

**INFLUENCE OF  $\text{Sr}^{2+}$  SUBSTITUTION AT Ca SITE OF  
DIVALENT-DOPED  $\text{La}_{0.5}\text{Ca}_{0.5-x}\text{Sr}_x\text{MnO}_3$  ( $x = 0, 0.10, 0.20$ ) MANGANITE ON  
ELECTRICAL RESISTIVITY AND MAGNETORESISTANCE**

**NURUL IMANI BINTI ZULKIPLI**

Final Year Project Report Submitted in  
Partial Fulfilment of the Requirements for the  
Degree of Bachelor of Science (Hons) Physics  
in the Faculty of Applied Sciences  
Universiti Teknologi Mara

July 2025

This Final Year Project Report entitled **“Influence of  $\text{Sr}^{2+}$  substitution at the Ca site of divalent-doped  $\text{La}_{0.5}\text{Ca}_{0.5-x}\text{Sr}_x\text{MnO}_3$  ( $x = 0, 0.10, 0.20$ ) manganite on electrical resistivity and magnetoresistance”** was submitted by Nurul Imani Binti Zulkipli in partial fulfilment of the requirements for the Degree of Bachelor of Science (Hons) Physics, in the Faculty of Applied Science, and was approved by

DR ROZILAH RAJMI  
Supervisor B. Sc (Hons.) Physics  
Faculty of Applied Sciences  
Universiti Teknologi MARA  
02600 Arau, Perlis

DR SITI ZULAIKHA MOHD YUSOF  
Project Coordinator B. Sc (Hons.) Physics  
Faculty of Applied Sciences  
Universiti Teknologi MARA  
02600 Arau, Perlis

DR ROSYAINI AFFINDI ZAMAN  
Programme Coordinator B. Sc (Hons.)  
Physics Faculty of Applied Sciences  
Universiti Teknologi MARA  
02600 Arau, Perlis

25 July 2025

## ABSTRACT

### INFLUENCE OF $\text{Sr}^{2+}$ SUBSTITUTION AT Ca SITE OF DIVALENT-DOPED $\text{La}_{0.5}\text{Ca}_{0.5-x}\text{Sr}_x\text{MnO}_3$ ( $x = 0, 0.10, 0.20$ ) MANGANITE ON ELECTRICAL RESISTIVITY AND MAGNETORESISTANCE

Manganites with the general formula  $\text{La}_{1-x}\text{A}_x\text{MnO}_3$  ( $\text{A} = \text{Ca}$  and  $\text{Sr}$ ) are well known for their colossal magnetoresistance effect, where a material's resistivity changes drastically under a magnetic field. This property makes them promising candidates for magnetic sensors and spintronic applications. The effect of Sr substitution at the Ca site in  $\text{La}_{0.5}\text{Ca}_{0.5-x}\text{Sr}_x\text{MnO}_3$  ( $x = 0, 0.10, 0.20$ ) manganites on electrical resistivity and magnetoresistive properties was studied. The samples were prepared using a solid-state reaction technique, which involved the sequential processes of weighing, grinding, calcination, pelletizing, and sintering. The electrical resistivity of the samples was measured using the four-point probe technique over a temperature range of 30 K to 300 K, under applied magnetic fields of 0 T and 0.8 T. The measurements revealed a metal-insulator transition (MI) in all samples. The transition temperature ( $T_{\text{MI}}$ ) decreased with increasing Sr content. Specifically, at 0 T, the  $T_{\text{MI}}$  shifted from 110 K ( $x = 0$ ) to 54 K ( $x = 0.20$ ), and the overall resistivity decreased significantly with increasing Sr concentration. In addition, an enhanced magnetoresistance (MR) effect was observed for the  $x = 0.20$  sample, which is attributed to spin-dependent interfacial tunneling enhanced under a low magnetic field of 0.8 T. The magnetoresistance peaked at  $x = 0$  and decreased progressively with further Sr doping, likely due to stabilized ferromagnetic ordering. This stabilization led to a reduction in the rate of  $e_g$  electron hopping and elongation of the Mn-O bond length, thereby weakening the double exchange mechanism. This study is significant as it highlights the impact of A-site cation substitution on the structure property relationships in manganites. As potential candidates for magnetoresistance and spintronic applications, the results demonstrate that  $\text{Sr}^{2+}$  substitution effectively modifies the electrical properties of La-based manganites.

## TABLE OF CONTENTS

<b>ACKNOWLEDMENT</b>	i
<b>ABSTRACT</b>	ii
<b>ABSTRAK</b>	iii
<b>TABLE OF CONTENTS</b>	iv
<b>LIST OF TABLES</b>	ix
<b>LIST OF FIGURES</b>	x
<b>LIST OF ABBREVIATION</b>	xii
<b>CHAPTER 1 INTRODUCTION</b>	1
1.1 Introduction	1
1.2 Problem Statement	2
1.3 Research Questions	4
1.4 Objectives	4
1.5 Significance of study	4
<b>CHAPTER 2 LITERATURE REVIEW</b>	6
2.1 Introduction of Manganite	6
2.1.1 Crystal Structure	6
2.1.2 Crystal Field Splitting	7
2.1.3 Jahn Teller (JT) Effect	9
2.1.4 Charge Ordering (CO)	11
2.2 Studies about Effect of Substitution on A-site on Magnetic Properties	13
2.3 Studies about Magnetoresistance on Manganite	14
2.4 Studies on $\text{La}_{1-x}\text{Ca}_x\text{MnO}_3$ and $\text{La}_{0.5}\text{Ca}_{0.5-x}\text{Sr}_x\text{MnO}_3$	15
<b>CHAPTER 3 RESEARCH METHODOLOGY</b>	18
3.1 Introduction	18
3.2 Preparation of Sample	18
3.2.1 Selection of Chemical	18
3.2.2 Composition of Samples	19
3.2.3 Equation and calculations of preparation of samples	20
3.2.4 Description of Preparation of Sample	22

3.3	Sample Characterization	27
3.3.1	Electrical Resistivity Measurement	27
<b>CHAPTER 4 RESULT AND DISCUSSION</b>		<b>30</b>
4.1	Introduction	30
4.2	Electrical Resistivity vs Temperature	31
4.3	Magnetoresistance Resistivity	37
<b>CHAPTER 5 CONCLUSION AND RECOMMENDATION</b>		<b>44</b>
5.1	Introduction	44
5.2	Conclusion	44
5.3	Recommendations	45
<b>REFERENCES</b>		<b>47</b>
<b>APPENDICES</b>		<b>55</b>
<b>CURRICULUM VITAE</b>		<b>66</b>