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A NOVEL METHOD FOR ZINC OXIDE NANOSTRUCTURE
SYNTHESIS VIA COMBINED ELECTROSPINNING AND
SOLVOTHERMAL TECHNIQUES

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A Thesis Submitted in Partial Fulfillment of the Requirements for the
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Department of Chemical Engineering

Faculty of Engineering

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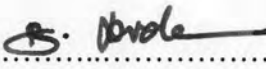
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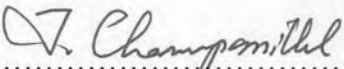
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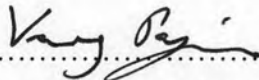
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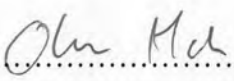
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นราธิป สังฆพพรหม: วิธีใหม่ในการสังเคราะห์สังกะสีออกไซด์ที่มีโครงสร้างแบบนาโน ด้วยเทคนิคการปั่นเส้นใยด้วยไฟฟ้าสถิตผสมกับโซลโวเทอร์มอล (A NOVEL METHOD FOR ZINC OXIDE SYNTHESIS VIA COMBINED ELECTROSPINNING AND SOLVOTHERMAL TECHNIQUES) อ. ที่ปรึกษา : ผศ. ดร. วรงค์ ปวรอาจารย์, อ. ที่ปรึกษาร่วม : รศ. ดร. พิชญ์ สุภผล, 113 หน้า.

สังกะสีออกไซด์คือสารกึ่งตัวนำที่มีสมบัติเชิงแสง ความร้อน และ อิเล็กทรอนิกส์ที่ดี ในงานวิจัยนี้ สังกะสีออกไซด์ที่มีโครงสร้างแบบนาโนได้ถูกสังเคราะห์ขึ้นด้วยเทคนิคการปั่นเส้นใยด้วยไฟฟ้าสถิตผสมกับเทคนิคโซลโวเทอร์มอล โดยขั้นตอนแรกสังกะสีอะซีเตตผสมกับพอลิไวนิลแอลกอฮอล์ (พีวีเอ) ถูกสร้างให้เป็นเส้นใยนาโนโดยวิธีการปั่นเส้นใยด้วยไฟฟ้าสถิต หลังจากนั้นเส้นใยผสมถูกนำไปสังเคราะห์ให้เป็นสังกะสีออกไซด์ด้วยเทคนิคโซลโวเทอร์มอลโดยใช้ ออกทานอลเป็นตัวกลางการเกิดปฏิกิริยา ผลของปริมาณสังกะสีอะซีเตตส่วนเกิน อุณหภูมิและเวลาในการทำปฏิกิริยาได้ถูกศึกษาเพื่อหาสภาวะการโตของสังกะสีออกไซด์ที่มีโครงสร้างแบบนาโน จากการศึกษาพบว่า ที่อุณหภูมิของปฏิกิริยาโซลโวเทอร์มอลในช่วง 170 ถึง 250 องศาเซลเซียส ผลิตภัณฑ์ที่ได้เป็นสังกะสีออกไซด์ในโครงสร้างเฮกซะโกนอล ผลิตภัณฑ์ที่ได้จากเทคนิคโซลโวเทอร์มอลเมื่อใช้เส้นใยนาโนผสมระหว่างพีวีเอและสังกะสีอะซีเตต โดยปราศจากสังกะสีอะซีเตตส่วนเกินที่เติมเข้าไปเป็นสารตั้งต้น พบว่ายังคงสภาพเป็นเส้นใยสังกะสีออกไซด์ และเมื่อเติมสังกะสีอะซีเตตเพิ่มเข้าไป จะเกิดสังกะสีออกไซด์ที่มีลักษณะเป็นแท่งนาโน เกาะอยู่บนสังกะสีออกไซด์ที่มีโครงสร้างแบบนาโน โดยความยาวของแท่งจะเพิ่มขึ้นเมื่อเพิ่มปริมาณสังกะสีอะซีเตตที่เติมเข้าไป หรือเพิ่มอุณหภูมิและเวลาในการทำปฏิกิริยา นอกจากนี้ยังพบว่าสังกะสีอะซีเตตที่อยู่ในเส้นใยสามารถเปลี่ยนไปเป็นสังกะสีออกไซด์ได้โดยที่พีวีเอยังคงอยู่ และสังกะสีอะซีเตตเริ่มที่จะเปลี่ยนไปเป็นสังกะสีออกไซด์โดยสมบูรณ์ที่อุณหภูมิในการทำปฏิกิริยา 200 องศาเซลเซียส และการโตของผลึกจะเพิ่มขึ้นเมื่ออุณหภูมิในการทำปฏิกิริยามีค่า 250 องศาเซลเซียส

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NARATIP SANGKHAPROM : A NOVEL METHOD FOR ZINC OXIDE
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SOLVOTHERMAL TECHNIQUES.

THESIS ADVISOR: ASST. PROF. VARONG PAVARAJARN, Ph.D.,

THESIS COADVISOR: ASSOC.PROF. PITT SUPAPHOL, Ph.D., 113 pp.

Zinc oxide (ZnO) is semiconductor materials due to its good optical, thermal and electrical properties. In this work, ZnO nanostructures were synthesized by combination of electrospinning and solvothermal techniques. First, zinc precursor, i.e. zinc acetate ($\text{Zn}(\text{CH}_3\text{CO}_2)_2$) was formed into nanofibers by electrospinning with the aid of poly(vinyl alcohol) (PVA). Subsequently, the PVA/zinc acetate composite nanofibers were subjected to the solvothermal process, in which octanol was used as the reaction medium, in order to synthesize zinc oxide nanostructure. The effect of quantity of excess zinc acetate, reaction temperature and reaction time for solvothermal process were investigated to find growth mechanism of ZnO nanostructures. It was found that when the solvothermal temperature is in the range of 170 to 250 °C, all products are ZnO in the hexagonal phase. The products from the solvothermal synthesis, using PVA/zinc acetate composite nanofibers without excess zinc acetate in the reaction medium, are nanofibers of polycrystalline ZnO. When there is excess zinc acetate presented in the reaction system, ZnO nanorods are formed and deposited on the ZnO nanostructures. The length of the rods increases with an increase in either reaction temperature or the quantity of excess zinc acetate. Moreover, zinc acetate within the composite fibers can be converted into ZnO, while PVA is still retained. Zinc acetate starts to completely convert into ZnO at 200 °C and the growth of the ZnO crystals is more immense as the reaction temperature is raised to 250 °C.

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CONTENTS

	Page
ABSTRACT (THAI)	iv
ABSTRACT (ENGLISH)	v
ACKNOWLEDGMENTS	vi
CONTENTS	vii
LIST OF TABLE	x
LIST OF FIGURES	xi
CHAPTER	
I INTRODUCTION	1
II THEORY AND LITERATURE SURVEY	4
2.1 Properties of Zinc Oxide.....	4
2.2 Electrospinning Process.....	6
2.2.1 Mechanism of Electrospinning Process.....	8
2.2.2 Parameters and Conditions for Electrospinning Process.....	9
2.2.3 Applications of Electrospinning.....	13
2.3 Methods for Synthesizing Zinc Oxide Powder.....	17
2.3.1 Thermal Decomposition Method.....	17
2.3.2 Sol-Gel Method.....	18
2.2.3 Precipitation Method.....	18
III EXPERIMENTAL	20
3.1 Materials.....	20
3.2 Equipments.....	20
3.2.1 Electrospinning System.....	20
2.3.2 Solvothermal System.....	21
3.3 Procedures.....	23
3.3.1 Preparation of Spinning Solution.....	23
3.3.2 Spinning of the PVA/Zinc Acetate Composite Fibers	23

CHAPTER	Page
3.3.3 Conversion of the Composite Fibers into ZnO Nanostructure by Solvothermal Technique.....	24
3.3.4 Conversion of the Composite Fibers into ZnO Nanostructure by Conventional Method.....	24
3.4 Sample Characterizations	25
3.4.1 X- ray diffraction Analysis (XRD).....	25
3.4.2 Scanning Electron Microscopy (SEM).....	25
3.4.3 Thermogravimetric and Differential Thermal Analysis (TG-DTA).....	25
3.4.4 Fourier Transform Infrared Spectroscopy (FT-IR)....	26
IV RESULTS AND DISCUSSION.....	27
4.1 Properties of as-spun PVA/Zinc Acetate Composite Fibers.....	27
4.2 Conversion of the Composite Fibers into ZnO Nanostructure by Conventional Method.....	30
4.3 Conversion of the Composite Fibers into ZnO Nanostructure by Solvothermal Technique.....	34
4.3.1 The Effect of PVA-to-Zinc Acetate Ratio.....	34
4.3.2 The Effect of Excess Zinc Acetate	41
4.3.3 The Effects of Reaction Temperature and Reaction Time	56
4.4 Comparison between Calcined Products and Solvothermal Products.....	79
V CONCLUSIONS AND RECOMMENDATION.....	88
5.1 Conclusions.....	88
5.2 Recommendations for Future Work.....	89
REFERENCES.....	90
APPENDICES.....	96

	Page
APPENDIX A: SIZE DISTRIBUTION OF ZnO NANOSTRUCTURES.....	97
APPENDIX B: CALCULATION OF THE CRYSTALLITE SIZE..	106
APPENDIX C: LIST OF PUBLICATION.....	108
VITA.....	113

LIST OF TABLES

TABLE		Page
2.1	Properties of wurtzite ZnO	5
2.2	The literature review of effect of concentration of zinc acetate in PVA solution on PVA/zinc acetate composite fibers	15
4.1	Diameter of fibers and crystallite size of the ZnO nanostructures synthesized via the solvothermal technique, with various PVA-to-zinc acetate ratios.....	38
4.2	Dimension of ZnO nanostructure synthesized using various amounts of excess zinc acetate powder.....	52

LIST OF FIGURES

FIGURE		Page
2.1	Stick and ball representation of ZnO crystal structures.....	4
2.2	Schematic diagram of the electrospinning process	7
3.1	Experimental set up for electrospinning process	21
3.2	Diagram of the solvothermal system	22
3.3	Autoclave reactor.....	22
4.1	SEM images of the as-spun fibers prepared from the spinning solution	28
4.2	Frequency distributions of fiber diameter of the as-spun fibers prepared from the spinning solution.....	29
4.3	Thermogravimetric curves of the PVA/zinc acetate composite fibers	31
4.4	FT-IR spectra for PVA/zinc acetate composite fibers and fibers calcined at 600 °C for 2 hr.....	32
4.5	XRD results for PVA/zinc acetate composite fibers and fibers calcined at 600 °C for 2 hr.....	33
4.6	SEM image and size distribution of ZnO fibers calcined at 600 °C for 2 hr.....	33
4.7	XRD results for ZnO nanostructures with various PVA-to-zinc acetate ratio	34
4.8	SEM images for ZnO nanostructures with various PVA-to-zinc acetate ratio.....	35
4.9	Frequency distribution for ZnO nanostructures with various PVA-to-zinc acetate ratio.....	37
4.10	FT-IR spectras for ZnO nanostructures with various PVA-to-zinc acetate ratio.....	39

FIGURE	Page
4.11 TG curve of ZnO nanostructure.....	40
4.12 XRD results for particles part in the ZnO nanostructures with various the amount of excess zinc acetate powder.....	42
4.13 XRD results for fibers part in the ZnO nanostructures with various the amount of excess zinc acetate powder.....	42
4.14 SEM image for ZnO nanostructure synthesized from PVA/zinc acetate composite fibers with PVA-to-zinc acetate ratio of 1.5 and the excess zinc acetate powder of 0.1 g.....	44
4.15 Frequency distribution for size of particles within the fibers of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and the excess zinc acetate powder of 0.1 g.....	44
4.16 SEM images of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and the excess zinc acetate powder of 1 g.....	46
4.17 Frequency distributions of ZnO nanostructures that synthesized with PVA-to-zinc acetate ratio of 1.5 and the excess zinc acetate powder of 1 g.....	47
4.18 SEM images of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and the excess zinc acetate powder of 5 g.....	48
4.19 SEM images of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and the excess zinc acetate powder of 10 g.....	49
4.20 Frequency distributions of ZnO nanostructures that synthesized with PVA-to-zinc acetate ratio of 1.5 and the excess zinc acetate powder of 5 g.....	50
4.21 Frequency distributions of ZnO nanostructures that synthesized with PVA-to-zinc acetate ratio of 1.5 and the excess zinc acetate powder of 10 g.....	51

FIGURE	Page
4.22 FT-IR spectra for fibers part in the ZnO nanostructures with various the amount of excess zinc acetate powder.....	53
4.23 FT-IR spectra for particles part in the ZnO nanostructures with various the amount of excess zinc acetate powder.....	55
4.24 XRD results for ZnO nanostructures with various reaction conditions.....	57
4.25 SEM images of ZnO nanostructures synthesized via the solvothermal reaction in 1-octanol at 170 °C for 0 hr and 170 °C for 2 hr.....	58
4.26 SEM images of ZnO nanostructures synthesized via the solvothermal reaction in 1-octanol at 200 °C for 0 hr and 200 °C for 2 hr.....	59
4.27 SEM images of ZnO nanostructures synthesized via the solvothermal reaction in 1-octanol at 250 °C for 0 hr and 250 °C for 2 hr.....	60
4.28 Average fiber diameter and average diameter of particles within the fibers of ZnO nanostructures that synthesized via the solvothermal reaction in 1-octanol at various temperatures and reaction times.....	62
4.29 Crystallite size of ZnO nanostructures that synthesized from via the solvothermal reaction in 1-octanol at various temperatures and reaction times.....	63
4.30 FT-IR spectra of ZnO nanostructures that synthesized from via the solvothermal reaction in 1-octanol at various temperatures and reaction times.....	64
4.31 XRD results of pure PVA fibers and PVA fibers after subjected to the solvothermal reaction at 250 °C for 2 hr.....	65
4.32 SEM image of pure PVA fibers after subjected to the solvothermal reaction in 1- octanol at 250 °C for 2 hr.....	66

FIGURE	Page
4.33 FT-IR results for pure PVA fibers and PVA fibers after were added into the solvothermal system at 250 °C for 2hr.....	67
4.34 XRD results for fibers part in ZnO nanostructures with various reaction conditions.....	68
4.35 XRD results for particles part in ZnO nanostructures with various reaction conditions.....	69
4.36 SEM images of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and 10 g of excess zinc acetate powder at 170 °C for 0 hr and 170 °C for 2 hr.....	70
4.37 SEM images of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and 10 g of excess zinc acetate powder at 200 °C for 0 hr and 200 °C for 2 hr.....	71
4.38 SEM images of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and 10 g of excess zinc acetate powder at 250 °C for 0 hr and 250 °C for 2 hr.....	72
4.39 Average diameter of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and 10 g of excess zinc acetate powder via the solvothermal reaction under various reaction conditions.....	73
4.40 Average length of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and 10 g of excess zinc acetate powder via the solvothermal reaction under various reaction conditions.....	74
4.41 Crystallite size of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and 10 g of excess zinc acetate powder via the solvothermal reaction under various reaction conditions.....	75

FIGURE	Page
4.42 FT-IR spectra of fibers part inZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and 10 g of excess zinc acetate powder via the solvothermal reaction under various reaction conditions.....	76
4.43 FT-IR spectra of particles part inZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and 10 g of excess zinc acetate powder via the solvothermal reaction under various reaction conditions.....	78
4.44 XRD results for the ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 via the solvothermal reaction at 170 °C, 200 °C and 250 °C for 2 hr and subsequently calcined at 600 °C for 2 hr.....	80
4.45 SEM images for the ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 via the solvothermal reaction at 170 °C, 200 °C and 250 °C for 2 hr and subsequently calcined at 600 °C for 2 hr.....	82
4.46 Size distributions for the ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 via the solvothermal reaction at 170 °C, 200 °C and 250 °C for 2 hr and subsequently calcined at 600 °C for 2 hr.....	83
4.47 FT-IR results for the ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 via the solvothermal reaction at 170 °C, 200 °C and 250 °C for 2 hr and subsequently calcined at 600 °C for 2 hr.....	84
4.48 XRD result of PVA/zinc acetate fibers directly calcined at 250 °C for 2 hr.....	85
4.49 SEM images of PVA/zinc acetate fibers directly calcined at 250 °C for 2 hr.....	86
4.50 Size distribution of PVA/zinc acetate fibers directly calcined at 250 °C for 2 hr.....	86

FIGURE	Page
4.51 FT-IR results of PVA/zinc acetate fibers directly calcined at 250 °C for 2 hr.....	87
4.52 Thermogravimetric curve of PVA/zinc acetate fibers directly calcined at 250 °C for 2 hr.....	87
A1.1 Frequency distributions for fiber diameter and diameter of particle within the fibers of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 at 170 °C for 0 hr and 170 °C for 2 hr.....	98
A1.2 Frequency distributions for fiber diameter and diameter of particle within the fibers of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 at 200 °C for 0 hr and 200 °C for 2 hr.....	99
A1.3 Frequency distributions for fiber diameter and diameter of particle within the fibers of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 at 250 °C for 0 hr and 250 °C for 2 hr.....	100
A2.1 Frequency distributions for diameter and length of particles part of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and the excess zinc acetate powder of 10 g at 170 °C for 2 hr.....	101
A2.2 Frequency distributions for diameter and length of particles part of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and the excess zinc acetate powder of 10 g at 200 °C for 0 hr.....	102
A2.3 Frequency distributions for diameter and length of particles part of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and the excess zinc acetate powder of 10 g at 200 °C for 2 hr.....	103

FIGURE		Page
A2.4	Frequency distributions for diameter and length of particles part of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and the excess zinc acetate powder of 10 g at 250 °C for 0 hr.....	104
A2.5	Frequency distributions for diameter and length of particles part of ZnO nanostructures that synthesized from PVA-to-zinc acetate ratio of 1.5 and the excess zinc acetate powder of 10 g at 250 °C for 2 hr.....	105