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Synthesis and Characterization of Zno - Nanorods by Sol-Gel Method for White LED Phosphors

Chandar Rao. P[1*], Sreelatha C. J.[1] and Ravinder G. [1]

[1]Dept. Of Physics, Kakatiya University, Warangal-506009, Telangana State, India

ABSTRACT

We have well chemically synthesized the ZnO nanorods via sol-gel method showing broad luminescence in the visible wavelength range. Their lengths and diameters were 1um and 100nm respectively. X-ray diffraction results revealed that the synthesized ZnO product was highly crystalline having hexagonal wurtzite structure. The photoluminescence (PL) spectroscopy was taken by exciting the ZnO nanorods with the He-Cd laser it has one peak, the peak intensity of the near band edge luminescence at 480nm .After the luminescence peak ranges from 400-800 nm and it is broad enough to be used as a phosphor for a white LEDs. The LED shows a white light emission and the electroluminescence measurement show a strong enlargement blue LED current. These results clearly shows that ZnO nanorods better alternate and constructive approach to get high production white LEDs and also other phosphors.FTIR spectra was studied and reported.

KEYWORDS— Sol-Gel method, ZnO Nanorods,XRD, SEM, PL, FTIR

*Corresponding Author

P. Chandar Rao

Department of physics,

Kakatiya University,

Warangal -506009 (Telangana) India.

Email. chandarraop@gmail.com,mobile no- 9959937253

INTRODUCTION

Light emitting diodes have attracted a lot of attention in recent times as potential candidates for new generation illumination in present days; light emitting diodes (LEDs) have paid extent attention due its important applications in common house hold, commercial and industrial areas. Now the time has come to replace the traditional light by LEDs[1]. Since last few years zinc oxide (Zno) is being considered as a potential compound for LEDs due to several advantages moreover the rapid increase of the global interest in ZnO material is due to the fact that it has varied range of low dimensional structures such as nanoparticles (NPs) nanorods (NRs), nanobelts (NBs) and nanotubes (NTs) which can be grown on any substrate without the need of lattice matching[2,3]. Because of low dimensionality the quantum confinement effect plays an important role and enhance the oscillation strength of the exactions ,which in favourable for radiative recombination of exciting at room temperature. further more, no NRs have large number of intrinsic and extrinsic deep-level defects that emit different colours of light including violet, blue, green, yellow, orange, and red[4,5]. Thus, these properties make a start to fabricate ZnO NRs based different colours of LEDs[6]. ZnO NRs have potential of being used as intrinsic white light emitting diodes. We report only the design and fabrication process of white LED with ZnO nanorods as phosphor material excited with a blue LED. Our device achieves the commission International Del Eclairage (CIE) chromaticity colour coordinates of (0.31, 0.32) for white LED at 350 mA current[7].

CHEMICAL USED

For the synthesis of ZnO nanorods the chemicals were purchased from sigma Aldrich 99% purity Zinc nitrate hydrate ($Zn(NO_3)_2.6H_2O$), hexamethylenetetramine ($(CH_2)6N_4$) and deionised (DI) water. All chemicals were of analytical reagent grade and were directly used without any special treatment.

MATERIALS AND METHODS

We have planned to synthesis the ZnO nanorods by sol gel process. For the synthesis of ZnO nanorods. First we take a 10mg Zinc nitrate hydrate ($Zn(NO_3)_2.6H2O$) and hexamethylenetetramine ($(CH_2)6N_4$) were dissolved in aqueous deionised (DI) water solution, after then 50 mL of solution were transferred to a glass beaker this was covered by an aluminium foil and kept in an electric oven at 90^0C for 4 hours. After the reaction, the sample was collected from the bottom of the glass beaker and dried in air at 60^0C for few hours. Finally the powder samples were collected in a bottle and kept for fabrication of LED device.the powder samples was crushed by agate morter for uniformity after the Zno nanorods powder coated on a commercially available blue LED to get white LED. The morphology and structure properties of samples were investigated by scanning electron microscopy(SEM), and x-ray spectrometer(XpertPhillips) .Photoluminescence (PL) measurements were taken using photoluminescence spectra line of 400 nm as the excitation source.

MATERIAL CHARACTERIZATION

For the material characterization we used XRD pattern of Zno nanoparticles was recorded with the help of Bruker D8 x-Ray Diffractometer with CuK_α (λ=1.5418A°) radiation .The prepared Zno material microscopic images were taken by Hitachi S-4800 scanning Electron Microscope (SEM).Fourier Transform Infrared Spectra of Zno were recorded with the help of FTIR-8400S Spectrometer Shimadzu. Photoluminescence (PL) measurements were taken with the help of a He-Cd laser line of 400 nm as the excitation source.

RESULTS AND DISCUSSION

We were synthesised the Znonanorods by the simple sol gel method in room temperature conditions .The Znonanorods (NRs) grown in solution by a simple chemical method. The figure 1 represents the respective X-Ray diffraction spectra for the synthesized Nanomaterials.The JCPDS Card No: 36-1451 approves the powder XRD spectra of Nano materials. The resulting Znonanorods of all peaks exhibits hexagonal crystal structure .The NRs with different diameters and length observed as shown in figure (1). The lengths and diameters of Zno NRs were found to be 2-10um and 200-800nm, respectively. The inset of Fig (2) shows the sharp edges and corners of the hexagonal Znonanorods and demonstrates that the crystalline of the Zno is fine.

The diffraction peaks at scattering angle(2θ) of 31.90,34.50,36.30, 47.50,56.60,62.90,67.90, 69.20,72.90 and 77.00 correspond to the reflection from 100, 002, 101, 102, 110, 103, 200, 112, 201,004, and 202 crystal planes respectively which correspond to the typical diffraction peaks of hexagonal Zno[8]. The XRD pattern is identical to the hexagonal phase with wurtzite structure and polycrystalline nature.

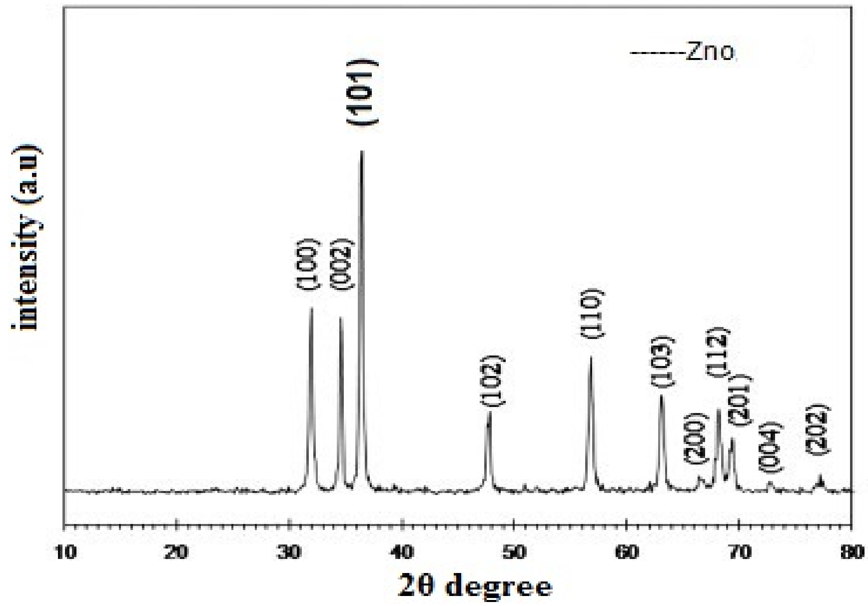

Figure 1: X-ray Diffraction of Znonanorods on a Glass Substrate

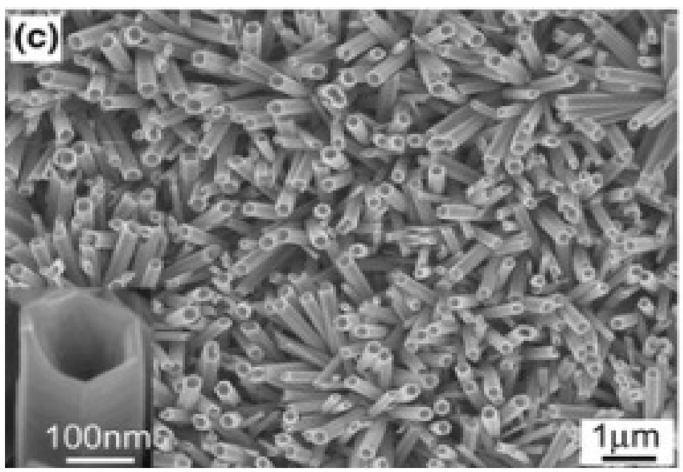

Figure 2: Scanning Electron Microscopy Image of as Grown Znonanorods on a Glass Substrate

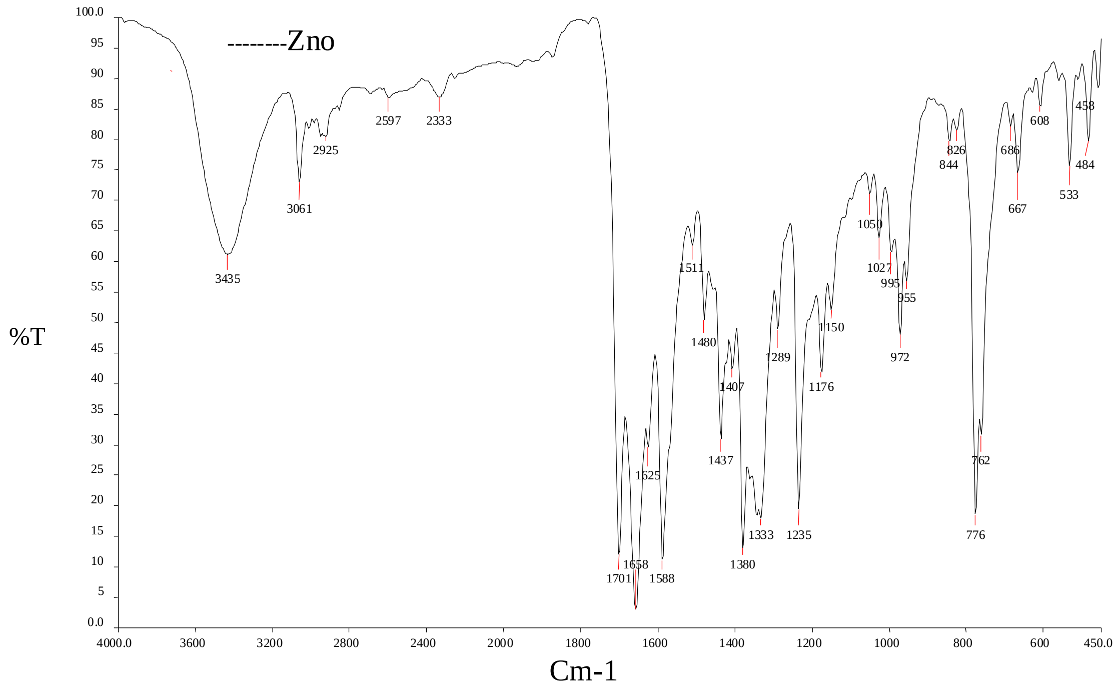

Figure 3: Shows the FTIR Spectra of Zno

The IR spectra manifest the absorption bands in the range 400-1200cm^{-1}, which were due to oxygen metal linkages and the absorption band 533cm^{-1}. This was the one of the IR active mode and it corresponds to hexagonal wurtzite structure of Zno.The FTIR spectra of Znonanorods absorption band near 3435 cm^{-1} represent O-H mode those at 3061 cm^{-1} are C-H mode, and 1701 cm^{-1} are the C=O stretching mode. The bands in the spectral range from 458-3600cm^{-1}were attributed to the vibration of the organic residuals and to water incorporation.

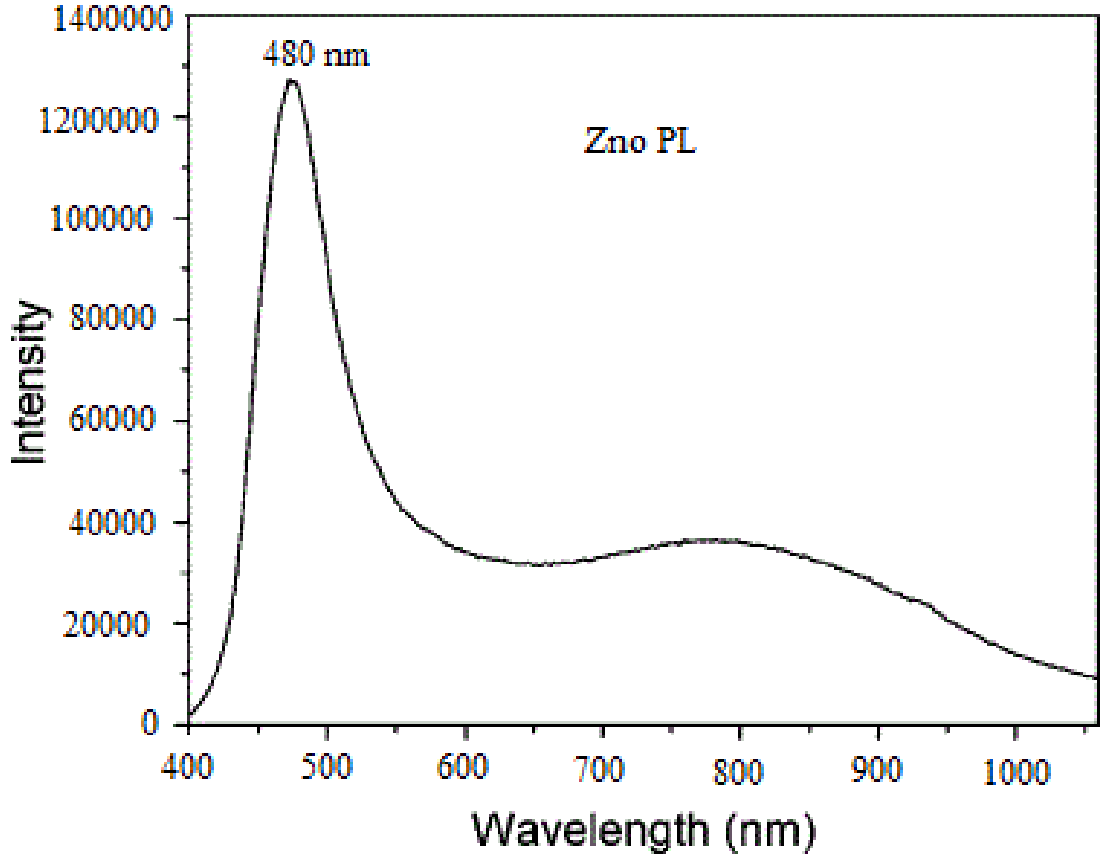

Figure: 4 Photoluminescence (PL) Spectrum of Zno

Photoluminescence (PL) measurements were performed by using a computer controlled UV-visnear IR spectrometer with an integrating sphere.

The photoluminescence (PL) measurement for prepared Znonanorods phosphors recorded at room temperature by exciting with the 480nm peak associated with the near band-edge luminescence at 480 nm is broad enough to be used as a phosphor for white LED

The Znonanorods phosphors coated on a commercially available blue LED. The 480nm emissions of blue LED act as the excitation source for Znonanorods phosphors. The electroluminescence measurements carried out for white LED .The emission intensity increases linearly with increasing the LED current from 350mA to 850mA. The CIE chromaticity coordinates corresponding to the electroluminescence of fabricated white LED (0.31, 0.32) is close to pure white light (0.33., 0.330) according to the 1931 CIE coordinate diagram[9]. (Figure not shown here) photograph of white light emission from Znonanorods phosphor based white LED.

CONCLUSIONS

To summarize, high quality Znonanorods has been prepared by sol gel method .The structural properties are studied. The XRD shows that the a single cystalwurtzite hexagonal structure .Room temperature of Zno phosphor show a strong emission band located at 480nm .The

Znonanorods phosphors coated on a commercially available blue LED, emitting 480nm emission used for fabrication of white LED .FTIR spectra also studied and reported. Finally the properties of the Zno can be very good

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