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**Abstract**

In the present paper we report the synthesis of spinel Manganese Chromite’s (MnCr$_2$O$_4$) Nano-Crystalline by sol gel method. The sample was calcined at different temperature like 750$^\circ$C and 950$^\circ$C for good results. Ethylene glycol which is used to control the agglomeration of Nanoparticles. By powder x-ray diffraction combine average particle size of Nanoparticles was determined which shows that crystal size increases from 18nm to more when we increase the sintered temperature. SEM shows that results are in good agreements. From PL spectra the band gap energy was calculated which is almost 4.03 eV at 750$^\circ$C but it can decrease when we increase the temperature like 950$^\circ$C is 3.89 eV. Raman results showed that wavelength is maximum like 1306cm$^{-1}$ and 1465cm$^{-1}$.

**Keywords**

Synthesis, Spinel Maganese Chromites, Sol-gel Method, SEM.
1. Introduction:

In normal structure spinels are good group of minerals, which concentrate in a cubic crystal system with anion oxide arranged in a cubic filled framework. Cation A reside in tetrahedral site and Cation B also in octahedral site in the lattice. They are also like divalent form such as AA and BB and as trivalent or quadrivalent cation such as Manganese, Aluminum, Zinc and Magnesium and Chromium. Oxygen is usually anion site. These spinels and spinels like compounds are increasingly used in scientific phenomena. These spinels are widely used in architectural science due to interesting chemical properties like moisture sensor, Catalyst, Magnetic materials, Semiconductors, high-temperature ceramics, and hard materials. Manganese chromites ceramic spinels are widely used as regenerative agents, moisture sensors, and valuable substance.

For the synthesis of Manganese chromites various methods have been reported including Mechanical formulation, Chemical method, ultrasonic spray pyrolysis, micro emulsion method, microwave method, solution method, heat method, ball grinding method and sol gel method. Maximum systems are challenging to use in extensive manufacture due to long reaction times, extraordinary reaction temperature, toxic reagents, due to complex processes and products from those synthetic method. So here we used sol gel method which is friendly environment and low-cost method.

Our energy demand grows everyday fossils fuels shortage and environmental issues arising out of it. Excess use of fossil fuels. Researchers around the world are actively pursuing alternative methods of energy production such as batteries capacitor and fuel cell. Rechargeable metal are batteries and regenerative fuel cell dependent and oxygen electrolysis catalyst with high theoretical STI discharge C energy density, energy, fast charge-discharge mechanism, Non-toxic nature, and environmental friendliness ideal are option. These devices require oxygen ulcers are high-performance and both are capable of oxygen deficiency and developmental reactions. Main bottle neck modern energy and conversion equipment is lacking in roc efficient and durable bifunctional oxygen electro catalyst cathode compartment. Platinum based electro catalyst are most considered efficient catalyst for oxygen deficiency response.

In this paper we have synthesized spinel of Maganese chromites by means of sol gel technique and calcination temperature was 750°C for 4 hours. Cineration temperature effect the structure, surface of Nanoparticles.

2. Experimental Section:

2.1. Materials required:

Manganese Nitrate (Mn(NO₃)₂.4H₂O, Chromium Nitrate Cr(NO₃)₂.9H₂O), distilled water and 1, 2 Ethanediol all are purchased from sigma Aldrich.

2.2. Synthesis of a Sample:

For the synthesis of Manganese precursor gel stoichiometric amount of Mn(NO₃)₂.4H₂O and chromium nitrate were dissolved in de-ionized water and mix. After becoming a homogenous solution stirrer, the solution at 40-50°C for 20 minutes. After stirring the temperature add 1, 2 Ethanediol dropwise at same temperature for 1 h. The solution concentrated by evaporating the solution at 60-70°C. Prepared ointment was dried up at 105°C in oven for 3 hours. Dried gel was ground in agate motor and calcined at 750°C for 4 hours.
3. Discussion and results:

3.1. XRD:

X-ray diffraction pattern of Nano-particles Manganese chromites obtained by sol-gel method depending on calcination temperature shown in fig 1. As the evidence about crystal arrangement and sample level is observed by X-ray technique. The XRD arrangement of MnCr$_2$O$_4$ is shown in figure 1.2. We can observe that value of 2$\theta$ starts from 20 to 70 and the main peaks of X-ray results according to given calcination temperature was 750°C are 20.5, 30.5, 40, 40.5, 45.5, 50.5, and 55.5. Crystal structure of spinel is cubic that showed that sample has reached a high purity. At 750°C temperature we obtain single phase spinel. Lattice parameters of samples a and c which analyzed at 750°C are 6.115Å and 13.244Å correspondingly. These are the c and our coordination parameters that are most relevant to those listed. C/a ratio is 13.087Å. Spatial space of spinel is 141/amd. The composition is in the form of mixed valence oxide (+2 and +3 oxidation state) where Maganese contain (Mn$^{+2}$) octahedral sites. For MnCr$_2$O$_4$ similar diffraction exist peaks and crystal planes indexed with spin cubic structure with some weak characteristic’s peaks of Cr$_2$O$_3$. The crystalline size of Maganese chromites is calculated by using Scherer’s formula which is almost 18nm respectively.

![Fig 1: Schematic diagram of synthesized Manganese chromites](image)

![Fig 1.2: Xrd pattern of MnCr$_2$O$_4$ calcination at 750°C](image)
3.2. **Scanning Electron Microscopy:**

Surface morphology of manufactured Mn-Cr-O nanoparticle has been investigated by using Scanning electron microscopy. It has been shown to be relatively small and fine particles when we increase the temperature of spinel. Under altered situations, SEM phantasmagorias are designed as show in fig 1.3. With low consistency, the particles have semi-spherical structure, the results of which can be seen that can be particle have well separation good symmetry and spherical shape. Increase the temperature above 750°C makes the particle more disorganized and less spherical between particles. It was also looked at that molar balance Mn/Cr has a significant effect on the size and shape of brush.

![Scanning electron microscopy of Manganese chromite](image1)

**Fig 1.4: Scanning electron microscopy of Manganese chromite**

3.3. **Raman Spectroscopy:**

The Raman spectra for MnCr$_2$O$_4$ which shows in fig 1.4 spinel in the region are between 1200 to 1600. And this spectrum shows the collective features has a strong tip around 1465cm$^{-1}$ and group of approaches between 1200 and 1600C. The less powerful structure is measurable at around in 1500 in each sample.

![Raman spectroscopy of Manganese nitrate](image2)

**Fig 1.4: Raman spectroscopy of Manganese nitrate**
3.4. PL spectroscopy:
Monitoring is appropriate by Photoluminence that the physical properties of Nano-particles changes with their dimensions and reduced by a nanometer measured called a quantum volume effect. From recombination of surface state Photoluminence can be originates. The Nano-particle photovoltaic tissues shows that the wavelength at room temperature is 347nm according to fig. 1.5. For example, it was observed from Photoluminence quantum confinement increase the band gap energy of MnCr$_2$O$_4$. In addition, other is located approximately at 500nm characteristics for the presence of ionized Mn vacancies alone. The spectrum shows two emission peaks one available around at 380nm in (UV region) corresponding to the excitonic release of the adjacent band space. Furthermore, the spectrum also reveals luminance powder narrow size diffusion of Nanoparticles across the entire width and only a few maxima in Nano-meters (FWHM).

![Fig 1.5: PL spectroscopy of Manganese nitrate](image)

Conclusion:
The results showed that the Manganese chromites spinel structure was wonderfully synthesized by the predicted sol-gel method using chromium, Manganese nitrate as the ancestors under thermal decomposition. Sample Xrd data confirmed Nano-fusion formation MnCr$_2$O$_4$ at calcination temperature of 750˚C. This method demonstrates the genius potential in the production of MnCr$_2$O$_4$ for mass production. Calcination temperature 750˚C is required to find spinel Manganese chromites shows by Xrd analysis. SEM images are displayed particle- like sphere has a diameter of 33nm. The P.L. Nano structure reveals the band gap 4.03ev and when we increase temperature in it band difference is reduced and become 3.89ev, which is associated with the band gap transition. The obtained MnCr$_2$O$_4$ are in the form of cubes with an average particle size of 30-50nm that are interrelated weak wander walls talks with an overlapping mesh fringes.

References


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