Bi^{3+}doped $LaGaO_3$ Nanoparticles through Polyol Method and their properties

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Abstract

Pure and Bi^{3+}unravel $LaGaO_3$ nanoparticles($LaGaO_3$: Bi^{3+} were synthesized by Polyol intermediated system and latterly have been characterized by their structure, optic and photoluminescence studies. XRD revealed the conformation of single- phase LaGaO3 nanoparticles with orthorhombic harmony. From UV- Vis studies, it's set up that the immersion of Pure $LaGaO_3$ is less compared with Bi^{3+} unravel LaGaO3 nanoparticles and the optic band gap decreases in $LaGaO_3$: Bi^{3+} , Eu^{3+} nanoparticles. From immersion gamuts and FE- SEM analysis the synthesized nanoparticles size set up to be around 20nm. Photoluminescence studies revealed that the samples are with high structural and optic quality which can be used in photonic and optoelectronic bias.

Keywords *: Polyol method, LaGaO3 nanoparticles, Photoluminescence, Optical absorption, SEM, particle size*.

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1. Introduction

Exploration on nanosized semiconductors stimulated great interest in the recent history due to their unique parcels and implicit operations in different areas similar as photocatalysis, solar cells, display panels, etc.(1). LaGaO3 oxide perovskites are entering renewed attention because of their implicit use as substrates for high temperature superconducting thin flicks(2). As LaGaO3 is a wide band gap semiconductor, it can be effectively used in photonic and optoelectronic bias (3). The lanthanum gallate demitasse has an orthorhombically distorted centro symmetric GdFeO3- type perovskite like structure with space group Pbnm(4). The LaGaO3 crystal structure has corner connected GaO6 octahedra embedded three dimensional sublattice that also has La3 in oxide ions of eightfold collaboration. This has the implicit to serve as a host material in phosphor operations. There are no of styles similar as solid state response,co-precipitation, hydrothermal, sol- gel, polyol and wet chemical styles used for the conflation of oxide nanoparticles, still among all, the polyol intermediated system is one of the more extensively honored styles due to its several advantages like soft chemistry, easy to handle and taking no special or precious outfit and conformation of nanoparticles with veritably fine flyspeck size distribution(5- 6). In the present study, we've synthesized the undoped and Bi^{3+} unravel LaGaO3 nanoparticles by Polyol intermediated route and the work was aimed to probe the structural, optic and Photoluminescence parcels of the synthesized material.

2. Experimental

For the medication of undoped and Bi3 unravel LaGaO3 nanoparticles, stoichiometric quantities of Lanthanum(III) Nitrate Hexahydrate(Sigma- Aldrich, 99.99), Gallium(III) Nitrate Hydrate(SigmaAldrich, 99.99), Bismuth(III) Nitrate Pentahydrate(Sigma- Aldrich, 99.99) used as precursor mariners. The ligand that gives the stabilisation is used in the form of Ethylene glycol(MERCK, 99.99). This also acts as a detergent. First, an accurate counted quantum of precursors are taken in 10 ml double distilled water and stirred well for 20 twinkles. After that 20 ml of ethylene glycol was added to the result. result was shaken and kept under shifting. Temperature was measured using Pt-Rh thermocouple and also by thermometer. When the temperature was raised to 100oC, around 4 gm. of urea was added and temperature was raised further to 120oC and maintained at this temperature for 2 hours. The precipitate attained after 2 h of response was cooled, centrifuged, washed doubly with methanol, and doubly with acetone. The dried precipitate was obtained using the standard conditions. The samples were completely base and fired to the asked temperatures 500 – 900 °C for 5 hours.

3. X-Ray Diffraction

X-ray diffraction pattern of the synthesized sample LaGaO3Bi3) was recorded using powder X-ray diffraction system. X-ray diffraction was recorded for the sample by means of a sluggishly moving radiation sensor in the range of 10 °- 100 ° where monochromic wavelength of 1.5405 Å(Cu) was used. The Fig- 1 shows theX-ray diffraction pattern of LaGaO3 Bi3 nanomaterial. The peaks of theX-ray diffraction pattern can be compared with the standard available data for the evidence of the structure, with the use of JCPDS(Joint Committee on Powder Diffraction norms- card.no.24- 1102). Pure LaGaO3 phase can be attained at 900oC. The crystalline sizes were roughly estimated to be below 50 nm by using the Scherer's formula from the full- range at half outside(FWHM) of diffraction peaks. The diffraction pattern of LaGaO3:Bi^{3+} is observed between the 2θ values of 10 ° and 90 °.

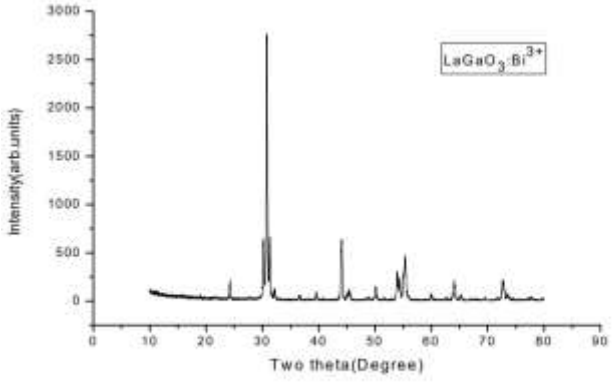

Fig-1: X-ray diffraction pattern of $LaGaO_3$:Bi^{3+} nanoparticles.

4. UV- Vis Spectroscopy and Band gap computation

The UV- Vis absorbance of the sample was measured using a LABINDIA UV 3092 UV- Vis Spectrophotometer. Figure 2 (a) depcts the absorption that was experimentally observed. The UV- Vis obsorption spectrum shows that the absorbance is high below 235 nm wavelength region and the dopant increases the absorbance of LaGaO3 vastly. From UV- Vis studies, it's set up that the immersion of Pure LaGaO3 is less compared with Bi3 unravel LaGaO3 nanoparticles and the optic band gap decreases in LaGaO3: Bi^{3+} nanoparticles(Figure2(b)). The advised optic band gap is 3.89 eV which is near to the estimated band gap of LaGaO3(4.2- eV)(5). This suggests that semiconductors with lower band gaps are preferred in order to show high photoluminescence parcels by absorbing visible light. From the immersion spectra the synthesized nanoparticle size is set up to be around 20 nm.

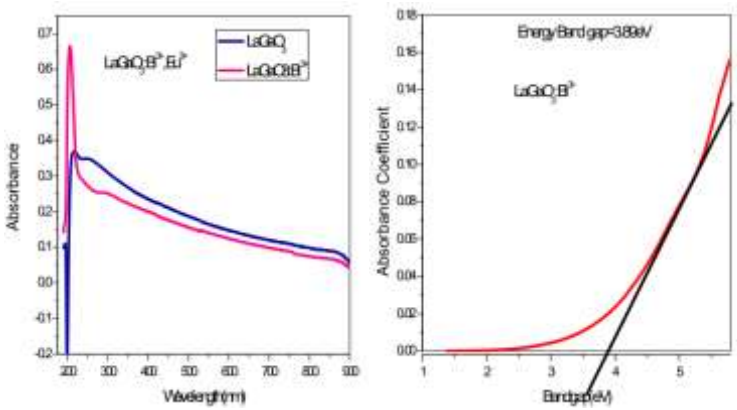

Fig.2. (a) Absorption and optical band gap energy LaGaO3 nanoparticles

By applying FE-SEM on pure and $La0.99GaO3:0.01Bi^{3+}$ samples, the morphology of the synthesized sample surfaces was investigated. Fig-3 shows FE-SEM micrographs of the pure and $La0.99GaO3:0.01Bi^{3+}$ nanoparticles annealed at 900oC. The particle sizes increase with the increase in the temperature, because at higher temperature, the growth of particles is significantly promoted, leading to excessive sintering and aggregation of particles. It is found that both the samples have same morphology. It is clearly seen that the powder consists of agglomerated particles with quasi spherical shape with an average particle size ranging from 20 to 100 nm and average crystallite size around 50 nm.

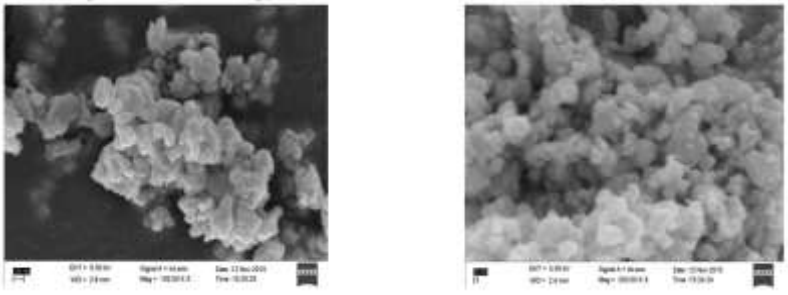

Fig.3.FE-SEM micrographs of the pure and $La0.99GaO3:0.01Bi^{3+}$ nanoparticles

5. Photoluminescence study

The photoluminescence (PL) spectrum of Bi^{3+} doped LaGaO3 and undoped nanoparticles is obtained from the use of a PL spectrometer. PL spectrum of Bi^{3+} doped LaGaO3 nanoparticles after heat-treatment at 900oC are shown in the Figure-3. Photoluminescence (PL) spectra of Bi^{3+} doped LaGaO3 nanoparticles are measured with an excitation wavelength of 254 nm. The intensity of PL emission is found to be increasing on doping Bi^{3+} ions with increase in temperature. This clearly confirms that the effect of doping Bi^{3+} ions has enhanced the luminescence properties of the host lattice. High Photoluminescence (PL) is observed when 1 mol% of Bi^{3+} and is doped into LaGaO3 host lattice. This could be attributed to the high purity and perfect crystallinity of the synthesized nanoparticles.

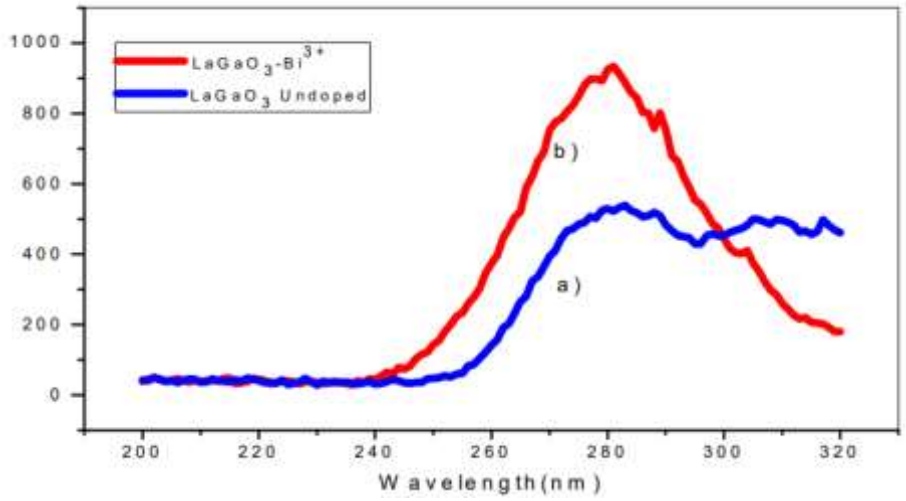

Fig-4: PL Emission spectra of LaGaO3:Bi3+ nanoparticles after heat-treatment at 900°C for 5hrs.

6. Conclusions

The LaGaO3 nanoparticles doped with Bi^{3+} were prepared by using a non-complex and inexpensive technique with Polyol mediation. When the synthesis temperature was 120- 170 ° C in the Polyol process, we obtained LaGaO3: Bi^{3+} nanoparticles not only with a small size but also with good absorption in the Ultraviolet and Visible regions. The powder XRD confirms the crystallinity of the synthesized sample and from absorption spectra we got an average particle size of 20 nm for the doping concentration of 1 mol %(0.01). The surface morphology of the synthesized nanopowder is observed from FE-SEM analysis. It is evident that from the photoluminescence spectrum, the PL intensity increased on doping Bi^{3+} ions into the host lattice. These results showed a great promise for the Bi^{3+} doped LaGaO3 nanoparticles for applications in optoelectronic and display devices.

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