



Dy³⁺ Emission of K₂Zn(SO₄)₂ Synthesized by Wcm

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ABSTRACT

K₂Zn(SO₄)₂ doped Dy is prepared by wet chemical method. Doping concentration of Dysprosium is taken as 0.1mol% to 1mol% each time. To check phase purity and crystallinity of the prepared sample XRD is done. Photoluminescence is studied for the respective phosphor. Dy³⁺ emission observed when K₂Zn(SO₄)₂:Dy excited at 350nm. The colour co-ordinates of K₂Zn(SO₄)₂:Dy found as x= 0.412 and y= 0.366 which shows nearer to yellow region in CIE diagram.

I. INTRODUCTION

A lot of investigations are focused on the preparation and luminescent properties of lanthanide phosphors. For the preparation of luminescent materials, a variety of methods have been designed, including solid-state reaction [1–3], sol–gel reaction [4–6] hydrothermal technology etc. Furthermore, these methods have other disadvantages such as complicated operating procedure and the high cost. It is urgent to develop the single doped phosphor materials by simple synthesis method having high efficiency and less consumption of electricity [7]. The term "wet chemical methods" emerged in contrast to conventional and solid-state synthesis methods of compounds. It uses lower temperature and shorter duration of phase formation.

For the generation of white light emission, Dy³⁺ ion is used as an activator in many host lattices because it gives emission in the blue and yellow region of the visible spectrum. Dysprosium ions which give the emission line in the blue region (470nm-500nm) having ⁴F_{9/2}→⁶H_{15/2} transition and in yellow region (570nm- 600nm) having ⁴F_{9/2}→⁶H_{13/2} transition [8, 9].

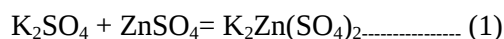
The sulphates are an important mineral class and include some very interesting and attractive specimens. The typical sulphate-class minerals are vitreous, average in density, average in hardness, and are originally formed in veins, oxidation zones and contact metamorphic zones,

and in evaporated deposits. Some sulphate-class minerals are soluble and several others are fluorescent. All other properties are variable [10].

Present paper deals with the synthesis of K₂Zn(SO₄)₂ doped with dysprosium and its photoluminescence study. Also XRD and CIE of present phosphor has been reported.

II. EXPERIMENTAL

Present phosphor has been prepared by wet chemical method. Analytical grade K₂SO₄, ZnSO₄ and sulphate form of dysprosium are used as starting material. K₂SO₄ and ZnSO₄ of analar grade are taken in a stoichiometric ratio and dissolved separately in double-distilled de-ionized water, resulting in a solution of K₂Zn(SO₄)₂ (Eq. (1)). Water soluble sulphate salt of dysprosium then added to the solution to obtain K₂Zn(SO₄)₂:Dy. Confirming that no undissolved constituents were left behind and all the salts had completely dissolved in water, and thus reacted:



The sample kept at 80°C for 24 hrs and then cooled till room temperature. The sample obtained in the form of white powder taken for the further characterization.

III. RESULTS AND DISCUSSION

3.1 XRD of $K_2Zn(SO_4)_2$

The prepared sample is characterized by X-ray powder diffraction (XRD), to check the phase purity and crystallinity. XRD of the prepared sample is taken by using X'pert-PRO PANalytical diffractometer equipped with x'Celerator solid-state detector. The instrument consists of vertical theta-theta goniometer having range of 0° - 160° 2 theta. The radiation used is Cu K-alpha-1 where as nickel metal is used as beta filter. The sample was tested at a scanning step of 0.001, in the 2θ range from 10° to 90° . Figure 1 is XRD of the prepared sample shows the sharp peaks indicates the crystalline nature of the sample.

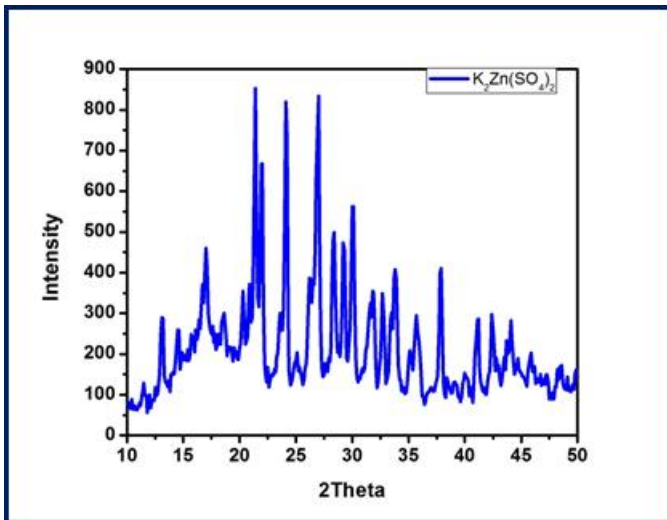


Figure 1. XRD of $K_2Zn(SO_4)_2$

3.2 Photoluminescence study of $K_2Zn(SO_4)_2:Dy$

The excitation spectra of $K_2Zn(SO_4)_2:Dy$ shows that there are four peaks in the range of 300-400nm as shown in figure 2. An excitation spectra shows the intensity at 350nm is maximum. Therefore, 350nm is chosen as an excitation wavelength the emission of Dy^{3+} is recorded. figure 3 shows the photoluminescence emission of Dy^{3+} ions is at 487nm and 574 nm in $K_2Zn(SO_4)_2:Dy$ phosphor. The emission at 487nm is due to $^4F_{9/2} \rightarrow ^6H_{15/2}$ which is in the blue region while the emission at 574nm is due to $^4F_{9/2} \rightarrow ^6H_{13/2}$ in the yellow region shown in figure 4. The intensity for increasing concentration has been increased however one may try for more concentrations and different dopant. These emissions are may be one of candidate for white light emission of solid state lighting.

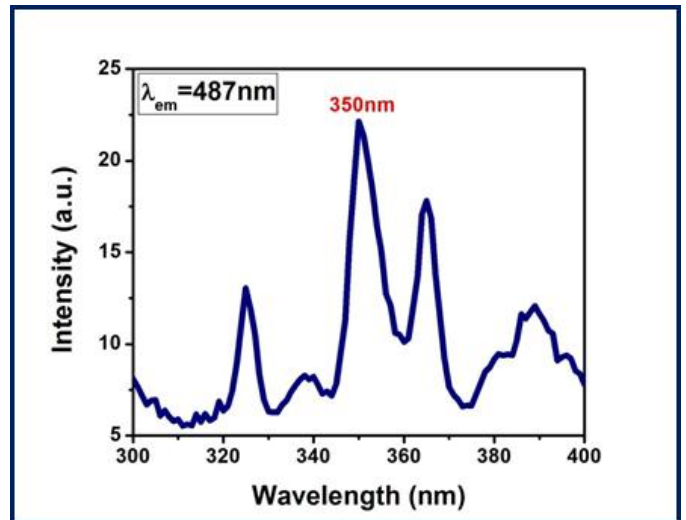


Figure 2. PL excitation of $K_2Zn(SO_4)_2:Dy$

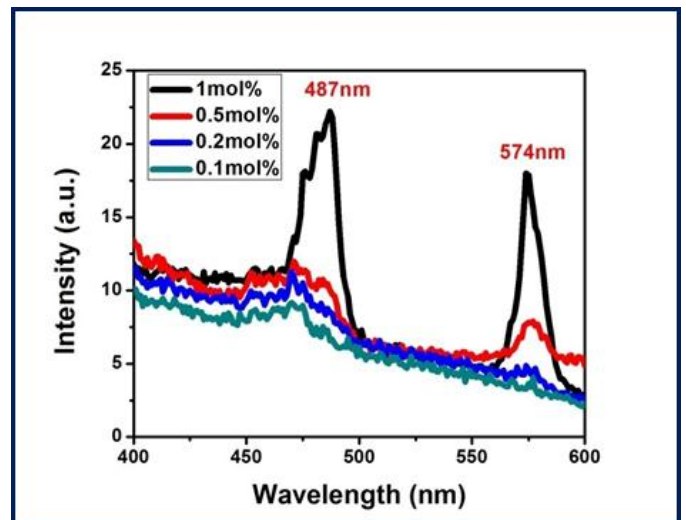


Figure 3. PL emission of $K_2Zn(SO_4)_2:Dy$

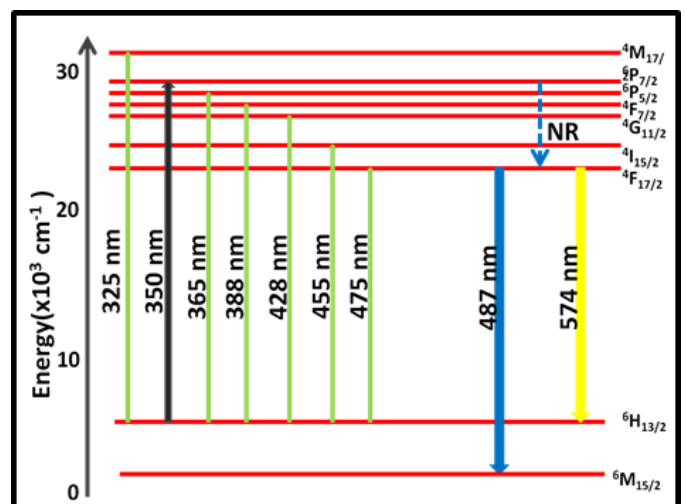


Figure 4. Energy Level diagram Dy^{3+} in $K_2Zn(SO_4)_2$

3.3 CIE of $K_2Zn(SO_4)_2:Dy$

The Commission International del Eclairage (CIE) system is the most common method to describe the

composition of any colour in terms of three primaries. The CIE chromaticity coordinate for this phosphor is found to be (x=0.412, y=0.366) shown in figure 5.

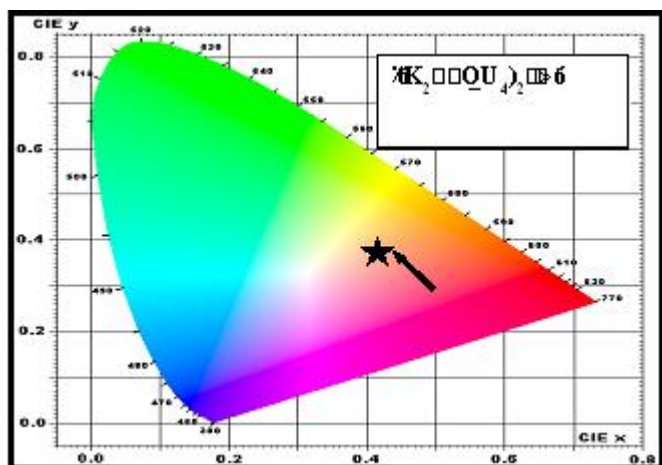


Figure 5. CIE of $K_2Zn(SO_4)_2:Dy$

IV. CONCLUSION

The PL emission spectra of $K_2Zn(SO_4)_2:Dy$ phosphor, when excited at 350 nm, exhibited two prominent peaks at around 487nm and 574nm. The emission at 487nm is in the blue region while the emission at 574nm is in the yellow region. Dy^{3+} emission at 487 nm and 574 nm which are corresponding to $^4F_{9/2} \rightarrow ^6H_{15/2}$ and $^4F_{9/2} \rightarrow ^6H_{13/2}$ transitions of Dy^{3+} ion, respectively. It is well known that the former weak blue emission at 487 nm ($^4F_{9/2} \rightarrow ^6H_{15/2}$) is corresponded to the magnetic dipole transition, which hardly varies with the crystal field strength around Dy^{3+} . While the later stronger yellow emission at 574 nm ($^4F_{9/2} \rightarrow ^6H_{13/2}$) belongs to the hypersensitive forced electric dipole transition, which is strongly influenced by the outside surrounding environment. $K_2Zn(SO_4)_2:Dy$ phosphor may be the good candidate for LED. One may try for different concentrations and different phosphor.

V. REFERENCES

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