

GRADUATE SCHOOL CHIANG MAI UNIVERSITY JUNE 2017



GRADUATE SCHOOL CHIANG MAI UNIVERSITY JUNE 2017



A THESIS SUBMITTED TO CHIANG MAI UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE A Copyright<sup>O</sup> by Chiang Mai University A I I r i g h t s r e s e r v e d

### GRADUATE SCHOOL, CHIANG MAI UNIVERSITY JUNE 2017

ANUPONG SUKEE

## THIS THESIS HAS BEEN APPROVED TO BE A PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN APPLIED PHYSICS

### **Examination Committee:**

(Asst. Prof. Dr. Wiradej Thongsuwan)

(Assoc. Prof. Dr. Pisith Singjai)

#### (Dr. Orawan Wiranwetchayan)

(Dr. Suphaporn Daothong)

### **Advisor Committee:**

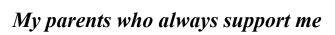
Rock Singstre Advisor

(Assoc. Prof. Dr. Pisith Singjai)

≺.....Co-advisor

(Dr. Orawan Wiranwetchayan)

9 June 2017 Copyright © by Chiang Mai University



То



**ลิขสิทธิ์มหาวิทยาลัยเชียงใหม**่ Copyright<sup>©</sup> by Chiang Mai University All rights reserved

### ACKNOWLEDGEMENT

This thesis is not written if I do not acquire many continued assistance, suggestion and moral support from many people.

First of all, I would like to express my deepest appreciation to advisor Assoc. Prof. Dr. Pisith Singjai who always gives me the useful suggestion, problem solving and encouragement throughout this thesis. He has given a great opportunity to me for learning and doing a research about nanoscience and nanotechnology.

Secondly, I would like to be grateful for my co-advisor, Dr. Orawan Wiranwetchayan who has given me the valuable advices and supported my wish throughout doing research.

I would like to special thank Mr. Ekkapong Kuntarak for a lot of knowledge, understanding and techniques about Raman spectroscopic measurement.

I would like to thank Mr. Wattikon Sroila for his always help in Ultraviolet-visible spectroscopic measurement.

I am also like to all members of the Nanomaterials Research Unit, Chiang Mai University for special time, friendship, good inspiration and best assistance.

Special thanks to the Department of Physics and Materials Science, Chiang Mai University and the Science Achievement Scholarship of Thailand (SAST) for their continued support.

Finally, I would like to be most grateful for my family for their understanding and good moral support.

Anupong Sukee