National Conference on 'Advanced Analytical Tools for Materials Characterization' (AATMC-2018)

 | Volume 5 | Issue 4 | Print ISSN : 2395-1990 | Online ISSN : 2394-4099
Themed Section: Science and Technology

Synthesis & Thermal, Optical & Dielectric characteristics of Gadolinium doped EuF_3 nanoparticles in presence of α – glycine

Manoj P Mahajan*1, M. M. Khandpekar2

*1Department of Physics, A. P. Shah Institute of Technology, Opp. Hypercity Mall, G. B. Road, Thane, Maharashtra, India

2Material Research Laboratory, Birla College of Arts, Science & Commerce, Kalyan, 421304, Maharashtra, India

ABSTRACT

EuF_3: Gd nanoparticles have been synthesized in the presence of α- glycine via chloride route at room temperature. The synthesised nanoparticles shows hexagonal phase with lattice parameters a = b = 6.920 A° and c = 7.085 A° (JCPDS No. 32-0373). The average size of nanoparticles calculated with Debye- Scherer equation was found to be 51 nm. Thermal characteristics were studied from TGA/DTA spectrum and it shows decomposition in two stages. UV-VIS studies show three wavelengths which find applications in optoelectronic devices. Dielectric studies explained d.c conduction process.

Keywords: Glycine, Chloride Route, Hexagonal Phase, Decomposition, Optoelectronic.

I. INTRODUCTION

Dielectric material plays vital role in the construction of microcircuits. Because of the high permittivity and stable thermal as well as chemical properties rare earth materials have attracted researcher and are widely used as dielectric materials [1,2]. Literature review tells us that there are fewer reports on dielectric properties of EuF_3 nanoparticles. Because of sharp emission lines, rare earth material also finds application in the field of optoelectronic devices. Water solubility limits the use of rare earth material in biological fields. Surface modification makes it water soluble that can be done by adding organic ligands.

II. EXPERIMENTAL

EuF_3 nanoparticles were synthesised via chloride route and to reduce agglomeration microwave drying was employed. The solution of $EuCl_3.6H_2O$ (0.064 mol, 1.65 gm), $GdCl_3.6H_2O$ (0.064 mol, 0.8435 gm), Glycine $C_2H_5NO_2$ (0.064 mol, 0.0480 gm) and NH_4F (0.576 mol, 3.200 gm) was prepared in distilled water. Ammonium fluoride forms three parts and the other reagents forms one part (molar ratio of 1:3). A mixture of 7 ml of europium chloride ($EuCl_3.6H_2O$), 1.5 ml of gadolinium chloride ($GdCl_3.6H_2O$) and 1.5 ml of glycine ($C_2H_5NO_2$) is taken in a clean beaker. 10 ml of Ammonium fluoride (NH_4F) is then swiftly injected into the mixture using a syringe. The white precipitate appears instantly which is dried in microwave oven for 30 minutes. The nanocrystals thus obtained are washed with distilled water several times and kept for drying each time in the oven. The finished product is stored in sealed tubes for further characterisation.

III. RESULTS AND DISCUSSION

A. Thermal Studies

The TGA analysis of α- glycine modified EuF_3:Gd nanoparticles can be divided in to two stages in temperature range from room temperature to

National Conference on 'Advanced Analytical Tools for Materials Characterization' (AATMC-2018)

© 2018 IJSRSET | Volume 5 | Issue 4 | Print ISSN : 2395-1990 | Online ISSN : 2394-4099
Themed Section: Science and Technology

830°C. The first stage shows prominent decomposition occurring at 270°C with nearly 50% weight loss. This is seen as a sharp endothermic peak in the DTA curve. A small endothermic peak at around 530 °C marks the second stage where there is liberation of NH4, Cl_2 etc from the sample. Thus heating the sample removes the surface attachments making EuF_3:Gd nanoparticles water insoluble. The TGA/DTA profile is shown in Figure 1.

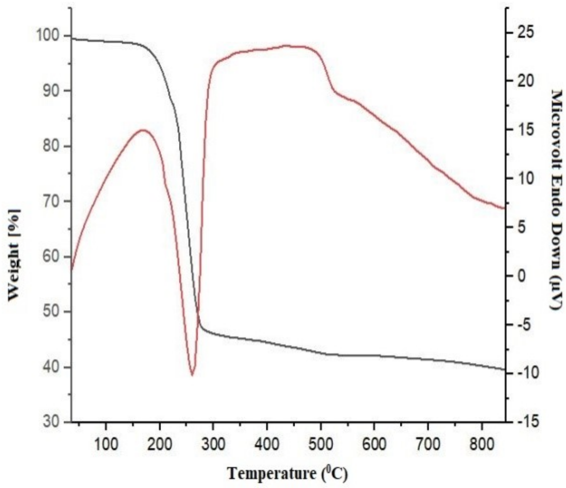

Figure 1. TGA/DTA plot of EuF_3: Gd @ glycine

B. Optical Studies

The UV-VIS spectra EuF_3: Gd @ glycine is shown in Fig. 2. The spectra shows absorption edges at 460 nm, 580 nm & 625 nm corresponding to band gap energies (Eg = hc/λ) E_1 = 2.70 eV, E_2 = 2.14 eV & E_3 = 1.98 eV respectively. These multiple absorption edges indicate quantum dot like nature of the synthesized nanoparticles. Beyond 400nm a wide transparent window suggests that the synthesized nanoparticles can be used in optoelectronics devices.

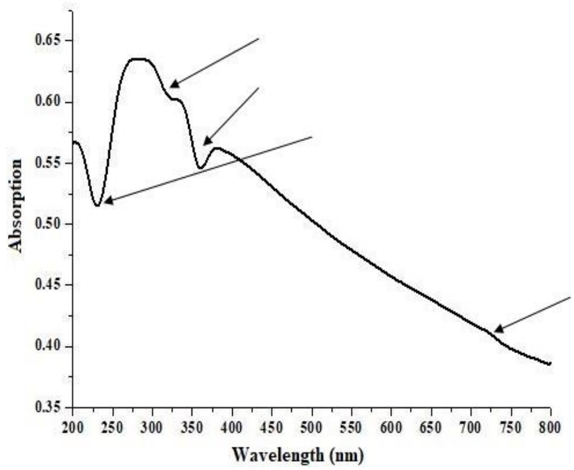

Figure 2. UV-VIS spectra of of EuF_3: Gd @ glycine

C. Dielectric Studies

The variation of dielectric constant and dielectric loss as function of frequency (log F) in range 1 KHz to 5 MHz is studied and shown in Fig. 3. The dielectric constant has highest value at low frequency which gradually decreases when the frequency changes to 10 KHz. This decrease in the value of dielectric constant is due to space charge polarization taking place in the dielectric material. For higher frequency values the dielectric constant and dielectric loss remains constant which means for higher frequencies dielectric constant is independent of frequency.

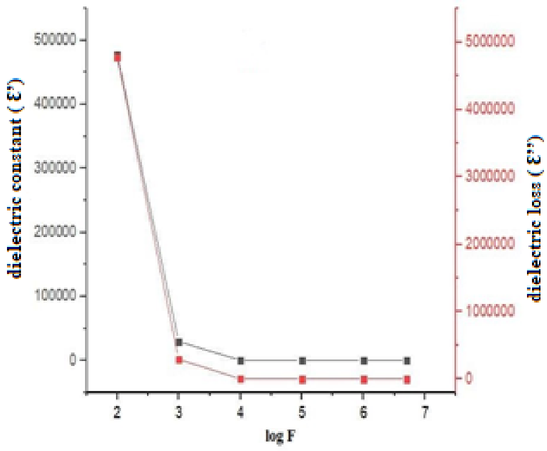

Figure 3. Variation of dielectric constant and dielectric loss as function of log F

© 2018 IJSRSET | Volume 5 | Issue 4 | Print ISSN : 2395-1990 | Online ISSN : 2394-4099
Themed Section: Science and Technology

The variation of dielectric loss as function of frequency also studied in the frequency range 1 KHz to 5 MHz for synthesised nanoparticles which is shown in Fig. 4. For low value of frequency the dielectric loss is constant. For higher frequency the dielectric loss gradually decreases. This is due to the fact that at higher frequencies dipole follows the variation in the field the dielectric loss decreases.

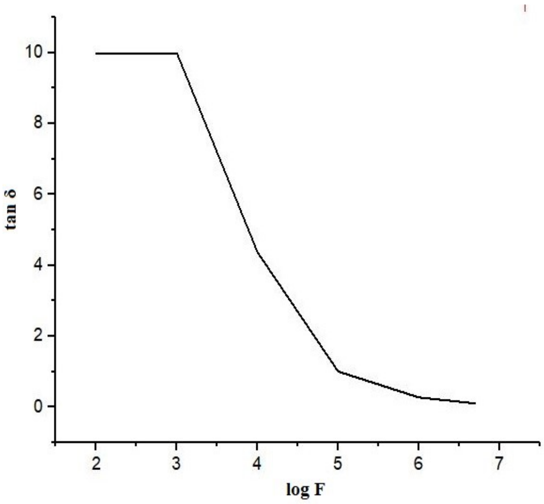

Figure 4. Variation of tan δ as function of Frequency (log F)

IV. CONCLUSION

Gadolinium doped EuF_3 nanoparticles have been synthesised in the presence of glycine as modifier with subsequent drying in microwave to obtain the final finished product. The synthesised nanoparticles shows hexagonal phase with particle size of 51 nm. The TGA/DTA shows two stage decomposition at around 270 ^{o}C (sharp) and 530 ^{o}C (weak). The UV-VIS spectra shows presence of three absorption edges are obtained at 460 nm, 580 nm & 625 nm corresponding to band gap energies ($E_g = hc/\lambda$) E_1 = 2.70 eV, E_2 = 2.14 eV & E_3 = 1.98 eV respectively. The dielectric study shows sharp decrease in value at lower frequency which is independent at higher frequencies. The dielectric loss gradually decreases as observed in graph. This is due to the fact that at higher frequencies dipole follows the variation in the field and dielectric loss decreases.

V. ACKNOWLEDGMENTS

The authors wish to thank Material research laboratory, Birla College, Kalyan (W) for providing research facilities and A.P.Shah Institute of Technology for Institutional support. MPM wishes to thank IIT Mumbai (SAIF) and IIT Madras for providing the experimental facilities for advanced characterisation.

VI. REFERENCES

[1] A. Goswami and R. Ramesh Varma, Thin films, 28 (1975) 157.
[2] B.J.M.Reddy , G.P.Jyothi, M.V.R.Reddy, M.N.Chary and F.N.Reddy, Phy. Stat.ol.(a) 137 (1993) 241.
[3] Amit T Singh, M.M.Khandpekar, Material Research Express 2 (2015) 055401.
[4] M M Khandpekar and S G Gaurkhede, Journal of Crystal Growth 401 (2014) 453-457
[5] Anatoly Safronikhin , Tatyana Shcherba, Heinrich Ehrlich, Georgy Lisichkin, Applied Surface Science 255(2009)7990- 7994