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ORANGE RED EMISSION FOR DYSPROSIUM DOPED $BaZrO_3$ PEROVSKITES

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Abstract

$BaZr_xDy_{1-x}O_3$perovskites were prepared by the conventional solid state ceramic route for x = 0.9, 0.99 and 0.999. The powders were calcined at 1250°C. X –ray diffraction patterns of the samples confirmed the cubic phase formation and no considerable additional peaks were found. The absorbance spectra of all samples showed absorption in the UV regions. All the samples showed emissions at around 480 nm, 578 nm and an intense peak around 630 nm for an excitation at 350 nm. The intensity of peaks increases with the decrease in doping concentrations of Dy^{3+}. Chromaticity values of the samples measured using CIE chromaticity diagram were also discussed.

Keywords: Barium Zirconate, perovskites, photoluminescence, Dysprosium

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1. INTRODUCTION

The emissions of Dy^{3+} ions corresponds to the $^4F_{9/2}\rightarrow{}^6H_{15/2,\ 13/2,\ 11/2}$transitions between the complicated f levels in Dy^{3+} ions and it find potential applications in the field of display devices [1,2]. The emissions also depend on the temperature, concentration and activators. Two kind of luminescent centers, NearInfra-Red (NIR) to visible upconversion [3,4] and yellow-green upconversion luminescence [5] etc. makes dysprosium a promising candidate in the field of luminescent materials [2]. Zirconia based perovskites have high melting points, low chemical reactivity with corrosion compounds and better phase consistency over a wide range of temperature [6]. Among these $BaZrO_3$ is an important host material for lanthanides in optoelectronic applications since they may not undergo any phase transitions even up to their melting temperatures [7]. In the present paper, the luminescent properties of $BaZr_xDy_{1-x}O_3$ compounds for varying values of x were investigated and we report the visible luminescence in Dy^{3+} activated in $BaZrO_3$ host material.

II. EXPERIMENTAL

Conventional solid state ceramic route was used for the preparation of $BaZr_xDy_{1-x}O_3$ compounds. High purity $BaCO_3$, ZrO_2 and Dy_2O_3 (Hi-media Chemicals, India) were taken in stochiometric ratios and mixed thoroughly in acetone medium in an agate mortar for about 2 hours. The samples were dried and calcined at 1250 °C for about 5 hours in an electrically heated furnace.The powders were ground well. Calcined powder samples were used for X-ray diffraction studies (Philips XPERT PRO) using Cu-Kα radiation. The absorption spectra of the samples were measured using a Varian, Cary 5000 spectrophotometer. The Photoluminescencespectra of the samples were measured using a Spectroflurometer (Model FP 8500, Jasco International). The CIE colour co-ordinates based on CIE 1931 chromaticity calculations were also discussed.

III. RESULTS AND DISCUSSIONS

3.1 XRD Analysis

Figure 1 shows the XRD patterns of $BaZr_xDy_{1-x}O_3$ (x = 0.9, 0.99, 0.999) compounds. All the samples crystallize in the cubic phase of $BaZrO_3$ and were compared with the standard JCPDS file (JCPDS 06-0399).It is evident from the XRD patterns that there is no considerable phase change for the doped samples compared with that of $BaZrO_3$ perovskites.

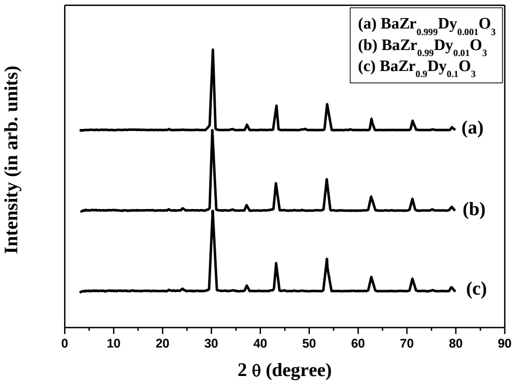

Figure 1 XRD patterns of Dy^{3+} doped $BaZrO_3$

3.2 UV–Visible Spectra

Figure 2 shows the absorbance spectra of Dy^{3+} doped $BaZrO_3$compounds. All the samples show strong absorption in uv region (250 nm) which can be attributed to band edge absorption of $BaZrO_3$and peaks around 260 to 400 nm can be attributed to the f–f electronic transitions of Dy^{3+} [8]

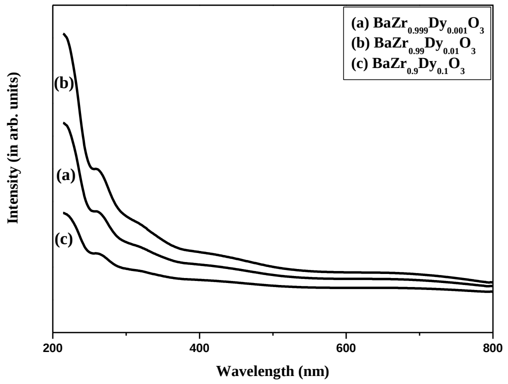

Figure 2 Absorbance Spectra of Dy^{3+} doped $BaZrO_3$

3.3 Photoluminescence Spectra

Figure 3 shows the emission spectra of Dy^{3+} doped $BaZrO_3$ for an excitation of 350 nm. The strong peaks around 480 nm and 578 nm correspond to the Dy^{3+} ion, and can be assigned to be due to the transition between $^4F_{9/2}$ - $^6H_{15/2}$ and $^4F_{9/2}$ - $^6H_{13/2}$ levels respectively. The strong peak was observed around 630 nm corresponds to the Dy^{3+} ion, and can be assigned to the transition between $^4F_{9/2}$ - $^6H_{11/2}$ levels [1].

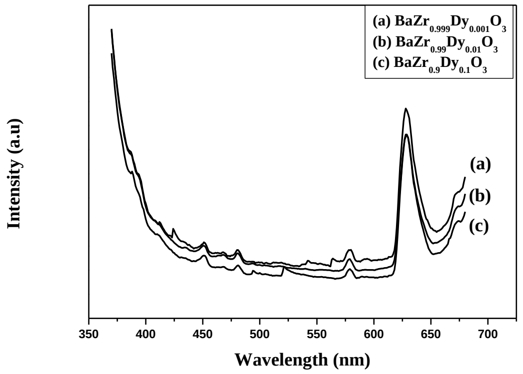

Figure 3Emission Spectra of Dy^{3+} doped $BaZrO_3$

The CIE colour co-ordinates based on CIE 1931 chromaticity calculations of the luminescence spectra is calculated using the colour calculator program developed by Radiant Imaging. The chromaticity (x, y) colour coordinates of the as prepared samples are obtained as x = 0.4055 and y = 0.3766. CIE diagrams of the samples is given in figure 4.

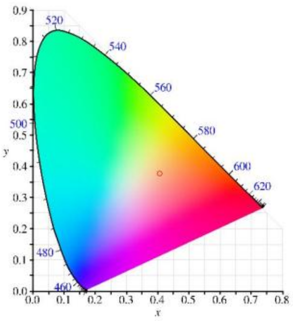

Figure 4CIE diagram of Dy^{3+} doped $BaZrO_3$

VI. CONCLUSIONS

Trivalent Dysprosium doped $BaZrO_3$perovskites were prepared by the conventional solid state ceramic route. The powders are calcined at 1250 °C for 5 hours. The structure of the samples were analysed using X –ray diffraction techniques. No additional phase was observed in patterns of $BaZr_xDy_{1-x}O_3$**.** All samples show strong absorption in the uvregion (250 nm) and is due to the absorption of $BaZrO_3$. The peaks around 260 to 400 nm are due to the f–f electronic transitions of Dy^{3+}. Emission peaks were observed at 480 nm and 578 nm for the doped samples corresponding to $^4F_{9/2}$ - $^6H_{15/2}$ and $^4F_{9/2}$ - $^6H_{13/2}$transitions of Dy^{3+} ions and the strong peak round 630 nm corresponds to the Dy^{3+} ion, and can be assigned to the transition between $^4F_{9/2}$ - $^6H_{11/2}$ levels. The intensity of the emission peaks is increasing with the doping concentration of Dy^{3+} ions. The CIE colour co-ordinates of the PL spectra based on CIE 1931 chromaticity calculation were also analysed.

VII. ACKNOWLEDGMENTS

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REFERENCES

[1] I. M. Nagpure, K. N. Shinde, S. J. Dhoble, A. Kumar, J. Alloy. Compd., 481 (2009) 632–638.

[2] H. Choi, C. H. Kim, C. H. Pyun, S. J. Kim, J. Lumin., 82 (1999) 25-32.

[3] M. Wermuth, T. Riedener, H. U. Güdel, Phys. Rev. B., 57.8 (1998)4369.

[4] H. U. Güdel, M. Pollnau,J. Alloy. Compd., 303 (2000) 307-315.

[5] A. Li, Q. Lu, Z. Zheng, L. Sun, W. Wu, W. Liu,et.al.,J. Appl. Phys.,102.11 (2007) 3102.

[6] T. Maekawa, K. Kurosaki, S. Yamanaka, J. Alloy. Compd. 407 (2006) 44-48.

[7] P.G. Sundell, M.E. Bjorkentum, G. Wahnstrom, Phys.Rev.B.73 (2006) 104112.

[8] X. Liang, C.Zhu, Y.Yang, S.Yuan, G. Chen, J. Lumin 128 (2008) 1162–1164.