ELECTRICAL PROPERTIES OF MODIFIED AND UNMODIFIED LANTHANUM STRONTIUM COBALT FERRITE (LSCF) CATHODES VIA COMPLEX NON-LINEAR LEAST SQUARES (CNLS) AND DISTRIBUTION OF RELAXATION TIME (DRT) ANALYSIS

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This Final Year Project Report entitled **"Electrical Properties of Modified and Unmodified Lanthanum Strontium Cobalt Ferrite (LSCF) Cathodes Via Complex Non- Linear Least Squares (CNLS) and Distribution of Relaxation Time (DRT) Analysis"** was submitted by Nur Masyitah binti Umar in partial fulfillment of the requirements for the Degree of Bachelor of Science (Hons.) Physics, in the Faculty of Applied Sciences, and was approved by

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ABSTRACT

ELECTRICAL PROPERTIES OF MODIFIED AND UNMODIFIED LANTHANUM STRONTIUM COBALT FERRITE (LSCF) CATHODES VIA COMPLEX NON-LINEAR LEAST SQUARES (CNLS) AND DISTRIBUTION OF RELAXATION TIME (DRT) ANALYSIS

This research investigates the electrochemical behavior of modified and unmodified lanthanum strontium cobalt ferrite (LSCF) cathodes for symmetrical solid oxide fuel This research investigates the electrochemical behavior of modified and unmodified lanthanum strontium cobalt ferrite (LSCF) cathodes for symmetrical solid oxide fuel cell (SOFC) systems using Complex Nonlinear Least Squares (CNLS) fitting and Distribution of Relaxation Time (DRT) analysis. The primary objectives were to evaluate and compare the electrochemical performance of both cathode types and to determine the most representative Equivalent Circuit Model (ECM) for interpreting their impedance responses.The results show that the **modified LSCF cathode**, treated with zirconium tetrachloride ($ZrCl_4$), exhibited **significantly lower polarization resistance (Rp)** particularly at **700 °C (1.10 Ω·cm² vs 1.31 Ω·cm²)** and **800 °C (0.26 Ω·cm² vs 0.51 Ω·cm²)** compared to the unmodified cathode. This indicates improved oxygen surface exchange and charge transfer capabilities. Furthermore, DRT analysis of the modified sample revealed **sharper, well-resolved peaks** corresponding to distinct electrochemical processes, while the unmodified sample showed overlapping, broadened peaks, indicating slower kinetics. In identifying the most suitable ECM, the **modified cathode consistently fit a simpler, stable model (R1–R4)** across all temperatures, whereas the **unmodified cathode required additional elements**, particularly at 750 °C, suggesting more complex or less stable behavior. These outcomes confirm the **effectiveness of $ZrCl_4$ surface modification** in enhancing intermediate-frequency processes and overall cathode performance.Ultimately, this study contributes to the development of high-performance SOFC cathodes through surface engineering and highlights the strength of DRT analysis over conventional CNLS fitting for resolving complex impedance behaviors.

TABLE OF CONTENTS