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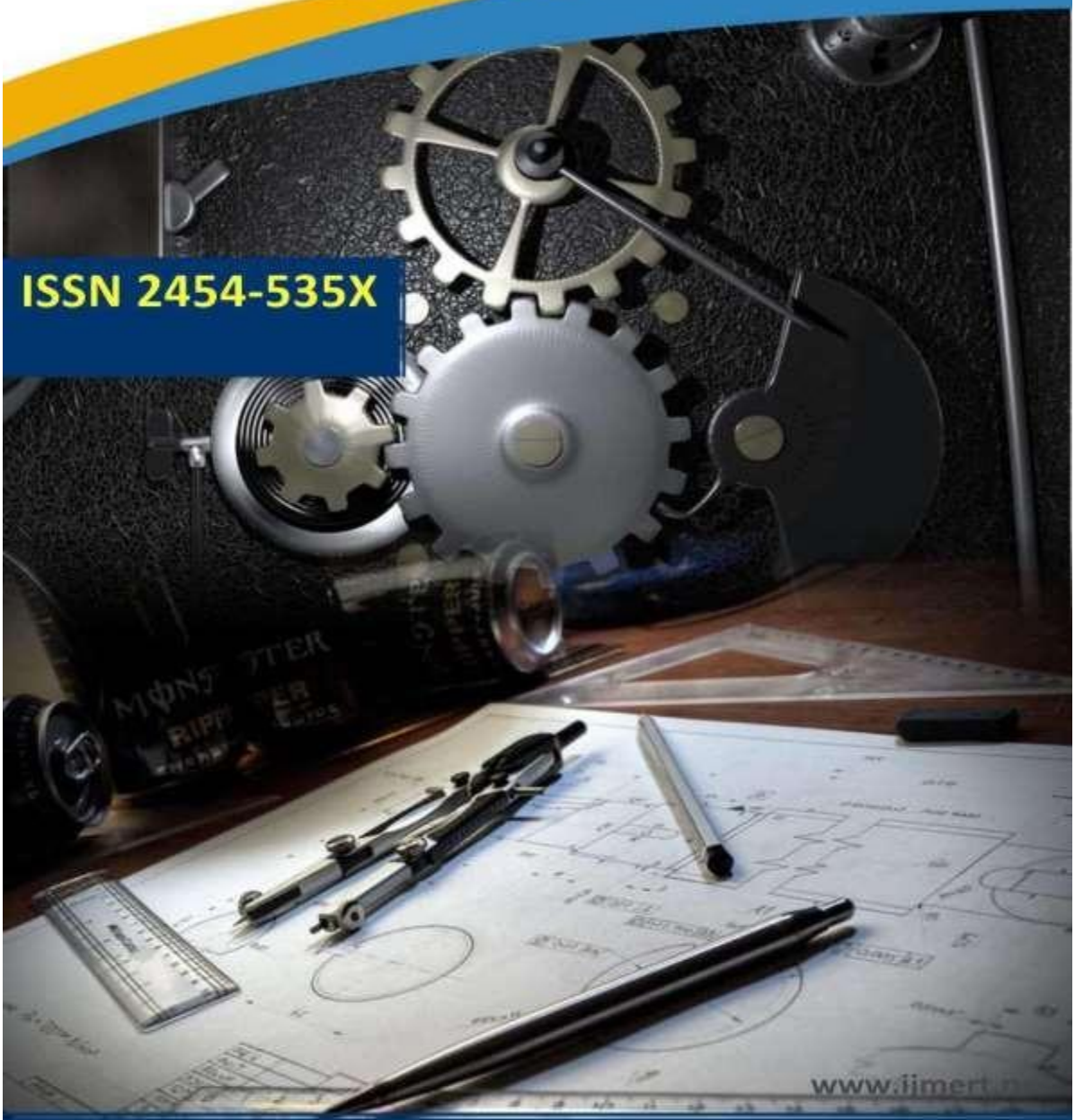

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Synthesis and Characterization of ZnO Nano Particles by Sol gel method

M.Praveen[1], K.Bala Krishna Yadav [2], Lakshmi Singh[2], G.Arun Kumar [2]

[1]Assistant Professor, Department of Mechanical Eng. SITS, Hyderabad.

[2] Students of III B Tech I semster, Department of Mechanical Eng. SITS, Hyderabad.

Abstract: Now-a-days, it is very difficult to understand the behavior of ZnO nano particles deposited on Mild steel by any process. Challenge to design the suitable material for various industries like ship industries, marine industries and petro chemical industries .Generally ships do fail due to corrosion problem so to overcome this metals are undergone heat treatment process and coating is done with suitable materials to overcome corrosion. For this study the ZnO nano particles were synthesized by sol gel process. The characteristics of ZnO nano particles were studied by using X-Ray Diffraction (XRD) for crystal structure, Particle Size Analyzer for finding particle size of ZnO nano particle. The absorption spectra of ZnO nano particles suspended in deionized water were recorded at room temperature using UV-visible spectroscopy and the morphology of ZnO nano particles was investigated by Scanning Electron Microscopy (SEM).

I Introduction:

Nano science and Nanotechnology refer to the understanding and control of matter at the atomic and molecular levels; here the length scale is approximately 1 to 100 Nanometers. Nanotechnology has a wide variety of applications in different fields and some of them are Material, Metallurgical and Mechanical. In these design, characterization, production and application of structure, devices and systems by controlling shape and size at Nanometerscale.

Nano particles are entities with diameters in the range of 1-100 nm. This new field of Nanoparticles is lying between the traditional fields of chemistry and solid-state physics. Therefore, a significant gap exists between these regimes with unique characteristics that neither obeys the law of physics nor quantum chemistry. The smaller is the particle, the higher is the surface-to-volume ratio. Thus, more atoms tend to reside on the surface than inside the particle itself. Particle chemical/mechanical properties that are once determined by the molecular structures are now influenced by the defects on the surface

II preparation of ZnO nano particles:

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Zinc Oxide is prepared by Solution Combustion Process. Stoichiometric amounts of Zinc Nitrate and Urea are taken into beaker and stirred it for 30 minutes on a magnetic stirrer and individual beaker has to take and collect separately and stirrer it for half hour.

General equation for sol gel method of Zinc Oxide

$$Zn(NO_3)_2\ 6H_2O + NH_2CONH_2 \longrightarrow ZnO + N_2 + H_2O + CO_2$$

The oxidation states of the elements is as follows

Zn = +2 C=+4 N=0

H= +1 O= -2

Using the oxidation state values we can balance the equation

$$3(Zn(NO_3)_2\ 6H_2O + 5NH_2\ CONH_2 \longrightarrow 3ZnO + 8N_2 + 5CO_2 + 16H_2O$$

Stirring rapidly on the magnetic stirrer with mixture of nitrate and urea for one hour the gel will be formed at the bottom of the beaker. Collecting the particles in the plate and place in the furnace for two hours for calcination process.

III Results and Discussions:

A X-Ray Diffraction of ZnO:

In the XRD pattern of the ZnO Nano particles, the peaks are observed at 31.769°, 32.437°, 36.270° and 58.593°. The (h k l) values of the peaks are (1 0 1), (1 0 2), (1 0 0), and (1 0 1) respectively. These results are coincided with JCPDS card number 75 – 0566, and it shows that the ZnO Nano particles having the Hexagonal structure. The average crystalline size is measured using the Debye-Scherer's formula.

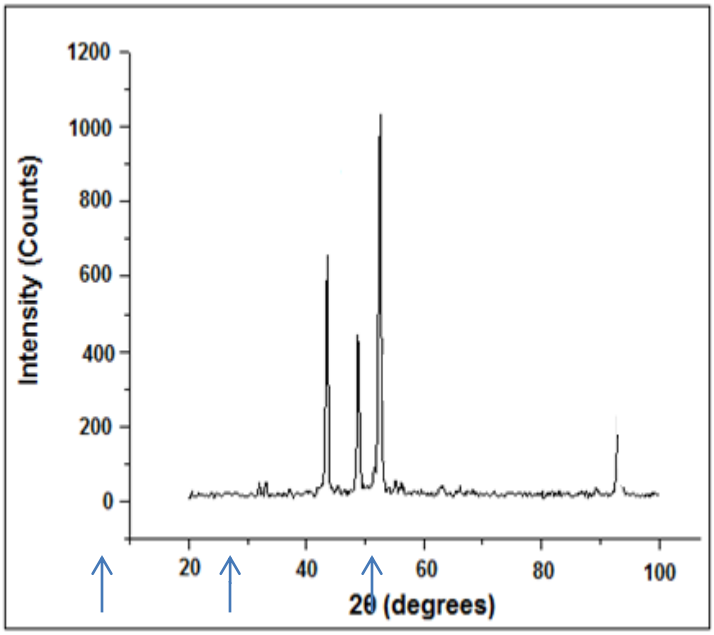

Figure 1: XRD Pattern of ZnO nano particle.

According to Debye-Scherer equation:

$$\boldsymbol{D = \frac{0.9\lambda}{\beta cos\theta}}\text{nm}$$

Where D ─ Average size of the particle (nm)

λ ─Wavelength of the radiation (A°)

θ ─Diffraction angle (degree)

B ─ full width half maximum (radians)

(FWHM) of the peak

From the above formula we obtained the average crystalline size is 30 nm. The lattice parameters a = b=2.242 (A°), c=4.194 (A°).

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B Scanning Electron Microscopy of ZnO:

The grain size, shape and surface properties like morphology were observed by the SEM with different magnifications. The SEM images of ZnO nanoparticles which are prepared by solution combustion process as shown in the figure below.

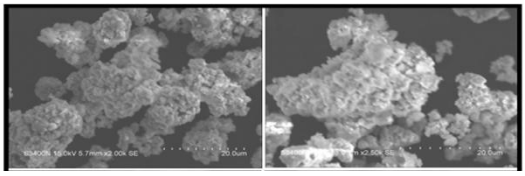

Figure 2: SEM image of ZnO nanoparticle

It shows that the particles exhibit agglomeration like structure due to some excess elements present in it.

C Ultraviolet –visible Spectroscopy (UV-Vis) of ZnO nanoparticle:

The absorption spectrum of ZnO nano particles is as shown in below Figure. 21. The energy band gap of ZnO nano particles is compared with ZnO bulk materials. The energy band gap for bulk nano materials is 3.3 eV. The fundamental absorption, which corresponds to electron excitation from the valence band to conduction band, can be used to determine the value of the optical band gap.

The Tauc relation between the absorption coefficient (α) and the incident photon energy (hϑ) can be written as….

$$(\alpha h\vartheta) = A(h\vartheta - E_g)^n$$

Where, A – is absorption, Eg – is the band gap of the material and exponent n – depends on the type of transition. Here, the transitions are direct so it can be taken as n=1/2.

For, n = ½ direct transitions,

substituting the 'n' value in the above equation it changes into

$$(\alpha h\vartheta)^2 = A^2(h\vartheta - Eg)$$

The energy band gap is measured with the help of absorption spectrum and a graph of $(\alpha h\vartheta)^2$ versus hϑ is plotted in Figure. 21.

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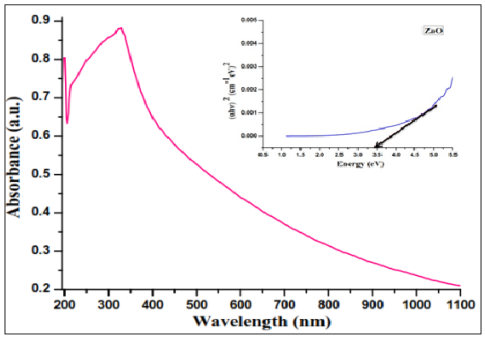

Figure 3: UV-Vis absorption spectra of ZnO nanoparticles

The extrapolation of the straight line to $(\alpha h\vartheta)^2=0$ gives the value of the energy band gap of prepared Al_2O_3 nano particles and it gives 3.43 eV. An increase the band gap is observed due to the quantum confinement effects in the nano particles.

IV Conclusions:

XRD pattern reveals that the ZnO Nano particles having the HexagonalStructure and average crystalline size measured to be 38nm. UV-Vis shows that the energy band gap of Al_20_3 Nano particles are 3.34eV. Morphology of ZnO nano particles shows agglomeration structure because of the combustion was done in opened air. The Energy dispersive X-ray spectroscopy reveals that the required phase has been obtained.

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