

**DEVELOPMENT OF ELECTROSPUN NANOFIBER MODIFIED
DISPOSABLE ELECTRODE FOR BIOSENSOR APPLICATIONS**

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for the Degree of Doctor of Philosophy
The Petroleum and Petrochemical College, Chulalongkorn University
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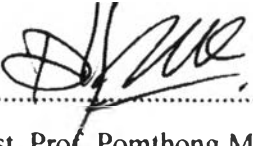
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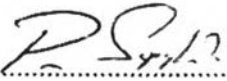
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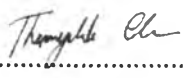
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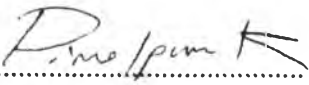

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ABSTRACT

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Keywords: Electrospinning/ Nanofiber/ Graphene/ Carbon nanotube/ Glucose/ Dopamine/ Carbon screen-printed electrode/ Vapor-phase/ Polymerization/ Carbonization

A new type of biosensor was fabricated using a carbonized hybrid gold (Au)/graphene (G) nanowire and vapor-phase polymerization of conductive polymer constructed on a disposable screen-printed carbon electrode (SPCE). Electrospinning, carbonization and conductive polymeric coating processes were combined to achieve the selective and sensitive determination of biomolecules such as glucose (GU) and dopamine (DA). Scanning electron microscopy (SEM), transmission electron microscopy (TEM) and X-ray diffraction (XRD) were used to characterize the surface morphology and physical properties of the electrospun products. The basic characterization of electrochemical behavior of the various modified electrodes in $[\text{Fe}(\text{CN})_6]^{3-/4-}$ was studied by cyclic voltammetry (CV) and Electrochemical impedance spectroscopy (EIS). The results show that modified electrodes exhibited drastically high current response compared to unmodified electrode. Moreover, the various methods of electrochemical studies; amperometry (APM), square-wave voltammetry (SWV) and differential pulse voltammetry (DPV) were used to systematically measure and optimize the oxidation current of biological analyses. Finally, the linear current response to biological concentrations, sensitivity, limit of detection (LOD) and interfering studies. The modified electrode could be a promising candidate for use as a high-potential electrode, representing a new approach for the selective and sensitive determination of biological products with long-term sensor stability.

บทคัดย่อ

พงศ์พล เอกบุตร : การพัฒนาวัสดุตรวจจับสารชีวภาพด้วยเส้นใยระดับนาโนที่ผ่านการขึ้นรูปด้วยกระบวนการปั่นเส้นใยไฟฟ้าสถิตย่นขั้วไฟฟ้าแบบใช้แล้วทิ้ง (Development of Electrospun Nanofiber Modified Disposable Electrode for Biosensor Applications)
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การพัฒนาวัสดุตรวจจับสารชีวภาพด้วยเทคนิค คาร์บอนไนโซชัน (carbonization) และการเคลือบผิวเส้นใยด้วยพอลิเมอร์นำไฟฟ้าในสถานะไอ (vapor-phase polymerization) บนขั้วไฟฟ้าคาร์บอนแบบใช้แล้วทิ้ง โดยกระบวนการดังกล่าวสามารถนำมาใช้ในการปรับปรุงผิวขั้วไฟฟ้า ส่งผลให้ขั้วไฟฟ้ามีความไวต่อปฏิกิริยาทางไฟฟ้าเคมีของสารตรวจวัด เช่น น้ำตาล กลูโคสและโดพามีน ได้อย่างมีประสิทธิภาพ เส้นใยระดับนาโนที่พัฒนาขึ้นนี้จะถูกศึกษาสมบัติทางกายภาพด้วยเทคนิค Scanning Electron Microscopy (SEM) Transmission Electron Microscopy (TEM) และ X-ray diffraction (XRD) ตามลำดับ หลังจากนั้นเส้นใยนาโนจะถูกนำไปปรับปรุงพื้นผิวของขั้วไฟฟ้าทำงาน โดยขั้วไฟฟ้าที่ผ่านการปรับปรุงผิวจะถูกศึกษาพฤติกรรมทางไฟฟ้าเคมีโดยใช้เทคนิคไซคลิกโวลแทมเมทรี (cyclic voltammetry) และอิมพีแดนซ์อิเล็กโทรสโคปี (electrochemical impedance spectroscopy) จากผลการทดลองพบว่าขั้วไฟฟ้าที่ผ่านการปรับปรุงผิวด้วยเส้นใยนาโนมีการตอบสนองต่อสัญญาณไฟฟ้าที่สูงกว่าขั้วไฟฟ้าที่ไม่ได้ผ่านการปรับปรุงผิวอย่างชัดเจน นอกจากนี้เทคนิคการวัดทางไฟฟ้าเคมีอื่นๆ เช่น เทคนิคแอมเพอโรเมทรี (amperometry) เทคนิคสแควเวฟโวลแทมเมทรี (square-wave voltametry) และเทคนิคดิฟเฟอเรนเชียลพัลส์โวลแทมเมทรี (differential pulse voltametry) ได้ถูกนำมาใช้ในการศึกษาปฏิกิริยาออกซิเดชันของสารตรวจวัดชีวภาพอย่างเหมาะสม โดยในงานวิจัยจะทำการศึกษา ค่าช่วงความเข้มข้นของการตรวจวัดที่มีความสัมพันธ์เชิงเส้นตรง (linear current response) ความไวของการตรวจวัด (sensitivity) ค่าขีดจำกัดของการตรวจวัด (limit of detection) และสภาพแวดล้อมที่รบกวนต่อสัญญาณการตรวจวัด (interfering studies) ซึ่งจากผลการทดลองทั้งหมดจะเห็นได้ว่า ขั้วไฟฟ้าที่ผ่านการปรับปรุงด้วยเส้นใยระดับนาโนด้วยวิธีต่างๆ มีศักยภาพในการนำมาพัฒนาขั้วไฟฟ้าที่มีความไวและมีความเสถียรภาพสูง

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