COMBUSTION SYNTHESIS OF $GdVO_4$: Pb^{2+}, Eu^{3+} RED PHOSPHOR COMPOUND

B. N. Mahalley *, M. B. Mahalley and R. B. Pode
Department of physics, Nagpur University
Campus, Nagpur- 440010, India
* email : mahalleybn@yahoo.com

Pure Yttrium vanadate, in aqueous solution, was first synthesized by the reaction of yttrium nitrate and ammonium metavanadate by Arbit and Sebrennikov in 1965 [1]. Krylov et al. patented this technique for the industrial applications [2]. In subsequent years, many workers prepared yttrium vanadate by aqueous solution with different materials and patented their techniques [3-6]. Hydrolyzed colloidal mixture of the aqueous V_2O_5 + Y_2O_3 + H_2O system has been used for preparation of YVO_4 powder [7].

The products of combustion synthesis are highly reactive containing minimum number of impurities, can be prepared rapidly; it requires little use of specialized equipment products and can be chemically homogeneous material of a single crystalline phase or intimate mixture of several phases. Patil with his co-workers and other research groups [9-12] have carried out the synthesis of various single and mixed ceramic oxides, ranging from zirconia toughened alumina to superconductors, using fuel such as Urea [CO $(NH_2)_2$], Tetraformal trisazine (TFTA,C_4H_{16},N_6O_2), Corbohydrazide ($CH_7CH_6N_4O$), Oxalo-dihydrazide (OHD,$C_2H_6N_4O_2$), Malonodihydrazide, Glycine $C_2H_5NO_2$), 3 Methylpyrazole–5one (3MP5O,$C_4H_6N_2O$), Diformyl hydrazine (DFH,$C_2H_4N_2O_2$) by combustion method. Combustion synthesis has been shown to be useful preparative route for oxide ceramic powders including $YBa_2Cu_3O_{(7-x)}$. The combustion synthesis of intermetallic compound in Zirconium–Aluminium binary system has been investigated by Anselmi et al.

The luminescence properties of Pb^{2+} doped alkaline earth – sulphate has been reported by Folkart et al.. Various Pb activated host phosphor materials are available. The excitation varies from 220 to 410 nm and emission changes from 278 to 620 nm and depends on the host material. The Pb^{2+} ion belongs to ns^2 type impurities. For free ion, the ground state is $^1S_0$ arising from the s^2 configuration and the lowest excited levels are $^3P_0$, $^3P_1$ and $^1P_1$ derived from the excited sp configuration .

The Pb^{2+} luminescence can be useful in obtaining a low cost green and red emitting phosphor. A relatively new discovered phosphor, $Sr_3Gd_2Si_6O_{18}$:Pb^{2+},Mn^{2+} relies on strong Pb^{2+} absorption, efficient energy transfer to Mn^{2+} and strong green emission of the latter, for use as a green component of a tricolor lamp phosphor. However, this phosphor suffers from the problem of degradation. Pb^{2+} emission has been studied in borates, haloborates, phosphates , sulphates , carbonates , oxides , halides , oxyhalides etc. In several of these hosts, Pb^{2+} emission is quenched at low temperatures.

In the present work, Eu and Pb doped $GdVO_4$ material has been synthesized by combustion process using fuel (3MP5O). The formation of crystalline powder has been checked by XRD. The powder has been characterized by FTIR, SEM, particle size analysis and surface area measurement.

The doubly doped vanadate powder has been prepared by the combustion of redox mixture containing metal nitrates [Gd $(NO_3)_3$], ammonium nitrate [NH_4NO_3], ammonium metavanadate [NH_4VO_3], 3-methyl-5-one [3MP5O] as a fuel and [Eu $(NO_3)_3$], [Pb $(NO_3)_2$] as impurities at 400 ^{0}C. The resulting amorphous material on calcining at 650 ^{0}C for 1 h yields crystalline powder. This was then washed with 0.1 N HCl and NH_4OH (30 %) for several times.

Photoluminescence excitation and emission spectra were also recorded. Strong emission line at 618 nm due to $^5D_0 \rightarrow {}^7F_2$ transition in red region was observed. The decay time of 618 nm line has been measured. The average decay time is found to be 688 μs. The photoluminescence quantum efficiency is found to be 60 %.

In conclusion, we have synthesized $GdVO_4$:Pb^{2+},Eu^{3+} red luminescent phosphor by combustion process. The main advantages of the process are in saving of energy and processing time. The $GdVO_4$:Pb^{2+},Eu^{3+} red luminescent material could be prepared economically by the combustion route.

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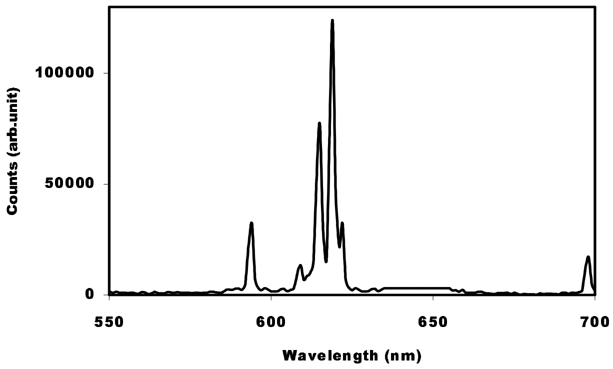

Fig 1 : Emission curve in $GdVO_4$:Pb^{2+}, Eu^{3+} (0.5, 5 mol %) powder material, excited at 318 nm.