SUMMARY
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The brief summary of the thesis entitled "Synthesis and Optical properties of some Inorganic Phosphors" is presented. The thesis has been divided into five chapters.

I. Introduction

II. Materials and methods

III. Synthesis, Characterization and Optical Properties of Europium doped Phosphors

IV. Synthesis, Characterization and Optical Properties of Terbium doped Phosphors

V. Synthesis, Characterization and Optical Properties of Dysprosium doped Phosphors

Chapter-I Introduction

Phosphors are luminescent materials, which means 'light bearer' in Greek and appears in Greek myths as the personification of the morning star Venus. These materials absorb light and emit it at other wavelength in the visible region. These materials are mainly inorganic substances, which are prepared by proper heat treatment adopting various methods such as solid-state, combustion, sol-gel, hydrothermal, microwave and colloidal precipitation etc.

This chapter deals with the introduction and brief history of the phosphors. The phenomenon of luminescence, types of luminescence, luminescence process, the important physical processes which play a role in a luminescent material i.e excitation, emission, non-radiative return to the ground state and energy transfer, luminescent centers of phosphors and luminescence of specific lanthanide ions are explained in detail in this chapter.

Nowadays, phosphors are widely applied for commercial and industrial uses. These have been utilized in lamp industries, cathode ray tubes, X-ray and ionizing radiations, vacuum fluorescent displays, field emission displays, infrared up-conversions, plasma display devices and many advanced display devices that provide illuminated text, graphics or video output are also described in this chapter.
Chapter-II Materials and Methods

This chapter comprises of two parts. Part one of this chapter gives the description of the various materials used for the preparation of phosphors and the other various necessary requirements for the synthesis process e.g. fluxes, fuel, crucibles, furnaces, firing atmospheres. Also the various processes such as solid-state, sol-gel, co-precipitation, hydrolyzed colloidal reaction, spray pyrolysis, hydrothermal, microwave and combustion used for the synthesis of inorganic phosphors are described in this part.

Author of the thesis has employed combustion method for the synthesis of phosphors in the entire work incorporated in the present thesis. Briefly, combustion synthesis consists of firing of an aqueous solution that contains metal nitrates and a proper organic fuel between temperatures range of 400–600°C. The reaction is highly exothermic, very fast and self-sustaining. This results in a dry, crystalline, fine oxide powder. A key feature of this process is that the heat required to drive the synthesis is mainly provided by the exothermic reaction of the reagents. Thus it reduces the requirement of external heating source. Actually, metal nitrates can also be decomposed by simple calcinations to metal oxides, upon heating to or above their decomposition temperature. Thereafter these oxides can react together to give new products. However, in this case constant external heat supply is necessary to maintain the system at the high temperature so that a complete conversion of the reactants can take place. On the contrary, the combination of nitrates with an organic fuel causes the ignition of this mixture of precursors at a low temperature that results to an exothermal reaction which provides itself the heat necessary for the synthesis. In addition, as the reagents are mixed in an aqueous solution, the method enables a good chemical homogeneity of the system which leads to a nearly instantaneous reaction. Thus, combustion synthesis provides an interesting alternative over other elaborated techniques because it offers several attractive advantages such as simplicity of experimental set-up, surprisingly short time between the preparation of reactants and the availability of the final product, homogeneous product and highly economic due to energy saving.

The part two of this chapter describes various techniques and instrumental methods used for characterization of the prepared inorganic phosphors. These techniques are luminescence spectroscopy, tristimulus colorimetry, X-ray diffraction
studies, scanning electron microscopy, transmission electron microscopy, energy dispersive X-ray analysis.

Chapter-III Synthesis, Characterization and Optical Properties of Europium doped Phosphors

This chapter deals with the synthesis, characterization and optical properties of europium doped phosphors. Europium was the first isolated, high purity rare earth element to enter the public marketplace, in 1967, as a source of the color red in TV sets. A very interesting property of the europium ions is their bright red (Eu$^{3+}$) and bright blue (Eu$^{2+}$) luminescence. The emission of Eu$^{3+}$ ion is usually in the red spectral region and characteristics of 4f$^6$ energy level transition emission. These emission lines correspond to the following transitions: $^5D_0 \rightarrow ^7F_i$, $^5D_0 \rightarrow ^7F_3$, $^5D_0 \rightarrow ^7F_2$, $^5D_0 \rightarrow ^7F_1$, and $^5D_0 \rightarrow ^7F_0$. The spectra are dominated by the $^5D_0 \rightarrow ^7F_2$ forced electric-dipole and the $^5D_0 \rightarrow ^7F_1$, magnetic-dipole transitions. The main emission peak is located at 605-625 nm, ascribable to the electric-dipole transition of $^5D_0 \rightarrow ^7F_2$. This electric-dipole transition emission is utilized for practical application. The center of strongest line is at 612 nm.

The synthesis, characterization and optical properties of the following europium doped phosphors synthesized using urea/glycine as organic fuel in the combustion synthesis have been discussed in this chapter.

1. YAlO$_3$:Eu
2. GdAlO$_3$:Eu
3. MgAl$_{1.8}$Y$_{0.2}$O$_4$:Eu
4. YVO$_4$:Eu
5. GdVO$_4$:Eu

Chapter-IV Synthesis, Characterization and Optical Properties of Terbium doped Phosphors

This chapter deals with the synthesis, characterization and optical properties of terbium doped phosphors. Trivalent Tb ions have been expected as one of the promising species which provide optical devices in blue and green color regions and many investigations have been conducted in various compounds. As is well known, the efficient blue-green emissions of Tb$^{3+}$ originate from the $^5D_3 \rightarrow ^7F_j$ and $^5D_4 \rightarrow ^7F_j$ transitions. Tb$^{3+}$-activated phosphors have been widely used in various fields such as three-band fluorescent lamps, projection television tubes, and x-ray intensifying...
screens. \( \text{CaIn}_2\text{O}_4 \) being a semiconducting compound having band gap of 3.9 eV which is wide enough to incorporate visible luminescence centers such as rare-earth ions, can act as a potential host matrix for phosphors.

The synthesis, characterization and optical properties of the following terbium doped phosphors synthesized using urea (glycine also in case of \( \text{CaIn}_2\text{O}_4: \text{Tb} \)) as organic fuel in the combustion process have been discussed in this chapter.

1. \( \text{CaIn}_2\text{O}_4: \text{Tb} \) (urea assisted)
2. \( \text{CaIn}_2\text{O}_4: \text{Tb} \) (glycine assisted)
3. \( \text{SrIn}_2\text{O}_4: \text{Tb} \)
4. \( \text{CaAl}_2\text{O}_4: \text{Tb} \)
5. \( \text{YP}_2\text{O}_5: \text{Tb} \)
6. \( \text{SrZn}_2\text{O}_2: \text{Tb} \)

Chapter-V Synthesis, Characterization and Optical Properties of Dysprosium doped Phosphors

This chapter deals with the synthesis, characterization and optical properties of dysprosium doped phosphors. Rare-earth doped multi-component oxide phosphors have been extensively studied for several years for applications in display devices, lights and detectors. Trivalent dysprosium activated phosphors having excellent luminescence properties and high efficiency are well-known. The emission of \( \text{Dy}^{3+} \) shows the following two transitions: \( ^4\text{F}_{9/2} \rightarrow ^6\text{H}_{15/2} \) (~470nm) and \( ^4\text{F}_{9/2} \rightarrow ^6\text{H}_{13/2} \) (~570nm). The later one with \( \Delta J=2 \) is hyper sensitive. The color of luminescence of this ion is whitish. The emission color of the luminescence is close to white because of the yellow \( ^4\text{F}_{9/2} \rightarrow ^6\text{H}_{13/2} \) and blue \( ^4\text{F}_{9/2} \rightarrow ^6\text{H}_{15/2} \) emissions of \( \text{Dy}^{3+} \). The whitish color turns to yellow in some host lattices.

The synthesis, characterization and optical properties of the following dysprosium doped phosphors synthesized using urea as an organic fuel in the combustion process have been discussed in this chapter.

1. \( \text{YVO}_4: \text{Dy} \)
2. \( \text{GdVO}_4: \text{Dy} \)

The list of publications of the author and some important publications are given in the end of the thesis.