Synthesis and Characterization of $LaCrO_3$ By Sol-Gel Method

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ABSTRACT

The researchers having a huge attention in the field of nanomaterial due the wide applications in the field of science and technology. The nonmaterial's proves as a promising material in the field of catalysis .In this paper we explain the synthesis of $LaCrO_3$ nanoparticles 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 by XRD, SEM, EDS and IR spectroscopy. The prepared nanoparticles were characterized by XRD from which the average crystallite size calculated by Scherrer's formula found to be 13.01nm having JCPDS Card No. 33-0701 from which thelanthanum chromate is a Pervoskite type orthorhombic material. The SEM spectrum shows greyish black surface of lanthanum chromium oxide nanoparticles. The EDS of $LaCrO_3$ 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 594.08 cm^- and 420.48 cm^-respectively.

KEYWORDS: LaCrO3, 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 nanoparticles high energy ball milling and melt mixing, method based on evaporation, such as physical vapour deposition ,laser vaporisation,(ablation) ionised cluster beam deposition ,laser pyrolysis, sputter deposition such as magnetron sputtering, ECR plasma deposition, electric arc deposition, molecular beam epitaxy (MBE),chemical vapour deposition, synthesis of nanoparticles by colloidal route, Langmuir-Blodgett method, hydrothermal synthesis, sonochemical synthesis, microwave synthesis[1,2]. These nanoparticles are used as a catalyst because of their large surface area. The metal oxides nanoparticles can be useful as gas sensors for most of gases. Metal oxides give huge surface zone those aides in catalytic utilization of materials. 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 [1,2]. 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 MerckChemicals Mumbai and used without further purification. Chemicals involves Lanthanum nitrate, Chromium nitrate, Citric acid, Double distilled water

Synthesis of $LaCrO_3$ nanoparticles:

The LaCrO3 prepared by sol-gel method. For this synthesis first dissolve lanthanum nitrate [La (NO3)3] 0.07 moles, chromium nitrate [Cr (NO3)3] 0.075 moles in minimum amount of distilled water , while dissolve citric acid0.09 moles in another beaker. Both the solutions then mixed and heated at 80^0C with continuously stirring toevaporate distilled water on the magnetic stirrer for minimum 2- 3 hours. 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.[2,9]

Preparation thick films of LaCrO3 nanoparticles:

Thick film preparation method is similar to our earlier work[1]. The powder of nanoparticle of $LaCrO_3$ 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 ($LaCrO_3$). The organic part consisted of 8% ethyl cellulose and 92% butyl carbitol acetate. The $LaCrO_3$ 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.

RESULTS AND DISCUSSIONS

XRD analysis:

The XRD spectrum for prepared doped LaCrO3 is as shown in fig.1.The spectrum shows the main 2θ peaks at 32.33^0 , 40.050^0 ,46.56^0 ,57.99^0 ,68.020^0 From which the average crystallite size calculated by Schererformula Eq. (**1**).is 13.04 nm.

$$D = K\lambda/\beta \cos\theta \quad \ldots\ldots\ldots\ldots\ldots (1) \text{ [Scherer formula]}$$

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]. The JCPDS Card No. for this prepared material is 33-0701. From which we confirmed that our material is orthorhombic.

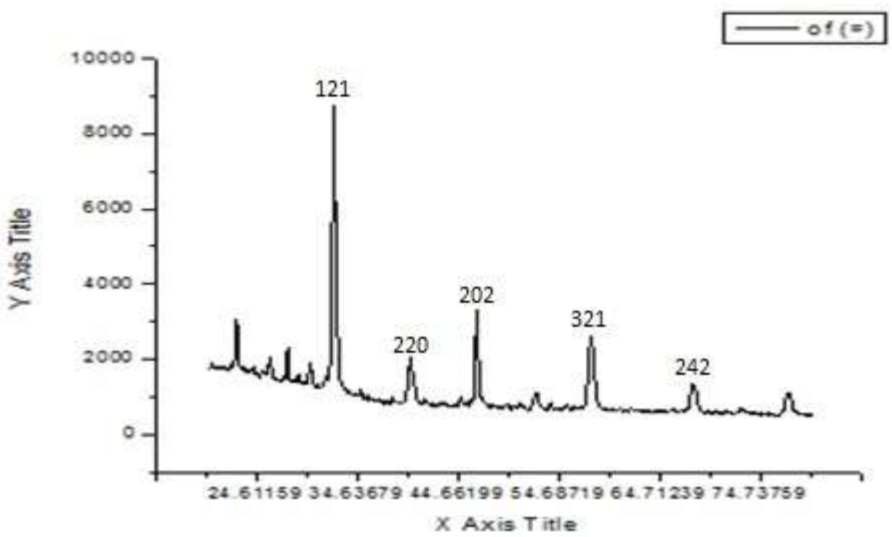
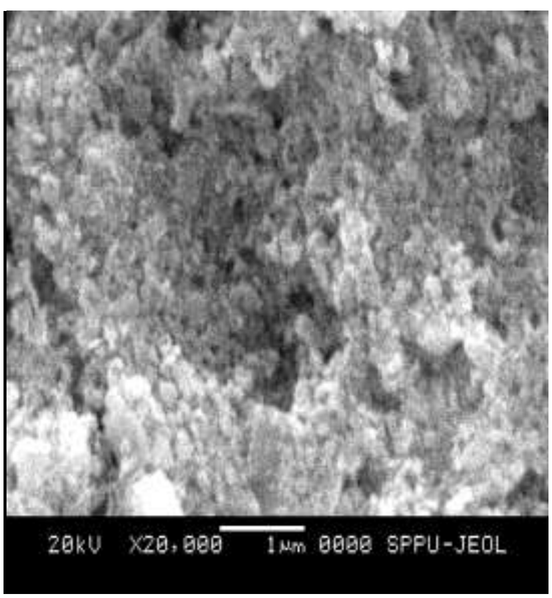


Fig.1. XRD image of prepared LaCrO$_{ss}$Nanoparticles

SEM Analysis:

The scanning electron microscopy(SEM) images of prepared LaCrO3Nanoparticles are shown in fig.2, a and b at 20,000 and 10,000 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.



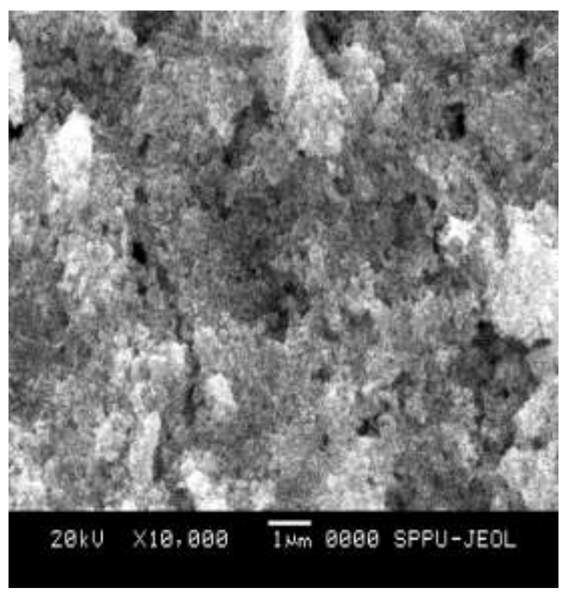


Fig 2 a **Fig.2 b**

Fig. 2 a,b) SEM Images of prepared $LaCrO_3$ nanomaterial.

Elemental Analysis:

With the help of energy dispersive spectroscopy (EDS) we can study the elemental composition in material, which is very useful to find out subtle concentration of elements, present in the prepared material, The EDS spectrum of LaCrO3showsits elemental composition, such that La- 11.33%, Cr- 10.46%, O- 78.21% as shown in Table 1 from which the exact elemental ratio of prepared LaCrO3 material is can be seen from fig.

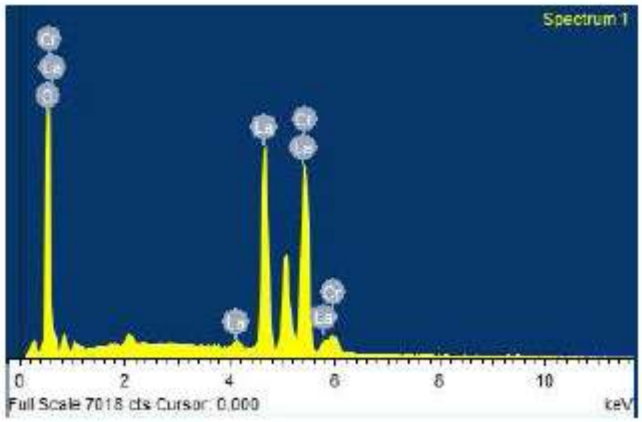


Fig.3 EDS image of $LaCrO_3$ nanoparticles showing elemental composition of prepared $LaCrO_3$ material

Table-1

Sr No.	Element	Elementary Weight % calculated from EDS
1	Oxygen	78.21%
2	Chromium	10.46%
3	Lanthanum	11.33%
	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 . As LaCrO3is ABO_3 type Pervoskite material in which A and B is any metal from transition elements, inner transition elements and P-block metal element is can be conceivable. Thus metal oxide stretching frequencies can be confirmed, for normal metal oxides from FTIR studies. The FTIR of prepared $LaCrO_3$material is shown infig.4 from which shows characteristic absorption bands at 594.08 cm^{-} for La –O stretch and 420.48 cm^{-s} for Cr-O stretch [13,14,15]can be seen from fig.4

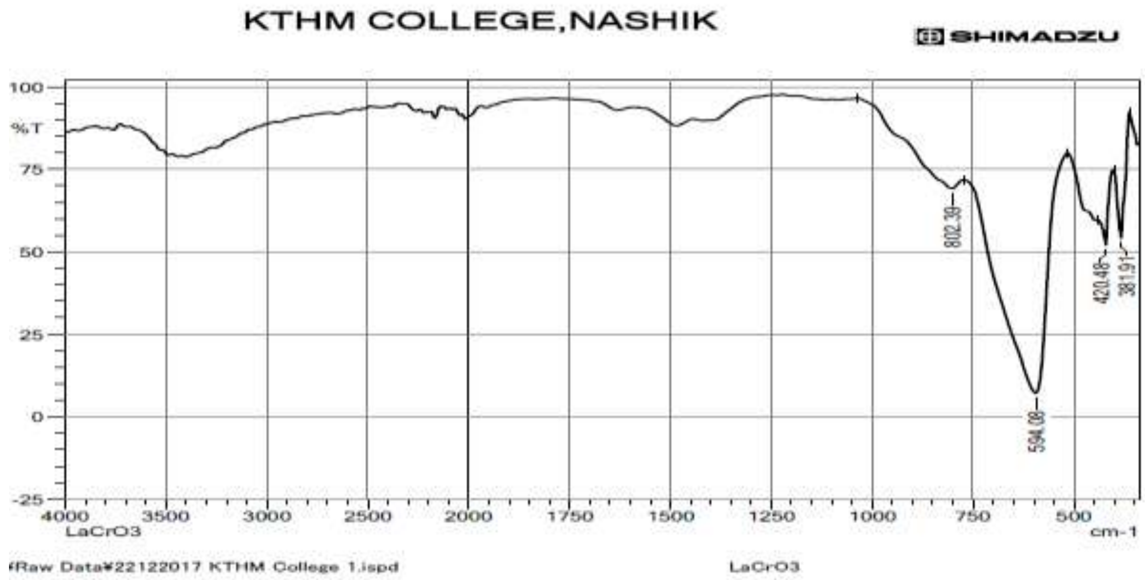


Fig.4: FTIR spectrum of synthesized $LaCrO_3$, Nanoparticles.

CONCLUSIONS

The orthorhombic $LaCrO_3$ Pervoskite material successfully prepared by sol-gel method having JCPDS card No. 33-0701 and their thick films also prepared by conventional screen printing method. Characterization is done by XRD from whichnanoparticles of prepared $LaCrO_3$up to 13.01nm.are confirmed. From SEM studies we canobserved that the heterogeneous surface of $LaCrO_3$ microspores and mesopores as seen from its surface micrographs. It is greyish black in colour and 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 596 cm^- for La –O stretch and 416.04 cm^- for Cr-O stretch showed by FTIR studies.

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