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BIO APPROACH: GREEN SYNTHESIS OF ZnO:Dy^{3+} NANOPHOSPHOR

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Abstract

In the present work, we report on the synthesis of ZnO nanophosphor doped with Dy^{3+} *(3wt%) by green synthesis method. The final product was well characterized by powder X-ray diffraction, Fourier transform infrared spectroscopy and photoluminescence spectroscopy. The powder X-ray diffraction patterns of the as-formed product show hexagonal wurtzite structure. The crystallite size estimated using Scherrer's method was found to be in the range 23–25 nm. Photoluminescence properties of ZnO doped with* Dy^{3+} *(3wt%) for ultra violet excitation was studied in order to investigate the possibility of its use in white light emitting diode applications. The emission spectra consists of intra 4f transitions of* Dy^{3+}*, namely* $^4F_{9/2}\rightarrow{}^6H_{15/2}$ *(483 nm), and* $^4F_{9/2}\rightarrow{}^6H_{13/2}$ *(573 nm). Therefore, the present phosphor was highly useful for display applications.*

***Keywords:* Nanophosphors, X-ray diffraction, Green synthesis**

I. INTRODUCTION

Nanotechnology and nanoscience are being developed to explore and contrive single atoms and molecules for numerous applications in different field of scientific world. Nanoparticles are of great scientific attention as they are a viaduct between bulk materials and atomic or molecular structures. The size and shape tailored nanostructures has been the topic of intensive investigation in materials science [1, 2]. Zinc oxide nanoparticle is a unique material having multipurpose applications. A number of physical and chemical preparative methods for accessing nanostructured zinc oxide are on records. Of these chemical methods are hazardous to the environment. This leads to the thought of an eco-friendly method to synthesize nanoparticles. "Green synthesis" of nanoparticles makes use of environmental friendly, non-toxic and harmless reagents [3-5]. The advantage of using plants for the synthesis of nanoparticles is that they are easily available, safe to handle and possess a broad variability of metabolites that may add in reduction. The most important bioreductants in the synthesis of metal nanoparticles are plant extracts.

In this work, the syntheses of ZnO:Dy^{3+} nanophosphors are prepared by using aqueous leaf extract of Azadirachtaindica.

II. EXPERIMENTAL

Zinc nitrate hexahydrate ($Zn(NO_3)_2.6H_2O$) was purchased from Nice Chemicals, India without purification. Solutions prepared from double distilled water. Further, 10 mL of Azadirachtaindica aqueous extract was taken and boiled at 60-80 °C by using magnetic stirrer. When the temperature of the solution was reached at 60 °C, 5g of zinc nitrate hexahydrate ($Zn\ (NO_3)_2.6H_2O$) and 3 wt% of dysprosium nitrate were added. Then the mixture was boiled until it becomes deep yellow colored paste. Then, it transferred to a ceramic crucible cup and heated in furnace at 350 °C for 2 hr. Finally, obtained light yellow colored powder. This powdered product was used for the further studies.

III. RESULTS AND DISCUSSIONS

3.1 Ftir Spectra

FTIR measurements were carried out to find the functional groups involved in the bioreduction of $ZnO:Dy^{3+}$ nanophosphors. The figure represents the FTIR measurements of biologically synthesized ZnO nanophosphors and Dy^{3+} (3 wt %) doped ZnO nanophosphor samples in the wavenumber range 400 - 4000 cm^{-1} using a KBr pellet technique at room temperature. The twin role of the plant extract and the presence of some functional groups as a reducing and capping agent were confirmed by FTIR analysis of the prepared samples. The broad transmission band at 3420 cm^{-1} is attributed to the overlapping of O–H stretching modes of vibration in hydroxyl functional group in alcohols and N–H stretching vibrations in amides and amines. The peak at 1635cm^{-1} assigned to the amide I bond of proteins which clearly indicates the leaf extracts to bind on the surface of green synthesized zinc oxide nanoparticles after heat treatment. The band at 550 cm^{-1} is corresponding to tetrahedral Zn^{2+} stretching. The band at 458 cm^{-1} is assigned to the stretching mode of ZnO. The spectrum obtained clearly shows ZnO transmission bands in the region between 400 and 600 cm^{-1}. The peaks at 483, 467, 443, 427, and 413 cm^{-1} corresponds to the standard peak of ZnO due to ZnO stretching frequency of Zn–O bonds confirms the presence of M–O vibrational bands [6-8]. From FTIR results, it can be concluded that some of the biomolecules from A. indica extract formed a strong

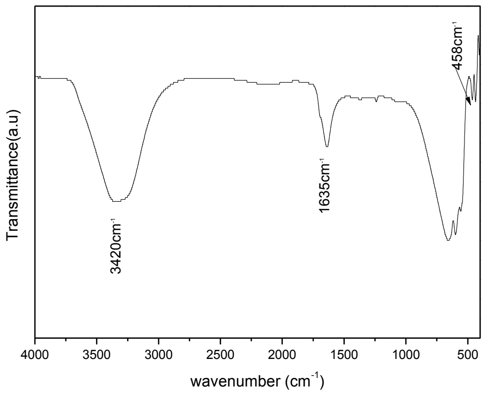

Fig 1: FTIR spectrum of $ZnO:Dy^{3+}$ nanophosphors

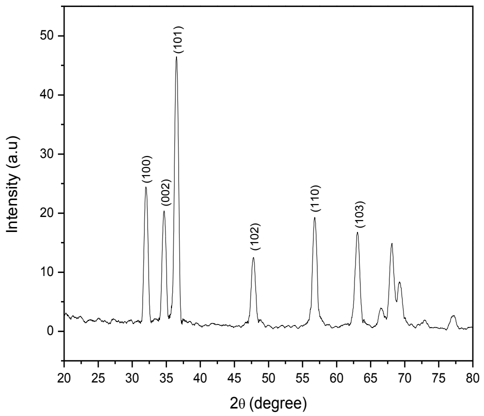

Fig 2: XRD pattern of $ZnO:Dy^{3+}$

capping on the nanoparticles.

3.2 X Ray Diffraction Analysis

The XRD pattern of prepared ZnO:Dy^{3+} nanophosphors is shown in figure 2. All the XRD peaks were indexed by hexagonal wurtzite phase of ZnO (JCPDS Card No. 36 -1451). The peak broadening in the XRD pattern clearly indicates that small nanocrystals are present in the samples. There is no evidence of bulk residue materials and impurity. Six peaks appear at different 2θ values are shown in the figure. The sharp diffraction peaks indicate the good crystallinity of the prepared particles. Absence of characteristic reflections related to Dy phases indicates that Dy^{3+} ions had systematically been substituted Zn^{2+} or had been incorporated into interstitial sites in the ZnO lattice. Crystal size of the synthesized nanoparticles was calculated from the Debye-Scherrer equation

$D = K\lambda / \beta \cos\theta$, where D is the crystallite size of zinc oxide nanoparticles, λ is the wavelength of the X –ray source (0.1541 nm), β is the full width at half maximium of the diffraction peak, K is the Scherrer constant with a value of 0.9, and θ is the half diffraction angle- Bragg angle. The crystallite size of the Dy^{3+} doped zinc oxide nanophosphors was found to be 25nm. XRD pattern reveals that the ZnO:Dy^{3+} nanophosphors prepared by bio-route method are crystalline.

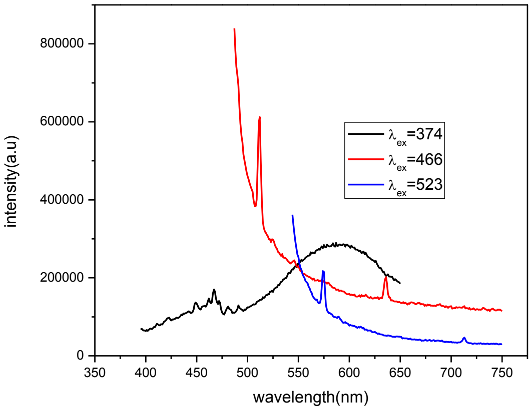

Fig 3: Photoluminescence spectra at various excitation wavelengths

3.3 PHOTO LUMINESCENCE SPECTRA

The Photoluminescence spectra were recorded with different excitation wavelengths (at 375, 467 and 524 nm) and are shown in Fig. 3. It is observed that under 375 nm excitation wavelengths, broad emission spectrum is observed due to the overlapping of emission bands of ZnO nanoparticles and that of Dy^{3+} ions. Photoluminescence spectra under 374nm excitation consist of two main emissions in the blue region (450–500 nm) and in the yellow (550–600 nm) regions. These blue and yellow emissions were assigned to the electronic transitions $^4F_{9/2} \rightarrow {}^6H_{15/2}$ and $^4F_{9/2} \rightarrow {}^6H_{13/2}$ respectively of the Dy^{3+} ions. The blue $^4F_{9/2} \rightarrow {}^6H_{15/2}$ emission corresponds to the magnetic dipole (MD) transition and the yellow $^4F_{9/2} \rightarrow {}^6H_{13/2}$ emission belongs to the hypersensitive forced electric dipole (ED) transition [9, 10]. A weak red emission corresponding to the $^4F_{9/2} \rightarrow {}^6H_{11/2}$ transition was also observed under 466 nm excitaion.

IV. CONCLUSIONS

ZnO: Dy^{3+} nanophosphors were successfully were synthesized from Zn(NO$_3$)$_2$ and neem leaves extract by green synthesis method and were characterized by FTIR, XRD and photoluminescence analysis. The X-ray peak broadening of ZnO nano-particles annealed at 350^{0}C was due to the small crystallite size and lattice strain. The XRD profile confirmed hexagonal wurtzite structure of ZnO in the prepared phosphor samples. The prepared phosphor samples gave strong blue and yellow emissions corresponding $^4F_{9/2} \rightarrow {}^6H_{15/2}$ and $^4F_{9/2} \rightarrow {}^6H_{13/2}$ respectively at 374nm excitation. Thus, it is concluded that reported biologically synthesized ZnO: Dy^{3+} nanophosphors can act as an effective candidate for various display applications.

V. ACKNOWLEDGMENTS

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REFERENCES

1. L. Li, N. Koshizaki, G.H. Li, J. Mater. Sci. Technol. 24 (2008) 550–562.
2. J.B. Prasanna kumar, G. Ramgopal, Y.S. Vidya, K.S. Anantharaju, B. DarukaPrasad, S.C. Sharma, S.C. Prashantha, H.B. Premkumar, H. Nagabhushana, Spectrochim. Acta Part A 141 (2015) 149–160.
3. P.Rajiv ,S.Rajeshwari, R.Venckatesh, Spectrochim. Acta A 112 (2013) 384–387.
4. S.D.Caruthers, S.A.Wickline ,G.M.Lanza, Curr. Opin .Biotechnol. 18 (2007) 26–30.
5. D.Nath, P.Banerjee, Environ. Toxicol. Pharmacol .36 (2013) 997–1014.
6. H.A.Salam, P.Rajiv, M.Kamaraj, P.Jagadeeswaran, S.Gunalan, R. Sivaraj, Int.Res.J.Biol.Sci.1 (2012) 85–90.
7. D.Sharma, J.Rajput, B.S.Kaith, M.Kaur, S, Thin Solid Films 519 (2010) 1224–1229.
8. C.Vani, K.Sergin ,Annamalai, Int.J .Pharm. BioSci. 2 (2011) 326–335.
9. Tamanna Bhuyan, Kavita Mishra, Manika Khanuja, Ram Prasad, Ajit Varma, Materials Science in Semiconductor Processing 32 (2015) 55–61.
10. P.B. Devaraja et al.Materials Characterization 97 (2014) 27–36