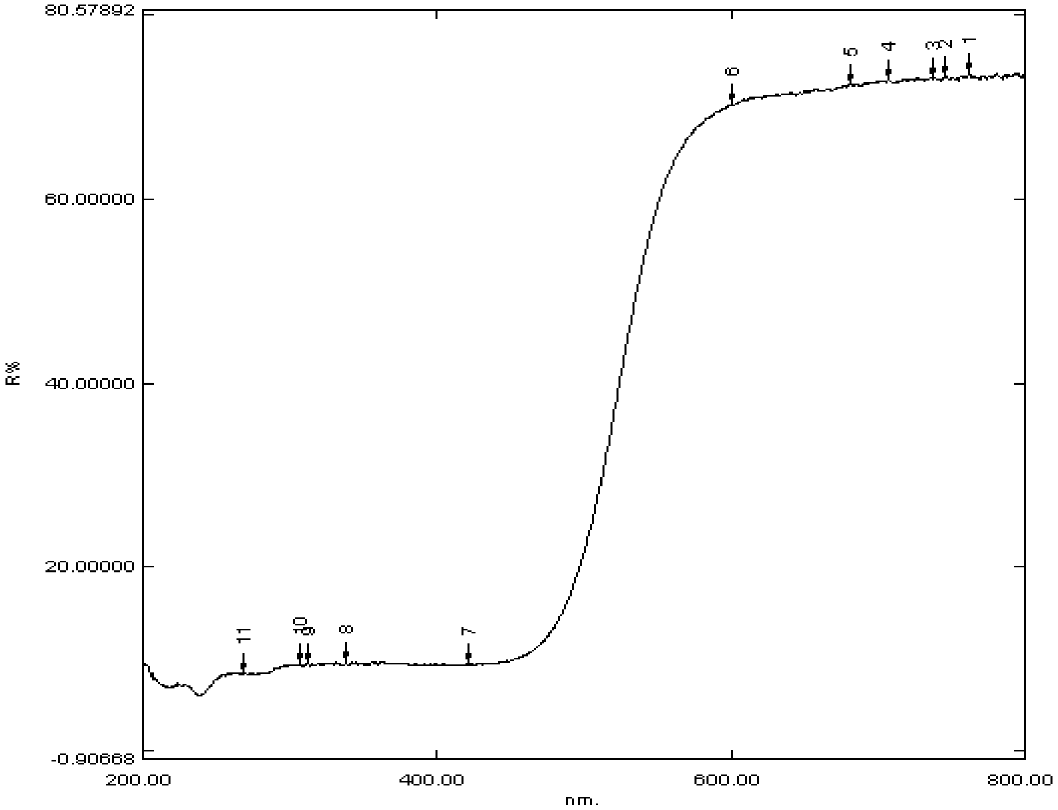

Figure 2. UV-DRS spectrum of CdS

The bandgap for CdS is found to be 2.37 eV which is in accordance with the reported value of 2.42 eV for CdS.

Photocatalytic Activity

The photocatalytic activity of CdS for degradation of methylene blue, rhodamine B and malachite green is shown in Figure 3.

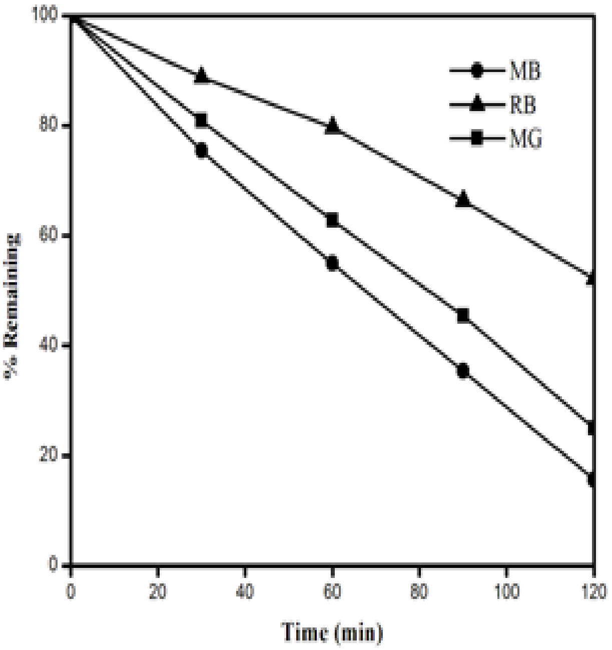

Figure 3. Photocatalytic activity of CdS for degradation of MB, RB and MG

The catalyst showed high activity for the degradation of methylene blue (nearly 85 % degradation of methylene blue was observed in 120 minutes). The catalyst showed nearly 50 % degradation of Rhodamine B and nearly 75 % degradation of malachite green over a period of 2 hoursThe activity of CdS for photocatalytic reduction of malachite green in presence of ascorbic acid and EDTA is shown in Figure 4.

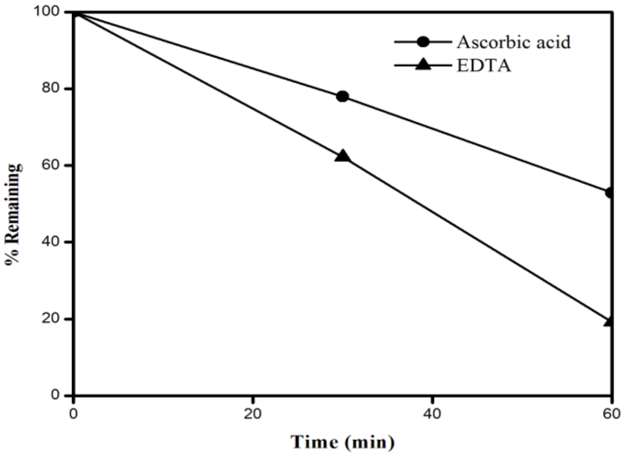

Figure 4. Activity of CdS for photocatalytic reduction of MG in presence of ascorbic acid and EDTA

Photocatalytic reduction of malachite green was also studied over CdS catalyst. The catalyst showed a very high activity for the photocatalytic reduction of malachite green in presence of EDTA. Nearly 80 % of malachite green was degraded over a one hour period. In comparison only about 50 % of malachite green was degraded in presence of ascorbic acid over a one hour period.

IV. CONCLUSION

CdS particles synthesised by a simple method showed excellent activity for photocatalytic degradation of methylene blue and photocatalytic reduction of malachite green in presence of EDTA.

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