A HYBRID POLYTHIOPHENE-DYE SENSITIZED SOLAR CELL

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A Thesis Submitted in Partial Fulfilment of the Requirements
for the Degree of Master of Science
The Petroleum and Petrochemical College, Chulalongkorn University
in Academic Partnership with
The University of Michigan, The University of Oklahoma,
Case Western Reserve University
2013

Thesis Title:	A Hybrid Polythiophene – Dye Sensitized Solar Cell
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ABSTRACT

5472009063: Polymer Science Program
Jaruwan Joothamongkhon : A Hybrid Polythiophene-Dye Sensitized Solar Cell
Thesis Advisors: Assoc. Prof. Rathanawan Magaraphan 99 pp.
Keywords: Doctor blade/ Electrophoretic deposition/ Electropolymerization/ Noni leaves/ Polythiophene/ Zinc oxide

This work aims to study the efficiency of converting sunlight into electricity of dye sensitized solar cell (DSSC). ZnO was used as a semiconductor and fabricated ZnO photoanode by the doctor blade method. The extracted noni leaves was used as a sensitizer and obtained the highest conversion efficiency in comparison to other natural dyes because it absorbed both visible and near infrared wavelength region which enhanced the efficiency of DSSC. Moreover, the efficiency of noni leaves-ZnO DSSC increased with respect to the thickness of ZnO films (from 4 to 12 micrometers). This is due to the increment of ZnO nanoparticles and consequently the augmentation of dye loading. In addition, the electrophoretic deposition (EPD) was employed to prepare ZnO film for photoanode in DSSC. The as-prepared ZnO films were smooth and uniform, and their thickness was increased with the increase in deposition voltage (from DC 15 V to 24 V) and deposition times (5 min to 20 min). As a consequence, the conversion efficiency of noni leaves-ZnO DSSC increased. The short-circuit current and conversion efficiency of DSSC increased because of the increment of ZnO contents and dye loading. On the other hand, the open-circuit voltage declined due to the possible charge recombination occurred. To improve the efficiency of the dye-sensitized solar cell, the polythiophene layer prepared by electropolymerization was fabricated on the as-prepare ZnO film. The hybrid polythiophene-ZnO DSSC showed the increase in efficiency. This result indicated that the dark current reduced and consequently improved the conversion efficiency of DSSC in the presence of the polythiophene layer.

บทคัดย่อ

จารุวรรณ จูฑะมงคล : ชื่อหัวข้อวิทยานิพนธ์ (ภาษาไทย) เซลล์แสงอาทิตย์ชนิดสีย้อมไวแสงที่มีส่วนประกอบของพอลิไทโอฟีน (ภาษาอังกฤษ) (A Hybrid Polythiophene - Dye Sensitized Solar Cell) อาจารย์ที่ปรึกษา : รศ.ดร. รัตนวรรณ มกรพันธุ์ 99 หน้า

งานวิจัยนี้นำเสนอเกี่ยวกับประสิทธิภาพการเปลี่ยนพลังงานแสงอาทิตย์เป็นพลังงานไฟฟ้าของเซลล์แสงอาทิตย์ชนิดสีย้อมไวแสง ในงานวิจัยนี้เซลล์แสงอาทิตย์ทำมาจากสารกึ่งตัวนำซิงค์ออกไซด์ที่เตรียมได้จากวิธีการปาดแบบดอกเตอร์ เนื่องจากสีย้อมสกัดจากใบยอจะดูดกลืนแสงทั้งในช่วงความยาวคลื่นที่ตามองเห็นและช่วงใกล้อินฟราเรดจึงให้ประสิทธิภาพสูงสุดเมื่อเปรียบเทียบกับสีย้อมจากธรรมชาติชนิดอื่นๆ จากผลการทดลองพบว่าเซลล์แสงอาทิตย์ชนิดนี้มีประสิทธิภาพเพิ่มขึ้นเมื่อความหนาของฟิล์มซิงค์ออกไซด์มากขึ้น เพราะอนุภาคของซิงค์ออกไซด์และการดูดซับของสีย้อมบนอนุภาคมีมากขึ้น อีกวิธีหนึ่งในการเตรียมฟิล์มซิงค์ออกไซด์คือการเตรียมด้วยไฟฟ้า ฟิล์มที่ได้จากการเตรียมด้วยวิธีนี้จะเรียบและสม่ำเสมอ และความหนาของฟิล์มจะเพิ่มขึ้นเมื่อศักย์ไฟฟ้าและเวลาที่ใช้มาขึ้น ค่ากระแสและประสิทธิภาพเพิ่มขึ้นเนื่องจากปริมาณของอนุภาคซิงค์ออกไซด์และสีที่ดูดซับมีมากขึ้น แต่อย่างไรก็ตาม ค่าศักย์ไฟฟ้ามีค่าลดลงเนื่องจากโอกาสในการเกิดกระแสมืดมีมากขึ้น นอกจากนี้ชั้นของพอลิไทโอฟีนซึ่งเตรียมด้วยวิธีพอลิเมอไรเซชันแบบใช้ไฟฟ้าถูกนำมาใช้เพื่อที่จะเพิ่มประสิทธิภาพของโซล่าร์เซลล์ ชั้นของพอลิไทโอฟีนจะถูกเตรียมบนฟิล์มซิงค์ออกไซด์ และประสิทธิภาพที่ได้จากวัสดุผสมพอลิไทโอฟีน-ซิงค์ออกไซด์แสดงค่าที่เพิ่มขึ้นเนื่องจากชั้นพอลิไทโอฟีนจะไปช่วยลดการเกิดกระแสมืดของโซล่าร์เซลล์

ACKNOWLEDGEMENTS

Firstly, I would like to express my sincere gratitude to my advisor, Assoc. Prof. Rathanawan Magaraphan, for providing valuable guidance, inspiration, encouragement, and opportunities. Also, I am very grateful to Asst. Prof. Boonyarach Kitiyanan and Asst. Prof. Vorrada Loryuenyong, member of the thesis committee for their kind cooperation.

I would like to appreciate Asst. Prof. Sojipong Chattraporn from the Department of Physics, Chulalongkorn University for the kind support of I-V measuring instrument and Dr. Charoenkwan Kraiya from the Department of Chemistry, Chulalongkorn University for the kind support of the electrochemistry potentiostat. In addition, I would like to thanks all faculty members and staffs at The petroleum and Petrochemical College, Chulalongkorn University for their knowledge and assistance.

Moreover, I would like to give my special thanks to all members in my research group, as well as all of my friends for their friendship, encouragement and kind assistance.

I am grateful for the financial support provided by the government budget, Thailand; the Petroleum and Petrochemical College; and the National Center of Excellence for Petroleum, Petrochemicals, and Advanced Materials, Thailand.

Finally, I wish to express my deep gratitude to my family for their love, understanding and encouragement during all year spent for my M.S. study.

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ABBREVIATIONS

CP	Conductive polymer
DC	Direct current
DSC	Dye-sensitized solar cell
DSSC	Dye-sensitized solar cell
EPD	Electrophoretic deposition
FF	Fill factor
FTO	Fluorine-doped tin oxide
HOMO	Highest occupied molecular orbital
I^-	Iodide
I_2	Iodine
I_3^-	Triiodide
$LiClO_4$	Lithium perchlorate
LiI	Lithium iodide
LUMO	Lowest unoccupied molecular orbital
PV	Photovoltaic
PTh	Polythiophene
TCO	Transparent conductive glass
TiO_2	Titanium dioxide
UV	Ultraviolet
Vis	Visible
ZnO	Zinc oxide

LIST OF SYMBOLS

J	Current densities
J_m	Maximum-current point
J_{sc}	Short-circuit current
V	Voltage
V_{oc}	Open-circuit voltage
V_m	Maximum-voltage point
P	Power density
η	Conversion efficiency