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PHOTOCATALYTIC AND ANTIBACTERIAL ACTIVITIES OF TiO_2 AND SILVER AND ZINC DOPED TiO_2 NANOPARTICLES

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Abstract:
The TiO_2 and Ag and Zn doped TiO_2 nanoparticles were synthesized by sol-gel method.The sol-gel method is one of the versatile method to prepare doped and co-doped nanoparticles. sol gel method has emerged as simpler and better option than physical and chemical procedures as it is fast, clean and eco-friendly alternative that does not involve any costly instruments .Synthesis of doped and co-doped nanoparticles having good photocatalytic activity have great potential for the degradation of dye. We have tried to develop new effective antimicrobial reagents with good photocatalytic activities which are not resistant to disease causing microbes.

Keywords: *Photocatalytic; Antibacterial; Nanoparticles.*

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1. Introduction

Nanotechnology deals with nanometre sized objects. It is expected that nanotechnology will develop at several levels: materials, devices and systems. Nanoparticles were studied because of their size-dependent physical and chemical properties[1]. Lots of applications of the nanomaterials to biological system and medicines are found in drug and gene delivery[2,3], bio detection of pathogens[4], detection of proteins[5], probing of DNA structure[6] ,tissue engineering[7,8] , tumour destruction via heating (hyperthermia)[9], separation and purification of biological molecules and cells[10] , MRI contrast enhancement[11]. Nanotechnology has also more applications in electronics, optics, optoelectronic devices, solar cells, fuel cells, food, water pollution treatment, chemical and biological sensors and many more. Use of the photocatalytic process to degrade organic dye pollutants with visible light has important industrial implications because it can use the relatively inexpensive solar light[12]. Our main aim of research is to develop new, simple, cheaper, novel and green methods for the synthesis of doped and co-doped nanoparticles and to improve their photocatalytic activity or the degradation of dyes and antibacterial agent.[13]

These kind of natural chemical properties of nanoparticles have been changed by doping process such as size dependent variation of the band gap energy Furthermore, impurity ion doped into these nanostructures can influence their electronic structure and transition probabilities. Ag and

Zn have been incorporated into TiO_2 Nanostructure by sol-gel processing. Doping TiO_2 nanoparticles, with transition metal ions and non-metals usually results in hampered enhancement efficiency of the photocatalyst.Several method have been developed for synthesis of doped and co-doped nanoparticles. The sol-gel method is one of the versatile methods to prepare doped and co-doped nanoparticle .Metallic nanoparticles has emerged as a simpler and better option than physical and chemical procedures as it is fast, clean and eco-friendly alternative that does not involve any costly instruments.

2. Materials and Methods

2.1. Material

All chemicals used in this study (Titanium n-butoxide, Butanol, Ethanol, Glycerol) were AR grade. Nanoparticles were washed by deionized water.

2.2. Method

2.2.1. Preparation of Tio_2 Nanoparticles

5 ml of Titanium n-butoxide dissolved with 5 ml n-butanol drop by drop with continuous stirring in round bottom flask on magnetic stirrer.36.4 ml ethanol and 13.6 ml acetic acid were taken in RB flask under ice cold condition and the mixture is subjected to stirring for 10 minutes. Then glycerol (0.3 ml) as gelling agent was added to it. Then Titanium n-butoxide solutions were mixed in it. This mixture was stirred vigorously for three hours. Kept this mixture in room temperature for gelation. Next day kept this solution in oven at 60^0C then next day kept it at 100^0C until the gelling reaction was completed. Then finally TiO_2 nanoparticle obtained in powdered form.[6]

2.2.2. Preparation of Ag Doped Tio_2 Nanoparticles

Titanium n-butoxide dissolved with n-butanol drop by drop with continuous stirring in round bottom flask on magnetic stirrer.Then added 0.5% $AgNO_3$ .36.4 ml ethanol and 13.6 ml acetic acid were taken in RB flask under ice cold condition and the mixture is subjected to stirring for 10 minutes. Then glycerol as gelling agent was added to it. Then Titanium n-butoxide solutions were mixed in it. This mixture was stirred vigorously for three hours.

Kept this mixture in room temperature for gelation. Next day kept this solution in oven at 60^0C then next day kept it at 100^0C until the gelling reaction was completed. Then finally Ag doped TiO_2 nanoparticle obtained in powdered form.

2.2.3. Preparation of Zndoped Tio_2 Nanoparticles

Titanium n-butoxide dissolved with n-butanol drop by drop with continuous stirring in round bottom flask on magnetic stirrer. Then added 0.5% $ZnCl_2$ .36.4 ml ethanol and 13.6 ml acetic acid were taken in RB flask under ice cold condition and the mixture is subjected to stirring for 10 minutes. Then glycerol as gelling agent was added to it . Then Titanium n-butoxide solutions

were mixed in it. This mixture was stirred vigorously for three hours. Kept this mixture in room temperature for gelation. Next day kept this solution in oven at 60^0C then next day kept it at 100^0C until the gelling reaction was completed. Then finally Zn doped TiO_2 nanoparticle obtained in powdered form.

3. Results and Discussions

TiO_2 and silver, zinc doped TiO_2 nanoparticles were characterized by the SEM and XRD analysis.

The detailed study of morphology of the sample were performed by SEM. Instrument used was Make Jeol model –JSM-5400, acceleration voltage -10 KV .The microstructure of TiO_2 (fig 1) and Silver (fig2) and Zinc doped TiO_2 (fig 3) shown in figure.

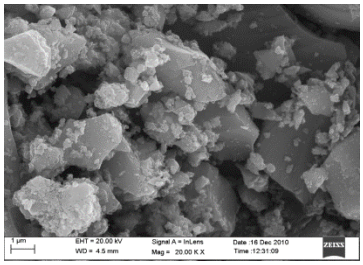

Figure 1: TiO_2 nanoparticles

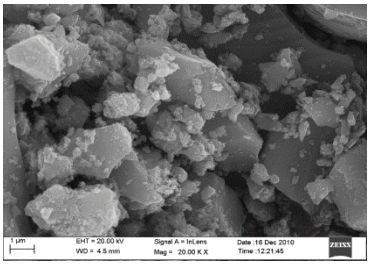

Figure 2: Silver doped TiO_2

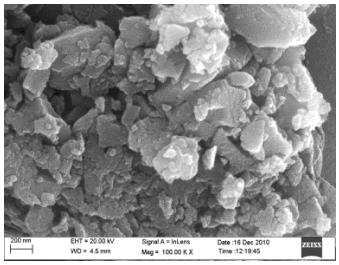

Figure 3: Zn doped TiO_2

The SEM Images shows the particles have nano sized.

The XRD diffraction spectrum of calcined powder was recorded using Instrument is panalyticle and empyrean respectively used target is Cu k-alpha with the wavelength target is 1.54 angstroms .It is well know that the calcination improve the crystallity of particles.

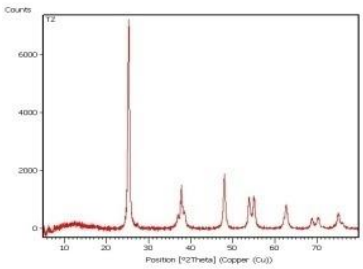

Figure 4: Zinc Doped TiO_2

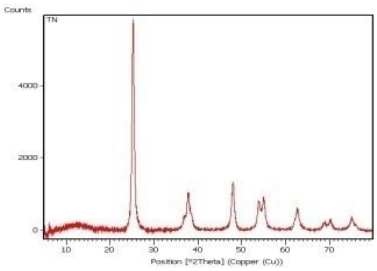

Figure 5: TiO_2 nanoparticles

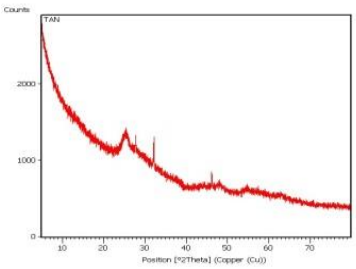

Figure 6: Silver doped TiO_2

TiO_2 nanoparticles have photocatalytic and antibacterial activity. Doping TiO_2 nanoparticles, with transition metal ions and nonmetals usually results in a hampered enhancement efficiency of the photocatalyst and improves antibacterial activity. Environmental cleaning using TiO_2 photocatalyst has attracted a great deal of attention due the increase in the level of environmental pollution in the world.

3.1. Photocatalytic Activity of Nanoparticles

The nanoparticles reduce the dye solution can be studied by spectrophotometrically. The graphs are taken by Labindia V UV-Vis spectrophotometer. Different dilution of dye and different concentration of nanoparticles on different time intervals have been studied .[14]

Absorption Studies

Toluidine blue solution: - prepared different conc. Of dye and Monitored the spectra of this solution Table (1) show the absorption spectra of Toluidine blue solution with different dilution.

Table 1: Firstly take 20 ml dye and put on sunlight, absorption spectra of selected dye on different time intervals have been studied

S.No.	Time	Azur I		Aniline Blue		Toluidine Blue	
		λmax	Absorbance	λmax	Absorbance	λmax	Absorbance
1.	10 min	290	0.845	235	0.922	285	0.943
2.	20 min	290	0.776	235	0.907	285	0.920
3.	30 min	290	0.758	235	0.903	285	0.885
4.	40 min	290	0.641	235	0.881	285	0.768
5.	50 min	290	0.639	235	0.877	285	0.758

Take 20 ml selected dye and 0.001 gram TiO_2 nanoparticles were added in different dye. In presence of TiO_2 nanoparticles, dye absorption spectra suffered a slight red shift in the band peak position, which indicated that the absorption of different dye on to the TiO_2 nanoparticles. TiO_2nanoparticles were added different solution of dye and put on sunlight. In presence of TiO_2 nanoparticles dye absorbance decreases dye on different time intervals have been studied:-

Table 2: Toluidine Blue +0.001 gm TiO_2 nanoparticles

S.No.	Time	Azur I		Aniline Blue		Toluidine Blue	
		λmax	Absorbance	λmax	Absorbance	λmax	Absorbance
1.	10 min	290	0.742	235	0.728	285	0.665
2.	20 min	290	0.615	235	0.604	285	0.468
3.	30 min	290	0.422	235	0.399	285	0.348
4.	40 min	290	0.338	235	0.282	285	0.328
5.	50 min	290	0.285	235	0.212	285	0.256

Take 20 ml selected dye and 0.001 gram Ag doped TiO_2 nanoparticles were added in different dye. In presence of Ag doped TiO_2 nanoparticles, dye absorption spectra suffered a slight red shift in the band peak position, Which indicated that the absorption of different dye on to the Ag doped TiO_2 nanoparticles. Ag doped TiO2 nanoparticles were added different solution of dye and put on sunlight. In presence of Ag doped TiO_2 nanoparticles absorbance of dye decreases on different time intervals have been studied:-

Table 3

S.No.	Time	Azur I		Aniline Blue		Toluidine Blue	
		λmax	Absorbance	λmax	Absorbance	λmax	Absorbance
1.	10 min	290	0.486	235	0.832	285	0.717
2.	20 min	290	0.276	235	0.750	285	0.387
3.	30 min	290	0.248	235	0.663	285	0.299

Take 20 ml selected dye and 0.001 gram Zn doped TiO_2 nanoparticles were added in different dye. In presence of Zn doped TiO_2 nanoparticles, dye absorption spectra suffered a slight red shift in the band peak position, Which indicated that the absorption of different dye on to the Zn doped TiO_2 nanoparticles. Zn doped TiO2 nanoparticles were added different solution of dye and put on sunlight. In presence of Zn doped TiO_2 nanoparticles absorbance of dye decreases on different time intervals have been studied:-

Table 4

S.No.	Time	Azur I		Aniline Blue		Toluidine Blue	
		λmax	Absorbance	λmax	Absorbance	λmax	Absorbance
1.	10 min	290	0.512	235	0.822	285	0.622
2.	20 min	290	0.348	235	0.728	285	0.432
3.	30 min	290	0.320	235	0.615	285	0.342
4.	40 min	290	0.217	235	0.512	285	0.225

This study shown the Silver doped and Zinc doped TiO2 have better photocatalytic activity than TiO2 nanoparticles.

Antibacterial Activity

An antibacterial substance is an agent that interferes the growth and reproduction of bacteria. In particular, silver ions have strong inhibitory and bacterial effects and possess a broad spectrum antimicrobial activity.

Table 5

S.no.	Nanoparticles	Zone of inhibition	Bacteria
1.	TiO2	23 mm	Staphylococus
2.	Zn dped TiO2	25 mm	Staphylococus
3.	Ag Doped TiO2	30 mm	Staphylococus
4.	TiO2	21 mm	E-Coli
5.	Zn doped TiO2	23 mm	E-Coli
6.	Ag doped TiO2	25 mm	E-Coli
7.	TiO2	20 mm	Pseudomonas aourginosa
8.	Zn doped TiO2	21 mm	Pseudomonas aourginosa
9.	Ag doped TiO2	24 mm	Pseudomonas aourginosa

4. Conclusions

TiO_2 and Silver and Zinc doped TiO_2 nanoparticles were synthesized by sol gel method. The morphology study was demonstrated the particles have nano sized and the nanoparticles have photocatalytic and antibacterial activity.

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