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Synthesis and Photoluminescence characterization of $NaMgSO_4F$: Ce phosphor

S. R. Choube[1], S. C. Gedam[2]* and S. J. Dhoble[3]

[1]Department of Physics, Rajashree Mulak Womens College of Engineering, Nagpur–440019
[2] K.Z.S. Science College, Kalmeshwar, Nagpur 441501, India
[3] Department of Physics, RTM Nagpur University, Nagpur -440033, India

Abstract
Ce^{3+} emission in $NaMg(SO_4)F$ phosphor prepared by wet chemical method is reported in this paper. The synthesized phosphor is characterized by X-ray diffraction, photoluminescence excitation and emission spectra. The emission spectra shows a dominant peak at 349 nm due to the 5d→4f transition of Ce^{3+} when monitored at excitation wavelength of 263 nm. In this host very low concentration of cerium is used. The characteristic emission of the $NaMg(SO_4)F$ phosphor in the UV region of spectrum makes it a strong candidate for the use in scintillation applications.

Keywords: Wet chemical method, XRD, PL

INTRODUCTION

Rare earth (RE) ions posses' unique optical behavior when doped in to materials and have paved the way for the development of optical amplifiers and phosphors. The optical value of these ions results from the electronic transitions occurring with in the partially filled 4f energy shell of the lanthanide series. Traditionally, inorganic scintillators have played an important role in the detection and visualization of high-energy radiation. Applications in medical diagnostics and dentistry are only a few examples in which inorganic scintillators are used.At present, the most popular scintillators are sodium iodide doped with thallium, NaI:Tl^+ and cesium iodide doped with thallium, CsI:Tl^+. The Sulfates are an important mineral class and include some very interesting and attractive specimens. Some Sulfate Class minerals are soluble and several are fluorescent. Although many minerals belong to this class only barite, gypsum, and anhydrite can be considered common. We have reported some fluoride and chloride based materials as phosphors [1]. These halosulphates, $KZnSO_4Cl$:Ce, Dy and $KMgSO_4Cl$:Ce,Dy; $KMgSO_4Cl$:Eu; $NaMgSO_4Cl$:Ce have been reported as phosphors by wet chemical , solid state diffusion and melting route and characterized XRD, photoluminescence (PL), thermoluminescence (TL), Lyoluminescence (LL). Therefore, it is considered to develop the halosulphate based material such as $NaMg(SO_4)F$.In this paper wet chemical synthesis of $NaMg(SO_4)F$ is reported and explained Ce^{3+} emission in this phosphor at very low concentration level.

We have reported some inorganic materials as phosphors [2-12]. The $KZnSO_4Cl$: Ce, Mn and $KMgSO_4Cl$: Ce, Mn phosphors were prepared by wet chemical synthesis method. Other than these materials, $KZnSO_4Cl$:Ce; Ce, Dy and $KMgSO_4Cl$:Ce; Ce, Dy; $KMgSO_4Cl$:Eu; Na_3SO_4F: Ce; $NaMgSO_4Cl$:Ce; KCaSO4Cl: Ce; Dy have been reported as phosphors by wet chemical , solid state diffusion and melting route and characterized XRD, photoluminescence (PL), thermoluminescence (TL). Here we report $NaMg(SO_4)F$ as a host for luminescent (PL) material by doping Ce first time. Excellent photoluminescence (PL) results are observed. The phosphor may be used as a scintillator material.

EXPERIMENTAL

$NaMg(SO_4)F$ (pure); $NaMg(SO_4)F$:Ce, phosphors were prepared by a wet chemical method. The constituents of analar grade were taken in a stoichimetric ratio and dissolved separately in double distilled de-ionized water, resulting in a solution of $NaMg(SO_4)F$. Water soluble sulphate salt of Cerium was then added to the solution to obtain $NaMg(SO_4)F$:Ce. Confirming that no undissolved constituents were left behind, and all the salts had completely dissolved in water and thus reacted. The compounds in its powder form were obtained by evaporating on 80 ^{0}c for 8 hours. The dried samples were then slowly cooled at room temperature. The resultant polycrystalline mass was crushed to fine particle in a crucible. The powder was used in further study. Formation of the compound was confirmed by taking the x-ray diffraction (XRD) pattern. The photoluminescence (PL) emission spectra of the samples were recorded using Fluorescence spectrometer (Shimadzu, RF 5301 PC). The same amount of sample was used in each case. Emission and excitation spectra were recorded using a spectral slit width of 1.5 nm.

RESULTS AND DISCUSSIONS

Figure 1 shows PL excitation and emission spectra of $NaMg(SO_4)F$:Ce. In this host results are observed for different concentrations of Ce i.e. 0.5, 1, 2, 5 mole%. The XRD peaks of the present host were matched with the standard JCPDS file. When the emission wavelength is monitored at 349 nm, the excitation spectra consists of one band, due to the 4f→ 5d transition (f–d transition) of Ce^{3+} in the shorter wavelength at 262 nm. Emission spectrum consists of single broad bands that are correlated with some 5d→4f electronic transitions in the activating cerium ions at 349 nm having a small shoulder at 335 nm. In the emission spectra of $NaMg(SO_4)F$ phosphor characteristic UV emission peaks corresponds to the Ce^{3+} intra 4f transitions from the excited levels to lower levels. The emission peaks are located at 349 nm which falls in UV region of spectrum for different concentrations of Ce corresponding to the 5d $\rightarrow {}^4F_{7/2}$ and 5d $\rightarrow {}^4F_{5/2}$ typical transitions in the host lattice.

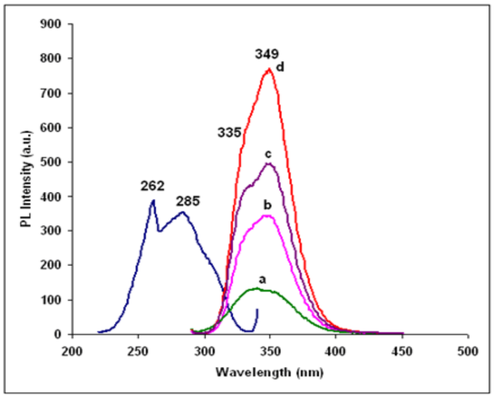

Fig 1. PL excitation and emission spectra of NaMg(SO_4)F:Ce a) 0.5 mole% b) 1 mole% c) 2 mole% d) 5 mole%

CONCLUSIONS

It is concluded that, the host NaMg(SO_4)F is suitable for the emission of Ce at concentrations level i.e. 0.5, 1, 2, 5 mole%. The results indicate that it could be a good candidate for scintillating phosphor.

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