

Developmental studies on yttrium phospho vanadate for lamp applications

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Yttrium orthovanadate is an important phosphor material owing to its application in TV screens and high pressure mercury vapour (hpmv) lamps. The effect of partial replacement by (PO_4) in YVO_4 on the emission characteristics and particle size distribution etc. are discussed.

Key words: Yttrium phosphor vanadate, lamps, luminescence

INTRODUCTION

Yttrium orthovanadate (YVO_4) activated with trivalent europium is an important phosphor material owing to its applications in hpmv lamps and in CTV screens as red primary [1,2]. It is a potential host for a number of impurities like Eu^{3+} and Tb^{3+} . This increases the scope of this being used as colour correcting phosphor in hpmv lamps. However, the presence of orange emission due to ${}^5\text{D}_0 \rightarrow {}^7\text{F}_1$ transition of Eu^{3+} makes it unsuitable for fluorescent lamp applications. Also it is interesting to note that non-rare earth impurities such as Bi^{3+} [3] when used in this system enhance the Eu^{3+} emission intensity.

RESULTS AND DISCUSSION

Preparation procedures and the luminescent measurements are the same as described earlier [4]. Yttrium orthovanadate (YVO_4) belongs to host sensitized group of phosphors, which when activated with Eu^{3+} gives intense orange-red emission characterising ${}^5\text{D}_0 \rightarrow {}^7\text{F}_2$ transitions of Eu^{3+} . Energy absorbed by the vanadate group is transferred to Eu^{3+} . YVO_4 , without any impurities emits in the blue region (~ 430 nm), corresponding to ${}^1\text{A}_1 \rightarrow {}^1\text{T}_2$ charge transfer transition in the vanadate network. The host emission is found to increase considerably when diluted by PO_4 to the extent of 75%. The effect of dilution of $(\text{VO}_4)^{3-}$ by $(\text{PO}_4)^{3-}$ has been described in detail [5]. Also it should be noted that this partial substitution leads only to isomorphous structure i.e. Xenotime structure. The increase in the host emission observed in terms of concentration quenching has been explained in detail [6]. In the case of YVO_4 , $\text{VO}_4(100\%)$ are the luminescent centres. On dilution with (PO_4) , concentration quenching effects are minimized.

Addition of Bi^{3+} in YVO_4 enhances considerably, Eu^{3+} emission under long-wave UV (365 nm) excitation. This is attributed to sensitization effects of Bi^{3+} . $\text{YVO}_4:\text{Bi}^{3+}$

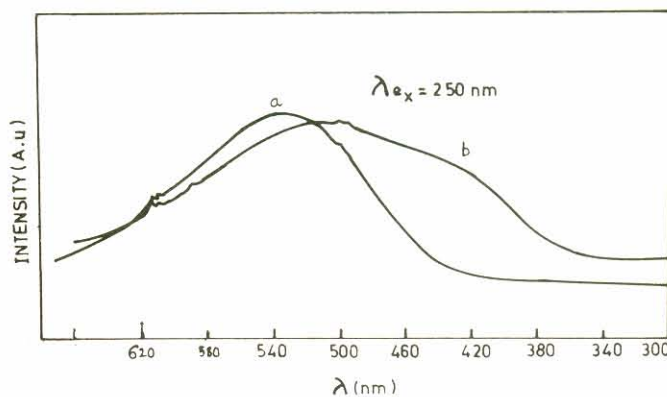


Fig. 1: Emission spectra at room temperature (300K) of (a) $\text{YVO}_4:\text{Bi}^{3+}$ (4m/o), (b) $\text{Y}(\text{VO}_4)_{0.5}(\text{PO}_4)_{0.5}:\text{Bi}^{3+}$ (4m/o)

emits in green region (~ 540 nm), but when a part of (VO_4) is replaced by (PO_4) an additional band in blue region (~ 430 nm) is observed. This may be attributed to the dominance of (VO_4) emission, rather than Bi^{3+} related centres which emit in the green region (Fig. 1). This partial replacement causes much difference in the emission intensities of Eu^{3+} lines, as given in Fig. 2. On dilution with (PO_4) , the orange emission due to ${}^5\text{D}_0 \rightarrow {}^7\text{F}_1$ transition of Eu^{3+} gains in intensity compared to red emission, corresponding to ${}^5\text{D}_0 \rightarrow {}^7\text{F}_2$ transition of Eu^{3+} . This is not desirable for a phosphor to yield saturated emission. Also it has been found that this partial replacement has striking influence on the particle size distribution of the product. Phosphor obtained from the yttrium phosphate-vanadate system leads to phosphor product with microcrystalline particles as compared to larger particles in the yttrium vanadate system.

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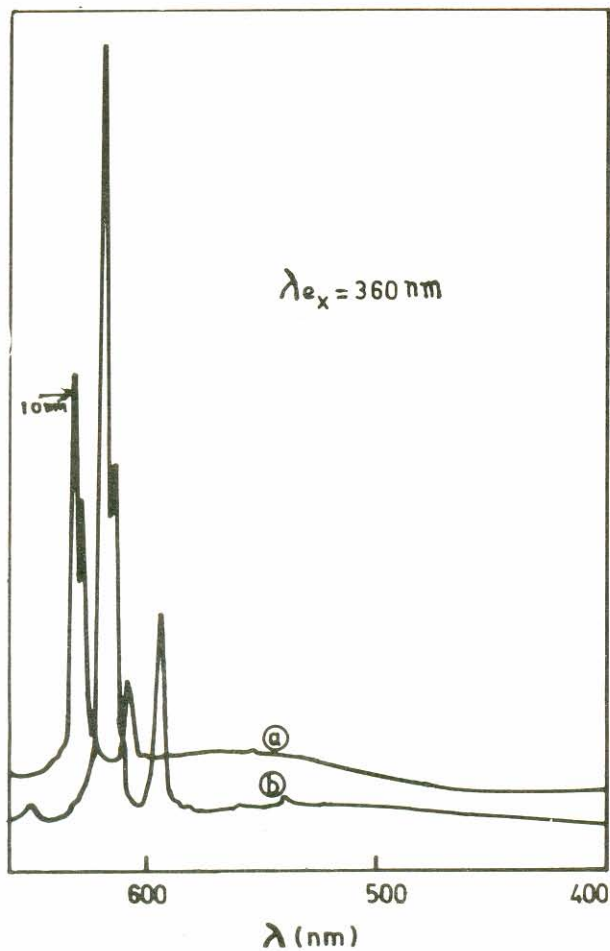


Fig. 2: Emission spectra at room temperature (300K) of (a) $YVO_4:Bi^{3+}$ (4m/o), Eu^{3+} (4m/o), (b) $Y(VO_4)_{0.5}(PO_4)_{0.5}:Bi^{3+}$ (4m/o) Eu^{3+} (4m/o)

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