CHAPTER 3
SCOPE AND OBJECTIVES

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CHAPTER 3
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3.1. General outline of the problem

The Molten Carbonate Fuel Cell (MCFC) is expected to be in use as dispersed power generation device in the future. Significant advances have been done in material selection for MCFC for the development of prototype MCFC power generators. However, several issues remain unsolved regarding the fabrication of cost effective reliable components for the commercialization of molten carbonate fuel cells. It is recognized that different methods of fabrication of cell components result in components with varied performance. The development of porous components with the desired pore structure is the major issue in the practical MCFC development.

Therefore, research to identify cost effective and reliable method of fabricating the components with enhanced durability and performance in MCFC is the goal.

From the discussion on available literature elaborated in Chapter 2, it is clear that the porous electrodes and matrix materials employed need further improvement in terms of the following.

1. The process of making nickel green sheets by tape casting technique should be made easy.
2. The electrodes prepared from the green tapes should possess adequate mechanical strength, structural integrity and desired properties as mentioned in Table 2.1.
3. MCFC employing the above components should have long life and higher power output.

Keeping this in view, an attempt has been made in the present research work to investigate systematically the method of fabrication of MCFC cell components namely, anode, cathode, electrolyte and matrix by tape casting technique and evaluated their performance in single cell MCFC.

The detailed objectives envisaged for each component is described in the next section.

3.2. Objectives of this work

3.2.1. Anode

This research focuses on the development of Ni electrodes with additives such as Al₂O₃ fibre by tape casting technique, which was not fully addressed till now. The detailed objectives are as follows
1. Fabrication of Ni green electrodes using both aqueous and non-aqueous tape casting processes. The tape casting parameters will be varied to arrive at the optimum composition of the slurry.

2. An optimized slurry formulation and process parameter variables will be selected for the preparation of nickel electrodes with additives such as Cr, Al alumina fibre and LiAlO₂. Alumina fibre as an additive is expected to improve the structural integrity and morphology of the nickel electrode.

3. The green tape characteristics such as thickness, density and shrinkage factor after casting and sintering will be calculated in order to get a reference data for comparing the electrodes fabricated with additives.

4. Sintering of the green tapes in H₂ atmosphere will be performed and their density, porosity and pore size distribution of the electrodes will be done. The sintered electrodes will be used in single cells and their performance will be evaluated.

3.2.2. Cathode

The following attempts are made to develop the cathode material.

1. The cathode structures will be fabricated from nickel green tapes prepared by aqueous tape casting process.

2. Preparation of lithiated nickel oxide catalyst and their physical characterization will be attempted.

3. The porosity and pore size distribution of the cathode will be done.

4. In order to get improved cathode, the following alternate cathode materials will be prepared and characterized.

4.1. The performance of LiNi₀.₅Co₀.₂O₂ as a cathode material in molten carbonate fuel cells will be evaluated using electrode structures prepared by non-aqueous tape casting. Electrochemical, optical and physical characterizations techniques will be used to optimize the cathode material and its performance as an alternate material.

4.2. La₀.₈Sr₀.₂CoO₃ will be coated onto the sintered nickel electrodes and its electrochemical performance will be studied in a laboratory scale 3-cm² half-cells.

4.3. Co coating will be done on nickel powder and green electrodes will be prepared by tape casting technique and processed as cathode by sintering in reduced atmosphere.

4.4. Solubility studies of these alternative cathode materials will be carried out to choose the best one for further characterization as cathode in cell studies.
3.2.3. Matrix

The following efforts will be made to get the electrolyte retention matrix structures with good stability.

1. Electrolyte retention matrix structures will be prepared both by aqueous and non-aqueous tape casting process. The processing parameters will be optimized and reported.

2. Alumina fibre will be incorporated into the LiAlO$_2$ matrix during the tape casting process to improve the mechanical strength and to minimize the crack formation.

3. Green, electrolyte impregnated, alumina fibre reinforced matrix structures will be prepared by the tape casting technique.

4. The physical properties such as green density, packing factor and shrinkage factor will be correlated with the slurry composition.

The present study also aims at the physicochemical characterization of these components in single cells. This will be helpful in achieving optimized structures for the components, which will have enhanced power output. Finally, single cells will be assembled using state-of-the-art and the optimized components through this research study and their performance will be investigated with respect to cell operating parameter variables.

The results achieved will be helpful as guidelines for the future development of MCFC.