Preface

Now a day's whole world is focus on energy crisis and also trying to resolve this problem by investigation of alternative energy sources. A major part of scientific community emphasis on developing new technologies for green and clean production of electricity to manage green pollution free environment. In the mean time several alternative energy conversion devices have been investigated. Fuel cell technology is one of the potentially efficient and environmental friendly due to its some positive chatcterstics ways to convert the chemical energy of fuels directly into electrical energy, avoiding combustion processes with a high conversion rate. In comparison of other fuel cells, solid oxide fuel cells (SOFCs) can convert a wide variety of fuels with simpler and cheaper designs. SOFCs also exhibit a lower sensitivity to fuel impurities. The SOFCs are assembled with basic components cathode, electrolyte and anode. An anode component plays a major role in the operation of SOFC. It must have high electronic conductivity and low ionic conductivity, stability in both oxidizing and reducing conditions and remain porous during cell operation. The perovskite and double perovskite systems are most widely used). However, use of $LaCrO_3$ is limited because of the limiting magnitude of the electrical conductivity. It becomes increasingly important to reduce the operation temperature of the fuel cells down in order to prolong the life span of a cell and manifold materials also reduce the overall cost of material processing & cell fabrication. The recent research is focusing on the development SOFCs with improving the durability, stability, and reliability of the devices.

Several investigations have been focused on perovskite and double perovskites structures due to high electronic activity of transition metals. A few perovskite and double perovskites structures materials have also been investigated. Doped lanthanum chromite (perovskite-structured) was investigated as superior electronic conductor for SOFCs.

A few others structures based on double perovskite like Sr_2NiMoO_6 was also explored as potential anode for SOFCs.

But their use in SOFC is still challenging due to technical interest. Recently, few double perovskite anode based materials gain much attention due their high electronic conductivity and thermal stability with other component of SOFC. In view of the above we have planned to

investigate a perovskite and double perovskite systems which can be used as anode for SOFCs having relatively lower cost.

In present thesis, two class of anode material have been investigated. Thesis deals with the perovskite and double perovskite based anode systems, lanthanum chromite ($LaCrO_3$) based systems and molybdate based Sr_2NiMoO_6 systems. It represented the results of structural, morphological, thermal and electrical studies on the doped and undoped systems.

The main objective of this thesis is to investigate structural and electrical properties of mixed (electronic and ionic) conducting materials that show promising materials properties for SOFC anode applications. This thesis has been compiled with VI chapters.

Chapter I give an overview to some basic concepts related to perovskite and double perovskite systems for solid oxide fuel cell, components of SOFCs and their requirements and a brief review of the literature on anode based systems. This chapter includes also the objectives of the present work.

Chapter II describes the details study of the synthesis techniques using a solid state reaction route and chemical reaction routes like Auto-combustion, Sole-Gel method and citrate-nitrate auto-combustion routes and in brief various characterization techniques, in brief, e.g. powder X-ray diffraction (XRD), TGA/DSC, scanning electron microscopy (SEM), FTIR, X-ray photoelectron spectroscopy (XPS), TEC (Thermal Expansion Coefficient) and conductivity and impedance spectroscopic techniques which are adopted during the present investigation.

Chapter III deals with lanthanum chromite ($LaCrO_3$) based anode systems. Crystal structure, microstructure, ion dynamics, electrical conductivity and Impedance analysis of pure $LaCrO_3$ prepared by two different synthesis routes and Gd^{3+} doped $LaCrO_3$ based systems have been discussed.

Chapter IV assigned for double perovskite Sr_2NiMoO_6 based anode systems. Crystal structure, microstructure, thermal properties, electrical conductivity and complex plane impedance analysis of the compositions have been discussed.

Chapter V concludes the brief overview and results and discussion on the rare earth (La^{3+}, Ce^{3+} and Sm^{3+}) doped strontium nickel molybdate (Sr_2NiMoO_6) based anode system. The structural, thermal, electrical conductivity and complex plane impedance analysis on this system have been incorporated.

Chapter VI summarizes the main findings of the present work and lists a few possibilities of future investigations.

In summary of thesis, the following topics have been covered.

1. In this thesis, two classes of anode systems have been synthesized via solid state reaction and chemical reaction routes.
2. Structural, microstructural, thermal and most importantly electrical properties have been discussed.
3. Compatibility of the prominent compositions has been studied by the TEC measurements.
4. Conductivity and impedance spectroscopic techniques have been used in these studies.
5. A few compositions of the each system have been proposed as potential anode materials for SOFC.
6. Rare earth doped anodes have also been investigated and reported their electrical conductivity for solid oxide fuel cells.