UNIVERSITI TEKNOLOGI MARA

SYNTHESIS AND CHARACTERIZATION OF RARE EARTH ELEMENTS CERIUM AND DYSPROSIUM DOPED LOW DENSITY Bi-2223 SUPERCONDUCTOR

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Thesis submitted in fulfilment of the requirements for the degree of Master of Science

Faculty of Applied Sciences

December 2015
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 of qualification.

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

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ABSTRACT

So far, there are limited reports on the investigation on the influence of the rare earth doped low density Bi_{1.6}Pb_{0.4}Sr_{2}Ca_{2}Cu_{3}O_{y} system where cerium and dysprosium doping samples possessed a weak connection in the bulk samples. Hence, this study is conducted to investigate the influences of rare earth elements (Ce, Dy) doping on the structural and superconducting properties in low density Bi_{1.6}Pb_{0.4}Sr_{2}Ca_{2}Cu_{3}O_{y} superconductor. In this research, the influences of cerium and dysprosium doped low density Bi_{1.6}Pb_{0.4}Sr_{2}Ca_{2}Cu_{3}O_{y} superconductor were studied based on the best level of low density and sintering time, furthermore, the technique of mixing the superconducting samples with sucrose was used to prepare the low density rare earth elements (Ce, Dy) doped Bi_{1.6}Pb_{0.4}Sr_{2}Ca_{2}Cu_{3}O_{y} superconductor. The optimum level of sucrose was found at 0.050 g mixed with 1.950 g of Bi(Pb)SrCaCuO powder while the critical current density, $J_{C}$ of high density (standard sample) and optimum low density was measured to be 3.746 A/cm$^2$ and 5.405 A/cm$^2$, respectively at 77 K under zero magnetic field. Furthermore, the optimal sintering time of the samples Bi_{1.6}Pb_{0.4}Sr_{2}Ca_{2}Cu_{3}O_{y} system was found at 850°C for 72 hours. The best $J_{C}$ achieved in high density and optimal low density samples were 7.547 A/cm$^2$ and 8.333 A/cm$^2$ respectively at 77 K under zero magnetic fields. However, it was found that both doped Ce and Dy at Ca site indicated deteriorations on the superconducting properties when compared with the undoped samples. The doping samples exhibited the increased values of $T_{C}$ and $J_{C}$ towards the optimum concentration and decreased after the further increase of Ce and Dy dopants.
First and foremost, I am most grateful to Allah, the almighty for providing me this opportunity and granting me the capability to proceed successfully.

I would like to express my deep gratitude and appreciation to my supervisor, Dr. Azhan Bin Hashim @ Ismail, for his constant help, support, encouragement and supervision throughout the study. His valuable comments and suggestions throughout the preparation of this thesis are greatly appreciated. I would also like to acknowledge Associate Dr. Azman Kasim as my co-supervisor in this research project.

Special thanks to the Malaysian Ministry of Education (MOE) for the financial support provided via Fundamental Research Grant Scheme (FRGS) no. 600-RMI/FRGS 5/3 (6/2012). Thank you too MYBRAIN scholarship to support my fees in this study.

Thank you especially to Faculty of Applied Sciences, University Technology MARA for giving me the opportunity to conduct this project. Thank you too to Science officers, lab assistants of Faculty of Applied Sciences and Institute of Sciences (IOS) of UiTM Malaysia for helping me in carrying out Field Emission Scanning Electron Microscope (FESEM) and electrical resistance measurement ($T_c$ and $J_c$) testing. And a lot of thank to Universiti Sains Malaysia, USM and their Science officers for helping me in carrying out X-Ray Diffraction (XRD).

I am extremely grateful to my lab mates, Nor Azura bt. Che Mahmud, Noor Syuhaida bt. Ibrahim, Siti Hawa bt. Jamil and Suazlina bt. Mohd Ali. Thanks a lot for your kind help and understanding regarding this work.

To my friends who never fail to encourage me until the end, Nor Aadila bt Abdul Aziz, Amirah bt. Asib, Affaah bt. Abdullah, Nur Baisyatul Ermiza bt. Suhaimi, Noranizah bt. Awang, Siti Nasuha bt. Mohd Rafien, Siti Musleha bt Ab. Mutalib and Nur Sha’adah bt. Zainuddin, my special thank go to all of you. I am very thankful to En. Syukri b. Muda, and other technical staff in the Physics Department for their technical favours.

My sincere thanks are also due to my dearest friends Wan Faridahana Bt. Wan Hussin, Siti Hazwani Bt Mohd Noor, Ezli Suhana Bt Razali, thank you for your blessing and moral support.

I would also like to express my deepest appreciation to my mother Che Kamariah Bt Ag.Senik for her continuous prayers for my success. And last but not least, to my family and relatives, thank you for your love, continuous support, encouragement, and understanding.
CHAPTER ONE
INTRODUCTION

This chapter includes the research background, research problem, research objectives, research significance, research scope and limitations of the study.

1.1 RESEARCH BACKGROUND

Solid state materials can be classified into several groups, which include insulators, semiconductors, conductors, and superconductors. Insulators, such as quartz and diamond are high resistant materials as insulators are insufficient to promote the electrons from the valence band to the conduction band as the gap energy exceeds ~9eV. Besides that, in this condition, the valence band is fully occupied, and the conduction band is empty (Oak Ridge National Laboratory, 1996).

Meanwhile, semiconductors, such as silicon and germanium have lower resistance than insulators but higher resistance than conductors. In terms of semiconductors, the electrical conductivity of an intrinsic semiconductor is very small since the electrical conduction is directly connected to the number of electrons in the conduction band as well as the number of holes in the valence band (Oak Ridge National Laboratory, 1996).

In the meantime, ordinary conductors such as silver or copper wire do not possess any energy gap because the conduction bands and valence bands are not separated. However, some energy will be lost as the currents flow as electricity is transferred into heat, sound or any other form of energy. This is because, electricity is conducted as the outer energy level electrons migrate as individual’s atom to another. These atoms form a vibrating lattice within the metal conductor where the warmer the metal the more it vibrates. Meanwhile, the movement of electrons through the maze produces collisions between the electrons with some imperfections or tiny impurities in the lattice. Hence, the electrons will fly off in all directions and energy will be lost in the form of heat as they bump into obstacles.

On the other hand, superconductor is a material that can conduct electricity without any resistance below a certain temperature and does not involve any energy release when it carries direct currents, hence, it is a material with an infinite conductivity. Since the current is finite, based on the Ohms law principle, the electric...