

UNIVERSITI TEKNOLOGI MARA

**EFFECTS OF GERMANIUM SUBSTITUTIONS AT
Cu/Sr SITES ON FLUCTUATION INDUCED
CONDUCTIVITY AND INTERPLANAR COUPLING
OF $\text{Tl}_{0.85}\text{Cr}_{0.15}\text{Sr}_2\text{CaCu}_2\text{O}_{7-8}$ SUPERCONDUCTOR**

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for degree of
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Author's Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This project has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research

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ABSTRACT

This thesis describes the effects of Germanium (Ge) substitutions at Cu/Sr sites on fluctuation induced conductivity and interplanar coupling of Tl1212 layered structure. Two series of Tl1212 superconductors were synthesized from $\text{Tl}_{0.85}\text{Cr}_{0.15}\text{Sr}_2\text{CaCu}_{2-x}\text{Ge}_x\text{O}_{7-\delta}$ ($x=0-0.6$) and $\text{Tl}_{0.85}\text{Cr}_{0.15}\text{Sr}_{2-y}\text{Ge}_y\text{CaCu}_2\text{O}_{7-\delta}$ ($y=0-0.3$) nominal starting compositions using the conventional solid state method. Substitution of Ge^{4+} in place of Cu in $\text{Tl}_{0.85}\text{Cr}_{0.15}\text{Sr}_2\text{CaCu}_{2-x}\text{Ge}_x\text{O}_{7-\delta}$ ($x=0-0.6$) series showed initial increase in zero critical temperature value, $T_{c \text{ zero}}$ from 98 K ($x=0$) to 100 K ($x=0.1$) and in the range of 85-86 K for $x=0.2-0.3$. The slow decrease in $T_{c \text{ zero}}$ is unexpected as tetravalent Ge^{4+} substitution is expected to strongly reduce hole concentration in the samples and suppress $T_{c \text{ zero}}$. While for substitution of Ge^{4+} in place of Sr in $\text{Tl}_{0.85}\text{Cr}_{0.15}\text{Sr}_{2-y}\text{Ge}_y\text{CaCu}_2\text{O}_{7-\delta}$ ($y=0-0.3$) series, electrical resistance measurements showed the zero critical temperature value, $T_{c \text{ zero}}$ were in the range of 90-98 K for $y=0-0.15$ and in range of 60-78 K for $y=0.2-0.3$. Analysis of excess conductivity behavior based on Aslamazov-Larkin model for the Ge free compound, revealed a 2D fluctuation behavior. However, substitution of Ge in both of the series induced 2D to 3D transition behavior with the highest transition temperature, T_{2D-3D} observed at $x=0.10$ and $y=0.10$ samples. The analyses of Fourier transformation infrared (FTIR) and X-ray diffraction (XRD) data indicate increasing CuO inter-plane coupling with Ge substitution at both Cu and Sr-sites. The increment was suggested to cause sustenance of the high $T_{c \text{ zero}}$ and metallic normal state behavior for $x=0-0.30$ and $y=0.03-0.15$ samples. This is supported by the excess conductivity analysis using the Lawrence Doniach model which also indicates an increase in the inter-plane coupling (J) values. It was suggested that the increase in inter-plane coupling may enhance correlation between the carrier of the superconducting samples which then decrease the anisotropy and resulted to better superconducting properties of the samples.

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TABLE OF CONTENTS

	PAGE
TITLE PAGE	
AUTHOR'S DECLARATION	ii
ABSTRACT	iii
ACKNOWLEDGEMENT	iv
TABLE OF CONTENTS	v
LIST OF TABLES	viii
LIST OF FIGURES	ix
LIST OF ABBREVIATIONS	xv
CHAPTER 1: INTRODUCTION	
1.1 Formation of Tl1212 phase	2
1.2 Superconducting Fluctuation Behaviour	3
1.3 Infrared Absorption Properties	6
1.4 Problem Statement	7
1.5 Objectives of study	8
1.6 Significance of the Study	9
1.7 Scope of study	10
CHAPTER 2: LITERATURE REVIEW	
2.1 The History of Superconductivity	11
2.2 Properties of Superconductors	
2.2.1 Zero Resistance	13
2.2.2 Meissner Effect	14
2.3 Types of Superconductor	
2.3.1 Type-I Superconductor	17
2.3.2 Type-II Superconductor	18
2.4 Theory of Superconductor	
2.4.1 The BCS theory	20
2.5 Normal State Behavior Study	
2.5.1 Anisotropy	22
2.5.2 Coherence Length	24
2.5.3 Excess Conductivity	
2.5.3.1 Excess Conductivity Study on various HTSC	26
2.5.4 Infrared Absorption Studies	27