Advance Physics Letter

Thermoluminescence glow curve analysis of UV irradiated $SrZrO_3$ phosphor through computerized glow curve deconvolution technique

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Abstract : The present paper reports the combustion synthesis, structural characterization, and thermoluminescence studies of $SrZrO_3$ phosphors. The samples were prepared by combustion a synthesis technique which is suitable for less time taking techniques also for large scale production for phosphors. The starting material used for sample preparation are $Sr(NO_3)_3$, $Zr(NO_3)_3$and and urea used as a fuel. The prepared sample was characterized by X-ray diffraction technique (XRD) Sample shows orthorhombic structure and the particle size calculated by Scherer's formula. The surface morphology of prepared phosphor was determined by field emission gun scanning electron microscopy (FEGSEM) technique. The TL glow curves for $SrZrO_2$ phosphor exhibit broad peak composed of three overlapping peaks, these peaks were deconvoluted using deconvolution program. The peaks at different temperatures indicate that different sets of traps are being activated within the particular temperature range each with its own value of activation energy (E) and frequency factor (s). The peaks observed were due to formation of trap levels by UV-rays irradiation and subsequently activation of traps on thermal stimulation. The trapping parameters for both the samples were calculated using Chen's peak shape method and reported in this paper.

Key Words- $SrZrO_3$,; Thermolumenescence; Deconvolution.

Broad Area- Luminescence.

Sub-Area-. Thermoluminescnecen.

I. INTRODUCTION

$SrZrO_3$ materials have been widely investigated due to their high potential for application as optical, electrical and stress sensors [1]. According to Cavalcante et al. 2007, the displacement of Zr or Sr atoms in disordered orthorhombic $SrZrO_3$ may induce some vacancies defects at the axial and planar oxygen sites of the $[ZrO_6]$ octahedral [2]. It is well known that the vacancies defects may play important roles as not only carriers (electrons–holes) traps but also luminescence centers and thus it is expected that the orthorhombic $SrZrO_3$[3-6]

In the present paper we report the structural characterization and optical properties of combustion synthesized $SrZrO_3$ phosphor. The structural characterizations were done by the XRD analysis and Morphological studies were done by using Scanning electron microscope. In optical properties TL studies was investigated in detail.

II. SYNTHESIS

The pure $Zr(NO_3)_3$, $Sr(NO_3)_3$ and urea chemicals purchased from sigma Aldrich as a raw material. The 1 gm/ml aqueous solution mixed with urea (3gm/ml) was the precursor solution. The mixture was stirred for one hour as a result solution converted into transparent gel form. The above semi solid sample was heated at 600 ± 10^0C temperature in muffle furnace, after few minutes a spontaneous ignition occurred. The sample change in to anhydrous form followed by a vigorous redox reaction to form $SrZrO_3$ phosphor with liberation of gaseous by products such as oxide of carbons and nitrogen's.

2.1 Instrument Used

The sample was characterized using thermoluminescence (TL), XRD and SEM. The XRD measurements were carried out using Bruker D8 Advance X-ray diffractometer. The X-rays were produced using a sealed tube and the wavelength of X-ray was 0.154 nm (Cu Kα). The X-rays were detected using a fast counting detector based on Silicon strip technology (Bruker LynxEye detector).Observation of particle morphology was investigated by FEGSEM (field emission gun scanning electron microscope) (JEOL JSM-6360) Thermally stimulated luminescence glow curves were recorded at

room temperature by using TLD reader I1009 supplied by Nucleonix Sys. Pvt. Ltd. Hyderabad. The obtained phosphor under the TL examination is given UV radiation using 254nm UV source. All measurements were carried out at a room temperature.

III. RESULTS & DISCUSSION:-

3.1 XRD Result:-

Figure 1 shows the X-ray powder diffraction (XRD) pattern of $SrZrO_3$ phosphor. From the XRD patterns, the peak indexed revealed the pure orthorhombic phase of $SrZrO_3$. The XRD pattern of $SrZrO_3$crystals indicates 12 diffraction intense peaks of orthorhombic structure at 2θ = 19.73, 25.45, 30.23, 32.54, 38.43, 40.15, 46.72, 47.81, 51.15, 61.95, 68.14 and 71.14 corresponding to (101), (110), (112), (021), (212), (301), (131), (232), (006) and (332) (Fig. 1). They are in good accordance with JCPDS card no. 89-8994. It is indicated that there is no impurity phase among all the phosphor samples. No any effect of fuel (urea) was found in XRD pattern[6,7-9].

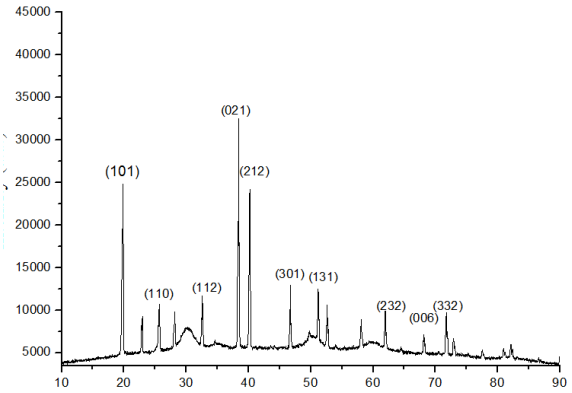

Figure 1. XRD pattern of $SrZrO_3$

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3.2 SEM Result:-

The SEM image (figure 2) of prepared phosphor show good surface morphology and connectivity with grains as the prepared phosphor by solution combustion synthesis method. From the SEM image the particle distribution of prepared sample were found 55nm to few micron size. The XRD support the SEM study for the particle distribution.

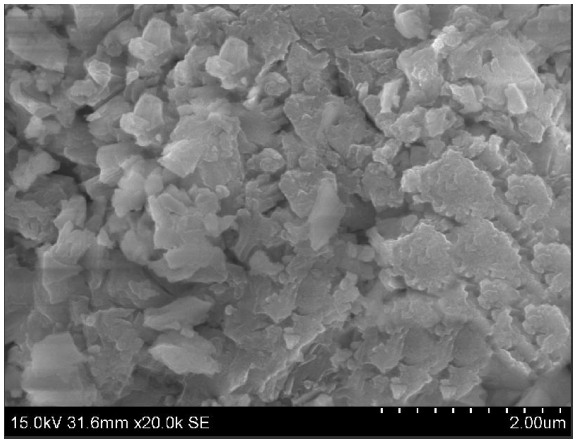

Figure 2. SEM Result of $SrZrO_3$ phosphor

3.2 Thermoluminescence Result:-

Thermoluminesence is the phenomenon of remission of pre-absorbed radiation. The prepared phosphor shows the TL glow curve at 143^0C. The corresponding kinetic parameters for recorded TL glow curve show second order of kinetic glow curve. The activation energy (i.e. required energy for escaping electron from trap level) and frequency factor (i.e. rate of escaped electron per second from trap level) was calculated by peak shape method. The information about trap centres was easily determined by TL glow curve study. Table 1 shows the calculation of kinetic parameter for deconvoluted TL glow curve of $SrZrO_3$ phosphor.[6,10-35]

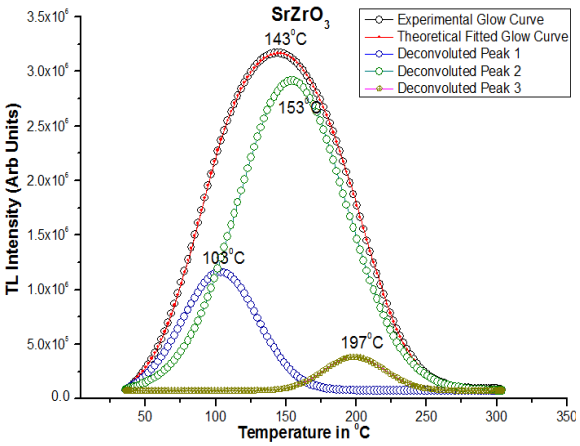

Figure 3. Deconvoluted thermoluminescence glow curve of $SrZrO_3$ phosphor

Table 1 Calculation of kinetic parameters for $SrZrO_3$ deconvoluted peaks

T_1	T_m	T_2	$\mu = \delta / \omega$	Activation energy E (eV)	Frequency factor s (s^{-1})
70	103	136	0.5	0.553	3.3×10^{08}
108	153	200	0.511	0.521	1.3×10^{07}
167	197	229	0.516	0.958	2.6×10^{11}

IV. RESULT AND DISCUSSTION:-

From the TL glow curve of $SrZrO_3$ pure phosphor synthesized by combustion synthesis technique showed broad TL glow curve UV induced. The CGCD technique used for calculation of kinetic parameters such as activation energy, order of kinetic and frequency factor three prominent peaks found at 103, 153 and 197^{0}C for fitted curves. It presents the formation of shallower trapping in the sample due to lower excitation by UV radiation. The Sr^{3+} sites and Zr^{4+} sites responsible for TL glow curve. The peaks observed were due to formation of trap levels by UV-rays irradiation and subsequently activation of traps on thermal stimulation. All the prominent peaks shows second order of kinetic proves the number of traps formation in the present TL glow curve. The activation energy is found in the range of 1.3×10^{07} to 2.6×10^{11} for deconvoluted fitted curve in the present sample.

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