ADEPT SYNTHESIS OF ZnO NANOPARTICLES USING DIRECT PRECIPITATION METHOD FOR PHOTOCATALYSIS

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ABSTRACT:

Photo catalysis a green technology that convert photonic energy to utilitarian chemical energy with rapid rise of photo reactor flow. The design and development of novel semiconductor photo catalysis is emphasized; inspite of other photo catalyst notably titanium dioxide and molybdenum, ZnO has been the prominent photo catalyst due to lower cost and potentially immense photocatalytic activity, border energy gap of 3.2ev exhibit lower photocatalytic rate can be enhanced by modifying ZnO to nanoscale range. In this work the ZnO Nanoparticle were fabricated by direct precipitation method and obtained nanoparticle was characterized by UV-Vis Spectroscopy which confirmed ZnO NP presence at the wave length range of 235nm with calcinations temperature 450\(^0\) C and SEM analysis witness the morphology of ZnO NP on its surface at1000X and 1,50,000X.

KEYWORDS: ZnO nanoparticles, direct precipitation, photo catalysis.

1. INTRODUCTION:

Zinc oxide is an N-type semiconducting metal oxide, it retains exemplary mechanical property, electrical property, biomedical systems, etc. Now a days, several type of inorganic metal oxides have been synthesized like TiO\(_2\), CuO, ZnO etc. From these inorganic metal oxides, ZnO has much interest because they are inexpensive to produce, safe and can be prepared easily. The preparation expense of Zinc oxide is up to 75\% lower than other inorganic metal oxide like TiO\(_2\)[1,2]. ZnO having tremendous semiconducting property with because of its direct large band gap width (3.37eV) and high exciton binding energy (60meV) [3,4]. In addition, zinc oxide has anti-inflammatory property and wound healing property along with good photocatalytic activity, UV filtration property [5].
It is used in cosmetic products like sunscreen lotion, and UV filter sunglasses etc. It has also been used for wide range of biomedical application like drug delivery, anti-bacterial, anti-cancer, etc. [1]. Various methods for synthesizing ZnO nanoparticle has been proposed, such as direct precipitation [6-9], thermal composition [10], chemical vapor deposition [11], spray pyrolysis [12], sol gel [13,14], for nanocrystalline zinc oxide have been proposed, such as solution precipitation, microemulsion, non microemulsion, ultrasonic radiation precipitation method [9]. Among these methods, precipitation approach while compared to other traditional methods provide facile way for large scale production and low cost. In this precipitation method does not need expensive raw material and complicated equipment [6,8].

The direct precipitation method is simpler than the other precipitation methods like homogeneous precipitation, solution precipitation etc. In direct precipitation method, the raw materials used are cheaper. Many researchers have utilized several methods to prepare ZnO nanoparticles using direct precipitation method like adding surfactants or using ultra sound field. In this work direct precipitation method is engaged to synthesize nano sized ZnO particle using urea as one of the reactants.

India. Urea (CH$_4$N$_2$O) was a common fertilizer which is used for agriculture. According to methodology all synthetic compounds are dissolved with distilled water to prepare precursor solution.

2.EXPERIMENTAL SECTION:

2.1 MATERIALS:

Synthesis of Zinc Oxide nanoparticles by direct precipitation method, in this research we use zinc sulfate (ZnSO$_4$), Sodium hydroxide (NaOH) were purchased from Eswarr Scientific & Co in Tamil Nadu,
2.2 SYNTHESIS PROCESS:

Synthesis strategy including the following steps, originally the urea solution is added into stirring tank containing the zinc sulfate solution under room temperature. Then the urea is gradually decomposed into CO$_2$ and NH$_3$ and the chemical reaction takes place. At last white precipitation is formed after calcination, then ZnO nanoparticles will be obtained. Diffuse 0.6 grams of Zinc sulfate and 0.2 g of urea in 100 ml of water. Gradually shake or mix the solution until the solution become completely transparent. Again, add few drops (2-4) of sodium hydroxide to the above solution and adjust the pH to 12. The solution will change into a whitish shady precipitate. At that point filter the solution using filter paper, and keep it in hot air oven at 350$^\circ$C until the water molecules removed completely.

3. FLOW CHART:

![Flow Chart](image)

Fig 1: This flow chart represents the synthesis process of ZnO nano DI WATER
3. REACTION PROCESS:

Zinc sulfate will detonate zinc and urea provided oxygen to make zinc oxide (ZnO). This zinc sulfate is naturally salt and it included to the DI water and it separate’s in to zinc (II) ion and sulfate ion. Urea is not a salt and simply get dissolved in the solution and float around. At a appropriate point small amount of sodium hydroxide is wrapped in the solution and hydroxyl groups in the solution shoots up. These hydroxyl groups will respond with zinc (II) ion to make zinc hydroxide $\text{Zn(OH)}_2$. Add some drops of sodium hydroxide in the solution until white precipitate is formed. After, the solution becomes white precipitate, it is exposed to the microwave. The zinc oxide nanoparticle is collected in white color fine powder form. And second, and more strangely, urea begins to decompose at higher temperatures giving out ammonia and carbon dioxide. In, this way, composed ammonia (weak base) diffuse back in to the water and make more hydroxyl groups.

Hydroxyl groups in the solution react with zinc (II) ions to make zinc hydroxide. Finally, in this previous process zinc hydroxyl are changed in to ZnO below thermal condition providing more cluster of zinc oxide crystals. By using microwave has used in previous process technique are used in given solution are large burst energy are increasing its temperature at very high rate. This outcomes in an enormous number of very small nanocrystals called cores which will self-assemble to make nanoparticles. However, if general warming is utilized, the decay of urea is moderately slow delivering small number of cores for longer durations. These will self-assemble and develop into bigger particles because of continues supply of growth materials. This is the reason behind why we can expect bigger particles of Zno if general heating is used [15 – 18].
\[
\text{Heat} \\
(\text{NH}_4)_2\text{CO} \rightarrow \text{CO}_2 + \text{NH}_3 \\
\text{NH}_3 + \text{H}_2\text{O} \leftrightarrow \text{NH}_3 \cdot \text{H}_2\text{O} \\
\text{NH}_3\text{H}_2\text{O} \leftrightarrow \text{NH}_4^+ + \text{OH}^- \\
\text{Zn}^{2+} + 2\text{OH}^- \leftrightarrow \text{Zn(OH)}_2 \\
\text{Zn(OH)}_2 \rightarrow \text{ZnO} + \text{H}_2\text{O}^- 
\]

In visual observation, the color doesn’t change were simply observed when chemicals were added. These white precipitations were captured by using a camera.

4. CHARACTERIZATION:

4.1 UV-VISIBLE SPECTROSCOPIC:

![Fig 2: UV – Visible Spectra of ZnO nanoparticles is confirmed by showing the peak value at 235 nm.](image)

From UV-visible spectra examined the sample of ZnO particles was ready by scattering in ethanol. The stable absorption peak in fig 2 represents to ZnO nanoparticle within the wavelength of 235 nm. This absorption peak corresponds to ZnO sample calcined at a temperature of 450°C. In between valence band to conduction band the electrons square measure transfer by this method is called electron transition and it form gap. This gap is point out as intrinsic band gap. Through this intrinsic band gap UV are absorb by using wavelength at 235 nm by this we confirmed the presence of ZnO nano particle. The band gap (E_g) of ZnO nanoparticles was determined by utilizing the recipe

\[E_g = \frac{hc}{\lambda} \]
Where:

\[ h = \text{plank's steady; } \]
\[ c = \text{speed of light and } \]
\[ \lambda = \text{frequency}. \] The relating band gap was seen as 3.27 eV [19-21].

4.2 SEM ANALYSIS:

Fig 3: Electron photomicrographs of ZnO nanoparticles (a) 1000X magnification & (b) 150000 X magnification

(b)

**Fig 3:** Electron photomicrographs of ZnO nanoparticles (a) 1000X magnification & (b) 150000 X magnification
In SEM results evaluated the intensity of particle and arrangement of ZnO particles which is represented in fig 3 (b). We observed that the particles were agglomerated with small spherical shaped and none uniform structure. The arrangement of ZnO nanoparticle in fig 3 (a) shows high compactness. This formation leads to some nanopores inbetween the particles. This same work was did by Samira Bagheri et al using Zinc nitrate as precursor shows smoother and more aggregated of ZnO nanoparticles[22].

5.APPLICATION:

5.1. PHOTOCATALYSIS

ZnO nanoparticle is used for photocatalysis activity in various forms such as nano powders, scaffolds, nanowires, nanorods, etc. Some organic pollutants such as methylene blue, monocrotophos, diphenylamine are treated for photocatalytic decomposition using radially oriented ZnO nanowires using poly-L- lactide nanofibers for applying water purification[23]. The result shown here is reduction of pathogenic bacterial densities by the photocatalytically active ZnO nanorods in the presence of visible light implies potential ex situ application in water decontamination at ambient conditions under sunlight[24]. The photodegradation of methylene blue and methyl orange was done in the presence of paper filled with ZnO nanorods under visible light[25]. The result demonstrate that the photodegrading of organic contaminants in aqueous solution is done by immersing ZnO thin film into that aqueous solution[26]. The enhanced result was found from the undoped ZnO nanoparticles for photocatalyst[27]. The result of ZnO nanoparticle annealed at 600° C possess complete photodegradation of the DR – 23 dye[28]. The result shows that Co- doped ZnO nanoparticle performs higher photocatalyst than Mn- doped ZnO nanoparticle[29]. The result of the work is the Ag-ZnO nanoparticle provide super high photocatalyst than ZnO nanoparticle[30].

6.CONCLUSION:

In this work, the ZnO nanoparticles were austiciously synthesized by direct precipitation method using Zinc sulfate as zinc source and urea as precipitating agents in aqueous solution. In UV – visible analysis, the absorption peak range of the generated ZnO nanoparticle at wavelength 235 nm. The SEM analysis shows that the particles surface morphology was small spherical structured.
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REFERENCE:


