Hydrothermal Synthesis of Zinc Oxide and Its Photocatalytic Effect

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Abstract

The zinc oxide (ZnO) has received considerable attention because of its unique optical, semiconducting, photocatalyst, piezoelectric and magnetic properties. The ZnO nanostructures were synthesized by hydrothermal method. For the synthesis of ZnO zinc acetate and NaOH were used in molar ratio of 1:25. The reaction temperature of hydrothermal system was set at 180^0C for 2h duration. The synthesized ZnO powders were characterized by field emission scanning electron microscope (FESEM) for morphological study and optical properties were revealed by UV-visible spectrophotometer. The synthesized ZnO powder photocatalytic activity was studied under sun light by using methylene blue as a model organic compound. The methylene blue solution was effectively degraded by using as synthesis ZnO under sun light (contain 5% UV)

Keyword: *ZnO, Hydrothermal method, photocatalytic activity*

Introduction

The ZnO is an important semiconductor material due to its various applications. The nanostructure ZnO has now in demand. The nanoscaleZnOposses good photoelectric, optical and piezoelectric properties those can be useful for solar cell, gas sensor, acoustic wave resonator, optoelectronic application, photocatalyst etc. Until, now there are different types of method have been used to synthesizevarious ZnO nanostructures [1]. These methods include physical vapor deposition, chemical vapor deposition, thermal decompositionand thermal evaporation process etc [1]. These methods have a high cost, complex and require high temperature. The hydrothermal method is well-developed synthetic techniques for ZnOnano and microstructures under mild experiment conditions, asreviewed by Lincot [2].Hydrothermal synthesis has become one of the mostpromising nanoscale materials fabrication routes,where polymorphism, particles size, crystallinity andmorphology of products could be very well controlled as compared to other techniques. [3]The shape and size distribution of ZnO particlescould be changed through the adjustment of different hydrothermal parameters including: ion concentrations, pHvalues, temperature and reaction timeetc [4].

The photocatalysis has now a great demand for the environment application for the degradation of organic dyes, pesticides etc.The photocatalytic properties of ZnO have been extensively studied, because of its low cost, high photochemical reactivity and nontoxic in nature. In this study we synthesize ZnO using

hydrothermal method. The photocatalytic activity of ZnO was evaluated in a sun light. The methylene blue was taken as a model organic compound.

Experiment

All the chemicals used were analytical grade and used without any further purification. The precursor Zinc Acetate and NaOH with a specific molar ratio was mixed in 40ml distilled water directly. The solution was stirred for few minutesand then transferred it into ateflon liner stainless steel autoclave. The reaction temperature was maintained at 180^0C for 2h duration. After completing this reaction the reactor was cooled down to a room temperature. The synthesized powder was collected by centrifugation and wash with distilled water and ethanol. The final sample was dried in hot air oven at temperature 60^0C for 12h.The synthesize ZnO nanostructures was characterized by FESEM for morphological study and UV visible spectrophotometer used for study the optical properties of nanostructure ZnO.

Photocatalytic activity study:

The experiment was carried out in sun light in an open atmosphere at adequate light. The 50mlsolution contains 5mg/l methylene blue and small amount of photocatalyst.This solution was kept in dark condition to maintain adsorption-desorption equilibrium. The sunlight radiation was focused by using converging lens. The sample was taken in every one hour interval it was centrifuge and supernatant was collected. The degradation of methylene blue was examined by UV-visible spectrophotometer.

Results and discussion.

The synthesized ZnO were characterized by using FESEM. The morphologies and nanostructures of ZnO were investigated by FESEM using Hitachi S-4800 Type-II field emission scanning electron microscope.

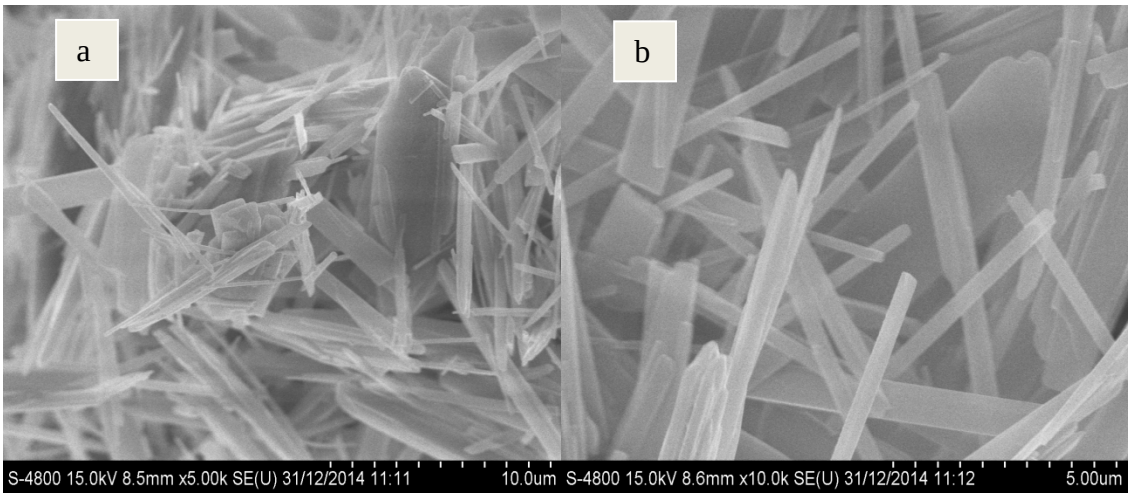

Fig 1 a SEM image of ZnO sample prepared by hydrothermal method and b) shows magnification image of corresponding sample

The figure 1.a and 1.b shows FESEM images of synthesized ZnO. The nanorod like shape observed having diameter in the range of 16nm to 300nm. The growth of nanorods increases more along the

direction of <2$\bar{1}\bar{1}$0> direction rather than <0001>direction [5]. The nanorod sizeincreases and the density decreases when increasing the depositiontime due to the Ostwald ripening [6].The optical property of hydrothermal synthesized ZnO evaluated by UV-Visible absorbance spectra. It has maximum absorbance peak at 220nm as shown in fig 2 below. It has wide range of visible light absorbance. It shows that it absorb both UV and visible light [7].

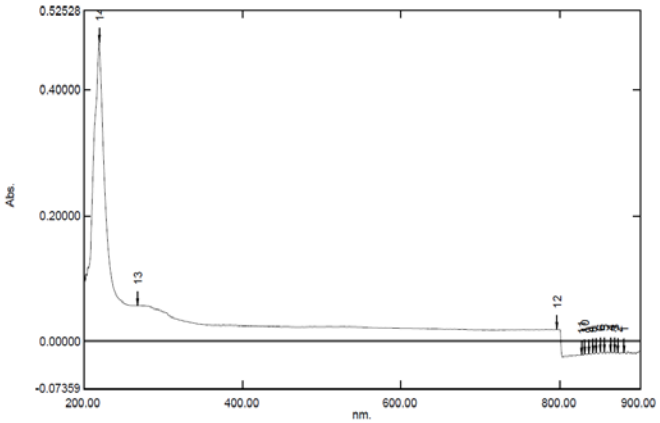

Fig 2.1 UV-Visible absorption spectra of ZnO prepared by hydrothermal method

Photocatalytic Degradation

The photocatalytic degradation of methylene blue was carried out under sun lightthat contain 5% UV light.The experiment carried out with photocatalyst and the degradation was studied. The efficiency of photocatalytic reaction was calculated from the following expression.

$$\eta = \frac{A0 - At}{A0}$$

The fig3.1 shows the UV-Visible absorption pattern of methlyene blue solution irradiated at different time intervals in the presence of photocatalyst. As shown in fig 3.2 The result shows the degradation of dyes upto 93% which was observed after 3hours of sun irradiation.

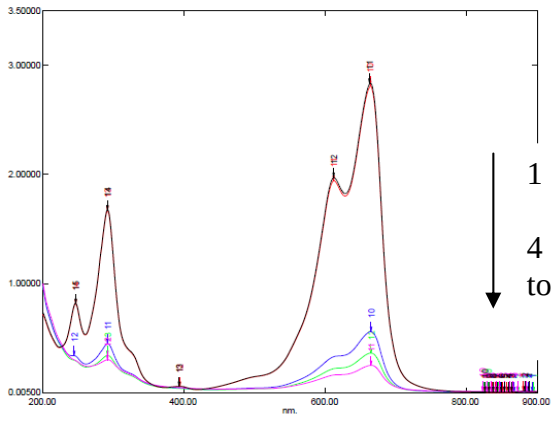

Fig 3.1 UV-Visble absorption spectra shows degradation of methylene blue solution with time

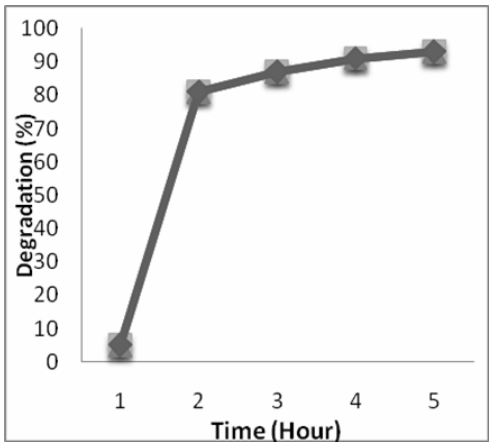

Fig 3.2 Decolorization of methylene blue in time

Conclusions

The ZnO nanostructure was successfully synthesized by using hydrothermal method. The ZnO nanorod was synthesized by using this method. The synthesized ZnO nanostructure shows photocatalytic activity in the sun light as well as UV light. The reason is ZnO photocatalyst should absorb not only UV but also visible light due to this property ZnO was found to be more photocatalytically active than TiO_2 under solar irradiation due to large absorbance of ZnO in visible range.Surface area and surface defects in nanoscale semiconductor has an important role in the photocatalytic activities.

Reference

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