UNIVERSITI TEKNOLOGI MARA

INFLUENCE OF RARE EARTH (Nd, Er) DOPING ON ELECTRICAL AND STRUCTURAL PROPERTIES OF LOW DENSITY $Bi_{1.6}Pb_{0.4}Sr_{2}Ca_{2-x}RE_{x}Cu_{3}O_{\delta}$ SUPERCONDUCTORS PREPARED VIA COPRECIPITATION TECHNIQUE

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ABSTRACT

The influence on electrical and structural properties of rare earth elements (Nd and Er) doped on low density $Bi_{1.6}Pb_{0.4}Sr_2Ca_{2-x}RE_xCu_\delta$ where x = 0.000, 0.025, 0.050, 0.100 and 0.200 is investigated. In determining the best level of sucrose, the samples were prepared via co-precipitation method with mixing of $C_{12}H_{22}O_{11}$ (0.00g, 0.05g, 0.10g and 0.015g) with standard $Bi_{1.6}Pb_{0.4}Sr_2Ca_2Cu_\delta$. For all series of standard samples, the best $T_{c\ zero}$ obtained was at 98 K which belongs to low density sample (S3) with addition of 0.10 g sucrose. Comparing to standard high density sample S1 (0.00g), the low density sample S3 (0.10g) exhibited higher critical current density J_c, by three folds. The XRD results confirmed that low density sample represented by S3 remains in tetragonal structure which indicate that adding sucrose into the samples did not change its crystal structure. For all Nd-doped and Er-doped samples, the curves of normalized resistance displayed normal metallic behavior above $T_{c\ onset}$. However, $T_{c\ zero}$ decreased for all doped samples due to increase in dopant concentration. Substitution smaller size of Nd^{3+} (1.123Å) and Er^{2+} (1.03Å) on Ca^{2+} (1.14Å) has distorted the lattice structure which leads to the decrease of $T_{c\ zero}$. Field Emission Scanning Electron Microscope (FESEM) and Energy Dispersive X-ray (EDX) were performed to determine the surface morphology and the composition of elements of the samples respectively. FESEM results showed that the grains are compacted and randomly distributed and as the concentration of dopant is increased. The misorientation at grain boundaries have formed weak links and hence limit the values of J_c.

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CHAPTER ONE

INTRODUCTION

This chapter consists of introduction which is discussed in briefly about research scope, a brief description of the issues addressed in problem statement, objectives, scope and limitations of the study, significance of the study and thesis layout of the research.

1.1 INTRODUCTION

Superconductivity is an interesting and challenging field of physics. For more than a century prior to discovery in 1911 of superconductors, which was known as a phenomenon where at low temperature of many metals, alloys and compounds are found to show no resistance to flow an electric current and to exclude magnetic flux completely. In other word, superconductor is a material that is able to conduct electricity without any resistance. It only show superconductivity nature when it reach critical temperature, T_c.

Superconductor is different in comparison to the normal conductor. The best normal conductor ever known is copper. Copper is a good conductor which allows the flow of current with a small amount of resistance. Current is transmitted by the flow of electrons moved through crystal lattices by applied electrical voltage. The electrons collide with the atoms in the lattice and this impedance to their motion contributes the electrical resistance of the metal. Generally, resistance is increases as the temperature goes up. The vibrating atoms in the lattice oscillate over a wider distance from their lattice position and interfere with the electron motion to a greater degree. Resistance is undesirable because it produce losses in current conduction through material. The uniqueness of superconductor thus has attracted many researchers to carry further research on this field.

The milestone made by Heiki Kamerleigh Onnes in 1911 has triggered further research on superconductors. He successfully liquefied helium by cooling it and reached temperature as low as 4.2 K. After this discovery, the phenomenon was found to occur for other elements such as Pb, Sn and Al at critical temperature between 4-10