UNIVERSITI TEKNOLOGI MARA

SYNTHESIS AND CHARACTERIZATION OF LOW DENSITY Bi(Pb)-2223 HIGH TEMPERATURE SUPERCONDUCTOR DOPED WITH EUROPIUM AND YTTERBIUM

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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 results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any 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

The conventional solid state reaction method was conducted in synthesizing low-density $Bi_{1.6}Pb_{0.4}Ca_2Sr_2Cu_3O_y$ High Temperature Superconductor doped with Europium and Ytterbium. The morphology and structural identification, elemental composition, critical temperature and critical current were determined by Field Emission Scanning Electron Microscopy (FESEM), X-Ray Diffraction (XRD), Energy Dispersive Spectrometry (EDS) and four point probes respectively. The optimum level of low density superconductor obtained within the sample with ratio of polycrystalline sucrose to Bi(Pb)-2223 powder was at 0.050:1.950, where the highest J_C obtained was 6.053 A/cm^2 at 77 K. The effect of rare earth elements, RE (Yb and Eu) substitutional doping in the optimum level of low-density $Bi_{1.6}Pb_{0.4}Sr_2$ $RE_xCa_{2-x}Cu_3O_y$ high-temperature superconductor have shown that for all series of doping concentration, the T_C and J_C gradually decreased as x is increased. XRD analyses at varying concentration of doping level confirmed that at starting composition ($Bi_{1.6}Pb_{0.4}Sr_2$ $RE_xCa_{2-x}Cu_3O_y$), the phases Bi(Pb)-2223 and Bi(Pb)-2212 (mixed phases) co-exist in the doped samples. The crystallographic structures underwent a transition from tetragonal $(a=b\neq c)$ to orthorhombic $(a\neq b\neq c)$ as doping concentration of Eu and Yb were increased due to contraction of c-lattice. Eu and Yb were detected in the grains of Eu-doped and Yb-doped Bi(Pb)-2223 superconductor implying that both atoms were successfully doped into the crystal structure of low-density Bi(Pb)-2223.

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CHAPTER ONE
INTRODUCTION

This chapter contains the background of the study, problem identification, objectives, significance, scope and limitations and applications of the study.

1.1 BACKGROUND OF STUDY

Superconductivity is one of the greatest achievements being discovered by researchers in the twentieth century. This phenomenon which electrical resistance in a material vanishes at certain temperatures, called critical temperature, T_C was accidentally observed by Onnes (1911) and his research collaborator when they were studying the properties of some metals using liquid helium in their laboratory. They found that mercury display a zero electrical resistance when it was cooled down to 4.2 K (Onnes, 1911). Until today, this noteworthy discovery has been observed in various metals, alloys and others. Until 1980, Nb_3Ge with $T_C = 23.9$ K remained the material with highest T_C. During the time, all the superconducting materials found displayed T_C below 30 K which was very low. These superconductors were recognized as conventional superconductors. The theory was only successful to explain its mechanism after 46 years of first discovery of superconductivity. A group of scientist asserted that in conventional superconductors, at certain low temperatures, electrons inside the materials form pairing due to the exchange of phonon-lattice interaction. These electrons called Cooper pairs have equal but opposite spins and momentum moving rapidly inside the materials and move rapidly without dissipating energy. This theory which was known as BCS theory was found by John Bardeen, Leon Cooper and J. Robert Schrieffer (Bardeen, et al., 1957). According to this theory, the highest T_C possibly achieved by a superconductor material will be below 30 K. However, the superconductivity was surprised with the discovery of $La_{2-x}Ba_xCu0_4$ (LBCO) superconductor system with T_C above 30 K (Bednorz, 1986), signifying the discovery of high-T_C superconductivity. This breakthrough signified that BCS theory on superconductivity cannot be applied to explain the pairing mechanism in this new superconductor. Later, the researchers