

วิธีใหม่สำหรับการตรวจวัดสารปฏิชีวนะเทระไซคลินและไฮโดรเจนเปอร์ออกไซด์โดยใช้ขั้วไฟฟ้าฟิล์มบาง  
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ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

A NOVEL METHOD FOR THE DETERMINATION OF TETRACYCLINE ANTIBIOTICS AND HYDROGEN  
PEROXIDE USING ANODIZED BORON-DOPED DIAMOND THIN FILM ELECTRODES

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งานวิจัยนี้มีจุดมุ่งหมายที่จะศึกษาการนำขั้วไฟฟ้าฟิล์มบางของเพชรที่โคปด้วยโบรอนซึ่งผ่านการดัดแปรได้แก่ ขั้วไฟฟ้าฟิล์มบางของเพชรที่โคปด้วยโบรอนซึ่งผ่านการแอนโนไดส์และขั้วไฟฟ้าฟิล์มบางของเพชรที่โคปด้วยโบรอนซึ่งผ่านการดัดแปรด้วยโครเมียมเฮกซะไซยาโนเฟอไรต์เพื่อไปใช้สำหรับการตรวจวัดสารปฏิชีวนะเทตระไซคลินและไฮโดรเจนเปอร์ออกไซด์ ทำการศึกษาเคมีไฟฟ้าของสารปฏิชีวนะเทตระไซคลินที่ขั้วไฟฟ้าฟิล์มบางของเพชรที่โคปด้วยโบรอนซึ่งผ่านการแอนโนไดส์ด้วยไซคลิกโวลแทมเมทรี โพลวีอินเจกชัน และไฮเพอร์ฟอร์มานซ์ลิควิดโครมาโทกราฟีซึ่งต่อกับระบบตรวจวัดทางเคมีไฟฟ้า เปรียบเทียบผลการทดลองโดยไซคลิกโวลแทมเมทรีกับขั้วไฟฟ้ากลาสคาร์บอนและขั้วไฟฟ้าฟิล์มบางของเพชรที่โคปด้วยโบรอน ขั้วไฟฟ้าฟิล์มบางของเพชรที่โคปด้วยโบรอนซึ่งผ่านการแอนโนไดส์จะให้ผลของไซคลิกโวลแทมโมแกรมสำหรับปฏิกิริยาออกซิเดชันของสารปฏิชีวนะเทตระไซคลินแบบไม่ผันกลับที่ชัดเจนและให้สัญญาณกระแสไฟฟ้าสูงสุดเมื่อเปรียบเทียบกับขั้วไฟฟ้ากลาสคาร์บอนและขั้วไฟฟ้าฟิล์มบางของเพชรที่โคปด้วยโบรอน วิธีดังกล่าวสามารถนำไปประยุกต์ใช้กับการตรวจวัดสารปฏิชีวนะเทตระไซคลินในตัวอย่างยาเตรียมและไข่ได้ จากการศึกษาเปอร์เซ็นต์การกลับคืนของสารมาตรฐานที่เดิมในตัวอย่างพบว่าผลการทดลองที่ได้เป็นที่น่าพอใจ นอกจากนี้ยังทำการศึกษาคีเคมีไฟฟ้าของไฮโดรเจนเปอร์ออกไซด์ที่ขั้วไฟฟ้าฟิล์มบางของเพชรที่โคปด้วยโบรอนซึ่งผ่านการดัดแปรด้วยโครเมียมเฮกซะไซยาโนเฟอไรต์ด้วยเทคนิคไซคลิกโวลแทมเมทรี และโพลวีอินเจกชันซึ่งต่อกับระบบการตรวจวัดทางเคมีไฟฟ้า โดยทำการศึกษาวิธีการเตรียมขั้วไฟฟ้าก่อนนำมาดัดแปร วิธีการตรึงทางเคมีไฟฟ้า และอัตราส่วนโดยโมลาร์ระหว่างโครเมียมไนเตรดและโปแทสเซียมเฮกซะไซยาโนเฟอไรต์เพื่อหาภาวะที่เหมาะสมสำหรับการเตรียมขั้วไฟฟ้าดัดแปร รวมทั้งทำการศึกษาผลของ pH และระบบอิเล็กโทรไลต์และบัฟเฟอร์เพื่อหาภาวะที่เหมาะสมสำหรับการตรวจวัดไฮโดรเจนเปอร์ออกไซด์ จากนั้นนำขั้วไฟฟ้าดัดแปรไปประยุกต์ใช้เป็นระบบการตรวจวัดแอมเปโรเมตริกต่อกับระบบโพลวีอินเจกชัน ซึ่งสารดังกล่าวสามารถนำไปประยุกต์ใช้กับการตรวจวัดไฮโดรเจนเปอร์ออกไซด์ในตัวอย่างยาเตรียม (ยาม่าเชื้อ)

อีกส่วนที่ทำการวิจัย คือ การศึกษาอันตรกิริยาระหว่าง J-aggregate,  $(H_4TPPS)_n$ , และพอลิเมอร์แบบนอนไอออนิก ได้แก่ Triton X-100 และ PEG 300 พบว่าสเปกตรัมของ J-aggregate,  $(H_4TPPS)_n$  ที่มี Triton X-100 และ PEG-300 เปลี่ยนเครื่องหมายไปจากสเปกตรัมของ J-aggregate,  $(H_4TPPS)_n$  ทำการอธิบายกลไกของปฏิกิริยาระหว่าง J-aggregate,  $(H_4TPPS)_n$ , และพอลิเมอร์แบบนอนไอออนิก

ภาควิชา .....เคมี.....ลายมือชื่อนิสิต.....ณัฐกานต์ หวังเฟื่องคนาคกุล.....  
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KEYWORDS : MODIFIED BORON-DOPED DIAMOND THIN FILM ELECTRODES/ FLOW INJECTION SYSTEM/TETRACYCLINES/HYDROGEN PEROXIDE

NATTAKARN WANGFUENGGANAGUL : A NOVEL METHOD FOR THE DETERMINATION OF TETRACYCLINE ANTI-BIOTICS AND HYDROGEN PEROXIDE USING ANODIZED BORON-DOPED DIAMOND THIN FILM ELECTRODES. THESIS ADVISOR : ASSOC. PROF. ORAWON CHAILAPAKUL, Ph.D., 149 pp., ISBN 974-14-1937-6

This study focused on the use of modified boron-doped diamond thin film (BDD) including anodized BDD and chromium (III) hexacyanoferrate (II) modified BDD electrodes for the determination of tetracyclines (TCs) and hydrogen peroxide. The electrochemistry of TCs was studied at an anodized BDD electrode using cyclic voltammetry, flow injection (FI) and high performance liquid chromatography (HPLC) coupled with electrochemical detector. Comparative experiments by cyclic voltammetry were performed at polishing glassy carbon (GC) and as-deposited BDD electrodes. The anodized BDD electrode exhibited well-defined irreversible cyclic voltammograms for the oxidation of TCs with the highest current signals compared to the as-deposited BDD and GC electrodes. The proposed method was applied to determine of TCs in pharmaceutical formulations and egg samples. Recoveries of spiked standard solution were determined. The results obtained were satisfactory. In addition, the electrochemistry of hydrogen peroxide was carried out at chromium (III) hexacyanoferrate (II) modified BDD electrode using cyclic voltammetry and flow injection coupled with an electrochemical detector. The effect of electrode pretreatment and electrodeposition methods, and the molar ratios between chromium nitrate and potassium hexacyanoferrate were investigated to find the optimum condition for the preparation of a modified electrode. The effect of pH and electrolyte/buffer systems was also investigated to find the optimum condition for detecting hydrogen peroxide. The modified electrode was used as the amperometric detector coupled with flow injection. The proposed method was applied to determine hydrogen peroxide in pharmaceutical formulation (disinfection solution).

Moreover, the study of interaction between J-aggregate,  $(H_4TPPS)_n$ , and nonionic polymers including Triton X-100 and PEG 300. The CD spectra of the J-aggregate,  $(H_4TPPS)_n$ , changed to the opposite sign CD spectra in the presence of Triton X-100 and PEG 300. The mechanism between J-aggregate,  $(H_4TPPS)_n$ , and nonionic polymers was described.

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## ABBREVIATIONS

BDD	Boron-doped diamond thin film
GC	Glassy carbon
TCs	Tetracyclines
OTC	Oxytetracycline
TC	Tetracycline
CTC	Chlortetracycline
DC	Doxycycline
FIA	Flow injection analysis
HPLC	High performance liquid chromatography
TLC	Thin layer chromatography
CE	Capillary Electrophoresis
CL	Chemiluminescence
LOD	Limit of detection
LOQ	Limit of quantitation
H <sub>2</sub> TPPS	5,10,15,20-Tetrakis-(4-sulfonatophenyl)porphyrin
cmc.	Critical micelle concentration
E <sub>p</sub>	Peak potential
i <sub>p</sub>	Peak current
i	Current
n	Electron per molecule oxidized; faradays mole of substance electrolyzed
F	The faraday; charge on one mole of electrons
A	Area (cm <sup>2</sup> )
$\alpha$	Transfer coefficient
n <sub>a</sub>	Number of electrons involved in the rate-determining step
C <sub>0</sub> <sup>*</sup>	Bulk concentration of species O
C	Concentration of solutions.
D	Diffusion coefficient (cm <sup>2</sup> /sec)
v	Scan rate (V/sec)
$\delta$	Diffusion layer thickness

t	Time
hr	Hour
mg	Milligram
mL	Millilitre
ppm	Part per million