

**FABRICATION AND CHARACTERIZATION OF
CERAMIC NANOCOMPOSITES IN DENTAL
PORCELAIN-BASED SYSTEMS**

ATTAVIT PISITANUSORN

**DOCTOR OF PHILOSOPHY
IN MATERIALS SCIENCE**

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่

Copyright© by Chiang Mai University

All rights reserved

**THE GRADUATE SCHOOL
CHIANG MAI UNIVERSITY**

SEPTEMBER 2007

**FABRICATION AND CHARACTERIZATION OF
CERAMIC NANOCOMPOSITES IN DENTAL
PORCELAIN-BASED SYSTEMS**

ATTAVIT PISITANUSORN

**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

**THE GRADUATE SCHOOL
CHIANG MAI UNIVERSITY**

SEPTEMBER 2007

**FABRICATION AND CHARACTERIZATION OF
CERAMIC NANOCOMPOSITES IN DENTAL
PORCELAIN-BASED SYSTEMS**

ATTAVIT PISITANUSORN

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

..... CHAIRPERSON

Asst. Prof. Dr. Yongyut Laosiritaworn

..... MEMBER

Assoc. Prof. Dr. Supon Ananta

..... MEMBER

Asst. Prof. Dr. Rattikorn Yimnirun

..... MEMBER

Dr. Sukdipown Thiansem

..... MEMBER

Dr. Nuanwan Sa-Nguansak

7 September 2007

© Copyright by Chiang Mai University

ACKNOWLEDGEMENTS

This thesis had been accomplished during the period of June 2004 to August 2007, in co-operation between Materials Science Program, Department of Physics, Faculty of Science, CMU and Institute of Ceramic, Glass and Construction Materials, Technical University of Freiberg, Freiberg, Germany.

I must acknowledge many people who have helped me throughout this work and greatly increased the quality of my education. I would first like to thank Assoc. Prof. Dr. Supon Ananta for the great opportunities, very good supervisions, valuable suggestions and all supports he has given me through out my thesis work.

I would like to thank my committee members, Asst. Prof. Dr. Rattikorn Yimnirun, Dr. Sukdipown Thiansem, Asst. Prof. Dr. Yongyut Laosiritaworn and, especially, the external committee member, Dr. Nuanwan Sanguansak, for their helpful advices, kindly comments and valuable suggestions and information about in- and out- of thesis. I am also grateful to Assoc. Dr. Nikorn Mangkorntong, Assoc. Dr. Pongsri Mangkorntong, Assoc. Prof. Dr. Thoranin Chairuangstri, Dr. Pisit Singhjai and Dr. Theparat Kaemaleelakul for their useful comments and technical advices about this work.

I must give a special thank to Prof. Dr. Wolfgang Schulle, Prof. Dr. Christos G. Aneziris and Dr. Bernd Ullrich for all opportunities, supports, suggestions and instructions about this work. I would also like to acknowledge Miss Yana Hubulkovu, Mr. Felix Homola and Mr. Tim Kratschmer for assistance, helpful suggestion and important knowledge about this work while I was in Germany. Last but not least

many thanks to our partners in Institut für Werkstofftechnik, especially Prof. Dr. G. Pusch and Mrs. G. Bittner; and Institut für Keramik, Glas- und Baustofftechnik der Bergakademie Freiberg, Freiberg, Germany.

I would like to thank all helps and supports from officers and technical staffs of Department of Physics, Faculty of Science, CMU, Mr. Suwit Chaisupan for XRD analysis, Electron Microscopy Research and Service Center (EMRSc) for SEM analysis and Mrs. Pannee Pupan for her assistance in the administration needed to keep my work and the rest of the department going.

My special thanks go to my senior alumni and friends at CMU, Dr. Nopawong Luevitoonvechakij, Mr. Manat Jaimasith, Miss Pattamaporn Prapitpongwanich, Miss Orawan Khumman, Mr. Athipong Ngamjarujana and Miss Rewadee Wongmanee-rung who have played, helped and encouraged me to get to this point. The experiences I have shared with them have helped shape who I am today.

I must acknowledge the Faculty of Dentistry and Faculty of Science, Graduate School, Nanoscience and Nanotechnology Center, Chiang Mai University; especially, The Ministry of University Affairs, Preecha-Varunee Govithaya Foundation for the Faculty of Science, CMU and Hexa Ceram Co., Ltd. for all Financial Supports.

Finally, I must thank my parents, Mr. Tawin Pisitanusorn, Mrs. Usa Pisitanusorn, and my sister, Mrs. Tanaratchada Attakorn, their love, kindness and support (financially and emotionally) is something I could not have accomplished what I have had without them. I am truly thankful.

Words can't express how much I appreciate all of you.

Attavit Pisitanusorn