UNIVERSITI TEKNOLOGI MARA

ROLE OF RARE-EARTH (Eu, Dy AND Yb) SUBSTITUTION ON DETERMINING THE STRUCTURAL, THERMAL AND SUPERCONDUCTING PROPERTIES OF BSCCO SUPERCONDUCTOR PREPARED VIA COPRECIPITATION METHOD

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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. The topic 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

In this study, the $Bi_{1.6}Pb_{0.4}Sr_2Ca_{2-x}RE_xCu_3O_y$ (RE = Eu, Dy and Yb) where $x = 0.000$, 0.025, 0.050, 0.100 and 0.200 which were synthesised through the coprecipitation (COP) method was successfully prepared. The phase purity and structural properties were performed by X-ray Diffractometer (XRD), Field-Emission Scanning Electron Microscopy (FESEM) and Energy Dispersive X-ray Spectroscopy (EDX). Meanwhile, the powders at each stage of the coprecipitated powder, precalcined and calcined products were characterized by Thermogravimetric Analysis (TGA) and Fourier Transform Infrared Spectroscopy (FTIR). Furthermore, the resistivity and critical current density were measured by using the four-point probe method. The Bi-2223 superconductor induced the additional Bi-2212 phase with increasing RE concentration. The crystallographic structures of the samples were slightly changed from tetragonal to orthorhombic in higher concentration of $x > 0.000$, $x > 0.100$ and $x > 0.025$ for the Eu, Dy and Yb samples, respectively. Consequently, the analyses showed a decrease of the lattice parameter c and volume fraction for the Bi-2223 phase with the substituted sample while the SEM investigations showed that the surface morphology of microstructures had degraded, the grain connectivity became weak and the porosity increased with RE concentration. This resulted in the degradation of superconducting properties and it exhibited less grain alignment and connectivity that resulted in the decline of J_C with RE substitution. However, Yb showed better grain alignment compared to the Eu and Dy substituted samples. TGA results showed identical thermal behaviour for each substitution samples, which underwent different stages during their formation. TG analyses showed that there were five steps of mass loss for precipitated powder. TG curve for the sample $x = 0.025$ Eu, Dy and Yb, which has been calcined for 24 hours at 845 °C shows only one drop in temperature above 800 °C. Apparently, no indication of mass loss could be seen below ~800 °C. Therefore, it revealed that the formation of the carbonate can be suppressed in the calcined stage. FTIR results showed that the apparent infrared spectrum on all the precursor powders qualitatively showed four main regions and the existence of –OH group has an ability to increase the diffusion rate between metals during synthesis process. Increasing the concentration of Eu, Dy and Yb substituted in the Bi-2223 caused the decrement of J_C and T_C values. J_C and $T_{C\ zero}$ of the substituted samples were found to be lower than for the pure sample with almost the same $T_{C\ zero}$; however, the Yb substitution showed greater J_C with 4.1910 A/cm^2 compared with the other substitutions.

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CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

The main theme of the thesis is to study the influences of rare-earth (RE = Eu, Dy and Yb) substitutes on the thermal, structural and electrical properties of $Bi_{1.6}Pb_{0.4}Sr_2Ca_{2-x}RE_xCu_3O_y$ where x = 0.000, 0.025, 0.050, 0.100 and 0.200 in Ca-sites. For this research, all of the samples were prepared by the coprecipitation (COP) method. The first chapter is the introduction of the thesis and it is divided into five sections, including the background of the study, the statement of the problem, the objectives of the study, the scope of the study and the significance of the study.

1.2 BACKGROUND OF THE STUDY

A superconductor is defined as a material that conducts electricity without resistance below certain temperatures. These temperatures are called critical or transition temperatures, T_C. Even though it was discovered in 1911 by Heike Kammerlingh Onnes (Onnes, 1911), the phenomenon of superconductivity is still being research and studied. In general, superconductor can be classified into two types, which are Type I and Type II superconductors. Meanwhile, the properties of Type I superconductor, T_C is lower than 25 K, hence, a Type I superconductor has a very sharp transition to the superconductor state and prevent some levels of external magnetic field penetration onto its surface. Examples of Type I superconductor include, lead (Pb), mercury (Hg) and tin (Sn). Consequently, the superconductivity mechanism of a Type I superconductor can be explained by the Bardeen-Copper-Schrieffer (BCS) theory. On the other hand, the T_C for a Type II superconductor is higher than the T_C for Type I superconductor, and allows some penetration of external magnetic fields onto the surface. Examples of Type II superconductors include yttrium barium copper oxide (YBCO), bismuth strontium calcium copper oxide (BSCCO), thallium barium calcium copper oxide (TBCCO) and