

**MICROSTRUCTURE AND ELECTRICAL PROPERTY
RELATIONSHIPS OF LEAD ZIRCONATE
TITANATE-LEAD MAGNESIUM
NIOBATE CERAMICS**

RUNGNAPA TIPA KONTITIKUL

**DOCTOR OF PHILOSOPHY
IN MATERIALS SCIENCE**

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่

Copyright © by Chiang Mai University

All rights reserved

**GRADUATE SCHOOL
CHIANG MAI UNIVERSITY**

APRIL 2005

ISBN 974-9883-14-4

**MICROSTRUCTURE AND ELECTRICAL PROPERTY
RELATIONSHIPS OF LEAD ZIRCONATE
TITANATE-LEAD MAGNESIUM
NIOBATE CERAMICS**

RUNGNAPA TIPAKONTITIKUL

**A THESIS SUBMITTED TO THE GRADUATE SCHOOL IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
IN MATERIALS SCIENCE**

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่

Copyright © by Chiang Mai University

All rights reserved

**GRADUATE SCHOOL
CHIANG MAI UNIVERSITY**

APRIL 2005

ISBN 974-9883-14-4

**MICROSTRUCTURE AND ELECTRICAL PROPERTY
RELATIONSHIPS OF LEAD ZIRCONATE
TITANATE-LEAD MAGNESIUM
NIOBATE CERAMICS**

RUNGNAPA TIPAKONTITIKUL

**THIS THESIS HAS BEEN APPROVED
TO BE A PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY
IN MATERIALS SCIENCE**

EXAMINING COMMITTEE

Supon Ananta

.....CHAIRPERSON

Asst.Prof.Dr. Supon Ananta

Tawee Tunkasiri

.....MEMBER

Prof.Emeritus Dr. Tawee Tunkasiri

Rattikorn Yimnirun

.....MEMBER

Dr. Rattikorn Yimnirun

Yongyut Laosiritaworn

.....MEMBER

Dr. Yongyut Laosiritaworn

Supasarote Muensit

.....MEMBER

Assoc.Prof.Dr. Supasarote Muensit

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

27 April 2005

© Copyright by Chiang Mai University

ACKNOWLEDGEMENT

This thesis had been accomplished during the period of July 2001 to April 2005, in co-operation between Materials Science Research Lab., Department of Physics, Chiang Mai University, Thailand, Department of Physics, Ubon Rajathanee University, Thailand and Electroceramic group, Department of Engineering Materials, The University of Sheffield, UK.

I would like to acknowledge my supervisors, Asst. Prof. Dr. Supon Ananta for valuable suggestion and discussions during the course of the PhD project, especially during writing of this thesis. I also wish to extend the most appreciation and gratitude to the external committee member, Assoc. Prof. Dr. Supasarote Muensit, and the committee members, Prof. Dr. Tawee Tunkasiri, Dr. Rattikorn Yimnirun and Dr. Yongyut Laosiritaworn. I also indebted Prof. Dr. W. E. Lee and Dr. D. R. Sinclair who have given the useful technical advice and a lot of research experience during my visit to the UK.

I am very grateful to the Ministry of University affairs, Thai Government, Thailand, Ubon Rajatane University and the Graduate School, Chiang Mai University for their contribution to funding my research.

There are many people who helped me to get to this point. I would like to take this opportunity to thank some of them who contributed most. They are Prof. Dr. Sukon Panitchapan, Dr. Anuson Niyompan, Dr. Aurawan Udomporn, Dr. Theerachai Bongkran, Ms. Chompoonuch Puchmark, Dr. Naratip Vittayakorn, Dr. Wandee Onreabroy, Miss Wanwilai Chaisan and Miss Wannaporn Boonyasatid.

I also wish to thank all the academic, technical and secretarial staff in the Department of Physics, Khon Kaen University and Chiang Mai University for their practical and intellectual help.

In particular, I would like to thank Dr. Prasert Kengkan and Dr. Janpen S. Thomas, from the Department of Physics, Khon Kaen University, who encouraged me to study higher degrees and her spiritual support throughout my PhD period.

On a personal note, my sincerely thanks go to my beloved, Dr. Anuson Niyompan, who has helped in preparing this thesis and supported me over the past nine years, and all my friends for a good and memorable time in Chiang Mai.

Finally, this thesis is dedicated to my parent for their perpetual support, encouragement and enthusiasm. From the beginning, they always encouraged me to excel and achieve the goals that I set for myself. Without their encouragement and support, I would never have made it this far. I wish they could share this with me.

Rungnapa Tipakontitikul

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved