

TRANSPORT CURRENT DENSITY PERFORMANCE OF DOPED  
TL1212 SUPERCONDUCTOR TAPES IN MAGNETIC FIELD

PREPARED BY:

MOHD ISA MOHD YUSOF  
AHMAD KAMAL HAYATI BIN YAHYA  
SYED YUSAINEE SYED YAHYA

DECEMBER 2006

## **ACKNOWLEDGEMENTS**

We would like to thank the Institute of Research Development and Commercialisation, Universiti Teknologi MARA (UiTM) for providing the financial support for this research project under IRDC grant in the period of December 2004 to December 2005. Without the financial assistance this project may not be possible.

We are indebted to Dr Zaiki Awang from Microwave Centre, Faculty of Electrical engineering, Universiti Teknologi MARA (UiTM) and Ms Rohani Omar, Research Assistance, UiTM for their technical assistance in various aspects which are crucial in this study.

Our greatest and ultimate debt and gratitude is due to Allah, the Most Beneficent and the Most Merciful. May He pardon and forgive our weaknesses and endow us with knowledge and wisdom.

## CONTENTS

	Page
ACKNOWLEDGEMENTS	IV
CONTENTS	
<b>LIST OF FIGURES</b>	VIII
<b>LIST OF SYMBOLS AND ABBREVIATIONS</b>	XIV
<b>LIST OF TABLES</b>	XVI
<b>ABSTRACT</b>	XVII
<b>CHAPTER I INTRODUCTION</b>	
<b>1.1</b> High Temperature Superconductor Dip Coated Tapes	4
<b>1.2</b> Objectives of the Study	7
<b>1.3</b> Significance of the Study	8
<b>CHAPTER II BACKGROUND OF SUPERCONDUCTIVITY</b>	
2.1 Introduction	10
2.2 Properties of Superconductors	10
2.2.1 Critical Temperature ( $T_c$ )	10
2.2.2 The Meissner Effect	11
2.2.3 Critical Magnetic Field	13
2.2.4 Critical Current Density ( $J_c$ )	14
2.2.5 Types of Superconductors	14
2.2.5.1 Type I Superconductor	14

2.2.5.2 Type II Superconductor	15
The History of Superconductors	16
Theory of Superconductor - The BCS Theory	18
Relation Between $J_c$ , $T_c$ and $H_c$	20
High Temperature Superconductors and Related Compounds	21
2.6.1 YBCO Superconductors	21
2.6.2 Thallium Based Superconductors	23
2.6.2.1 The Tl-1212 System	24
Fabrication of HTS Tapes	25
2.7.1 Powder-in-Tube Tapes	26
2.7.2 Dip Coating Tapes	28
Transportation Model In HTS Tapes	31
Superconductor Applications	33
<b>SAMPLES PREPARATION AND EXPERIMENTAL DETAILS</b>	<b>37</b>
Preparation of In-Doped Bulk Samples	37
Preparation of Dip-Coated Tape	39
Basic Sample Characterization Methods	41
3.3.1 X-ray Powder Diffraction	41
3.3.2 Electrical Resistance Measurement at 16 K to 300 K	43
3.3.3. Scanning Electron Microscope (SEM)	45

## ABSTRACT

Superconducting powder from high purity chemicals with nominal composition of  $Tl_{0.9}Bi_{0.1}Sr_{1-x}Ca_{0.9-x}Y_{0.1}O_{7-y}$  were used to fabricate Tl-1212/Ag superconducting tapes using the dip-coating (DC) method. The tapes were subjected to reannealing under different heating conditions where some of the tapes were subjected to intermediate mechanical rolling. Results showed that annealing temperature together with intermediate mechanical rolling (IR) could be optimized to increase  $T_c$  and 1212 phase formation and  $J_c$  of In-substituted Tl-1212/Ag tapes. The highest  $J_c$  was observed for the tape, which was reannealed at 910 °C for a total duration of 60 minutes and subjected to IR. The increased  $J_c$  could be due to the densification of superconducting core and the increase in 1212 phase after thermomechanical treatment. The performance of  $J_c$  of the tapes in external magnetic fields showed existence of weak links at low fields ( $< 0.2$  T) followed by strong links which are dominant at higher fields.