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Synthesis and Characterization of Capped ZnO Nanoparticles with Zinc acetate as a source

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Abstract:

Most preferentially, among different metal oxide Nanoparticles, ZnO have their own importance due to their vast area of applications, e.g. gas sensor, chemical sensor, bio sensor, cosmetics, optical and electrical devices, window material for displays, drug-delivery, ZnO is an attractive material for short wavelength optoelectronics applications owing to its wide band gap of 3.37 eV, large bond strength, large excitation binding energy (60 MeV) at room temperature.

In the present report, ZnO Nanoparticles were synthesized using a simple colloidal root method. Zinc acetate and sodium hydroxide were used as precursors to formulate ZnO Nanoparticles. The prepared samples were characterized by UV-Visible absorption spectroscopy, X-ray diffraction (XRD) techniques and FTIR. From XRD spectra observed that the ZnO crystal has a hexagonal structure, with space group P63mc. The average ZnO crystal particle sizes is calculated by using Scherer's equation and found to 3.1nm at the angle peak (101) is 36 deg.

Keywords: ZnO Nanoparticles, Simple chemical route, particle size and XRD

Introduction

ZnO nanomaterial's distinctive optical characteristics enable a variety of significant uses. For a new generation of ultraviolet (UV) optoelectronics, such as light-emitting diodes, diode lasers, and field emission displays, the bulk features of a broad direct band gap (3.37 eV at ambient temperature) and high excitation binding energy (60 MeV) are attractive. Researchers are drawn to ZnO's high third-order nonlinearity while creating potential optical devices like optical phase conjugators and switches. Furthermore, Zinc Oxide's significant optical absorption in UVA (400 nm to 315 nm) and UVB (310 nm to 280 nm) spectrum ranges is frequently used in cosmetics for UV screening to prevent skin damage from radiation. The use of ZnO nanoparticles (NP) in modern sunscreen formulations allows uniform coverage of skin surface, and renders sunscreen transparent improving overall aesthetic appeal [1-2].

The effort from the cosmetics sector to further increase the transparency of sunscreens results in a mean-size decrease of ZnO particles below 20 nm; however, this is offset by safety concerns about ZnO NP penetration in skin. If the nanomaterial contained in ZnO-based sunscreen remains on the skin's surface or is restricted to the stratum corneum (SC), the skin's topmost layer, then applying it is generally considered safe. Even though SC is only 10–40 μm thick (save for the palms and soles of the feet), its material-tight structure, made of dried, flattened corneocytes bound together by a lipid bilayer, gives it exceptional protection against environmental attack. Viable cells are found in the next layer of skin below the surface, known as the viable epidermis. These cells are vulnerable to toxicological risks brought on by exogenous nanomaterials [3-4].

Many methods for measuring the skin's absorption of nanomaterials have been demonstrated. Radio labelling, cathode luminescence, and Franz cell are a few of them. However, these methods are only applicable to in vitro research. Although electron microscopy and spectroscopic techniques offer comprehensive morphological data at the nanoscale, they may misrepresent the skin's transport characteristics [5-6].

2. Experimental

First solution

Zinc acetate [Zn $(CO_2CH_3)_2$] of 0.1M is dissolved in 100mL of methanol by using magnetic stirrer at room temperature (600rpm). Simultaneously the 2-Mercaptoethanol [C_2H_6OS] is dissolved in methanol and sodium hydroxide of 0.1M is dissolved in 100mL of methanol by the same process of stirring for 30 minutes. After obtaining the homogeneous solution, 2-Mercaptoethanol solution is added drop wise in Zinc acetate. While adding, the solution was continuously stirred. Then after 30minutes, we get homogeneous solution. Again, the sodium hydroxide solution is added in this solution drop wise on continuous stirring. The resultant solution (Zinc acetate + 2-Mercaptoethanol + NaOH) stir for 60 minutes. A white precipitate is obtained after the reaction gets complete. Then suspended capped ZnO nanoparticles were separated by centrifuging this colloidal solution for 4 to 5 times. After this, nanoparticles are dried in petri dish at room temperature for 24 hours.

Second solution: -

Same as above process, the Zinc acetate of 0.01M, Sodium hydroxide of 0.01M is dissolved in methanol also 2-Mercaptoethanol is dissolved in a methanol for 30 minutes. The 2-Mercaptoethanol solution is added in Zinc acetate solution drop wise and stirs solution for 30minutes. After this, the sodium hydroxide solution of 0.01M is added to solution drop wise. While adding, the solution was continuously stirred. Then resultant solution (Zinc Acetate + 2-Mercaptoethanol + NaOH) stir for next 60 minutes.

Colloidal solution is obtained at the end. Nanoparticles were separated by centrifugation process and then dried at room temperature for 24 hours. Same as above, the third solution is prepared for 0.15M of Zinc acetate, 2-Mercaptoethanol and Sodium hydroxide. After adding and stirring, the capped nanoparticles were obtained by same process.

Capped ZnO Nanoparticles were synthesized using a simple chemical route. Zinc acetate, and sodium hydroxide were used as precursors to formulate ZnO Nanoparticles and 2-Mercaptoethanol is used as a capping agent. The prepared samples were characterized by U-V Visible absorption spectroscopy, X-ray diffraction (XRD) and FTIR techniques.

3. Results and discussions

3.1 XRD-Pattern

X-ray Powder Diffraction (XRD) studies were carried using X-ray diffractometer with cuα radiation (λ = 1.5418 A) in the range of 30–65° to determine their crystal structure and Phase. The XRD pattern of the as synthesised ZnO material was represent in Fig. 1. The XRD spectra indicate that the ZnO crystal has a hexagonal structure, with space group P63mc (ICSD collection code: 065119) [7]. The average ZnO crystal sizes can be obtained by using Scherer's equation.

$$D = 0.89\lambda/\beta\cos\theta \text{----------}(1)$$

Where λ is the X-ray wavelength (1.54Å),

β is the Full-width at half maxima of the diffraction peak and θ is the Bragg diffraction angle.

By calculating the XRD diffraction peak broadening at (101), the average size was estimated to be about ~3.1 nm. Thus, it is necessary to somehow protect the particles from agglomerating. For average size is 3.1nm at the angle peak (101) is 36 deg.

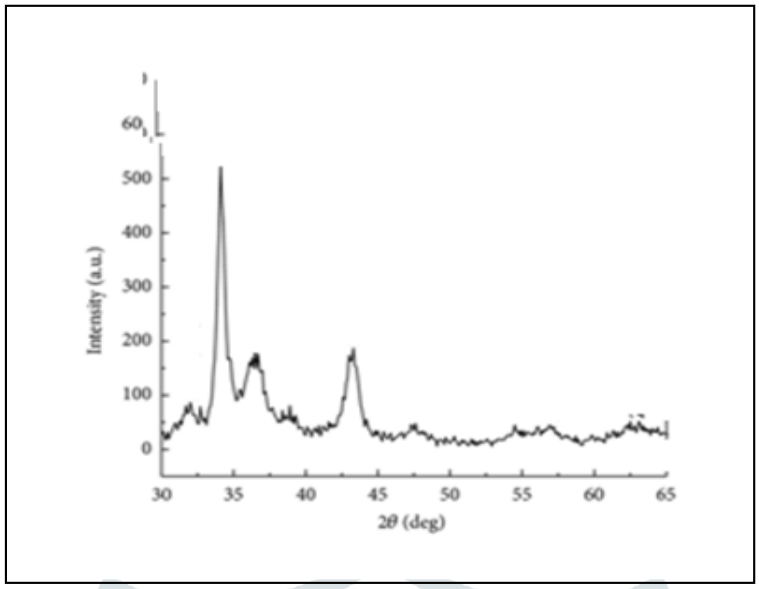

Fig. 1 XRD pattern of the prepared ZNO sample

3.2 UV-Visible study

When a chromatic beam of light is allowed to pass through a prism or grating, it will disperse in to seven colors from red to violet and the set of colors or band produced is called electromagnetic spectrum. When the near ultraviolet visible and near infrared regions of the electromagnetic spectrum are utilized, the electromagnetic techniques are referred to as UV-Visible spectroscopy. **Fig.2.** showed UV-Visible spectra of Zno for different concentration.

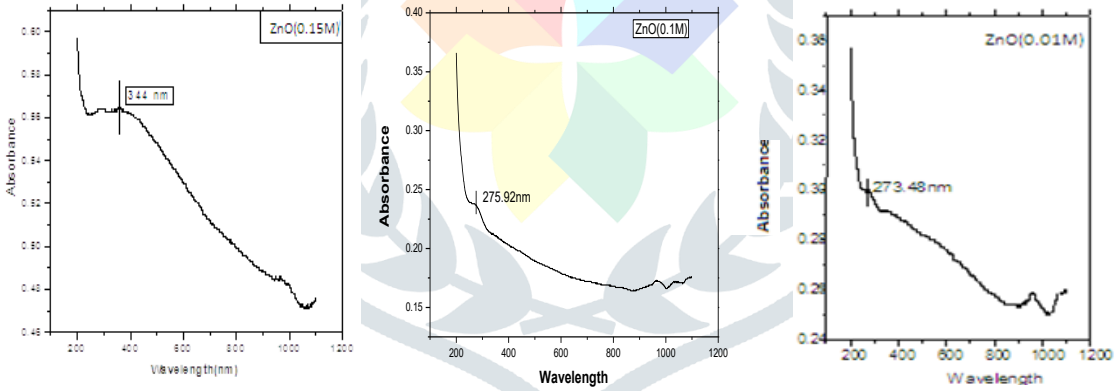

Fig. 2 UV-Visible spectra of Zno for different concentration

Size of synthesized Nanoparticles was calculated using effective mass approximation equation 2 and calculated result is given in Table. 1

$$E=E_B+\frac{\hbar 2\Pi 2}{2r}\left[\frac{1}{me}+\frac{1}{mh}\right]-\frac{1.8e2}{4\Pi\acute{\varepsilon}\varepsilon r}-\frac{0.124e2}{h2(4\Pi\varepsilon\acute{\varepsilon})}\left[\frac{1}{me}-\frac{1}{mh}\right] \text{---- (2)}$$

Table. 1

Sr. No.	Concentration	Wavelength(nm)	Radius(nm)	Size(nm)
1	0.1M	275.92	1.4	2.8
2	0.01M	273.48	1.4	2.8
3	0.15M	344	1.6	3.2

3.3 FT-IR Transmittance spectra

Fig 3. Shows FTIR spectra of Capped ZnO Nanoparticles. From Fig.3 observed that characteristic peaks at 1020, 1401, 1579, 2368 and 3391 cm^{-1} and related group present at particular wave number is given in Table 2.

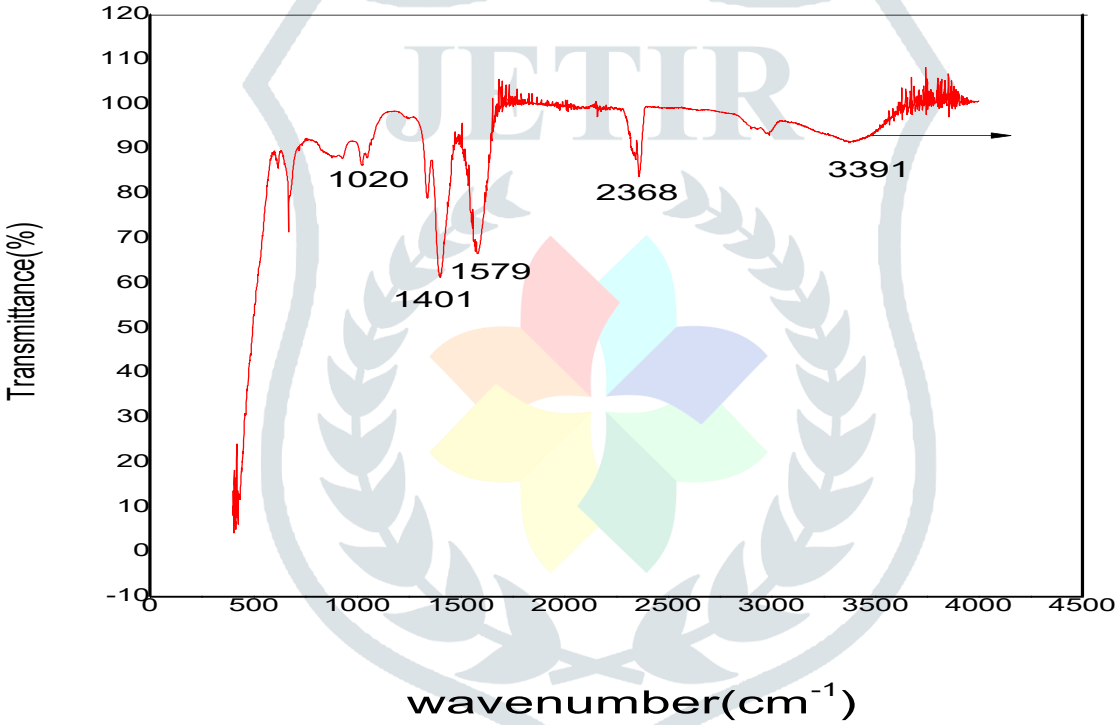

Fig. 3. FTIR of Capped ZnO Nanoparticles

Table. 2.

Sr. No.	Wave no.(cm^{-1})	Group present
1	**1020**	**C-O**
2	**1401** **1579**	**zinc carboxylic**
3	**2368**	**C-H(alkane)**
4	**3391**	**O-H (hydroxyl)**

Conclusions

- ✓ Capped ZnO nanoparticles were prepared by using colloidal Root Method using Zinc Acetate and NaOH as sources of 'Zn' and 'O'.
- ✓ 2-Mercaptoethanol is used as capping agent and methanol is used as Solvent.
- ✓ Capped ZnO nanoparticles are prepared of size ~3.1nm which is calculated by Scherrer's equation in XRD technique.
- ✓ In this method, Concentration of Sodium Hydroxide [NaOH] and Zinc Acetate [Zn $(CO_2CH_3)_2$], reaction rate are effective parameters that can change the particle sizes of a sample.
- ✓ These Capped ZnO nanoparticles will be used in Rubber manufacture, Medicine, Cigarette filters, food additive, coatings, and Corrosion prevention in nuclear reactors and in Nano rod sensors.
- ✓ This route is very simple, low cost and father the study can be carried out for agricultural and electrical applications.

References

1. A.K. Singh Advanced Powder Technology 21 (2010) 609.
2. Zhen Song, Timothy A. Kelf, Washington H. Sanchez, Michael S. Roberts, Jaro Rička, Martin Frenz, and Andrei V. Zvyagin Biomed Opt Express. 2 (2011) 3321.
3. Dai D. C., Xu S. J., Shi S. L., Xie M. H., Che C. M., *Opt. Lett.* 30 (2005) 3377.
4. Rob J Vandebriel Wim H De Jong Nanotechnol Sci Appl. 5 (2012) 61
5. Uschi M. Graham, Alan K. Dozier, Günter Oberdörster, Robert A. Yokel, Ramon Molina, Joseph D. Brain, Jayant M. Pinto, Jennifer Weuve, and David A. Bennett Chem Res Toxicol. 2020 (33) 1145.
6. Zhen Song, Timothy A. Kelf, Washington H. Sanchez, Michael S. Roberts, Jaro Rička, Martin Frenz, and Andrei V. Zvyagin Biomedical Optics Express 2 (2011) 3321
7. Dalia Ahmed Mohammed Osman1, Mustafa Abbas Mustafa Journal of Nanoscience and Nanoengineering 1 (2015) 248.