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Photo Catalytic Application of In - Zn Bio Nanocomposite

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Abstract

Indium Zinc oxide nanocomposite (IZO) was synthesized by green method. In this exploration developed IZO with high efficiency of photo catalyst properties using methylene blue (MB) under visible irradiation. The structural, morphological, and optical properties were studied for the synthesized nanocomposite. From SEM analysis it exhibit as polycrystalline in morphology, UV-Vis spectra shows the band gap as 3.12ev. The enhanced photo catalyst efficiency is due separation of electron hole pair is favored due to In^{+3} ions and mainly oxygen vacancies. The adding of indium has changed the surface morphology and enhances the photocatalytic activity of prepared nanocomposite.

Key Words: Indium Zinc oxide nanocomposite; XRD; SEM/EDX; Photo catalyst activity

Introduction

Recently synthesis of nanocomposites has become considerable in current material science research due to its unique applications. ZnO is preferred as preeminent material due to its optical and electrical properties and application as solar cell, photocatalytic activity gas sensors [1]. The use of methylene blue (MB) dye has increased in dying for silk, wool and linen, as the use of these dyes discharge large amount of waste water so purification is necessary before it can discharge environment [2]. Though ZnO photo catalyst efficiency is not significant because of fast recombination of generated photoelectrons and holes.

As In2O3 semiconductor has indirect band gap of 3.2 ev having tremendous stability [3]. From literature doping of cations and anions with ZnO is degradation of various dyes has been drastically improved its photocatalytic activity and to further widen its light absorption in the visible region [4].

Materials Used

The reagents used were Indium (III) acetylacetonate (99.99% pure) 0.5 gm, and Zinc Acetylacetonate Hydrate powder 1.5gm procured from Sigma Aldrich, and gum kondgagagu from the local market. The precursors were made fine powdered by agate motor and pestle and further calcined in muffle finance at 200C for 1hr. The calcined powder turned to brownish yellow color which confirms the formation of Indium zinc oxide Nanocomposites (InZnONcs) (Figure 1).

Results and Discussion

Thermal studies

Thermal analysis, TG curve shows significant weight loss from 150̊C to 200̊C and to some extent 200°C to 300°C and further no more weight loss observed .The DTA curve shows the decomposition behaviour between 200°C to 250°C and a main exothermic peak at this temperature it starts losing weight Was observed at 220̊ C and weight loss continuous (Table 1), (Figure 2).

Structural studies

The XRD diffraction spectra of Indium doped ZnO with Kondagogu gum fitted well with polycrystalline hexagonal phase with wurzite structure from figure 3 [5], the wurtzite structure agree with JCPDS: 36-1541. At $2\theta = 32^0$ the diffraction peak specifies preferential orientation growth along (002) plane. The enhanced peaks at 2θ

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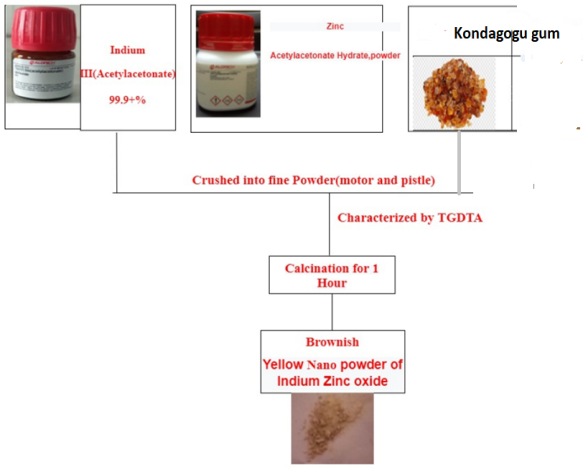

Figure 1: Flow chart of Synthesis process

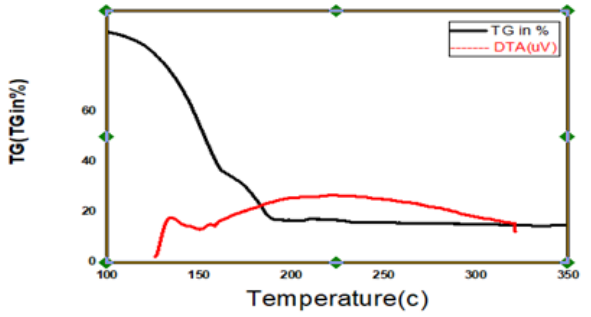

Figure 2: TGDTA analysis of Indium Zinc oxide Ncs with kondagagu gum

Endo-thermic Peak (Evaporation of OH)	Endothermic Peak (Decom of CO and OH)	Exothermic Peak (Amorphous Phase changed)
150^{0}C	200^{0}C	220^{0}C

Table 1: Descriptive Statics

= 32^0, 34.2^0, 36.4^0, 56.2^0 corresponding to (100), (002), (101) and (110) plane were observed. The pattern exhibit sharp intense peak (101) plane around 33.6° can be inferred as overlap plane of (222) In2O3 cubic plane and ZnO (002) plane. Using Debye-Scherer formula the crystallite size D is 15nm and full width half maximum (FWHM) 0.52000. All the XRD peaks correspond to ZnO and Indium, which confirms the deposited material's purity and crystallinity [6] (Figure 4).

Morphology

The morphology of the gum acacia mediated $In_2O_3 - ZnO_2$ confirms that ZnO is non-unormly distributed in InO matrix and having spherical at 250^o C [7]. It is clearly observed that highly porused Nano grains are formed which help to increase active sites and adsorb the more oxygen species on the surface.

Band Gap

InZnONcs band gap was considered by UV-Vis spectroscopy. Shows a band gap of 3.12ev.Tauc plot equation is used to find the band gap $\alpha h\upsilon = \alpha_0(h\upsilon - Eg)^{1/2}$ where $h\upsilon$, α_0 and Eg are photon energy [7], constant and optical band gap of Ncs, band gap energy was obtained through extrapolating the linear portion (Figure 5).

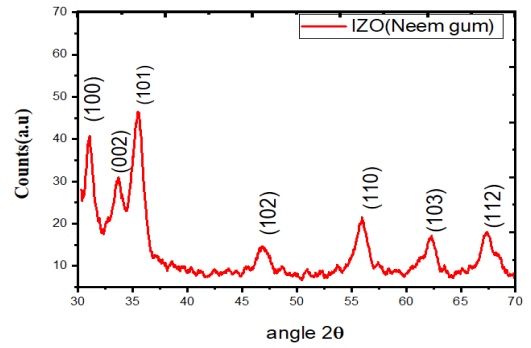

Figure 3: XRD pattern of Indium Zinc oxide Ncs with Kondagogu gum

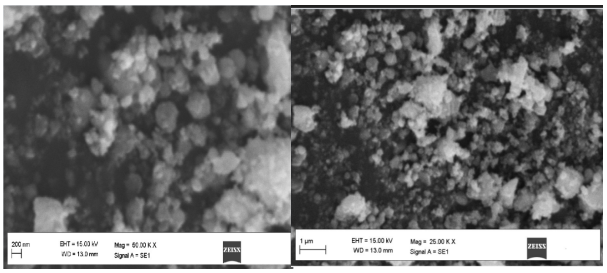

Figure 4: SEM Analysis of Indium Zinc oxide Ncs with Kondagogu gum

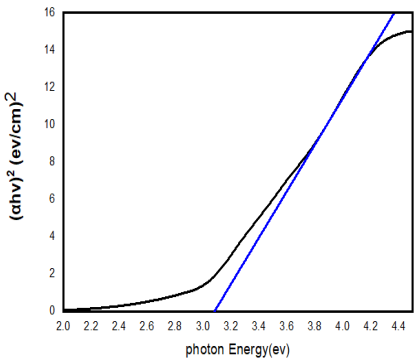

Figure 5: Band gap of Indium Zinc oxide Ncs with Kondagogu gum

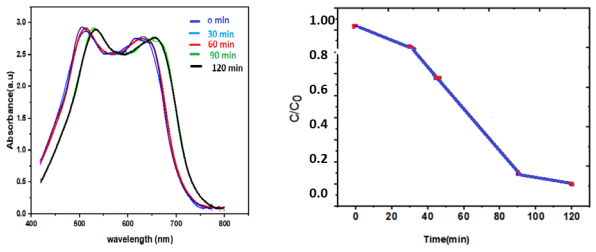

Figure 6: Absorption spectra for the degradation of MB using InZnONcs

Photocatalytic Performance

The photocatalytic degradation of Methylene Blue using-InZnONcs,a typical organic pollutant, Fig.6 shows the UV–vis

absorption spectra of MB- InZnONcsunder UV irradiation. The photo catalyst activity using visible light in ranges of 400-800 nm [8]. In our research Indium is doped which improved the photocatalytic activity, due to the dopant allowed the separation of electron-hole pair and improves photocatalytic performance. Photodegradation time profile of C/C_0 using photocatalyst, figure shows small self degradation under UV irradiation [9]. The rate constant of synthesized $ZnO_2 - In_2O_3$ Ncs was calculated to be 0.00731min (Figure 6).

Conclusion

The Green method technique for synthesis of InZnONcs. The XRD results showed hexagonal wurtzite polycrystalline and showed better enhanced photocatalytic activity. The crystallite size values of ZnO samples were found to be in the ranges from 15.8 nm. The optical results demonstrated that band gap energy as 3.12ev.

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