ISSN (Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

Volume 3, Special Issue 3, March 2014

2014 International Conference on Innovations in Engineering and Technology (ICIET'14)
On 21st & 22nd March Organized by

K.L.N. College of Engineering and Technology, Madurai, Tamil Nadu, India

Photo Catalytic Study of Agriculture Leachant Water Using Ceramic Based Thin Films

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ABSTRACT: Pesticides are group of artificially synthesized substances, toxic and non-biodegradable in the environment and are subjected to some chemical processes of degradation, hydrolysis, oxidation, and photo catalysis. In this work, ceramic based thin films were prepared to reduce the toxic nature of pesticides. To enhance the catalytic activity of this thin films, leachant water is incorporated with zinc oxide, thereby pesticides degraded to lower concentration. Zinc oxide (ZnO) and zinc sulphide (ZnS) thin films were prepared and characterized using SEM, AFM, XRD and FT-IR. Using photoluminescence Spectra (PL), the photo catalytic activity of nanoparticles were studied by observing the peak obtained at reduced wavelength of about 384 nm and enhanced band gap energy of about 3.2 eV for zinc oxide nanoparticles whereas zinc sulphide nanoparticle shows 3.7 eV . Using UV-Vis, degradation of pesticides in the leachant water was observed by exposing the thin film in the sunlight at various interval of time. Thus, zinc oxide thin film shows better degradation of pesticides when compared to zinc sulphide.

KEYWORDS: Photo catalytic activity, Leachant water, Pesticides.

I. INTRODUCTION

Nanotechnology is the science of developing materials by controlling the individual atoms and molecules to create devices that are thousand times smaller than current technology. They are the structures between 1nm and 100 nm in size. They achieve ethical challenges. It has been applied to many areas of study including electronic engineering, physical sciences, biomedical sciences and much other. Photo degradation is the process of degradation of a photodegradable molecule caused by the absorption of photons. Particularly those wavelength found in sunlight, such as infrared radiation, visible light and ultraviolet light. This type of photo degradation is used by some drinking water and waste water facilities to destroy pollutants. The leaching refers to the loss of water soluble plant nutrients from the soil, due to rain irrigation. It is an environmental concern when it contributes to groundwater contamination. Thin film is a layer of material ranging from factors of a nano meter to several micro meters in thickness.

II. EXPERIMENTAL METHODS

2.1 Preparation of zinc oxide nanoparticles

ZnO was synthesis by hydro thermal method. Zinc acetate 2.195g dissolved in 50ml of distilled water. 4g of ammonium powder was added with slow stirring. It is continued till the dissolution of ammonium oxalate takes place. The ammonia solution was added drop wise to raise the pH of the solution to about 10.A white precipitate of zinc oxalate was obtained. The precipitate is collected by filtration. It is then transferred on a watch glass and kept in air oven at 105^0C for a period of about 1 hour. After cooling, the dried powder was collected and transferred it in to a clean silica crucible. After that the silica crucible was heated in muffle furnace at 700^0C for 3 hours. ZnO Nano particle prepared.

2.2 Preparation of ZnO Thin film

ZnO thin film was deposited by sol-gel spin coating method onto glass substrates. Zinc dehydrate, 2-methoxethanol and ammonia were used material. After the deposition thin film was dried at 300^oC for 10 min in furnace to evaporate the solvent &remove organic residuals. Finally the thin film was prepared.

III. RESULTS AND DISCUSSION

3.1 XRD analysis of ZnO nanoparticles

The X- ray diffraction pattern of ZnO nanoparticles prepared using hydrothermal method is shown in fig 1.

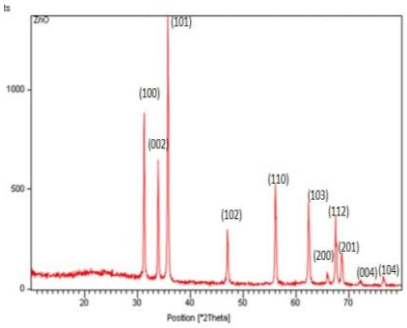

Fig 1.XRD analysis for ZnO nanoparticles

The grain size of ZnO nanoparticles was determined using Debye-Scherrer equation,

$$D = \frac{K\lambda}{\beta \cos\theta}$$

Where, D = Crystallite Size, K = Crystallite Shape factor=0.9, λ = X-ray wavelength, 1.5418 A° for CuKα ,θ = Observed peak angle in degree, β = full width half maximum.. Here the instrument used is XPERT- PRO x-ray diffract meter using CuKα Radiation (wavelength λ = 1.54016 A°) at 40 keV over the range of 2θ=20°- 80°.The intensity of diffraction peaks measured over a 2θ range from 20° to 80°. The XRD pattern shows characteristic peak at 2θ = 35.735°, corresponds to the (101) plane. It also shows a number of Bragg reflections corresponding to the (101), (102), (100), (002), (103), (112), (200), (004), (104) and (110) peaks with 2θ values at 31.251o, 33.9030, 35.7350, 47.0270, 56.0810, 62.3450, 65.8750, 67.4380, 68.5770, 72.030 and 76.450 and respectively. These peaks were matched well with the face centered cubic (FCC) structure of ZnO powder with JCPDS - 36-1451. The average crystallite size of the nano zinc borate is estimated as 29.065nm by Scherer's equation.

3.2 AFM analysis of ZnO nano particles

The AFM image of ZnO nano particles is shown in fig 2. From the figure it is understood that the total area taken for scanning is of dimension 2.5µm X 2.5µm. The approximate height of the particle is around 50nm.

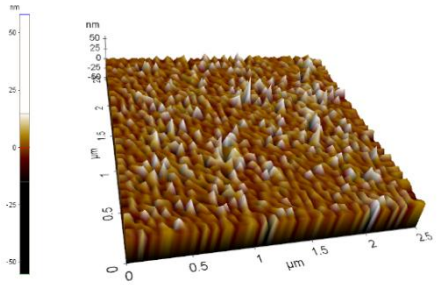

Fig 2. AFM image of ZnO nano particles

3.3 Photoluminescence analysis

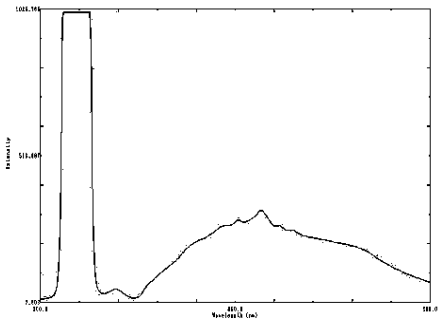

Fig 3. Photoluminescence Spectrum of ZnO

Photoluminescence (PL) spectrum of the nano particles obtained by both the processes are shown in fig 3.The peak in PL spectra corresponds to band to band transition and the spectra between 300-600nm are showing blue luminescence. Nano particles prepared via solid state reaction method show high luminescence than sol-gel derived nano particles. This could be due to the chemical instability caused during the fabrication process as can be seen from the PL spectrum of sol-gel derived nano particles; the intensity peak is at 384nm. From PL measurement, the band gap of ZnO nanoparticles was found to be 3.237 eV.

3.4 FT-IR Analysis

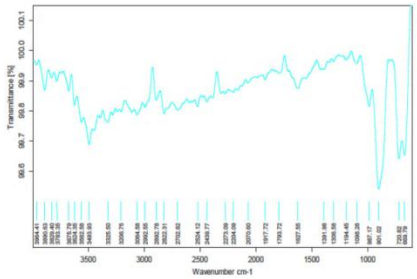

Fig 4. FTIR spectra of ZnO nano particles

FT-IR spectrum of ZnO nano particles shown in Fig 4 reveals that significant absorption peaks at 3493cm^{-1}, 1627cm^{-1}& 669cm^{-1}.The absorption band 669cm^{-1} was

assigned to Zn-O stretching vibration. The weak band near 1627cm^{-1} is assigned to H-O-H bending vibration mode were presented due to the adsorption of moisture, when FTIR sample disks were prepared in an open air atmosphere. Then observations provide the evidence for the presences of hydration in the structure.

3.5 UV Vis Spectra of dye with ZnO nano powder

UV spectrum recorded for the dye with Zinc Oxide is shown in fig 5. Sample is scanned at wavelength range 0-1000nm .the absorption peak of dye with Zinc Oxide power observed at a wavelengthof383nm.

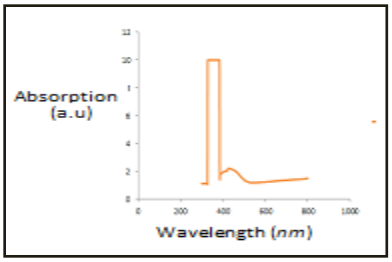

Fig 5.UV spectra of dye with ZnO nano powder

3.5.1 UV Vis spectra of ZnO nano powder dissolved in dye

Sample is scanned at wavelength range 0-1000nm. The absorption peak of dye with Zinc oxide power and exposed to sunlight at various intervals shown in fig 6 (a), (b), (c) observed at a wavelength of 416 nm, 407nm and 405nm respectively of about 5 min, 10 min and 15 min respectively.

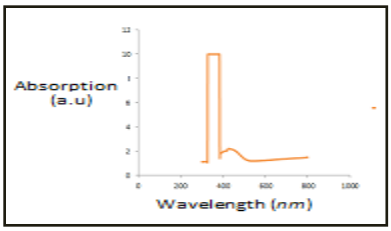

Fig 6 (a).UV spectra of dye with ZnO nano powder exposed in sunlight 5 mints

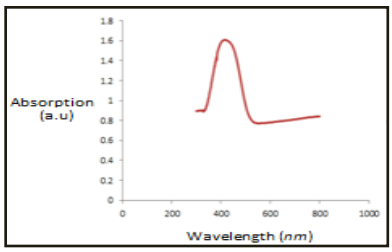

Fig 6 (b). UV spectra of dye with ZnO nano powder exposed in sunlight 10 mints

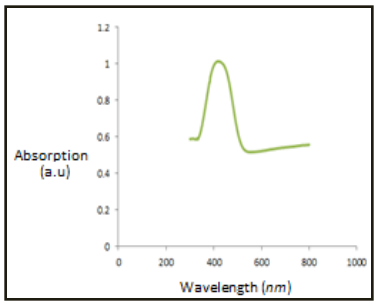

Fig 6 (c). UV spectra of dye with ZnO nano powder exposed in sunlight 15 mints

TABLE 1

Composition	Time (sec)	Absorption (%)	Λ (nm)
Dye	0	10%	384 nm
Dye with ZnO	0	10%	383 nm
Dye with ZnO+sunlight	5 min	2%	416 nm
Dye with ZnO+sunlight	10 min	1.6%	407nm

UV spectra of degradation with ZnO nano powder

3.6 SEM ANALYSIS ZINC OXIDE THIN FILM

The morphology of the sample is studied by the help of SEM. ZnO thin film was analyzed to study the nature and size of the particles. Fig 7 shows that the particles are having spherical morphology and are agglomerated. The particle size ranges about 250-300nm.

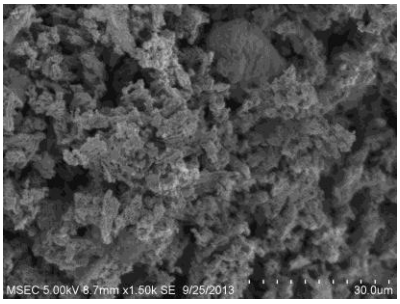

Fig 7. SEM image of ZnO thinfilm

3.5 UV-SPECTROPHOTOMETER ANALYSIS

3.5.1 UV spectra of ZnO thin film immersed in pesticide

Sample is scanned at wavelength range of 0-1000nm. The absorption peak of pesticides with Zinc Oxide thin film observed at a wavelength of 348 nm, 383nm and 348nm respectively which was treated at different time intervals of 10 min, 20 min and normal time respectively.

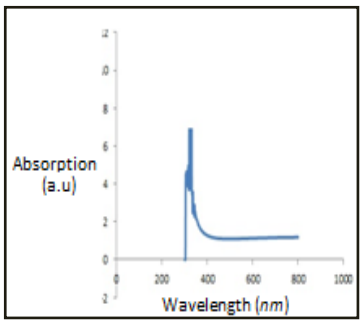

Fig 8 (a) UV spectra of pesticides with ZnO thin film & leachant water before 10 minutes.

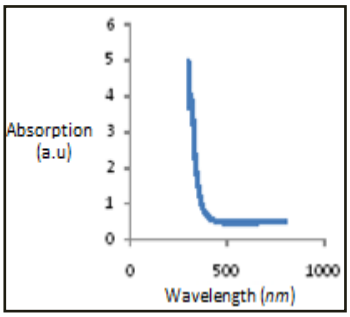

Fig 8 (b) UV spectra of pesticides with ZnO thin film & leachant water before 20 min.

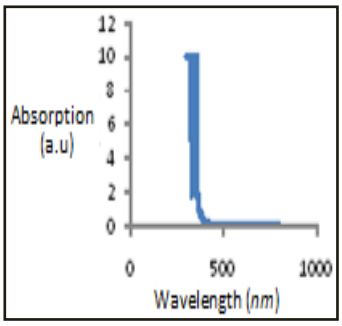

Fig 8 (c) UV spectra of pesticides with ZnO thin film & leachant water at normal time.

TABLE 2

UV spectra of pesticides degradation with ZnO thin film

Composition	Time (min)	Absorption (%)	λ (nm)
pesticides(mono crotophos) + ZnO thin film	0 min	10%	364 nm
Pesticides + ZnOthinfilm + sunlight	10 min	7%	348 nm
Pesticides + ZnOthinfilm + sunlight	20 min	5%	331 nm

IV. CONCLUSIONS

The photo catalytic material Zinc oxide nano particles were synthesized by hydrothermal method respectively. The prepared nano particles were coated on the glass using spin coating method. From the SEM analysis it was confirmed that the uniform distribution of nano particles over the glass. Also other characterization tests was carried by using PL, XRD and FTIR. Zinc oxide is used to degrade pesticides by photo catalytic effect. Therefore pesticides were degraded by ZnO thin film.

ACKNOWLEDGEMENT

The work described in this paper was supported by Mepco Schlenk Engineering College, Centre for Nano Science and Technology branch. I thank my guide for the great success for work and Co-workers.

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