Alanine Assisted Synthesis and Characterization of $\text{La}_{0.65}\text{Sr}_{0.3}\text{MnO}_3$ (LSM) Nanocrystalline Cathode Powders for Solid Oxide Fuel Cells (SOFCs)

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Solid oxide fuel cells (SOFCs) are generally known to be one of the most promising energy conversion devices, offering benefits such as system compactness, high efficiency and low environmental pollution. In this study, $\text{La}_{0.65}\text{Sr}_{0.3}\text{MnO}_3$ (LSM) nanoceramic powders were prepared through the citrate-nitrate auto-combustion route with a β -alanine-to-nitrate ratio of 1:1. Thereafter, a Thermolyne 47900 furnace was used to calcine the prepared powders at 900 °C for 4 hrs to remove carbonaceous residues, and then, the prepared powders were characterized using SEM/EDS, XRD, and TGA. Calculations using the Debye-Scherrer equation illustrated that the average crystallite size of the powders was approximately 20-25 nm. There was no loss in weight after reaching a temperature of ~700 °C, as indicated by TGA, signifying the completion of combustion. Electrochemical characterization of the $\text{La}_{0.8}\text{Sr}_{0.2}\text{MnO}_3$ (LSM) cathode powders was performed by coating these powders (as the cathode functional layer (CFL) with 40-60 wt% 8YSZ on the bottom and the catalyst layer (CL) on the top) using the screen printing technique on SOFC half-cells (NiO-YSZ+YSZ) obtained from CGCRI (Kolkata, India) with a cell size of 36 mm dia $\times$ 1.6 mm (effective electrode area of ~1.13 cm²). These cells were tested with H₂ and O₂ at 750-800 °C with flow rates of 1.2-1.8 lit min⁻¹ H₂ and 0.4-0.6 lit min⁻¹ O₂ with a hydrogen humidification of 3%. The current density (cd) and power density (pd) were the highest for the CFL containing 60 wt% LSM and 40 wt% YSZ. The cd and pd of the single SOFC cell were 0.8 A cm⁻² (at 0.7 V) and 0.6 W cm⁻², respectively, at 800 °C, a hydrogen flow rate of 1.8 lit min⁻¹ and an oxygen flow rate of 0.6 lit min⁻¹.

Keywords: Strontium-doped lanthanum manganite, Solid Oxide Fuel Cell, Nickel anode, Yttria-stabilized zirconia, Cathode functional layer, Current collector layer

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