

A HYBRID POLYTHIOPHENE-DYE SENSITIZED SOLAR CELL

Jaruwan Joothamongkhon

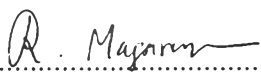
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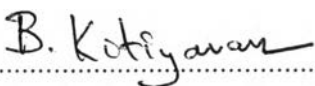
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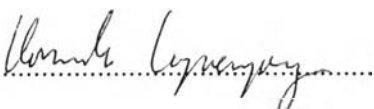
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ABSTRACT

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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

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

งานวิจัยนี้นำเสนอเกี่ยวกับประสิทธิภาพการเปลี่ยนพลังงานแสงอาทิตย์เป็นพลังงานไฟฟ้าของเซลล์แสงอาทิตย์ชนิดสีย้อมไวแสง ในงานวิจัยนี้เซลล์แสงอาทิตย์ทำมาจากสารกึ่งตัวนำซึ่งคือออกไซด์ที่เตรียมได้จากวิธีการปาดแบบคอกเตอร์ เนื่องจากสีย้อมสกัดจากใบยอจะดูดกลืนแสงทั้งในช่วงความยาวคลื่นที่ตามองเห็นและช่วงใกล้อินฟราเรดจึงให้ประสิทธิภาพสูงสุดเมื่อเปรียบเทียบกับสีย้อมจากธรรมชาติชนิดอื่นๆ จากผลการทดลองพบว่าเซลล์แสงอาทิตย์ชนิดนี้มีประสิทธิภาพเพิ่มขึ้นเมื่อความหนาของฟิล์มซึ่งคือออกไซด์มากขึ้น เพราะอนุภาคของซึ่งคือออกไซด์และการดูดซับของสีย้อมบนอนุภาคมีมากขึ้น อีกวิธีหนึ่งในการเตรียมฟิล์มซึ่งคือออกไซด์คือการเตรียมด้วยไฟฟ้า ฟิล์มที่ได้จากการเตรียมด้วยวิธีนี้จะเรียบและสม่ำเสมอ และความหนาของฟิล์มจะเพิ่มขึ้นเมื่อศักย์ไฟฟ้าและเวลาที่ใช้มากขึ้น ค่ากระแสและประสิทธิภาพเพิ่มขึ้นเนื่องจากปริมาณของอนุภาคซึ่งคือออกไซด์และสีย้อมที่ดูดซับมีมากขึ้น แต่อย่างไรก็ตาม ค่าศักย์ไฟฟ้ามีค่าลดลงเนื่องจากโอกาสในการเกิดกระแสมีมากขึ้น นอกจากนี้ชั้นของพอลิไทโอฟีนซึ่งเตรียมด้วยวิธีพอลิเมอร์เซชันแบบใช้ไฟฟ้าถูกนำมาใช้เพื่อที่จะเพิ่มประสิทธิภาพของโซลาร์เซลล์ ชั้นของพอลิไทโอฟีนจะถูกเตรียมบนฟิล์มซึ่งคือออกไซด์ และประสิทธิภาพที่ได้จากวัสดุผสมพอลิไทโอฟีน-ซึ่งคือออกไซด์แสดงค่าที่เพิ่มขึ้นเนื่องจากชั้นพอลิไทโอฟีนจะไปช่วยลดการเกิดกระแสมีดของโซลาร์เซลล์

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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