The effect in the crystal phase and luminescence property of $Zn_3V_2O_8$ with calcinations temperature

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Abstract. In this experiment, ammonium metavanadate (NH_4VO_3) and zinc nitrate Zn $(NO_3)_2$ as raw materials, combustion $Zn_3V_2O_8$ yellow phosphor prepared by using X-ray diffraction pattern (XRD), scanning electron microscopy (SEM) and emission spectrum Study on the crystal structure of the test $Zn_3V_2O_8$ phosphor morphology analysis and optical properties, in order to obtain vanadate matrix fluorescent material having excellent thermal stability and chemical stability, can be widely used in lighting and displays.

Introduction

The studied of energy conservation and environmental protection lighting technology and green illuminant material become a hot focus in the energy shortage and environment pollution problem increasingly prominent conditions. The white LED have been obtain by the near ultraviolet stimulate single chip substrate technology, it have light color stability, high color rendering and low production cost advantage, become the future development trend of the LED light materials[1-3]. The $Zn_3V_2O_8$ phosphor is a kind of better luminous properties material. The effective sensitization between VO_4^{3-} and rare earth, self-activated the luminescence properties exist in the electronic structure of $Zn_3V_2O_8$ phosphor, it leader to the $Zn_3V_2O_8$ phosphor present to short wave absorption and matrix material with doped rare earth ions[4-5].

The theoretical analysis and experimental study results shows that $Zn_3V_2O_8$ phosphor have a width emission spectrum [1]. Recent research shows the color rendering property of red YVO_4 phosphors was increased by rare earth Eu^{3+} doped. Whereafter, (Y, Gd, Lu)VO_4, $ScVO_4$ and (K, Rb, Cs)VO_3 phosphors have been compound by rare earth Eu^{3+} doped[2]. The $M_2V_2O_7$ (M: Ba, Sr, Ca) phosphors have been compound and the luminescence process of the regular tetrahedron structure of VO_4^{3-} have been studied by A.V. Ishchenko[3], Kuang Shaoping[4] and T. Nakajima[5]. The $Zn_3(VO_4)_2$ phosphors have been compound using Hydrothermal synthesis method and citric acid gel combustion method by Shreyas S.Pitale[6]. The $Mg_2V_3O_{12}$：Dy, Sm phosphors have been compound and the luminescence process of Sm-doped and Dy-doped by A.R. Dhobale[7-8] . In this paper we used Combustion Synthesis method the $Zn_3V_2O_8$ phosphor, in order to improve the compound cast and luminescence property of $Zn_3V_2O_8$ phosphor.

Experiment

The $Zn_3V_2O_8$ phosphor sample was prepared using muffle furnace (SX2-4-4TP). Firstly, the $Zn(NO_3)_2$（purity 99.99%）, NH_4VO_3（purity 99.99%）and $C_6H_8O_7 \cdot H_2O$（purity 99.99%）were mixed according to the stoichiometric ratio in beaker, adding the right amount of deionized water to dissolve it. Second, the beaker placed at the magnetic stirrer with 80 ℃, heat and stir it to form colloid. Thirdly, heating to dry colloid under the 100 ℃ and grinded the colloid in muffle furnace, the calcinations temperature is 600 ℃, 650 ℃, 700 ℃, 750 ℃, respectively, the calcinations time

is 100min, thermal insulation 4h, cooling 2h and the flow diagram of muffle furnace temperature was shown in figure 1.

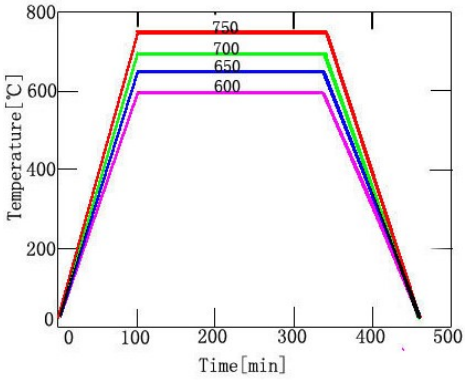

Figure 1 the flow diagram of muffle furnace temperature

The experimental results and discussion

The XRD analysis results of the sample $Zn_3V_2O_8$

The Figure is the XRD of the sample $Zn_3V_2O_8$, in this figure the curve is shows the peak value of the sample composition, the calcinations temperature is 600 ℃, 650 ℃, 700 ℃, 750 ℃, respectively, the calcinations time is 4h. The analysis results show that the position of the sample composition peak and the $Zn_3V_2O_8$ XRD curve of JCPDS standard calorie are consistent. The crystal structure result show that $Zn_3V_2O_8$ sample is orthogonal structure, the lattice constant a = 8.299 Å, b = 11.528 Å and c = 6.1116Å [Z = 4] (JCPDS 00-034-0378). The second phase is $Zn_3V_2O_7$, in figure 2 we are marked with the hollow pentagram. When the calcinations temperature is 700 ℃, the $Zn_2V_2O_7$ content is the least, the Crystal plane diffraction values of $Zn_3V_2O_8$ achieved maximum.

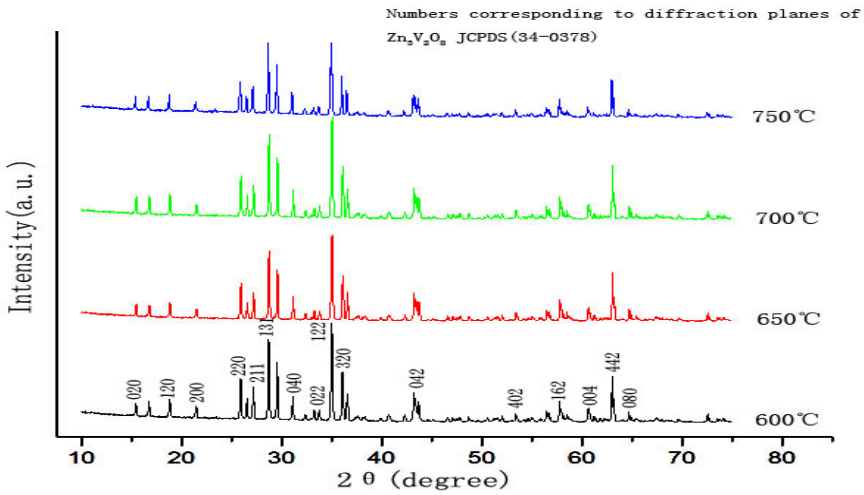

Fig2 the XRD of $Zn_3V_2O_8$ sample and the XRD standard calorie

The SEM analysis results of the sample $Zn_3V_2O_8$

The figure 3 is the SEM of the sample $Zn_3V_2O_8$ (the calcinations temperature was 600 ℃, the calcinations time was 4h). The result shows that the grain is rod structure, the grain radius of the sample $Zn_3V_2O_8$ in the range of 2μm—5μm, and the particle surface is smooth. The figure 3(a) shows that the sample $Zn_3V_2O_8$ phosphor appeared serious reunion phenomenon, even some grain weld together, the reunion phenomenon attribute to the calcinations temperature and grinding fineness.

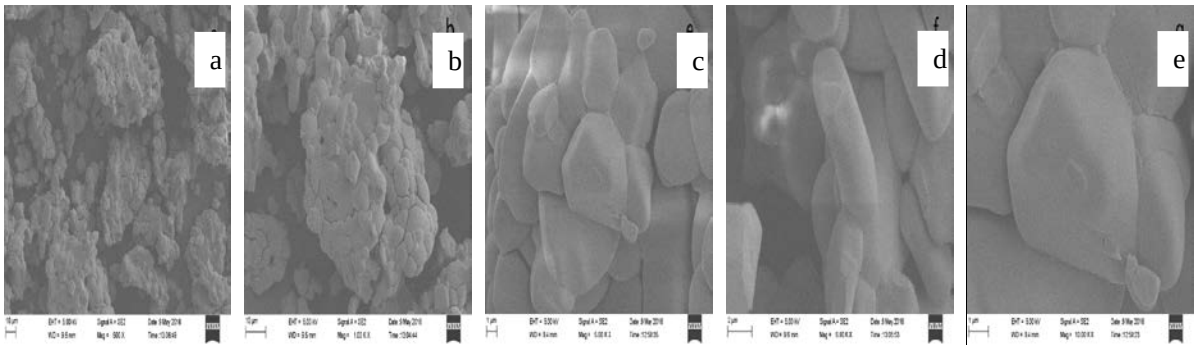

Fig 3 The SEM analysis results of the sample $Zn_3V_2O_8$

The excitation spectrum and emission spectrum analysis of the sample $Zn_3V_2O_8$

Figure 4 were the excitation spectrum and emission spectrum of the $Zn_3V_2O_8$ phosphor under the resultant temperature of 600℃, 650 ℃, 700 ℃and 750 ℃, respectively. The excitation spectrum show that the absorption band in the wavelength range of 300nm-420nm （$^1A_1$-$^1T_2$，$^1A_1$-$^1T_1$）, the strongest absorption peak appears at the wavelength of 360nm, it means that the sample $Zn_3V_2O_8$ can apply in the near ultraviolet excitation of white LED. The luminescent intensity is the weakest; this reason is that the sample has $Zn_2V_2O_7$ impurity under the sintering temperature of 600 ℃. The luminescent intensity is the strongest; this reason is that the sample is purest under the sintering temperature of 700 ℃. The results show that the effect in the luminescence property of $Zn_3V_2O_8$ with calcinations temperature.

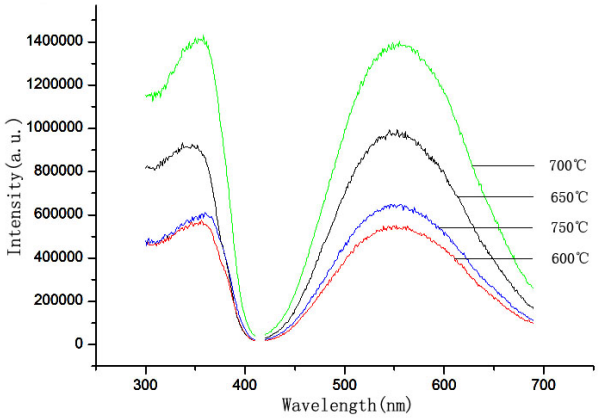

Fig 4 the spectrum analysis of the sample $Zn_3V_2O_8$

Conclusions

Based on (NH_4VO_3), ($Zn(NO_3)_2$) and $C_6H_8O_7$•H_2O as raw materials compound $Zn_3V_2O_8$phosphor using combustion synthesis method, and studied the crystal structure, morphology and luminescent property. The XRD analysis result shows that there is a small amount of $Zn_2V_2O_7$ impurities in the sample $Zn_3V_2O_8$. The luminescent intensity is the strongest for the sample which the sintering temperature is 700 ℃. The emission band is caused by the electron transfer between the VO_4^{3+} 2P and V^{5+} 3d, and formed broad emission band. The luminescence property is caused by the excited state from the $^3T_2$ to $^1A_1$ and from the $^3T_2$ to $^1A_1$, the transmission bandwidth is 420-690nm, and the strongest luminescence peak appears at the wavelength of 550nm. Luminous zone is cover the wavelengths of visible light, so the light as the white light.

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