Review on Advances of Lanthanum Based Perovskite Oxide

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Abstract- *In this review, the recent progress in the application of an important category of materials, i.e. ABO3 perovskite-type compounds. The systematics of the electronic structure of LaBO3 perovskite oxides, where the B element scans the 3d transition-metal series from Ti to Ni is examined. X-ray photoelectron spectra of valence bands and shallow core states are presented and compared with theoretical molecular cluster and free-ion multiplet models. Self-consistent ionic configurations are obtained from the embedded cluster calculations, which differ from the assumptions of crystal-field theory due to metal-oxygen covalency. The prospect for many-electron models is discussed.To this end, perovskite oxides, an important class of mixed oxide, have been attracting increasing attention for decades as potential replacements. Right now, the development of highly efficient perovskite oxide catalysts has been highly studied.Benefiting from the extraordinary tunability of their compositions and structures, perovskite oxides can be rationally tailored and equipped with targeted physical and chemical properties for example, redox behaviour, oxygen mobility, and ionic conductivity for enhanced catalysis. This perspective article summarizes the recent development of lanthanum-based perovskite oxides as advanced catalysts for both energy conversion applications and traditional heterogeneous reactions.*

Keywords- Perovskite oxides, Lanthanum-based,Heterogeneous, catalysis,Redox

I. INTRODUCTION

1.1 History

Perovskite with general formula ABO3, wherever A is either alkali or metallic element or lanthanum part or cluster IV part, and area unit called Perovskite Oxides. The perovskite structure is one in all the foremost extensively studied. Structures in solid state chemistry, solid state Physics, Material science, and earth science; German Chemist and mineralogist Gustav Rose discovered the mineral perovskite, CaTiO3 in 1839. Rose named CaTiO3, once Bulgarian monetary unit Perovsky, a Russian military official. though the term 'perovskite' was initially reserved for CaTiO3, it had been later applied to artificial compounds with the same ratio and crystal structure to the mineral. Goldschmidt extensively studied the primary artificial perovskite and pioneered several principles that stay applicable to the structure even nowadays.

1.2. Scope of project

Perovskites have emerged as an important new class of materials in the mixed-oxide family because of their exceptional thermal stability, electronic structure, ionic conductivity, electron mobility, and redox behavior. They have the general formula ABO3, where A is a typical lanthanide, alkaline, or alkaline-earth cation and B is any one of a variety of transition metal cations, such as Mn, Co, Fe, Ni, Cr, and Ti[2]. Perovskite oxide ABO3 where A is a rare earth element (La^{+3}) has a large ionic radius and 12-fold coordination while B is 3d transition metals (M^{+3}) has a small ionic radius and 6-fold cordination[3]. The possibility of the various combinations of A-site cation, B-site cation and the introduction of the lattice defect can generate various interesting properties.Last decade there have been carried extensive searches and investigations of various oxide systems like perovskite structure exhibit various attractive properties such as feroelectricity, piezoelectricity, superconductivity, catalytic performance, electric, dielectric, magnetic and their tunable geometric and electronic structures, high chemical activity, high chemical stability, and low cost, perovskites have been extensively used in a wide range of technological applications, such as catalysts in heterogeneous catalysis [4], oxygen sources in membrane separation [5], cathode materials in solid oxide fuel cells (SOFCs) [6], and high-temperature oxygen sensors [7] . The interesting properties of perovskites can be attributed to the partially occupied d subshells of transition metal ions. Because transition metals often have more than one stable oxidation state, it is possible for perovskites to be oxidized or reduced under various reaction conditions.It is very interesting to note that one important type of compounds, which are known as perovskite materials, have potential applications in all the aforementioned energy-related fields. Thus, they have received considerable attention and have been under rapid development during the past decade, in particular, over the past several years. In this review paper, we will summarize the recent progress in the research and development of perovskite materials within the fields of energy storage and conversion, with emphasis on our recent contributions to these important areas. Further prospects for using perovskite materials in energy applications are also presented [8]. Lanthanum-based perovskites containing transition metal in B-site, ($LaMO_3$, M=Co, Fe, Ni or Mn), show catalytic activity close to the noble metal, presenting low cost and high thermal stability. The efficiency of these materials depends on the synthesis method Such as solid state reaction [9], sol gel [10], auto combustion synthesis[11], hydrothermal synthesis[12], Precipitation[13] etc. The sample has been prepared by coprecipitation method. The average crystallite size and morphology of the sample obtained have been investigated.

II. LITERATURE SURVEY

1. **NadarajanArjun et.al; (2017)** -In this study, four completely different sorts of perovskite powders ($LaMnO_3$, $LaFeO_3$, $LaCrO_3$, and $LaNiO_3$) were ready and investigated as anode materials for supercapacitor. The as-prepared powders were merging with active carbon and afterward coated on the nickel plates because the collector layer of the supercapacitors. Becausethe of the liquid solutions (3 M KCl, 1 M LiOH, and and three MLiOH) were severally served because the electrolytes for the supercapacitor. The morphology and crystalline part were characterised bytransmission electron microscopy and XRD. Capacitance and electrical phenomenon were measured by the chemical science capacitance voltage analyzer and electrical phenomenon chemical analysis..The profiles of specific capacitance of the four {different|totally completely different |completely different} anodic electrodes and 3 different electrolytes were enforced. The electrical phenomenon results indicated that four unevenpseudocapacitors didn't show any Warburg-type line and semi-circle line within the low-frequency region. In keeping with CV profiles, the intrinsic $LaNiO_3$ exhibits the very bestspecific capacitance of 106.58 F/g in 3 M LiOH. moreover, the 98% of the initial capacitance of $LaNiO_3$ was preserved once five hundred charge-discharge life cycles at the utmost current density of 1 A/g. The economical charge storage of $LaNiO_3$ was attributed by the ion intercalated oxidation-reduction reactionsbeside with the suitableness of electrode-electrolyte interactions [14].
2. **F.A. Fabian et.al; (2015)** -Magnetic and structural properties are investigated in La (Cr,Fe,Mn) O_3nanoparticles obtained byco-precipitation technique. The X-ray diffraction measurements allied to Rietveldtechnique ensure the formation of $LaCrO_3$, $LaFeO_3$and $LaMnO_3$nanoparticles with crystal structure orthorhombic (Pbnm), orthorhombic (Pnma) and rhombohedralsymmetric (R-3c), severally. We have a tendency to additionally verified a decreasing within the average crystallization size from 73 to 2nm, relying of the transition metal. The magnetic measurements revealassociate magnetic attraction behavior for the $LaCrO_3$sample withTN 289K, and a weak magnetism ordering for the $LaMnO_3$ sample with Tc200 K [15].
3. **Liang Zhu et, al; (2016)** -In this review, the recent progress within the application of a very important class of materials, i.e. ABO_3perovskite-type compounds in the fields of energy storage and conversion, is reviewed. Four main areas, as materials for oxygen transporting membrane toward the applying in oxy-fuel combustion, as key material for solid oxide fuel cells for economic power generation from fuels, as room-temperature electro catalysts for oxygen reduction reaction and oxygen evolution reaction, and as material for solar cells for solar power harvest, square measure referred. Our past efforts in these analysis square measures are stressed. Some prospects concerning the longe term development within the application of perovskite materials in energy storage and conversion square measure projected [16].
4. **OxanaP.Taranet, al; (2016)**The catalytic behaviour of perovskite-like oxides $LaBO_3$ (B = transition metals like Cu, Fe, Co, Ni, Mn) prepared by the Pecini method were examined in wet peroxide oxidation of phenol as a model organic substrate. The study showed the activity of solely $LaCuO_3$ and $LaFeO_3$ perovskite-like catalysts, Cu-containing catalysts being a lot ofactive, although Fe-containing being a lot of stable. The leaching test proved the heterogeneous nature of the catalyst action. The semi-permanent experiments discovered the appropriate $LaFeO_3$ catalyst. XRD studies of the spent samples demonstrated the stability of the perovskite-like structure of the catalysts throughout the reaction. The idea regarding the nature of the active sites and the possible mechanism of the reaction was planned supported of the XPS study [17].

III. MATERIALS AND METHODS

All the chemicals used in this study such as La $(NO3)_3$.6H2O Analytical grade,Nitrates of transition metals (Co, Fe, Ni or Mnetc.) hexahydrate. Moreover, deionized water was used in the whole work.TheMixture solution was gently stirred, filtrated, washed and dried. The products were ground and annealed in pure alumina crucibles at '1000°C' for '2 h' in a muffle furnace (under air) with '10°C'/min heating rate in order to achieve the corresponding perovskite structure.

IV. DISCUSSION

The sample has been prepared by Coprecipitation route. The average crystallite size, morphology, structural, electrical and magnetic properties of the sample obtained has been investigated.

V. CONCLUSION

In summary, Lanthanum based perovskite $LaCrO_3$, $LaFeO_3$, $LaMnO_3$, $LaCoO_3$; has been synthesized by a co-precipitation processing. Well crystalline Lanthanum Perovskite oxide like ($LaMO_3$) (M- Transition metalslike Cr, Co, Fe, Ni or Mn) was composed at different annealing temperature.

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