Synthesis and Characterization of $LaCrO_3$ Dopped with Y by Sol-Gel Method

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ABSTRACT

In this paper we explain the synthesis of LaCrO3 nanoparticlesdopped with Yetrria by sol-gel technique, This is a very simple and cost effective method, also their thick film preparation by screen printing method and their characterization done by XRD, SEM, EDS and IR spectroscopy. The prepared nanoparticles were characterized by XRD from which the average crystallite size calculated by Scherer's formula found to be 24.66nm . The SEM spectrum shows greyish black surface of lanthanum oxide nanoparticles. The EDS of LaYCrO3 nanomaterial shows the elemental composition of prepared nanoparticles. The infrared spectrum analyze the typical IR stretching frequencies of La-O and Cr-O found to be 590.22 cm- and 447.49 cm-respectively.

Keywords: LaYCrO3, XRD, SEM, EDS, IR, Sol-gel Method.

INTRODUCTION:

Now a days nanomaterials are having wide applications in the different fields of research.As there are numerous methods for manufacture of but among them we are using Sol-gel for nanomaterial synthesis. Because this method is very convenient and easy for handling. This is the top-down approach for the synthesis of nanomaterials.These nanoparticles are used as a catalyst because of their large surface area[1,2]. The metal oxides nanoparticles can be useful as gas sensors for most of gases. The gas sensors Metal oxides give large surface area those aides in catalytic utilization of materials. Which can help us By and large, metal oxide thin and thick films gave a decent record for gas sensors[3,4,5,6]. Extensive quantities of gasses are tried for assortment of nanomaterials. Favorable position of gas detecting study gives affectability for different gasses, which manages their fixation at different spots, research facility, mining, air etc. upkeep of contamination gasses and unsafe gasses can be sense at the specific level and temperature for various metal oxides. The material like $LaCrO_3$and $LaFeO_3$ have attractedConsiderable attention because they can be made to have high electrical conductivity, high infrared reflectance and high visible transmittance. Low resistive $LaCrO_3$ films have been achieved by doping with different group elements like transitions and inner transition elements along with the some metals of P-block elements, and great results of sentivity are be reproduced.[7,8,9]

EXPERIMENTAL WORK:

Material and Methods:

All the in chemicals used in synthesis are of AR grade purchased from Merck Chemicals Mumbai and used without further purification. Chemicals involves Lanthanum nitrate, Chromium nitrate,yttrium nitrate, Citric acid, Double distilled water

Synthesis of $LaYCrO_3$ nanoparticles:

The $La_{1-x}Y_xCrO_3$ (x=0.4) were synthesized by sol-gel method. $La(NO_3)_3 \cdot 6H_2O$,$Y(NO_3)_2 6H_2O$, $Cr(NO_3)_3 \cdot 9H_2O$ were first dissolved in one beaker and citrate acid were dissolved inanother beaker in distilled water. Mix both thesolutions with continually stirring on magnetic stirrer and then keep it for 2-3 hr at 80°Cforevaporation of distilled water.At this stage a colour sol is obtained, with the constant heating sol is converted into viscousliquid means gel. This gel was initially dried under IR lamp for 1-2 hours. Then that rough particles were crushed and grinded, and then calcined for 5-6 hours at 550^0 C.[1,2,9]

Preparation thick films of $LaYCrO_3$ nanoparticles:

Thick film preparation method is similar to our earlier work[1]. The powder of nanoparticle of $LaYCrO_3$ converted into paste which was used to prepare thick films by simple screen printing method. Maintaining the inorganic to organic materials ratio at 70:30. The inorganic part consists of nanomaterial ($LaYCrO_3$). The organic part consisted of 8% ethyl cellulose and 92% butyl carbitol acetate. The $LaYCrO_3$ with ethyl cellulose (EC) were mixed thoroughly in an acetone medium with mortar and pestle. A solution of BCA which was added drop wise until proper thyrotrophic properties of the paste achieved. Now thick film was prepared on glass substrate by using standard screen -printing technique. The film was dried under IR lamp for 1 hr to remove the organic volatile impurities and then fired at temperature 550^0C for 30 minutes in muffle furnace. The prepared thick films are now ready for spectroscopic characterization and electrical characterization.

RESULT AND DISCUSSION:

XRD Analysis:

The XRD spectrum for prepared doped $LaYCrO_3$ is as shown in fig.1.The spectrum shows the main 2θ peaks at 32.33^0, 39.94^0,46.52^0,52.28^0,57.90^0 ,68.075^0 From which the average crystallite size calculated by Schererformula Eq. (**1**).is 24.66 nm by using online tiny tools updated software.

$D = K\lambda/\beta \cos\theta$ ……………. (1) [Scherer formula]

Where K=constant (0.89 to1.39), λ=Radiation of wavelength (1.54 A0) β=FWHM (Full Width Half wave Maxima), θ=Bragg angle in degree, D=Particle Size.,[11.12].

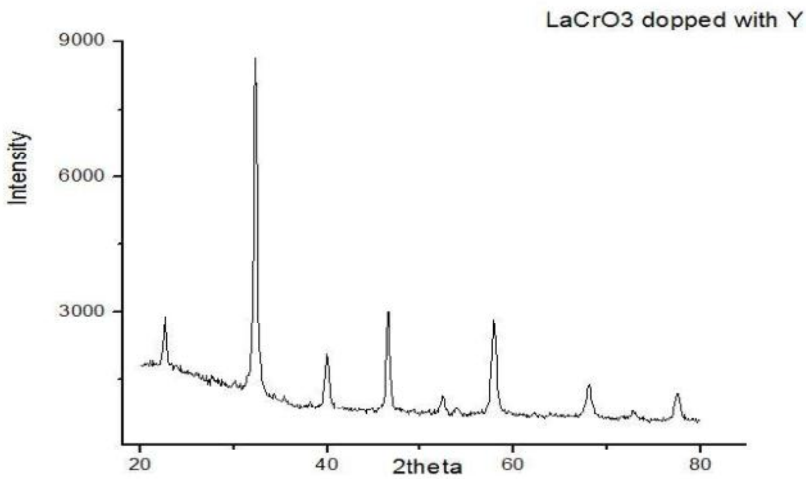
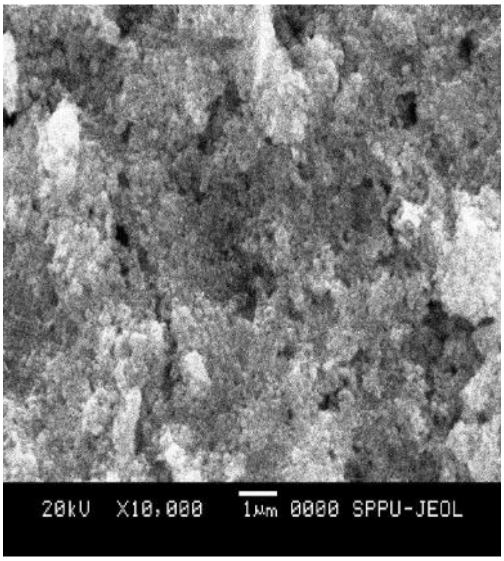


Fig.1: XRD image of prepared $LaYCrO_3$Nanoparticles

SEM Analysis:

The scanning electron microscopy(SEM) images of prepared LaCrO3Nanoparticles are shown in fig.2, a and b at 10,000 and 20,000 resolution respectively, this image shows the surface texture,colour and its porosity. It having heterogeneous surface, micropores and mesopores are seen from its surface. It is greyish black in colour.



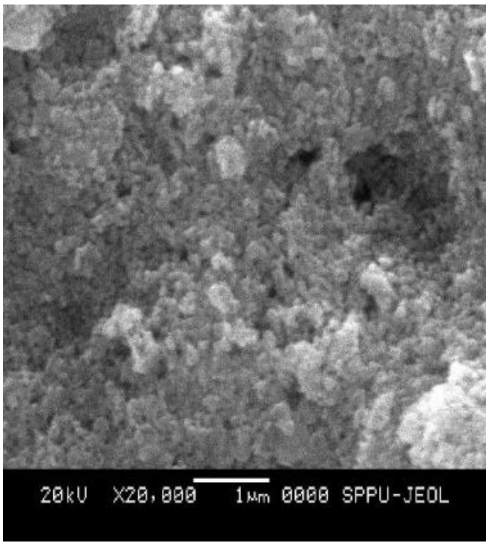


Fig 2 a **Fig.2 b**

Fig. 2 a,b) SEM Images of prepared $LaYCrO_3$ nanomaterial.

Elemental Analysis:

With the help of energy dispersive spectroscopy (EDS) we can study the elemental composition present in material, which is very useful to find out tenuous concentration of elements, present in the prepared material, The EDS spectrum of LaYCrO3showsits elemental composition, such that La- 10.40%,

Cr- 10.20%,Y-0.14%, O- 79.26% as shown in Table 1 from which the exact elemental ratio of prepared $LaYCrO_3$material is can be seen from fig.

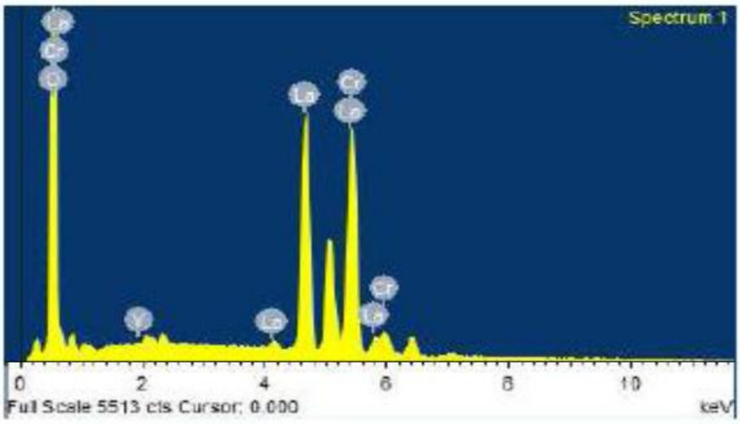


Fig. 3: EDS image of $LaYCrO_3$ nanoparticles showing elemental composition of prepared $LaYCrO_3$ material

Table 1

Sr. No.	**Element**	**Elementary Weight % calculated from EDS**
1	Oxygen	79.26%
2	Chromium	10.20%
3	Lanthanum	10.40%
4	Yttrium	0.14%
	Total	**100%**

FTIR Analysis:

One of simplest and widely used techniques for characterization of almost all types materials is FTIR spectroscopic technique. Basically it gives the idea about stretching frequencies of functional group of a material to the researcher . Thus metal oxide stretching frequencies can be confirmed, for normal metal oxides from FTIR studies. The FTIR of prepared material is shown infig.4 from which shows characteristic absorption bands at 590.22 cm^{-} for La –O stretch and 447.49 cm^{-} for Cr-Ostretch [13,14,15]can be seen from fig.4

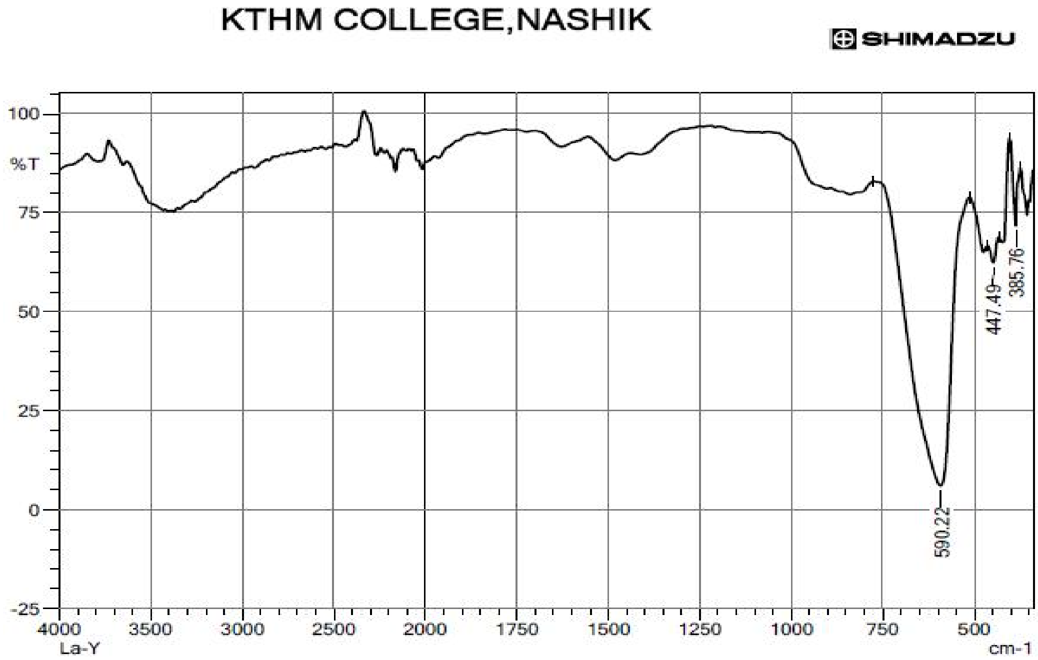


Fig.4: FTIR spectrum of synthesized $LaYCrO_3$, Nanoparticles.

CONCLUSIONS:

The $LaYCrO_3$ material successfully prepared by sol-gel methodand their thick films also prepared by conventional screen printing method. Characterization is done by XRD from whichnanoparticles of prepared $LaYCrO_3$up to 24.66nm.are confirmed. From SEM studies we canobserved that the heterogeneous surface of $LaYCrO_3$ microspores and mesopores as seen from its surface micrographs. It is greyish black in colourand from EDS this is proved that prepared nanoparticles have fixed elemental composition. From IR the stretching frequencies observed for prepared nanoparticles are the absorption bands at 590 cm^- for La –O stretch and 447.49 cm^- for Cr-O stretch showed by FTIR studies.

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