

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to Associate Professor Dr. Sanong Ekgasit and Associate Professor Chuchaat Thammacharoen for wholeheartedly provide the useful guidance, understanding, training and teaching the theoretical background and technical skills during my research.

I would like to thank Assistant Professor Dr. Warinthorn Chavasiri, Associate Professor Dr. Ruangpornvisuti, and Associate Professor Dr. Vittaya Amornkitbamrung for usefully substantial suggestions as the thesis committee.

Warmest thanks to my colleagues and organization: Sensor Research Unit, Department of Chemistry, Faculty of Science, Chulalongkorn University, and all good friends for the suggestions and spiritual supports throughout this research.

I would also especially like to thank partial financial supports in my research: The Office of the National Research Council of Thailand (NRCT), Center of Innovative Nanotechnology Chulalongkorn University (CIN-CU), National Center of Excellence for Petroleum, Petrochemicals and Advanced Materials (CE PPAM).

Whatever shortcomings in the thesis remain, they are the sole responsibility of the author

Above all, I am profoundly grateful to my parents and endearing family for all their loves, understanding, support, and encouragement during the whole period of my study.