Annexure – VIII

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002

PROFORMA FOR SUBMISSION OF INFORMATION AT THE TIME OF SENDING THE FINAL REPORT OF THE WORK DONE ON THE PROJECT

1. NAME AND ADDRESS OF THE PRINCIPAL INVESTIGATOR

Dr. R. P. SONEKAR
G. S. SCIENCE, ARTS & COMMERCE COLLEGE, KHAMGAON
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2. NAME AND ADDRESS OF THE INSTITUTION

G. S. SCIENCE, ARTS & COMMERCE COLLEGE, KHAMGAON
DIST- BULDHANA – 444303 (MS)

3. UGC APPROVAL NO. AND DATE

F.No.47-180/2002 (WRO) dated 19.12.2002

4. DATE OF IMPLEMENTATION

20 – 12 – 2002

5. TENURE OF THE PROJECT

From 20.12.2002 to 19.12.2004

6. TOTAL GRANT ALLOCATED

Rs.42000 - 00 (Rupees Forty Two Thousand only)

7. TOTAL GRANT RECEIVED

Rs.22000 - 00 (Rupees Twenty TwoThousand only)

8. FINAL EXPENDITURE

44568 - 00 (Rupees Forty Four Thousand Five Hundred Sixty Eight only)

9. TITLE OF THE PROJECT

<u>"STUDY OF BORATE HOST LUMINESCENT MATERIALS"</u>

10. OBJECTIVES OF THE PROJECT

The main objective of the present work was to prepare Inorganic Borate host Luminescent Materials doped with rare earth ions called phosphors by using simple, time saving and cost effective synthesis technique having desired properties and investigate the UV excited PL properties.

11. WHETHER OBJECTIVES WERE ACHIEVED

The objective of the project is achieved. The chemically stable and efficient Borate host Luminescent Materials such as $LaBaB_9O_{16}$: Ce^{3+}, $LaBaB_9O_{16}$: Eu^{3+}, $LaBaB_9O_{16}$: Eu^{2+}, $LaBaB_9O_{16}$: Ce^{3+}-Tb^{3+}, $LaBaB_9O_{16}$: Ce^{3+}-Mn^{2+}, $LaBaB_9O_{16}$: Ce^{3+}-Dy^{3+}, $LaBaB_9O_{16}$: Bi^{3+}-Mn^{2+}, BaB_8O_{13}: Eu^{3+}, $Ba_2Y(BO_3)_2Cl$: Eu^{3+}, $Li_6Y(BO_3)_3$: Eu^{3+} and $Li_6Gd(BO_3)_3$: Eu^{3+} have been prepared by a time saving low temperature low cost synthesis technique.

12. ACHIEVEMENTS FROM THE PROJECT

The main achievements of the project are,

1. **Novel Borate host Luminescent Materials called as phosphors such as $LaBaB_9O_{16}$: Ce^{3+}, $LaBaB_9O_{16}$: Eu^{3+}, $LaBaB_9O_{16}$: Eu^{2+}, $LaBaB_9O_{16}$: Ce^{3+}-Tb^{3+}, $LaBaB_9O_{16}$: Ce^{3+}-Mn^{2+}, $LaBaB_9O_{16}$: Ce^{3+}-Dy^{3+}, $LaBaB_9O_{16}$: Bi^{3+}-Mn^{2+}, BaB_8O_{13}: Eu^{3+}, $Ba_2Y(BO_3)_2Cl$: Eu^{3+}, $Li_6Y(BO_3)_3$: Eu^{3+} and $Li_6Gd(BO_3)_3$: Eu^{3+} have been prepared.**
2. **A novel synthesis technique which is a simple time saving low temperature and low cost synthesis technique as compared to the conventional SSD methods have been used for the preparation of the phosphors and found to be suitable.**

13. SUMMARY OF THE FINDINGS

The materials of different compositions with desired properties are required for various applications. It is wee established that the properties of material depends mainly on the composition, structure and morphology (particle size, shape and distribution. The variety of oxide materials exhibit interesting electrical, magnetic, optical and catalytic properties depending on the composition and structure. The synthesis of materials with desired composition, structure and properties continues to be challenge to chemists, material scientist and engineers. The conventional method for the material synthesis is solid state reaction. The conventional solid state reaction technique requires repeated grinding, palletizing and calcinations of reactants for larger durations at high temperatures. Other disadvantages of the method are the formation of undesirable phases. The area of application of materials is vast and varied, so is the need for material development suited for that application. One of the important applications of materials is in the field of luminescence.

Inorganic Borate host luminescent materials doped with rare earth ions exhibits strong absorption over the wide UV region and efficient emission in the visible region. Hence, the inorganic Borate host materials could be useful in developing the desired RGB emitting phosphors for applications in lighting and display. The fine powder samples of the inorganic Borate host materials $LaBaB_9O_{16} : Ce^{3+}$, $LaBaB_9O_{16} : Eu^{3+}$, $LaBaB_9O_{16} : Eu^{2+}$, $LaBaB_9O_{16} : Ce^{3+}\text{-}Tb^{3+}$, $LaBaB_9O_{16} : Ce^{3+}\text{-}Mn^{2+}$, $LaBaB_9O_{16} : Ce^{3+}\text{-}Dy^{3+}$, $LaBaB_9O_{16} : Bi^{3+}\text{-}Mn^{2+}$, $BaB_8O_{13}: Eu^{3+}$, $Ba_2Y(BO_3)_2Cl: Eu^{3+}$, $Li_6Y(BO_3)_3: Eu^{3+}$ and $Li_6Gd(BO_3)_3: Eu^{3+}$ have been prepared by a novel solution combustion technique. The method is based on the exothermic reaction between the fuel (Urea) and Oxidizer (Ammonium nitrate). Heat generated in the exothermic reaction between ammonium nitrate and urea is used to carry out the synthesis.

All the inorganic borate compounds $LaBaB_9O_{16} : Ce^{3+}$, $LaBaB_9O_{16} : Eu^{3+}$, $LaBaB_9O_{16} : Eu^{2+}$, $LaBaB_9O_{16} : Ce^{3+}\text{-}Tb^{3+}$, $LaBaB_9O_{16} : Ce^{3+}\text{-}Mn^{2+}$, $LaBaB_9O_{16} : Ce^{3+}\text{-}Dy^{3+}$, $LaBaB_9O_{16} : Bi^{3+}\text{-}Mn^{2+}$, $BaB_8O_{13}: Eu^{3+}$, $Ba_2Y(BO_3)_2Cl: Eu^{3+}$, $Li_6Y(BO_3)_3: Eu^{3+}$ and $Li_6Gd(BO_3)_3: Eu^{3+}$ shows strong Absorption over a wide UV range from 200 – 400 nm.

$LaBaB_9O_{16}$: Ce^{3+} shows characteristic double emission at longer UV region under UV 254 nm excitation. In $LaBaB_9O_{16}$: Eu^{3+}, intense red emission at 614 nm was observed for 254 nm excitation indicating the noncentrosymmetric position of Eu^{3+} ions in the lattice. In Ce^{3+}-Tb^{3+} co-doped $LaBaB_9O_{16}$ sample for the UV 254 nm excitation into Ce^{3+} absorption band, shows sharpTb^{3+} emission lines at 541 nm, which can be ascribed to the $^5D_4 \rightarrow {}^7F_5$ transition of Tb^{3+}. In Ce^{3+}-Dy^{3+} co-doped $LaBaB_9O_{16}$ sample intense Dy^{3+} emission was observed at 473,485.6 nm and 571.2 nm. In Ce^{3+}-Mn^{2+} co-doped sample strong green emission of Mn^{2+} at 518 nm and weak Ce^{3+} emission at 351.8 nm was observed which indicates the partial energy transfer. In Bi^{3+}-Mn^{2+} co-doped sample, weak Mn^{2+} emission at 543 nm and strong Bi^{3+} emission at 421 nm was observed indicating the poor energy transfer. From these results it can be concluded that $LaBaB_9O_{16}$ is a universal host lattice for variety of luminescent ions.

The emission spectrum of BaB_8O_{13}: Eu^{2+} under UV 254 nm excitation shows a single intense band peaking at 408 nm corresponding to the allowed $d \rightarrow f$ transition of Eu^{2+} ion. The emission spectrum is a structureless band and no additional emission band appears for higher doping concentration of Eu^{2+}.

The emission spectrum of $Ba_2Y(BO_3)_2Cl$: Eu^{3+} under UV excitation (254 nm) consists of a series of sharp lines between 580 – 650 nm which corresponds to the transitions $^5D_0 \rightarrow {}^7F_j$ (j= 1, 2, 3 …..) of Eu^{3+}. The emission spectrum mainly consists of two prominent emission lines at 591.6 nm and 610.8 nm corresponding to $^5D_0 \rightarrow {}^7F_1$ and $^5D_0 \rightarrow {}^7F_2$ transition and maximum at 610.8 nm. The other weak bands peaking at 620 nm and 651.4 nm can be assign to the components of $^5D_0 \rightarrow {}^7F_3$.

The emission spectra of $Li_6Y(BO_3)_3$: Eu^{3+} consists of groups of sharp lines between 580nm to 652nm, which originates practically only from the $5D_0$ levels of the Eu^{3+} ion. The emission spectra mainly consists of three sharp lines 592nm, 612nm & 624nm which are due to $^5D_0 \rightarrow {}^7F_1$, $^5D_0 \rightarrow {}^7F_2$, $^5D_0 \rightarrow {}^7F_0$ transitions. The dominant emission line is at 612nm which corresponds to $^5D_0 \rightarrow {}^7F_2$ transition of Eu^{3+}.

The emission spectra consists of groups of sharp lines between 580nm to 652nm, which originates practically only from the $5D_0$ levels of the Eu^{3+} ion.

The emission spectra of $Li_6Gd_{0.85}(BO_3)_3 : Eu_{0.15}$ mainly consists of three sharp lines 592nm, 612nm & 624nm which are due to $^5D_0 \rightarrow {}^7F_1$, $^5D_0 \rightarrow {}^7F_2$, $^5D_0 \rightarrow {}^7F_0$ transitions. The prominent emission line is at 592nm corresponding to $^5D_0 \rightarrow {}^7F_1$ transition of Eu^{3+}.

The peak excitation wavelengths and Emissions wavelengths of the prepared Borate host luminescent materials are shown in the following table.

Table- 2: excitation wavelengths and Emissions wavelengths

S N	COMPOUND	Excitation peaks (nm)	Emission peaks (nm)
1	$LaBaB_9O_{16}: Ce^{3+}$	258 nm, 274 nm, 289 nm and 329 nm , **274 nm**.	**349 nm** , 305 nm and 323 nm.
2	$LaBaB_9O_{16}: Eu^{2+}$	254 nm	380 nm, 408 nm
3	$LaBaB_9O_{16}: Eu^{3+}$	254 nm	589 nm, 597 nm , **614 nm**, 650 nm
4	$LaBaB_9O_{16}: Ce^{3+}-Tb^{3+}$	258 nm, 274 nm, 289 nm and 329 nm , **274 nm**.	481 nm, 491 nm, **541 nm** 590 nm ,620 nm
5	$LaBaB_9O_{16}: Ce^{3+}-Dy^{3+}$	**254 nm**	360 nm , 473 nm, 485.6 nm and 571.2 nm
6	$LaBaB_9O_{16}: Ce^{3+}-Mn^{2+}$	260 nm, **278** nm 293 nm	**518 nm,** 351.8 nm
7	$LaBaB_9O_{16}: Bi^{3+}-Mn^{2+}$	228 nm, 256 nm, **315 nm**	421 nm, **543 nm**
8	**$BaB_8O_{13}: Eu^{2+}$**	220 – 383 nm	**408 nm**
9	**$Ba_2Y(BO_3)_2Cl: Eu^{3+}$**	246.7	592 nm, 611 nm
10	**$Li_6Y(BO_3)_3: Eu^{3+}$**	251nm	593 nm, **612 nm,** 624 nm
11	**$Li_6Gd(BO_3)_3: Eu^{3+}$**	244nm	593 nm, 612 nm, 624

			nm

14. CONTRIBUTION TO THE SOCIETY

For general lighting purposes people are using conventional lighting devices such as incandescent lamps, fluorescent lamps and CFL. The efficiency of the conventional incandescent light bulb is just 5 % (15 lm/ W) and that of Fluorescent tube is 15 - 25 % (50 – 80 lm/ W). In fluorescent lamps and CFLs tricolor RGB phosphors in proper proportions are used to generate white light.

The efficiency and cost of the fluorescent lamps and CFLs devices is mostly governed by the cost of the phosphors used. In the present Project work, various Borate host Luminescent Materials called phosphorssuch as- $LaBaB_9O_{16}$: Ce^{3+}, $LaBaB_9O_{16}$: Eu^{3+}, $LaBaB_9O_{16}$: Eu^{2+}, $LaBaB_9O_{16}$: Ce^{3+}-Tb^{3+}, $LaBaB_9O_{16}$: Ce^{3+}-Mn^{2+}, $LaBaB_9O_{16}$: Ce^{3+}-Dy^{3+}, $LaBaB_9O_{16}$: Bi^{3+}-Mn^{2+}, BaB_8O_{13}: Eu^{3+}, $Ba_2Y(BO_3)_2Cl$: Eu^{3+}, $Li_6Y(BO_3)_3$: Eu^{3+} and $Li_6Gd(BO_3)_3$: Eu^{3+} with efficient luminescent properties have been prepared by a very simple, time saving and low temperature Solution Combustion technique.

Theses phosphors are the potential candidates of red, Blue and Green emitting phosphors in lighting and display applications.

15. WHETHER ANY PH.D. ENROLLED/PRODUCED OUT OF THE PROJECT

Yes.

Dr. R. P. Sonekar has been awarded Ph. D. in Physics by S G B Amravati University Amravati in 2008. Xerox copy of Degree Certificate is attached.

16. NO. OF PUBLICATIONS OUT OF THE PROJECT

04 (Xerox Copies are attached)

(PRINCIPAL INVESTIGATOR) **(REGISTRAR/PRINCIPAL)**