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Effect of Cd, Ni codoping on photocatalytic activity of Zinc Oxide, Synthesized by Citrate Gel Method

Ms. Sneha Salvi[1], P.B.Lokhande[2], H.A.Mujawar[3]
Department of Chemistry[1, 2, 3], Dr. Babasaheb Ambedkar Technological University, Lonere, India[1, 2, 3]
snehasalvi19june@gmail.com[1], pblokhande@dbatu.ac.in[2], hamujawar@dbatu.ac.in[3]

Abstract- In this work, Cd, Ni codoped ZnO photocatalyst were synthesized by Wet chemical method i.e. Citrate gel method using Zinc nitrate, Cadmium nitrate, Nickel nitrate as a precursor. The effect of Cd, Ni codoping on Structural and Photocatalytic activity of ZnO was investigated using TG-DTA, SEM, EDX and XRD characterization techniques and by using UV-Visible spectrophotometer. The successful doping of Cd, Ni in ZnO crystal structure was confirmed by EDX analysis. The crystallite size, lattice parameters and particle size were investigated using XRD and SEM. The comparative study of the photocatalytic degradation efficiency of Undoped ZnO and Cd, Ni codoped ZnO was carried out by means of degradation of Rhodamine 6G in presence of UV light and Solar light. The effect of various parameters such as doping Concentration, pH, Catalyst loading on photocatalytic degradation efficiency was checked. The synthesized Cd, Ni codoped ZnO has also been investigated as interesting antibacterial property against Escherichia coli and Staphylococcus aureus.

Index Terms- ***Cd, Ni codoped ZnO; Citrate gel; Photocatalyst; Rhodamine 6G; Antibacterial Activity***

1. INTRODUCTION

Now days, Environmental pollution has been recognized as one of the greatest problem of society and this is mainly due to increased industrial activity. These industries produce large amount of effluents containing contaminants which can cause serious environment pollution as well as disturb the aquatic system, making it unfit for human and animal consumption. Therefore, we need to minimize these contaminants from waste water. The one of the major contaminant of waste water is dye [15]. Rhodamine 6G dye is an organic laser dye which belongs from class Xanthenes dye [10]. Due to its high chemical stability and toxic nature, it is necessary to find out the photocatalytic system able to decompose Rhodamine 6G dye into biodegradable components. The conventional methods such as biological method and chemical processes like chlorination, ozonization are used to degrade the dyes. However these techniques are non destructive which giving rise to new type of water pollution by transferring non biodegradable matter into sludge, therefore it required further treatment. As a result of these, Advanced Oxidation Processes (AOP's) have been considered as an effective and efficient technique for treating organic dye effluent [8].

Recently, Researchers have been focusing more to fabricate nano materials due to its outstanding chemical and physical properties than bulk materials due to their excellent surface property [2]. Photocatalysis is an advanced oxidation process, used to degrade pollutants efficiently [1]. This process has increased great interest, as the most promising way to solve the environmental problems mainly the removal of residual dyes from industrial waste water. Photocatalysis in presence of semiconductor is an efficient method for converting toxic and non biodegradable organic compounds into carbon dioxide and water [9]. In recent years, several kinds of semiconductors have been studied as photocatalysts including TiO_2, ZnO, V_2O_5, Fe_2O_3, WO_3. Out of these, ZnO has emerged as the leading photocatalyst as an efficient and effective in green environmental management system [7].

Photocatalysts are generally semiconductors having wide band gap energy [11]. ZnO is a II-VI semiconductor with wide band gap i.e. 3.4 eV and having large exciton binding energy of 60 meV at room temperature. It is important semiconducting material due to its wide range of applications in Rubber industry, Pharmaceutical industry, Textile industry, Electronics and electro technology industries, etc. Also ZnO has emerged as more efficient catalyst due to its non toxic nature, low cost and high photochemical reactivity [4].

Many techniques have been used in the waste water treatment processes. However, these techniques are quite expensive and not able to mineralized toxic pollutants completely. As an alternative approach, Photocatalysis has emerged as one of the most efficient, sustainable and widely used technique for degradation and mineralization of harmful pollutants by converting it into CO_2 and H_2O.

In general, photocatalytic activity of photocatalyst can be enhanced by doping of metals or non metals, which helps to form new energy levels to shift the absorption into visible light region and hamper the photo induced electron hole pair recombination [10]. Recently, codoping has attracted the researchers

with great deal of interest due to enhanced photocatalytic efficiency of codoped materials [12].

A good photocatalyst should absorb light in a visible range than UV. Sun is the most abundant and cheaper energy source of radiant light and heat. Photocatalysis process utilizes our renewable energy source i.e. solar energy. In presence of solar light two types of reactions via photo catalysis occurs, the first reaction involving oxidation which occur due to photo induced positive holes, present in valence band and second reaction involving reduction, which is due to photo induced negative electrons, present in conduction band [7].

In the earlier studies, the various methods have been adopted to prepare nano photocatalyst materials. The traditional high temperature solid state methods are not suitable for synthesis of ZnO due to energy consuming and difficulty to control the particle size, whereas the methods such as chemical precipitation method, sol gel method and Hydrothermal method have been used to synthesize ZnO on large scale at low cost [3]. Various experimental works have been reported on fabrication of doped ZnO via sol gel method [6]. However, there is no any report on synthesis, characterization and photocatalytic activity of Cd, Ni codoped ZnO via Citrate gel method. The advantages of using Citrate gel method are, during the synthesis it requires low temperature, high purity product obtained, low cost synthesis [2], particle size, shape and properties can be controllable, it can be use for multicomponent system [14]. In this paper we demonstrate the effect of various factors such as dopant concentration, pH, Catalyst loading on the photocatalytic activity of Cd, Ni codoped ZnO.

2. EXPERIMENTAL WORK

2.1. Chemicals and Materials:

In the present work, for the synthesis of doped ZnO following chemicals like Zinc Nitrate (Zn $(NO_3)_2.6H_2O$), Cadmium Nitrate (Cd $(NO_3)_2.4H_2O$), Nickel Nitrate (Ni $(NO_3)_2.6H_2O$), Citric acid ($C_6H_8O_7$), Ethylene glycol (CH_2 (OH).CH_2.OH), Ammonium hydroxide solution (NH_4OH) were used. All these chemicals were of an Analytical grade and used without any further purification. The appropriate concentrations of Rhodamine 6G solution was prepared with distilled water.

2.2. Instruments:

Synthesized Cd, Ni codoped ZnO photo catalysts were characterized by Field Emission Scanning Electron Microscope (FE-SEM), Energy Dispersive X-ray spectroscopy of JEOL. In the synthesis nano materials, for the preparation of gel Magnetic stirrer with hot plate (REMI) and for the Calcination of products Muffle Furnace were used, Photo degradation of Rhodamine 6G in presence of UV light was carried out by means of UV photo reactor (13 W) of Nexa. The progress of Photocatalytic degradation (PCD) at an interval of 1hr in presence of UV light and Solar light was checked by means of decrease in absorbance on UV-Visible Spectrophotometer (HACH DR 5000).

2.3. Synthesis of cadmium, Nickel codoped zinc oxide

Many methods have been practiced to synthesized nano materials. The citrate gel method is a process similar to the sol gel process. It involves gelling and combustion of an aqueous salt solution containing salts and organic fuel. During the synthesis, metal nitrates and citric acid were used as oxidizing agent and combustion fuel. As it is effective and efficient method, Cd, Ni codoped ZnO was prepared by Citrate gel method.

The precursors were taken in the stoichiometric amount of $Cd_xNi_yZn_{1-x+y}O$ (x=0; y=0, x=0.02; y=0.08, x=0.04; y=0.06, x=0.06; y=0.04, x=0.08; y=0.02) to obtain final product. Firstly, Cadmium nitrate, Nickel nitrate, Zinc nitrate were separately dissolved in 100ml of distilled water, then mixed and stirred continuously at 70^oC for 1hr. After 1hr, 100ml solution of 1M citric acid was added drop by drop. Then 50ml of Ammonium hydroxide was added drop wise to maintain pH. After 4hrs, 10ml Ethylene glycol had been added as a capping agent to prevent agglomeration. The reaction mixture was stirred continuously until gel formed. Finally, the gel was calcined at 600 ^oC for 2hrs to obtained final product. The redox reaction between nitrates and citric acid proceed as follows [13]

$$6Zn(NO_3)_2 + 6Cd(NO_3)_2 + 6Ni(NO_3)_2 + 10\ C_6H_8O_7 \longrightarrow$$

$$6ZnO + 6CdO + 6NiO + 60CO_2 + 18N_2 + 40H_2O$$

2.4. Photocatalytic degradation of Rhodamine 6G dye in presence of UV light and Solar light:

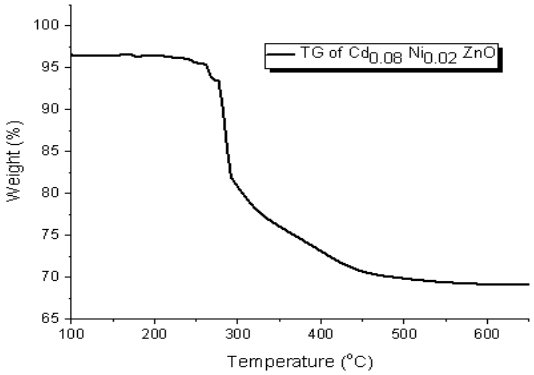
Solution of Rhodamine 6G having concentration 8.35 X 10^{-6} M was prepared by dissolving 0.020 g of Rhodamine 6G in minimum amount of distilled water and diluted it to 500ml with distilled water. The photocatalytic activity of as prepared photocatalysts was evaluated with the photocatalytic degradation of Rhodamine 6G under UV light and Visible light. For that 100ml solution of 8.35 X 10^{-6} M solution of Rhodamine 6G was taken and in that 0.1 gm of Cd, Ni codoped photocatalyst was added.

3. RESULTS AND DISCUSSION

3.1 Characterization of Cd, Ni doped ZnO:

3.1.1. Thermo Gravimetric analysis:

Small amount of samples were used in TG analysis to ensure calcination temperature of samples. The major weight loss was found between 250-500 ^{o}C which may be due to evaporation of water and organic compounds.



3.1.2. FE-SEM analysis:

Scanning Electron Microscopy (SEM) is used to investigate the morphology and particles size of materials. The morphology of Undoped ZnO and Cd, Ni doped ZnO samples have been investigated using Scanning Electron Microscopy as shown in figures 2a, 2a, 2c, 2d and 2e. The SEM images reveal that the particles are mostly spherical in shape. The particle size of Undoped ZnO and Cd, Ni codoped ZnO are in nano scale and which is in agreement with XRD result. The particles of Undoped ZnO and Cd, Ni codoped ZnO were found agglomerated and this agglomeration is due to very viscous nature of citric acid.

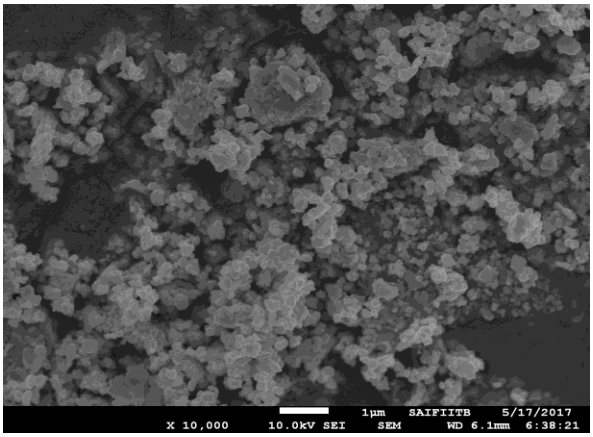


Figure 2(a)

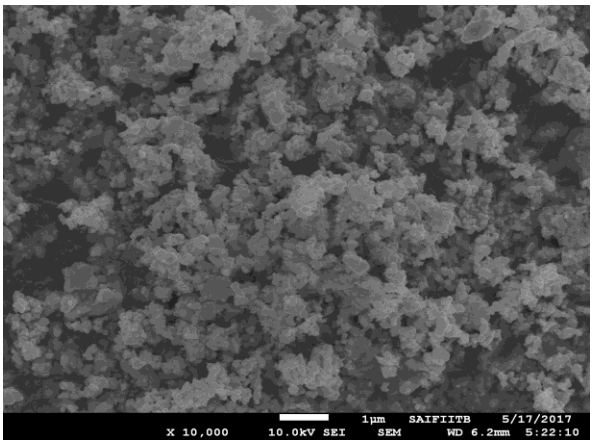


Figure 2(b)

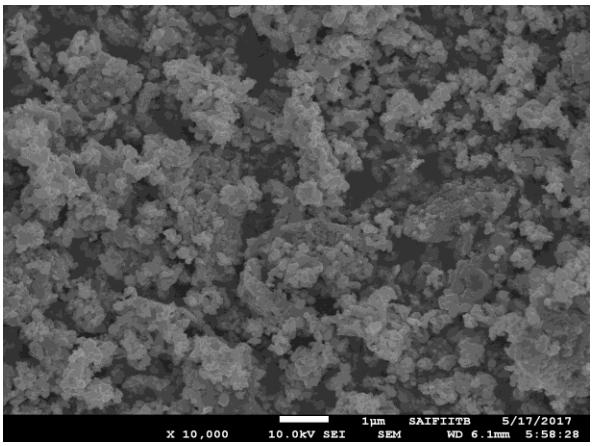


Figure 2(c)

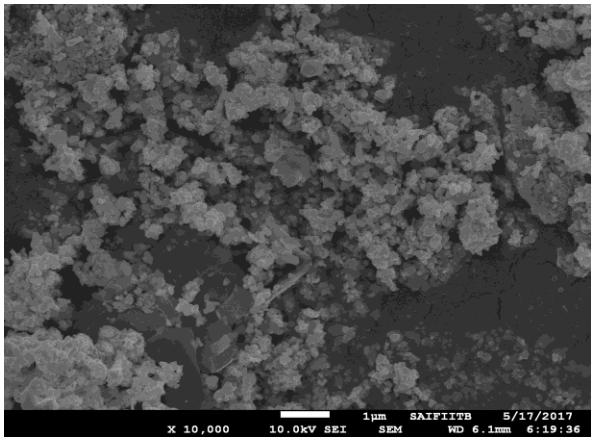


Figure 2(d)

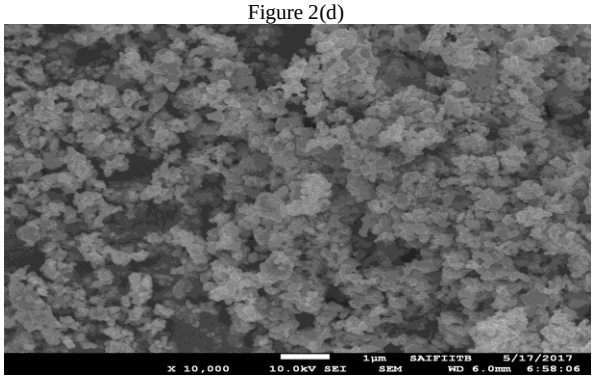


Figure 2(e)

Fig. 2 FE-SEM images of a) Undoped ZnO b) $Cd_{0.02}$ $Ni_{0.08}$ doped ZnO c) $Cd_{0.04}$ $Ni_{0.06}$ doped ZnOd) $Cd_{0.06}$ $Ni_{0.04}$ doped ZnO e) $Cd_{0.08}$ $Ni_{0.02}$ doped ZnO

3.1.3. EDX (Energy Dispersive X-Ray):

The EDX analysis provides the composition of elements in the material. Fig.3(a) Shows that the peaks corresponding to Zinc and Oxygen only as well as Figures 3(b), 3(c), 3(d) and 3(e) show that the peaks correspond to Zn, O, Cd and Ni. There is no any other impurity peaks were detected which confirms the purity of prepared samples as well as that strongly support the successfully doping of Cd and Ni in ZnO crystal lattice.

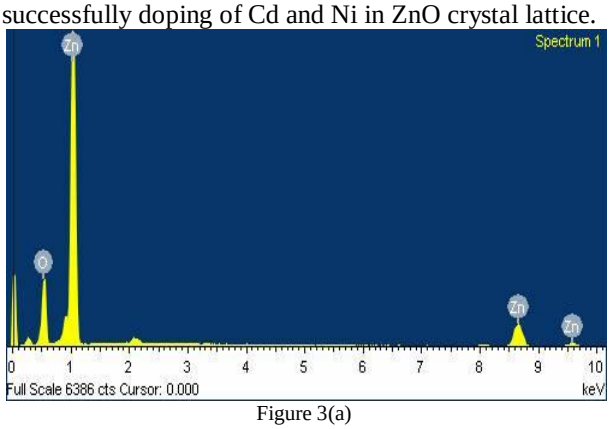


Figure 3(a)

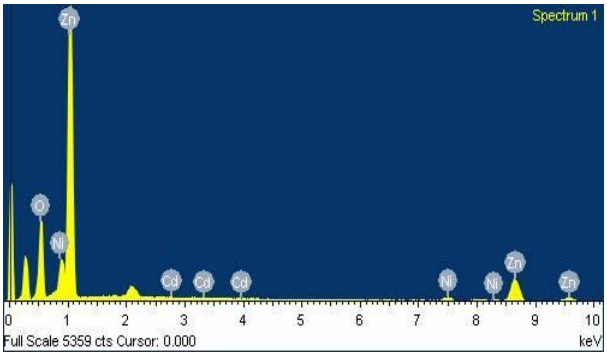


Figure 3(b)

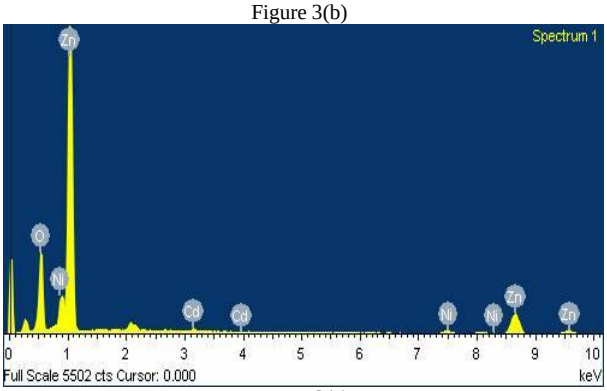


Figure 3(c)

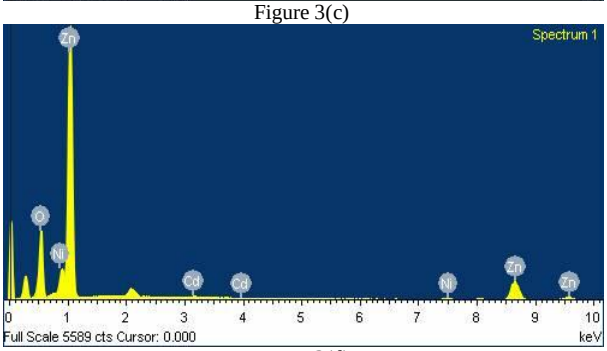


Figure 3(d)

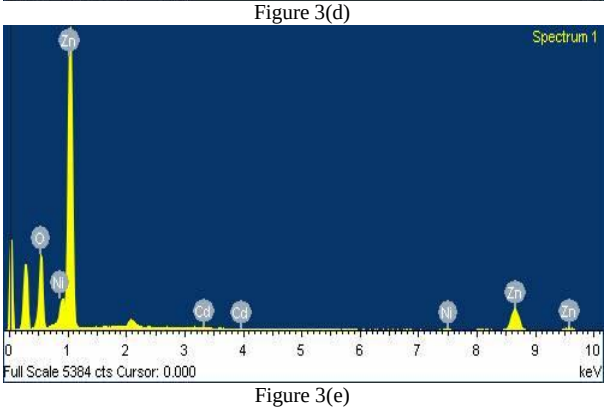


Figure 3(e)

Fig. 3 EDX images of a) Undoped ZnO b) $Cd_{0.02}$ $Ni_{0.08}$ doped ZnO c) $Cd_{0.04}$ $Ni_{0.06}$ doped ZnO d) $Cd_{0.06}$ $Ni_{0.04}$ doped ZnO e) $Cd_{0.08}$ $Ni_{0.02}$ doped ZnO

3.1.4. XRD Analysis (X-Ray Diffraction):

The phase purity and crystallographic structure of the prepared photocatalysts were determined by XRD technique. XRD pattern of the as prepared Undoped and Cd, Ni codoped ZnO ($Cd_XNi_YZn_{(1-X+Y)}O$, Where X=0.00, 0.02, 0.04, 0.06, 0.08) are shown in figure 4. All the diffraction peaks can be indexed for hexagonal wurtzite structure of ZnO. This diffraction data were in good agreement with the JCPDS card No. 80-0075 [3]. Figure 4 also reveals that, there is no change in hexagonal wurtzite structure of ZnO after doping of Cd and Ni. The intensity of XRD peaks was found higher and shows better crystallinity of prepared photocatalysts. In all Cd, Ni doped ZnO samples, Ni traces were observed at 200 plane due to phase segregation of NiO [13]. The narrow width of XRD peaks designate as highly crystalline nature of synthesized photocatalysts, also XRD analysis shows that all peaks are sharp.

The average crystallite size of the Undoped ZnO and Cd, Ni codoped ZnO was estimated using Scherrer's formula based on the 101 crystal plane. The calculated crystallite size was found in nano range as shown in Table 1.

$$D = \frac{K\lambda}{\beta cos\theta} \qquad (1)$$

Where D is the particle size in nanometer, K is a constant, λ is the X-Ray wavelength, β is the full width at half maximum, and θ is the Bragg's diffraction angle. The size of Undoped ZnO and Cd, Ni codoped ZnO is shown in Table 1 and which is in nano range.

Table 1. shows that the crystallite size decreases after doping of Cd and Ni into ZnO crystal lattice. This provided larger surface for efficient photocatalytic degradation of dye.

The lattice parameters a and c for the hexagonal wurtzite structure were calculated from the 100 and 002 planes by using following formula.

For the 100 crystal plane, lattice constant a was calculated by,

$$a = \frac{\lambda}{\sqrt{3}sin\theta}$$

For the 002 crystal plane, lattice constant c was calculated by,

$$c = \frac{\lambda}{\sin\theta}$$

The incorporation of Ni^{2+} in ZnO crystal lattice was also confirmed by calculating lattice parameter values a and c. Table 2 shows that the lattice constant a and c of Undoped ZnO and Cd, Ni doped ZnO. It is cleared that the lattice parameter of Cd, Ni codoped ZnO increases as concentration of Ni increases and this due to the ionic radius of Ni^{2+} is smaller than that of Zn^{2+}. Such an increased of lattice parameter values a and c suggest that Ni^{2+} ions were successfully incorporated into ZnO crystal lattice.

Table 1: Crystallite size from XRD

Samples	Particle size (nm)
Undoped ZnO	46.84
$Cd_{0.02}$ $Ni_{0.08}$ doped ZnO	40.88
$Cd_{0.04}$ $Ni_{0.06}$ doped ZnO	40.88
$Cd_{0.06}$ $Ni_{0.04}$ doped ZnO	40.89
$Cd_{0.08}$ $Ni_{0.02}$ doped ZnO	40.89

Table 1. shows that the crystallite size decreases after doping of Cd and Ni into ZnO crystal lattice. This provided larger surface for efficient photocatalytic degradation of dye.

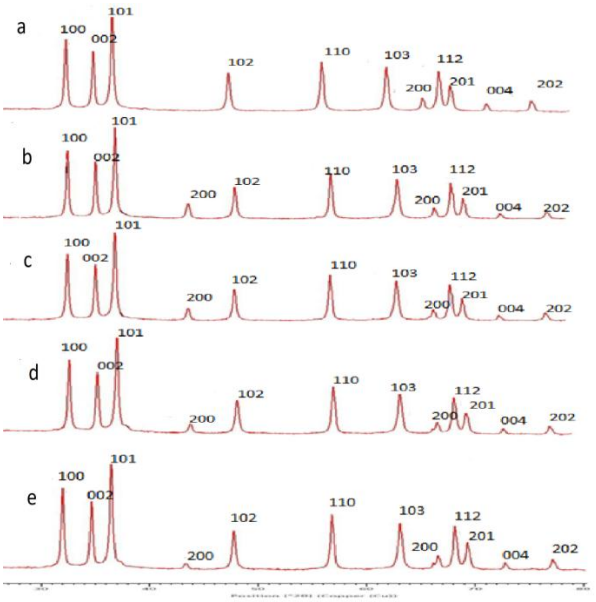


Fig 4. XRD images of a) Undoped ZnO b) $Cd_{0.02}$ $Ni_{0.08}$ doped ZnO c) $Cd_{0.04}$ $Ni_{0.06}$ doped ZnO d) $Cd_{0.06}$ $Ni_{0.04}$ doped ZnO e) $Cd_{0.08}$ $Ni_{0.02}$ doped ZnO

The lattice parameters a and c for the hexagonal wurtzite structure were calculated from the 100 And 002 planes by using following formula.

For the 100 crystal plane, lattice constant a was calculated by,

$$a = \frac{\lambda}{\sqrt{3}sin\theta}$$

For the 002 crystal plane, lattice constant c was calculated by,

$$c = \frac{\lambda}{\sin\theta}$$

Table 2. Lattice parameter values of Undoped ZnO and Cd, Ni doped ZnO

Samples	Lattice constant (A°)	
	a=b	c
Undoped ZnO	3.2278	5.1729
$Cd_{0.02}$ $Ni_{0.08}$ doped ZnO	3.2421	5.1939
$Cd_{0.04}$ $Ni_{0.06}$ doped ZnO	3.2346	5.1834
$Cd_{0.06}$ $Ni_{0.04}$ doped ZnO	3.2325	5.1799
$Cd_{0.08}$ $Ni_{0.02}$ doped ZnO	3.2291	5.1747

The incorporation of Ni^{2+} in ZnO crystal lattice was also confirmed by calculating lattice parameter values a and c. Table 2 shows that the lattice constant a and c of Undoped ZnO and Cd, Ni doped ZnO. It is cleared that the lattice parameter of Cd, Ni codoped ZnO increases as concentration of Ni increases and this due to the ionic radius of Ni^{2+} is smaller than that of Zn^{2+}. Such an increased of lattice parameter values a and c suggest that Ni^{2+} ions were successfully incorporated into ZnO crystal lattice.

3.1.5. UV-Visible Absorption study:

Figure 5 shows the absorption spectra of Undoped ZnO and Cd, Ni codoped ZnO, which are nearly identical one. It is seen that, when ZnO doped with Cd and Ni the absorption wavelength shifts toward longer wavelength. The λmax of Undoped ZnO, $Cd_{0.02}$ $Ni_{0.08}$ doped ZnO, $Cd_{0.04}$ $Ni_{0.06}$ doped ZnO, $Cd_{0.06}$ $Ni_{0.04}$ doped ZnO, $Cd_{0.08}$ $Ni_{0.02}$ doped ZnO was found to be 378, 379, 379.5, 380 and 381 respectively. This narrowing of band gap helps to efficient degradation in presence of solar light than in UV light.

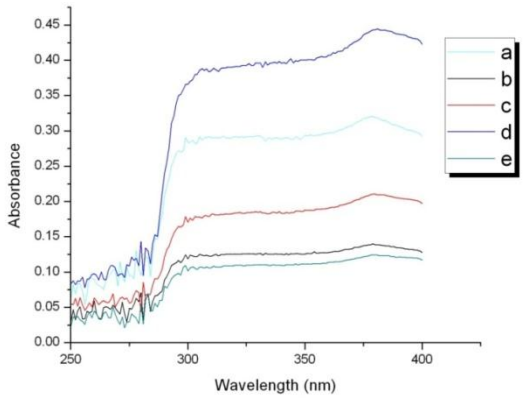


Fig. 5 UV-Visible spectra of **a)** $Cd_{0.02}$ $Ni_{0.08}$ doped ZnO b) $Cd_{0.04}$ $Ni_{0.06}$ doped ZnO c) $Cd_{0.06}$ $Ni_{0.04}$ doped ZnO d) $Cd_{0.08}$ $Ni_{0.02}$ doped ZnO e)Undoped ZnO

3.2 Photocatalytic activity of Cd and Ni doped ZnO

The presence of organic compounds in waste water effluent is a major environmental problem. Their toxicity can directly affect the health of ecosystem and due to contamination in surface water and ground water, it is unfit for drinking purpose also.

The varieties of organic dyes are being continuously introduced into an aquatic system, which are detrimental to human health. In this study, we carried out Photodegradation of Rhodamine 6G, as it is more toxic and chemically stable organic compound. So, it is need to remove this organic dye from aquatic system by using photocatalyst.

3.2.1. Photocatalytic activity in presence of UV light and Solar light:

The photo catalytic activity of the Undoped and Cd, Ni codoped ZnO nano materials were evaluated by means of degradation of Rhodamine 6G dye with an irradiation of UV light and Solar light. In a typical procedure, the mixture of 100 ml of 20 ppm solution of Rhodamine 6G and 100 mg of the Undoped and Cd, Ni codoped ZnO was separately stirred in the dark for 30 mins to reach adsorption-desorption equilibrium. Then, the solutions were directly irradiated under UV light and Solar light. At interval of 1hr, 5ml solution of the Rhodamine 6G was collected, then centrifuged and filtered to separate the photocatalyst powder by using whatmann filter paper 42. The concentrations of these samples were checked by measuring its absorbance at λ_{max} =537 nm using UV-Visible Spectrophotometer. The % degradation was calculated using formula;

$$\% \text{ Degradation} = \frac{Co-Ct}{Co} \times 100 \qquad (2)$$

Where C_o is the initial concentration of Rhodamine 6G solution and C_t is the Concentration of Rhodamine 6G solution at time t.

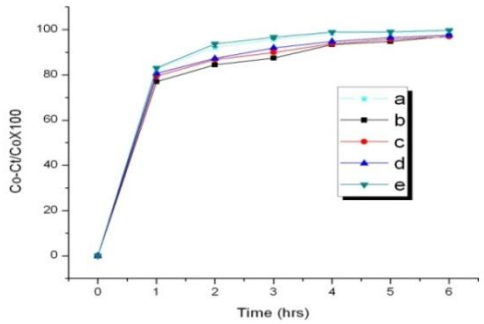


Fig. 6 PCD efficiency of **a)** Undoped ZnO **b)** $Cd_{0.02}$ $Ni_{0.08}$ doped ZnO **c)** $Cd_{0.04}$ $Ni_{0.06}$ doped ZnO **d)** $Cd_{0.06}$ $Ni_{0.04}$ doped ZnO **e)** $Cd_{0.08}$ $Ni_{0.02}$ doped ZnO in presence of UV light

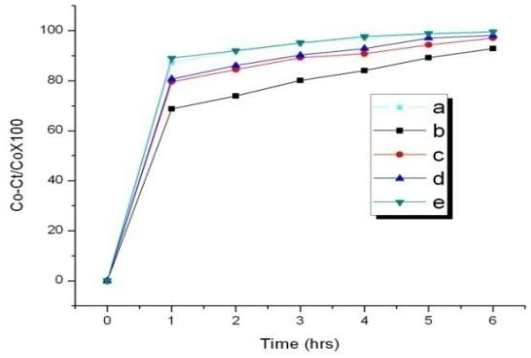


Fig. 7 PCD efficiency of **a)** Undoped ZnO **b)** $Cd_{0.02}$ $Ni_{0.08}$ doped ZnO **c)** $Cd_{0.04}$ $Ni_{0.06}$ doped ZnO **d)** $Cd_{0.06}$ $Ni_{0.04}$ doped ZnO **e)** $Cd_{0.08}$ $Ni_{0.02}$ doped ZnO in presence of Visible light.

PCD efficiency were studied by the degradation of Rhodamine 6G dye under UV light and Visible light as shown in fig. 6 and 7. In this work, PCD efficiency increase with an increase in concentration of Cadmium. The higher concentration of Cd possesses the best photocatalytic activity among Undoped ZnO and all of the doped ZnO. From figures 6 and 7, it is cleared that, the photo catalytic activity was found more in presence of Solar light than UV light. In this, degradation efficiency was checked at ordinary pH=6.8. It is necessary to study the effect of different pH on photocatalytic activity of Cd, Ni codoped ZnO by keeping other parameter constant.

3.2.2. Effect of pH:

The effect of pH of Rhodamine 6G dye solution on PCD efficiency was studied by varying pH from 5.8 to 9.8 with 20 ppm solution of Rhodamine 6G and 100 mg/100 ml catalyst loading. The acidic pH adjusted with 0.1N HCl whereas basic pH maintained with 0.1N NaOH solution. Photocatalytic activity mainly depends on pH of the aqueous Rhodamine 6G dye solution. Figs. 8, 9, 10, 11 and 12 revealed that, at pH 5.8 degradation rate is lower than ordinary pH 6.8. Whereas, at pH 8.8 the degradation rate was higher than pH 5.8, 6.8, 7.8 and 9.8. As pH increases, the formation of hydroxyl radicals increases, thus the rate of degradation increases. But the degradation rate of Rhodamine 6G dye retarded as pH increases above 8.8 because with increasing pH, formed hydroxyl radicals try to compete with organic dye molecules to adsorb on the surface of Cd, Ni codoped ZnO photocatalyst. On the opposite, at low pH (acidic) the adsorption of cationic laser dye i.e. Rhodamine 6G on Cd, Ni codoped ZnO photocatalyst is reduced because the surface of Cd, Ni codoped ZnO is positively charge, which are responsible for decrease in adsorption of cationic dye [9]. The degradation efficiency of Cd, Ni codoped ZnO was found high at pH 8.8.

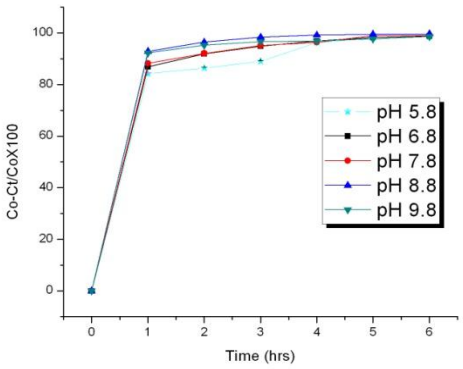


Fig. 8 Undoped ZnO

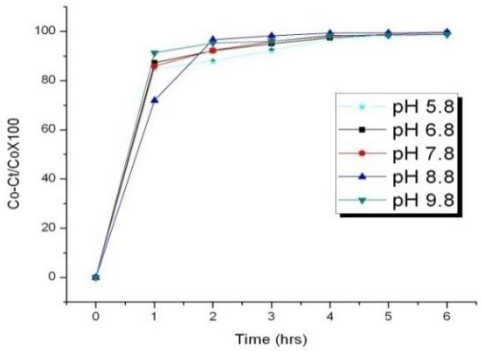


Fig. 9 $Cd_{0.02}$ $Ni_{0.08}$ doped ZnO

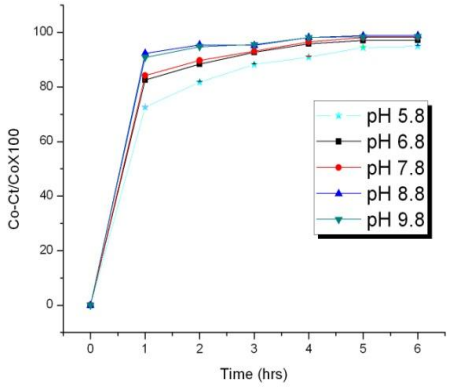


Fig. 10 $Cd_{0.04}$ $Ni_{0.06}$ doped ZnO

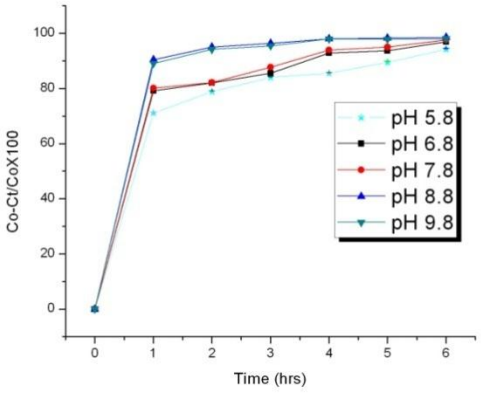


Fig. 11 $Cd_{0.06}$ $Ni_{0.04}$ doped ZnO

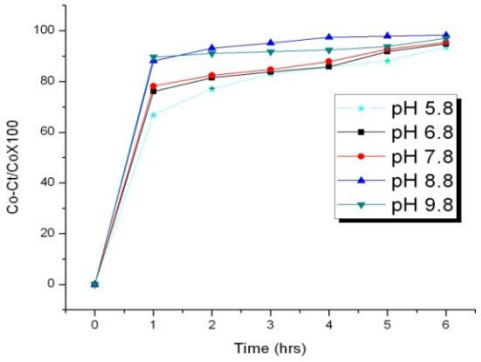


Fig. 12 $Cd_{0.08}$ $Ni_{0.02}$ doped ZnO

3.2.3. Effect of Catalyst loading:

To study the effect of catalyst loading, the experiments were carried out by varying amount of catalyst from 0.05 gm to 0.2 gm/100ml of 20 ppm solution of Rhodamine 6G at constant pH 8.8. Result shown in figures 13, 14, 15, 16 and 17 reveals that, the percentage removal of dye increases with increasing amount of photocatalyst. At lower amount of catalyst loading, such as 0.05 gm/100ml, % degradation decreases due to limited catalyst surface area. With increase in catalyst loading, active sites on catalyst surface increases due to that no. of hydroxyl radical and superoxide radical increases, which enhances the rate of degradation of Rhodamine 6G. But, if catalyst dosage increases beyond optimum level, the turbidity of solution increases which inhibits the penetration of light into the dye solution as well as agglomeration increases as a result of that % degradation decreases [7]. Figures 13, 14, 15, 16 and 17 show that, the maximum % degradation was observed with 0.150 gm/100ml of catalyst loading at constant pH 8.8.

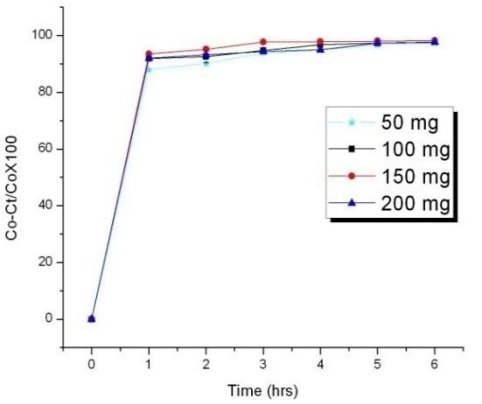


Fig. 13 Undoped ZnO

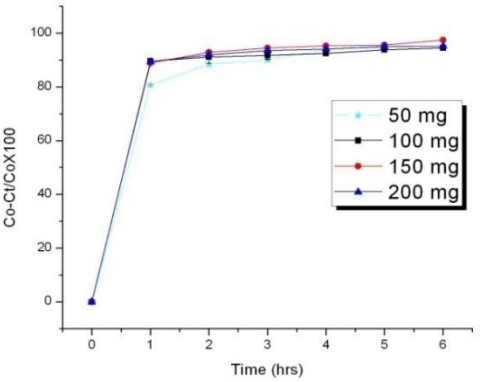


Fig. 14 $Cd_{0.02}$ $Ni_{0.08}$ doped ZnO

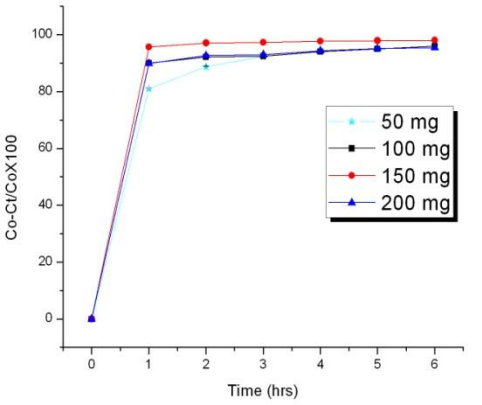


Figure 15. $Cd_{0.04}$ $Ni_{0.06}$ doped ZnO

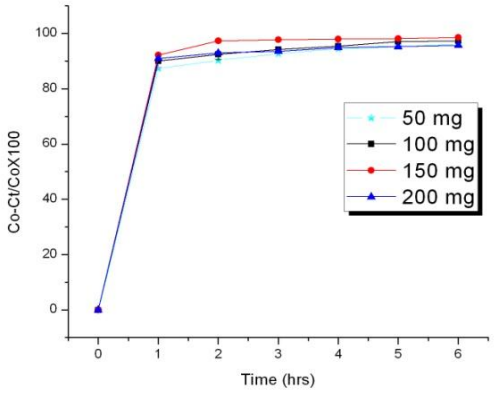


Figure 16. $Cd_{0.06}$ $Ni_{0.04}$ doped ZnO

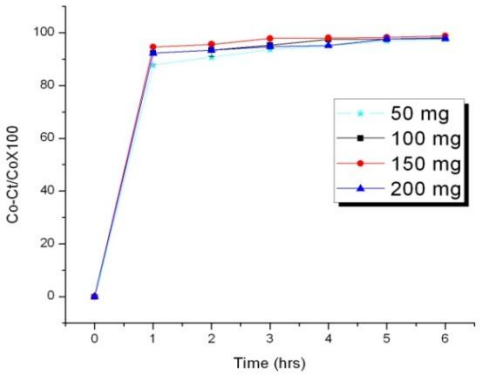


Fig. 17 $Cd_{0.08}$ $Ni_{0.02}$ doped ZnO

3.3 Antibacterial Activity:

Various chemical and physical processes have been developed for water purification treatment. The use of nano material in water purification technique is considered as a most reliable and efficient process. Despite their used in degradation of organic pollutants, it can be also useful as antibacterial substances. The antibacterial substances are those which kill or inhibit the growth of bacteria in aqueous media. The Antibacterial activity of Cd, Ni codoped ZnO was tested using Ditch plate technique and it is qualitative analysis. All samples of Cd, Ni codoped ZnO Nanoparticles with 40 mg/ml concentration of compounds exhibit killing effect on Escherichia coli (Gram negative) and Staphylococcus aureus (Gram positive).

3.4 Reuse of Photocatalyst:

The reuse of Cd, Ni codoped ZnO was studied by keeping pH 8.8 and catalyst loading 150mg/100 ml. The reaction was carried out with 6 hrs under exposure of sun light. After 6 hrs, the reaction mixtures was filter through whatmann filter paper 42, the residues was collected and washed repeatedly with distilled water, finally dried in an oven at 100˚C for 1 hr. These samples was then reused for next photocatalytic reaction batch and it is seen that photocatalytic activity of Cd, Ni codoped ZnO remains constant even after 3rd experiments.

4. CONCLUSIONS

ZnO and Cd, Ni codoped ZnO nano powder has been successfully synthesized by Citrate Gel Method with varying concentration of Cd and Ni and used as a catalyst in the process of photo degradation of Rhodamine 6G dye. The photocatalytic degradation experiments showed that Undoped ZnO and Cd, Ni codoped ZnO possessed high photo catalytic activity in presence of Solar light than UV light. The results show that $Cd_{0.08}$, $Ni_{0.02}$ doped ZnO has high photocatalytic activity than Undoped ZnO. By varying range of pH, it concludes that, at pH 8.8 the photo catalytic degradation efficiency was maximum.. The degradation efficiency also affected by varying catalyst loading with constant pH 8.8. The optimal catalyst dose was 150mg/100ml. The synthesized Cd, Ni codoped ZnO was found to be inhibitory and shows antibacterial effect against Escherichia coli and Staphylococcus aureus.

Conflict of Interests:

The authors declare that there is no conflict of interest regarding the publication of this paper.

5. ACKNOWLEDGEMENT

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