

**SYNTHESIS OF METAL OXIDE NANOSTRUCTURES  
BY MICROWAVE PLASMA AND DIRECT  
CURRENT HEATING METHODS**

**ARRAK KLINBUMRUNG**

**DOCTOR OF PHILOSOPHY  
IN MATERIALS SCIENCE**

**GRADUATE SCHOOL**

**CHIANG MAI UNIVERSITY**

**JULY 2014**

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**ARRAK KLINBUMRUNG**

**A THESIS SUBMITTED TO CHIANG MAI UNIVERSITY IN PARTIAL  
FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF  
DOCTOR OF PHILOSOPHY  
IN MATERIALS SCIENCE**

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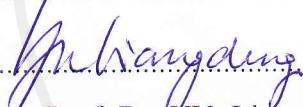
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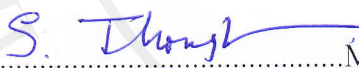
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ARRAK KLINBUMRUNG


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

**Examination Committee:**

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(Assoc. Prof. Dr. YU Liangdeng)

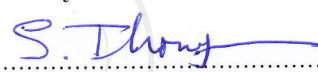
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(Assoc. Prof. Titipun Thongtem)


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(Assoc. Prof. Dr. Dheerawan Boonyawan)

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7 July 2014

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The seal of Chiang Mai University is a large, light gray watermark in the background. It features a central elephant standing under a sunburst, surrounded by Thai script and the English text 'CHIANG MAI UNIVERSITY 1964'.

*Special tribute to Prof. Dr. Somchai Thongtem*

*and*

*Assoc. Prof. Titipun Thongtem*

*for teaching and guiding me to be a scientist,*

*and*

*To the love of my family that can be always touched all my life*

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Arrak Klinbumrung

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