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PHOTOLUMINESCENCE CHARACTERIZATION OF $Li_2BaP_2O_7:Ce^{3+}$ PHOSPHOR

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Abstract- A new phosphor material $LiBaP_2O_7:Ce^{3+}$ was prepared by high temperature solid-state reaction. The formation of the compound was confirmed by recording the XRD spectra. The XRD pattern of as prepared phosphor showed well match with the available JCPDS data file. The earliar studies on this material were aimed at electrical applications such as conductance and impedance etc. However, no data on photoluminescence is available for this material. So we decided to study it for photoluminescence. In photoluminescence study,characteristic excitation & emission spectra of Ce^{3+} were been observed.
Keywords- Photoluminescence, Ce^{3+} emission , Phosphor

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Introduction

Inorganic phosphates encompass a large class of diverse materials with numerous important industrial uses, e.g., as catalysts, ion -exchange materials, solid electrolytes for batteries, as linear and non-linear optical components, chelating agents, in synthetic replacements for bone and teeth, and as phosphors, detergents and fertilizers [1,2,3,4,5]. As host materials, phosphates have gained much attention because of their excellent thermal and chemical stability[6,7,8,9,10,11]. Phosphates doped with rare earths have excellent efficiencies and adequate absorption bands and find tremendous applications in solid state lighting. For example, the phosphate compound $K_2CaP_2O_7$ can be synthesized at a temperature of 1053 K which is lower than that for other single phased phosphors reported [12,13,14]. At the same, codoped $K_2CaP_2O_7$: Eu^{2+},Mn^{2+}, can be prepared using the same procedure and the energy transfer between Eu^{2+} and Mn^{2+} in the compound can be studied. Eu^{2+} doped pyrophosphates usually give blue light emission, while Mn^{2+} doped pyrophosphates give orange or red light Single phased white light emitting phosphors such as $SrZn_2(PO_4)_2$: Eu^{2+}, Mn^{2+}, $Ca_9Y(PO_4)_7$: Eu^{2+}, Mn^{2+} , $Ca_9Gd(PO_4)_7$: Eu^{2+}, Mn^{2+},$Ca_7Mg_2P_6O_{24}$: Eu^{2+}, Mn^{2+} , $Ba_2Ca(BO_3)_2$: Ce^{3+},Mn^{2+} and $CaAl_2Si_2O_8$: Eu^{2+}, Mn^{2+} can be obtained by using energy transfer from a sensitizer (Ce^{3+} or Eu^{2+}) to an activator (Mn^{2+}) in the appropriate host[15,16,17].Given the interesting luminescent properties of phosphates, we were motivated to study a new $Li_2BaP_2O_7$ material. To the best of our knowledge no luminescence data is available on this material. Hence in the present paper we report luminescent properties of $Li_2BaP_2O_7:Ce^{3+}$ phosphpr.

Experimental

The phosphor material was prepared by solid state reaction.The starting materials used were of analytical grade. The raw materials used are Li_2CO_3,$BaCO_3$,$(NH_4)H_2PO_4$ and Ce_2O_3.The stiochiometric composition was mixed thorougly and ground in a mortar pestle till the mixture turned homogenous. The ground mixture was fired at 750^0C for 12 hours followed by slowly cooling. The samples at room temperature were taken out from furnace and crushed again. For preparation of this phosphor porcelain crucibles were used. The crushed samples were washed several times with double distilled water to remove the traces of unwanted impurities if any incorporated during synthesis and then dried at 160^0C for few hours. The dried samples were then used for further study. Photoluminescence spectra of the as prepared phosphor was recorded on SHIMADZU RF 5310PC with spectral slit width 1.5nm.

Results and discussions

The formation of the compound was confirmed by recording the XRD spectra. The XRD of as prepared phosphor showed excellent match with the available JCPDS data file. Also in the XRD pattern no phases of starting materials were observed which is an indirect proof for the formation of the desired compound. As all the results are related to PL of Ce^{3+}, general features of the emission are mentioned first. The Ce^{3+} ion is an efficient luminescence centre with a fast response. It has one electron in the 4f state that is lifted to the empty 5d shell upon excitation through interaction with radiation. Subsequent de-excitation occurs by an allowed 5d–4f electric dipole transition with a decay time of the order of 30 ns. Emission is usually in the form of broad bands[18,19,20]. The excitation spectra (Fig. 1) consist of distinct broad band peaking at 263 nm with shoulders around 244 and 273 nm. These are characteristic of Ce^{3+} excitation. Figure 2 shows the Ce^{3+} emission consists of a broad band centering at 342 nm. The observed broad band implies that characteristic transition 4f-5d of Ce^{3+} ions is involved [21,22,23]. From PL results presented here it can be seen that with increasing concentration of Ce^{3+} ions photoluminescence intensity shows marking increase.Since we have doped concentration up to 10m%Ce and also concentration quenching did not take place .It is therefore possible that more Ce doping could be brought about and in this way enhance Ce^{3+} luminescence in this very phosphor.

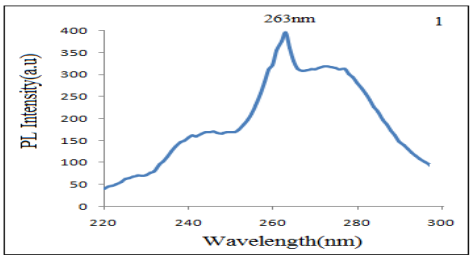

Fig.1- Photoluminescence excitation spectra of $Li_2BaP_2O_7:Ce^{3+}$ phosphor observed at 342 nm

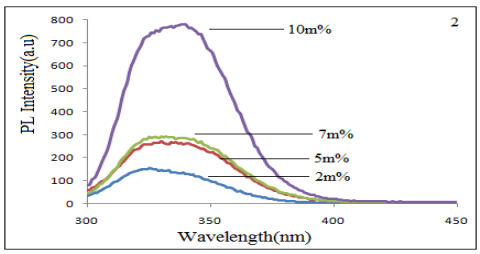

Fig.2- Photoluminescence emission spectra of $Li_2BaP_2O_7:Ce^{3+}$ phosphor monitored at 263 nm.

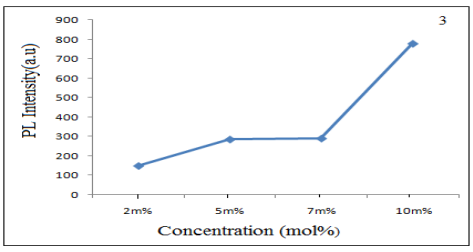

Fig.3- Variation in PL intensity with concentration of Ce^{3+} in $Li_2BaP_2O_7:Ce^{3+}$ phosphor

Conclusions

Results on photoluminescence of a new phosphor material are described in this paper. The solid state reaction could be followed for preparation of this phosphor material. Intense broad Ce^{3+} luminescence could be tuned with 263 nm excitation in this phosphor. In this phosphor material Ce has exhibited characteristic luminescence spectra and in this way has manifested itself in the desired oxidation state, that is Ce^{3+} form. Given the ease with which Ce^{3+} has entered into the lattice may prove to be a good host for other dopants as well.

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