



Review on: Synthesis of Perovskite using Sol-Gel approach

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Abstract:

Lead halide perovskites have emerged as one of the leading photovoltaic materials due to their long carrier lifetimes, high absorption coefficients, high tolerance to defects, and facile processing methods. Which makes them now already comparably efficient to silicon-based photovoltaics. High efficiency, flexibility, and cell architecture of the emerging hybrid halide perovskite have caught the attention of researchers and technologists in the field. This article provides a comprehensive review on characteristics of perovskite materials; perovskite material preparation and synthesis method and recent progresses are reported. Sol-Gel is a low cost, well-established and flexible synthetic route to produce a wide range of micro- and nanostructures. Small variations in pH, temperature, precursors, time, pressure, atmosphere, among others, can lead to a wide family of compounds that share the same molecular structures. In this work, we present a general review of the synthesis of LaMnO₃/LaCrO₃ based on Sol-Gel approach.

Keywords - Perovskite, Sol-Gel, nanoparticles, specific surface area, LaMnO₃ / LaCrO₃.

1. Introduction:

Every day, conventional, non-renewable fossil fuels energy consumption rapidly increases which causes humiliation of the environment through global warming, acid rains, increase in carbon dioxide content in the environment, smog etc. Eco-friendly energy resources such as solar, wind and tidal, and hydropower make best replacement for the fossil fuels so that, the utilization of conventional energy source can be avoided. Solar photovoltaic technology is one of the emerging renewable technologies. Recently, an emerging Photovoltaic solar cells based on organometal halide perovskite

materials which provide high efficiency and stability with low cost becomes attractive alternative to conventional photo voltaic Solar cell. The perovskite material has ability to achieve power conversion efficiency close to Cadmium Telluride (CdTe). The efficiency of methyl ammonium lead halide perovskite sensitized solar cells advancement from 3.8% to 22.1% within a very short period of research and development [1].

Perovskites shows diversity of electric, optical, and magnetic properties. Perovskite oxides shows variety of electrical properties and a variety of solid-state phenomena from insulating, semiconducting, metallic, and superconducting characters. Therefore, they are very interesting to be studied and applied in a large scale. The family of perovskite material consists large number of oxide forms, such as transition metal oxides with the general formula of ABO_3 . The oxide perovskite materials are broadly synthesized and studied for wide applications in different technological fields.

Perovskite was initially discovered by German geologist Gustav Rose in 1839 in Ural Mountains, and named after Russian mineralogist Lev A. Perovski, Lev Perovskii had discovered a cubic crystal structure with chemical composition $CaTiO_3$. This structure was named calcium titanium oxide ($CaTiO_3$) which had calcium ion (Ca^{2+}) at the corners, titanium ion (Ti^{2+}) BCC (body cubic-centred) and oxygen (O^{2-}) at the FCC (face cubic-centred) in a cubic crystal. Between both the cation, i.e. calcium and titanium, calcium ion was bigger in size. Perovskites exhibit general configuration ABX_3 which represents A as cation of bigger size, B as cation of smaller size, whereas X represents negative ion mostly of oxygen or halogens. In perovskites crystals, cation A is located between BX_6 octahedron connected through apex angle while cation B, possessing six fold coordination, is surrounded by an octahedral of anions [2,3]. In 1926, V. M. Goldschmidt, who was the first which synthesize and study perovskites materials, which were $CaTiO_3$, $NaNbO_3$, $SrTiO_3$, and $BaTiO_3$. In 1986, high temperature superconductivity in ceramics and perovskites was discovered by J. G. Bednorz and K. A. Muller [4,5].

2. Overview of Perovskite materials :

The chemical formula of perovskite material must have neutral balanced charge; therefore, the sum of total charges at A and B sites cations must be equal to total charges at O site (oxygen) of anion(s). A suitable charge distribution is to be achieved in the forms of $A^{3+} B^{3+} O^3$ or $A^{4+} B^{2+} O^3$ or $A^{1+} B^{5+} O^3$.

Based on ionic size limitations for the required cations and anions, a stability and formability range for ABX_3 perovskite with a cubic crystal structures can be achieved by following fundamental requirement, which are given as: The average ionic radii of A- and B-sites cations must be greater than 0.90 \AA and 0.51 \AA , respectively, and The value of tolerance factor must be lies in the range of 0.88–1.09. If the tolerance factor equal to unity i.e., $t = 1.0$ then it is indication of ideal perovskite crystal [6,7].

To form a perovskite structure, radius of ions A, B and X must obey the following rules:

$$\text{Rule of Tolerance Factor (TF): } 0.81 < TF = \frac{RA+RX}{\sqrt{2}(RA+RX)} < 1.110$$

$$\text{Rule of octahedral factor (OF): } 0.44 < \mu = \frac{RB}{RX} < 0.9$$

Where,

RA, RB and RX are ionic radii for A, B and X ions, respectively.

Following figure 1, shows structure of an ideal ABX_3 - type perovskite with a cubic crystal structure. Where A and B are cations with different electronegativity and size while X is an anion that is bonded to both A and B. It is important that, an atom has lower electronegativity and bigger atomic radius than atom B, due to symmetrical purposes of the crystal cubic structure. Any material with same crystal structure is called perovskite material. Depending on cations and anion they exhibit different properties like super conductivity, ionic conductivity, high thermal power etc..[8-10]

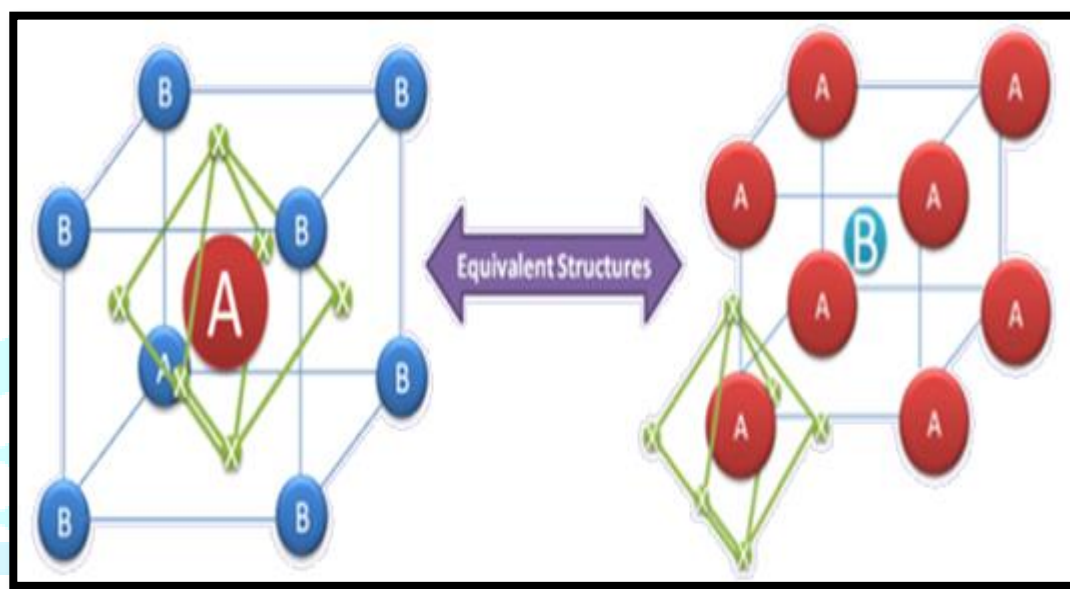


Figure 1: The general perovskite cubic crystal structure ABX_3 ,

Where, A and B are cations and X is an anion.

3. Synthesis methods of perovskite material:

There are various methods reported to synthesis of the perovskites structure which are: solid state reaction, co-precipitation, hydrothermal, alkoxide hydrolysis, metal-organic processing, sol-gel, electro spinning, electrochemical, microwave synthesis, physical vapour deposition, molecular beam epitaxial, the Pechini process, chemical vapour deposition, chemical solution deposition, Combustion Method etc..[11-14].

Athayde, D. Souza, D.F. Silva, A. Vasconcelos, D. Nunes, E.H. da Costa, J.C.D. reported that, Alkoxide, alkoxide-salt, and Pechini methods are the most popular Sol-Gel-based techniques used in the synthesis of perovskites. Sol-Gel method is one of the simplest techniques to synthesize high-quality nano and microstructures. The Sol-Gel Pechini method became the most used due to its versatility in preparing perovskite membranes, depositing dielectric films for the production of capacitors and multicomponent oxide materials. Sol-Gel is a low cost, well-established and flexible synthetic route to produce a wide range of micro- and nanostructures. Small variations in pH, temperature, precursors, time, pressure, atmosphere, among others, can lead to a wide family of compounds that share the same molecular structures. [15].

3.1 Sol-gel method:

The Sol-gel method is frequently used to synthesize nanomaterials. High stability and selective sensitivity of ABO_3 -type perovskite materials have an advantage that could be controlled by selecting suitable A and B atoms or by chemical doping. $NiTiO_3$, $CoTiO_3$, $BaZrO_3$, $LaMnO_3$, $MnTiO_3$, $PbTiO_3$ are some examples of common perovskite oxides. The Sol-gel process is one of the techniques among several reported techniques for preparation of perovskite materials. It is an appropriate technique for synthesis of dense nanomaterials with homogeneous texture and uniform morphology [60-61].

Parashar, M. Shukla, V.K. Singh, R. et. al. [16] describe that The Sol-Gel method involves the use of a colloidal solution (Sol) that evolves into a gel-like network including both a liquid and a solid phase as a result of several chemical reactions. It can be divided into two types: aqueous or hydrolytic and non-aqueous or non-hydrolytic. The aqueous Sol-Gel process can be described in five steps: hydrolysis, condensation, aging, drying and crystallization.

Sol-gel process gel is a chemical route used to synthesize glassy or ceramic materials at relatively low temperatures, based on wet chemistry processing, which involves the preparation of a sol, the gelation of the sol and the removal of the liquid existing in fine interconnected channels within the gel. It is combination of physical and chemical processes which includes following processes hydrolysis, condensation, polymerization, gelation, drying, and densification etc. The principle of Sol-gel method is based on a compound reaction between metal cations and a chelating agent (such as citric acid, or ethylene glycol also ethylenediaminetetraacetic acid (EDTA), oxalic acid, tartaric acid or glucose). The molar ratio for metal ions and chelating agent should be 1:1. It shows high reproducibility and an enhanced degree of homogeneity of the reaction mixture. In this method metal alkoxides as starting material, which is derivative of the alcohol ROH, where R is an alkyl group or a derivative of metal hydroxide $M(OH)_x$. The stoichiometric amounts of metal alkoxides dissolved in alcohol or distilled water at a temperature of 60–80°C under constant stirring. pH value of the metal alkoxides solutions must be control to avoid the formation of the precipitation and the homogeneous gel which can be carried out using basic or acidic solutions. It is called hydrolysis and condensation, which brought out formation of polymer chain. The polymer chain improve the viscosity of reaction mixture and produces gel. Then produced gel were beaten and grinded, and then calcined for 5-6 hours at 550⁰ C to obtain the pure materials[17-18]. Figure 2, reveals that the different stage of sol-gel method

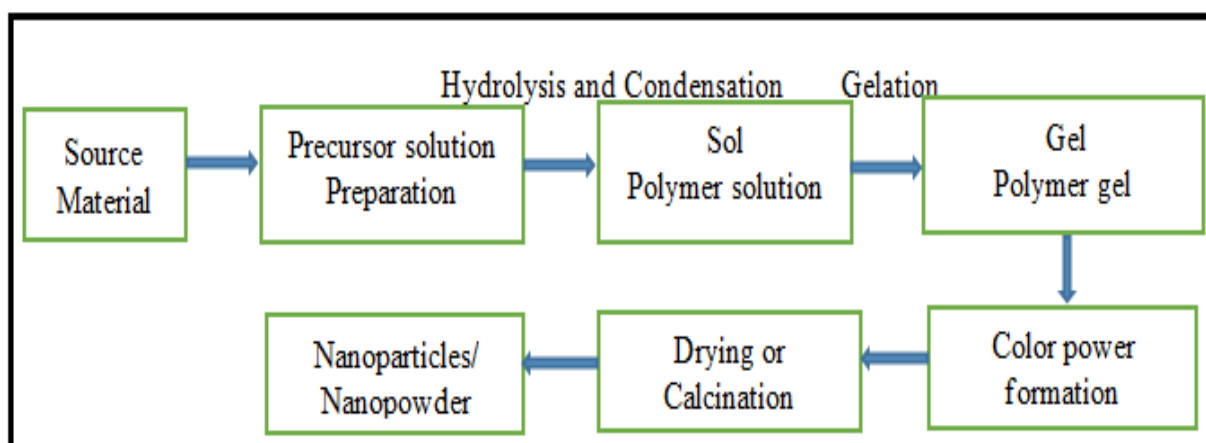


Figure 2: different stage of sol-gel method

Pechini, M.P.et al. [19]. reported that, the most significant advantages of Sol-Gel Pechini method process is its simplicity and the low-temperature precursor handling. This results in the fabrication of nanopowders with excellent purity and uniformity, as well as precise control of the final composition of the material. This method is also a popular choice for the synthesis of various mixed oxides due to its capacity to combine chemicals (such as lactic, glycolic, citric, and EDTA acids) leading to the creation of polybasic acid chelates with dissolved cations.

Kurajica, S. et al. [20] reported that, Chelating agents are employed to prevent et. al. partial metal segregation in the final compound, which might occur as a result of various interactions between metal ions in the solution. The polyesterification of chelates occurs when a polyhydroxy alcohol is added to the solution and heated, resulting in a cross-linked chain of metal atoms connected to organic radicals. When two chelating agents work together to complex all metal ions, a precursor solution is formed with all metal ions entirely bound. As a result, a more stable chelate complex system develops and the polymerization is aided by the following addition of ethylene glycol, which enhances uniformity. This method tends to reduce metal segregation after decomposition under heat treatment settings. In the synthesis process and subsequent heat treatment, the ratio of metal precursors to chelating agents is critical. In theory, this ratio should be high enough to ensure that all metal ions are tightly bound to their structures and prevents precipitates in the solution. The Sol-Gel Pechini method offers an excellent control over perovskite structure producing very homogeneous solutions. At temperatures near 1000 °C, this approach results in the creation of pure crystal perovskite structure [21].

Shinde, V.S. Kapadnis, K.H. Sawant, C.P. Ahiraro, A.N.et. al. [22] synthesized LaCrO_3 by sol-gel method. For this synthesis initially hydrolyze 3.03 g lanthanum nitrate [$\text{La}(\text{NO}_3)_3$], 3g chromium nitrate [$\text{Cr}(\text{NO}_3)_3$] in optimum distilled water, and 1.72g citric acid in different beaker. Both solutions are mixed and then heated at 80°C with constant stirring on magnetic stirrer to evaporate distilled water for minimum 2- 3 hours. During process of stirring a homogeneous viscous gel were obtained having dark greyish colour. This gel get initially dried under IR lamp for 1-2 hours. Then rough particles were beaten and grinded, and then calcined for 5-6 hours at 550° C. finally, pure material of LaCrO_3 obtain in greyish colour.

Pechini, M.P.et. al. [19] reported that, LaMnO_3 is a perovskite with the general formula ABO_3 . Each B atom occupies the vertex of the perovskite lattice and six oxygen atoms surround it to form an octahedron. The A element occupies the center of eight octahedrons. The oxidation state of B cation can be modulated by varying preparation steps during the perovskite synthesis, such as temperature, non-stoichiometry of cations A or B or substituting La^{3+} by lower oxidation state cations, such as Ca^{2+} , Ba^{2+} or Sr^{2+} , or even higher oxidation state cation such as Ce^{4+} . Sol-Gel technique is one of the easiest and most efficient methods to synthesize different LaMnO_3 nanoparticles.

Liu et. al. [27] synthesised LaMnO_3 of high surface area using citric acid and ethylenediaminetetraacetic acid (EDTA) as chelating agents. They found that EDTA-citrate produced smaller nanoparticles than the single citrate acid. The samples exhibited a high specific surface area showing excellent oxygen reduction and evolution reaction catalytic performance.

Shaterianet. al. [28] synthesised LaMnO_3 nanoparticles via Sol-Gel process using stearic acid as complexing reagent. The as-synthesized nanoparticles showed pure perovskite structure which presented a rhombohedral structure with average particle sizes of 20–30 nm.

Onrubia-Calvo et. al. [29] synthesised a series of Sr-doped $\text{La}_{1-x}\text{Sr}_x\text{MnO}_3$ perovskites ($x = 0.1, 0.2, 0.3, 0.4$ and 0.5) by varying citrate to nitrate molar ratio in the starting solution, pH and calcination protocol.

ChaozhuShuet. al. [30] used a facile nonstoichiometric strategy to introduce A-site cationic vacancies in LaMnO_3 , $\text{La}_{0.9}\text{MnO}_3$, $\text{La}_{0.7}\text{MnO}_3$, perovskite oxides were synthesized by combining Sol-Gel method and thermal treatment process in air. This procedure provides the advantage of great specific surface area and abundant cationic La vacancies on the surface, $\text{La}_{0.7}\text{MnO}_{3-\delta}$ ($\text{L}_{0.7}\text{MO}$) can provide effective active sites for oxygen electrode reactions and a large storage space for Li_2O_2 accommodation.

Amador, C.; Martin de Juan, L et. al. [31] reported that, the specific surface area (SSA) plays an important role in the synthesis processes. Depending on the preparation method of the perovskite material, the porosity, size and shape of pores and the pore distribution are impressively distinct. The comparative study of perovskite material, synthesis method and specific surface area are mentioned in following Table 1.

Table 1: Comparison of sol gel and other synthesis approaches w.r.to specific surface area

Perovskite Material	Preparation Method	specific surface area (SSA) in (m^2/g)	References
LaCoO_3	Solid-state synthesis	3.0	34
LaCoO_3	Sol-gel Method	15.0	37
LaCoO_3	Combustion method	5.7	39
LaCoO_3	Co-precipitation	8.0	38
LaMnO_3	Solid-state synthesis	4.0	34
LaMnO_3	Sol-gel Method	22.0	36
LaMnO_3	Combustion method	21.8	41
LaMnO_3	Co-precipitation	11.0	40
LaFeO_3	Solid-state synthesis	3.1	34
LaFeO_3	Sol-gel Method	16.5	32
LaFeO_3	Combustion method	9.3	32
LaFeO_3	Co-precipitation	5.4	32
BaTiO_3	Solid-state synthesis	0.4	35
PbTiO_3	Solid-state synthesis	0.5	35
LaAlO_3	Sol-gel Method	4.0	36
$\text{LaAl}_{0.6}\text{Mn}_{0.4}\text{O}_3$	Sol-gel Method	25.0	36
$\text{LaAl}_{0.4}\text{Mn}_{0.6}\text{O}_3$	Sol-gel Method	26.0	36
LaNiO_3	Solid-state synthesis	4.8	34
LaCuO_3	Solid-state synthesis	0.6	34
NdMnO_3	Sol-gel Method	20.0	43
SmMnO_3	Sol-gel Method	19.0	43
NdFeO_3	Sol-gel Method	2.3	44
SmFeO_3	Sol-gel Method	4.3	44
PrCoO_3	Co-precipitation	5.1	42
NdCoO_3	Co-precipitation	1.6	42

GdCoO ₃	Co-precipitation	2.1	42
LaCrO ₃	Solid-state synthesis	1.9	42
LaCrO ₃	Sol-gel Method	5-7	33
LaCr _{0.5} Mg _{0.5} O ₃	Sol-gel Method	6.08	33
LaCr _{0.5} Mg _{0.5} O ₃ ·2MgO	Sol-gel Method	13.6	33
LaCr _{0.5} Mg _{0.5} O ₃ ·6MgO	Sol-gel Method	24.2	33

The specific surface area of the perovskite is strongly affected by which preparation method to be used. From above table.2 it is conclude that, the highest surface areas mainly obtained by sol-gel better than other synthesis methods. Sol gel method provide better control of the structure, including porosity and particle size; possibility of incorporating nanoparticles and organic materials into sol-gel-derived oxides. Also sol gel method allows the fabrication of any oxide composition, but also some non-oxides, as well as the production of new hybrid organic-inorganic materials, which do not exist naturally. It provide high purity due to mixing at the molecular level. It does not requirespecial or expensive equipment.

4. Characterization of perovskites:

Lozano-Gorrín, A.D [45], and Abd Al-Rahman [46].Reported that, Phase and purity of synthesized nanoparticles plays very important role for the conclusion about the properties exhibited by the nanoparticles. Hence X-ray diffraction technique to identify the phase of perovskites. Phase purity of synthesized pervoskite can be identify by matching the XRD pattern of the synthesized material with the standard XRD pattern of the cubic phase of CaTiO₃ perovskite, Relative phase fractions of different phases present, lattice constants, unit cell volume, crystallite size, lattice strain, and theoretical density in the prepared nanoparticles can easily recognize by XRD data. Also FTIR (Fourier-transform infrared spectroscopy) used to identify chemical bonding and chemical structure of the prepared perovskites, FTIR can give structural confirmation which is similar to that obtained through XRD. Thermal stability and decomposition temperature of the prepared perovskites can be characterized by using thermal analysis techniques like Thermogravometric analysis (TGA), Differential thermal Analysis (DTA), and Differential scanning calorimetry(DSC).Scanning electron microscopies (SEM) and transmission electron microscopies (TEM) can be used to recognize the different morphological and surface characteristics of the synthesized perovskites.Measurement of the specific surface area of the prepared materials become important because, electrochemical performance and electro catalytic activity of the perovskites are mostly related with the specific surface area of the materials. Hence surface area values of synthesizedperovskites can be measured by Brunauer–Emmett–Teller (BET) nitrogen adsorption. XPS (X-ray photoelectron spectroscopy) also used to identify surface compositions of the various components of the prepared perovskites.

Shinde, V.S. Kapadnis, K.H. Sawant, C.P. Ahiraro, A.N. et. al. [22]. Synthesized the synthesis of LaCrO₃ nanoparticles dopped with Yetria 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⁻¹ and 447.49 cm⁻¹ respectively.

Gosavi, P.V. Biniwale, R.B. et al. [47]. Synthesized LaFeO₃ using sol-gel, combustion, and co-precipitation and measured the surface area and the average pore diameter of the prepared perovskites. They reported that, the surface area and Average pore diameter of the prepared LaFeO₃ as shown in Table 2 below.

Table 2:The Specific Surface area and Average pore diameter of the prepared LaFeO₃ for different synthesis methods.

Perovskite Material	Preparation Method	specific surface area (SSA) in (m ² /g)	Average pore diameter in A°
LaFeO ₃	Sol-gel Method	16.5 m ² / g	119 °A
LaFeO ₃	Combustion Method	9.3 m ² / g	140 °A
LaFeO ₃	Co-precipitation Method	5.4 m ² / g	205 °A

From above table it is observed that, Sol-gel and combustion methods resulted in higher porous surface with large internal pores contributing to higher surface area, while co-precipitation method resulted in less internal pores and lower surface area due to longer calcination time.

Situmeang, Rudy & Sembiring, Simon & Simanjuntak, Wasinton & Sembiring, Zipora & Yuwono, Surtpto. et al. [56]. Synthesis LaCrO₃ nanomaterial is using simultaneously the sol-gel and the freeze-drying method. Nitrate salts of lanthanum and chrome are dissolved in a pectin solution. The sample is thoroughly stirred using a magnetic stirrer while adjusting pH to 11 until a gel is formed. After the freeze-drying process, the precursors are subjected to a calcination treatment at 600°C, 700°C, and 800°C and subsequently characterized by X-ray diffraction (XRD), TEM and DRS analysed. The results verify that a major crystalline phase of LaCrO₃ perovskite is formed as the temperature of calcination increases. The crystallites size identification using the Scherrer equation shows that the size increases with calcination temperature increase. But the grain size analysis by TEM verifies that the calcination temperature has in fact a small effect on the size. The DRS analysis indicates that the band-gap energy is affected by the calcination temperature. The values obtained increase from 2.62 eV to 2.89 eV and 2.98 eV with temperature increase.

Iham, Chadli & Omari, Mahmoud & Abu-Dalo, Muna & Albiss, Borhan. et al. [57] Synthesized LaCr_{1-x}Zn_xO₃ through sol-gel method. The effect of Zn doping on the lanthanum chromite prepared was investigated. Thermal decomposition of the dried gel of LaCr_{0.8}Zn_{0.2}O₃ was characterized by TG/DTA thermal analysis. The synthesized powders were characterized by means of X-ray diffraction (XRD), infrared spectra (IR), and scanning microscope (SEM). Electrical properties were characterized by the standard four-probe technique. From the preceding analysis, it show the amorphous powders

crystallize in the orthorhombic structure with Pbnm (62) space group, where the crystallite size ranges from 29.46 to 53.21 nm. The oxides $\text{LaCr}_{1-x}\text{Zn}_x\text{O}_3$ have the comportment of semiconductors in the working temperature range 25–35⁰ C. The electrical conductivity increases with the degree of substitution x, whereas the maximum electrical conductivity obtained is 13.8 S/cm at 350 C for $\text{LaCr}_{0.3}\text{Zn}_{0.3}\text{O}_3$ where the electrical conduction occurs by a thermal activated of small polarons hopping. At higher temperature, the electrical behavior is similar to that of pure metal.

JamshaidAlam Khan and Javed Ahmad [58] reported the optical and transport properties of double perovskite $\text{La}_2\text{CrMnO}_6$ synthesized by auto combustion sol-gel method. The single phase formation with orthorhombic structure having Pbnm symmetry has been confirmed by Rietveld refinement of x-ray diffraction (XRD) pattern. The particle size has been calculated from Debye Scherer formula and scanning electron micrograph (SEM). The elemental composition has been checked using energy dispersive x-ray (EDX) spectroscopy. The infrared (IR) reflectivity spectrum has been measured in the frequency range of 30–7500 cm^{-1} at near normal incidence at room temperature. We observed only eight well resolved phonon modes. Indirect optical band gap 0.96 eV has been estimated using Tauc relation from UV-visible absorption spectrum. The DC electrical resistivity measurement suggests small polaronic hopping above room temperature. The temperature and frequency dependent AC dielectric measurements and the value of activation energy support semiconducting nature of the material.

Enhessari, Morteza&Salehabadi, Ali &Khoobi, Asma&Amiri, Razieh. Et al. [59] Synthesized LaCrO_3 perovskite nanopowders using a sol-gel method using stoichiometric proportion of materials containing lanthanum and chromium in stearic acid complexing agent. Structural analysis of LaCrO_3 indicated an octahedral framework in its XRD pattern bearing crystallite size in the range of 28 nm. The particle sizes were confirmed by morphological scanning of the sample. The optical properties of LaCrO_3 nanopowders clearly indicated an interesting optical activity of LaCrO_3 in the UV and visible ranges. The degradation activation energy (E_d) was calculated from the output of a moderate thermal programming profile at about 207.97 $\text{kJ}\cdot\text{mol}^{-1}$ using Kissinger equation. Capacity, impedance and AC resistance of the perovskites was obtained at 2.970 nF, 2.522 $\text{M}\Omega$ and 16.19 $\text{M}\Omega$, respectively.

Sol-Gel is a low cost, well-established and flexible synthetic route to produce a wide range of micro- and nanostructures. Small variations in pH, temperature, precursors, time, pressure, atmosphere, among others, can lead to a wide family of compounds that share the same molecular structures. Sol-Gel method is one of the simplest techniques to synthesize high-quality nano and microstructures. This method provides several advantages over other synthesis routes such as control over the texture, size and surface properties of the materials, easy to implement, low cost, high quality, and production of materials with large surface areas. This flexibility and simplicity make it very popular in the production of nanoscale powders and its wide used as a coating method [48-54].

Navas, D. Fuentes, S. Castro-Alvarez, A. Chavez-Angel, E. et al. [55] reported that the Sol-Gel method has many unique advantages over other synthesis method which are: Possibility of obtaining special products such as powders, films or coatings, microspheres, fibers. Obtaining new solids with

improved properties. High purity and homogeneity of the materials obtained. Saving energy during the process. Full control over the particle size and morphology. The solution and reaction step allows to incorporate easily, uniformly and quantitatively some trace elements, achieving a uniform doping at the molecular level. Also have following disadvantages which are: Very sensible to moisture. Difficult to scale up. Can include several steps and is a time-consuming process. Dimension and volume changes during different steps.

5. Conclusion and Discussion:

This review article provide basics of the perovskite structure also summarized that, Sol-Gel is a low cost, well-established and flexible synthetic route to produce a wide range of micro- and nanostructures. Small variations in pH, temperature, precursors, time, pressure, atmosphere, among others, can lead to a wide family of compounds that share the same molecular structures. Sol-Gel method offers a unique synthesis route to produce novel and tailor-made nanomaterials with full control of morphology, size, composition, and crystallinity porosity enhanced by combustion or hydrothermal/solvothermal treatment. Nevertheless, some precautions must be taken in order to obtain the best results. Sol-Gel method is one of the simplest techniques to synthesize high-quality nano and microstructures. This method provides several advantages over other synthesis routes such as control over the texture, size and surface properties of the materials, easy to implement, high quality, and production of materials with large surface areas. This flexibility and simplicity make it very popular in the production of nanoscale powders and its wide used as a coating method. The nanoparticle composition must be analysed before running the synthesis we have briefly described how can be phase identification of the perovskites and their structural analysis using Rietveld refinement of the XRD data. The morphological, surface characteristics, optical studies and how to identify surface compositions of the various components of the prepared perovskites were also included in characterisation of perovskite. The specific surface area of the perovskite, which is very important characteristic of a solid catalyst, is strongly affected by the preparation method used. We conclude that, porous surface with internal pores contributing the highest surface areas mainly obtained by sol-gel better than other synthesis methods. i.e. sol-gel is simple, cheap and better method to synthesize perovskite material. Sol-Gel processes in the future could be assisted with photocatalyst during synthesis. This could induce the formation of desirable doping processes or could reduce the formation of secondary phases. The use of biomaterials in the synthesis of Sol-Gel, especially organic waste, offers a novel low-cost and ecological platform for the manufacture of functional materials.

Acknowledgment:

The authors thank to Principal, L. V. H. College and Research Centre in Electronic Science, Panchavati, Nashik, India, for providing Library, computer and internet facilities.

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