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**EFFECT OF CARBON PRETREATMENT AND PREPARATION METHOD ON  
ALCOHOL ELECTROOXIDATION OF Au/G CATALYST**

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**A SPECIAL RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT  
OF THE REQUIREMENTS FOR  
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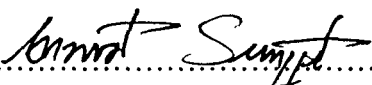
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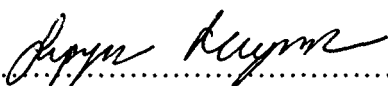
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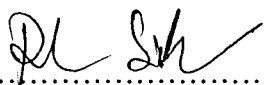
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**Abstract**

For direct alcohol fuel cells, both anodic and cathodic reactions are equally important especially for high molecular weight alcohols like glycerol and ethylene glycol. In this research, the production of Au/C catalysts for alcohol electrooxidation in alkaline solution was focused by studying the effect of carbon pretreatment and catalyst preparation methods on the electrocatalytic activity of the prepared catalysts. Carbon pretreatment used in this work was heat treatment at 600 °C for 30 minutes, and loading of Au on the carbon support was prepared by polyvinyl alcohol (PVA) and citrate protection methods. The amount of Au on carbon was varied at 20, 30 and 40 wt%. The influence of carbon pretreatment was conducted with 20 wt% Au catalyst. The amount of Au adsorbed on carbon was determined from the amount of the Au left in the filtrate after immobilization step by using Atomic Absorption Spectroscopy (AAS). The average particle size and size distribution of Au on carbon were analyzed by Transmission Electron Microscopy (TEM). The catalytic activity and stability of the prepared catalysts were characterized by conducting Cyclic Voltammetry (CV) and Chronoamperometry (CA), respectively. For 20 wt% Au/C, all Au metal was totally deposited on carbon for both PVA and citrate protection methods. However, at higher Au loading, there was some Au precursor left in the solution and the maximum Au loading obtained by the PVA and the citrate protection methods was about 27 and 37 wt%, respectively. For the effect of carbon pretreatment, it was found from TEM images that the average Au particle size on treated carbon was smaller than that on untreated carbon. This is due to the enhancement of carbon surface area by heat-treatment. As a consequence, the catalytic activity of Au/treated C was higher for both catalyst preparation methods. When the amount of Au loading increased, the average Au particle size became bigger because of the agglomeration of Au particles. This led to a reduction of catalyst activity. In comparison between two methods of catalyst preparation, the Au/C catalysts prepared by the PVA protection method performed better in terms of activity and stability than that by the citrated one. The results of CA also confirmed that the carbon pretreatment not only enhanced the catalytic activity but

also improved catalyst stability as observed from the lower decaying rate in the CV curves.

Keywords: Au/C Catalyst/ PVA Protection Method/ Citrate Protection Method/  
Glycerol Oxidation/ Ethylene Glycol Oxidation

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หัวข้อโครงการศึกษาวิจัย	ผลกระทบของการให้ความร้อนบนตัวรองรับ และ วิธีการเตรียมตัวเร่งปฏิกิริยา ที่มีต่อตัวเร่งปฏิกิริยา Au/C
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#### บทคัดย่อ

ปฏิกิริยาที่ข้าวแอนด์ข้าวแคโทคของเซลล์เชื้อเพลิงแอลกอฮอล์โดยตรงมีความสำคัญเท่ากัน โดยเฉพาะเมื่อใช้แอลกอฮอล์น้ำหนักโมเลกุลสูงเช่นกลีเซอรอลและเอทิลีนไกลคอลเป็นเชื้อเพลิง งานวิจัยนี้จะผลิตตัวเร่งปฏิกิริยา Au/C สำหรับทำปฏิกิริยาอิเล็กโตรออกซิเดชันของแอลกอฮอล์ในสารละลายต่าง โดยมุ่งเน้นศึกษาผลกระทบของการปรับสภาพคาร์บอน และวิธีการเตรียมตัวเร่งปฏิกิริยาที่มีผลต่อความว่องไวของตัวเร่งปฏิกิริยานั้น การปรับสภาพคาร์บอนกระทำโดยการใช้ความร้อนที่อุณหภูมิ 600 องศาเซลเซียส นาน 30 นาที วิธีการเตรียมตัวเร่งที่ใช้ในงานวิจัยมีอยู่ 2 วิธีคือ การใช้โพลีไวนิลแอลกอฮอล์ (PVA) และซีเตรทเป็นตัวปกป้องซอล (sol) โดยมีการเปลี่ยนแปลงปริมาณตัวเร่งทอง (Au) ในปริมาณร้อยละ 20, 30 และ 40 โดยน้ำหนัก สำหรับการศึกษาของการปรับสภาพคาร์บอนจะทำการศึกษาโดยใช้ปริมาณ Au ร้อยละ 20 โดยน้ำหนักเท่านั้น

ในการหาปริมาณของ Au ที่ดูดซับบนคาร์บอนนั้นจะวิเคราะห์จากปริมาณ Au ที่เหลือในสารละลาย หลังจากขั้นตอนการตรึง Au บนคาร์บอนโดยใช้เครื่อง Atomic Absorption Spectroscopy (AAS) ขนาดอนุภาคเฉลี่ยและการกระจายตัวของ Au บนคาร์บอนจะวิเคราะห์โดยใช้รูปถ่ายกำลังขยายสูงจากเครื่อง Transmission Electron Microscopy (TEM) ความว่องไวต่อการเร่งปฏิกิริยาและความเสถียรของตัวเร่งปฏิกิริยาจะถูกวัดโดยเทคนิค Cyclic Voltammetry (CV) และ Chronoamperometry (CA) ตามลำดับ ผลการทดลองพบว่า ในกรณีของตัวเร่งที่มีปริมาณทองร้อยละ 20 โดยน้ำหนัก ตัวเร่งทอง (Au) ทั้งหมดสามารถตรึงอยู่บนคาร์บอน แต่เมื่อต้องการเพิ่มปริมาณ Au ให้สูงกว่านี้ พบว่าปริมาณ

Au สูงสุดที่ตรึงบนคาร์บอนโดยวิธีการเตรียมแบบใช้โพลีไวนิลแอลกอฮอล์ และซีเทรทมีค่าสูงสุดร้อยละ 27 และ 37 โดยน้ำหนัก ตามลำดับ

สำหรับอิทธิพลของการปรับสภาพคาร์บอน พบว่าคาร์บอนที่ผ่านการปรับสภาพให้ขนาดเฉลี่ยของ Au ที่เล็กกว่าคาร์บอนที่ไม่ผ่านการปรับสภาพ ที่เป็นเช่นนี้เป็นเพราะการเพิ่มขึ้นของพื้นที่ผิวของคาร์บอนภายหลังการให้ความร้อน ส่งผลให้ความว่องไวของตัวเร่งปฏิกิริยาที่เตรียมจากทั้ง 2 วิธี ข้างต้นดีขึ้น เมื่อปริมาณของ Au เพิ่มขึ้น ค่าเฉลี่ยของขนาดอนุภาค Au จะใหญ่ขึ้น เป็นเพราะการรวมตัวกันของอนุภาค Au ซึ่งนำไปสู่การลดลงของค่าความว่องไวของตัวเร่งปฏิกิริยา ในการเปรียบเทียบระหว่างการเตรียมตัวเร่งปฏิกิริยาทั้ง 2 วิธี พบว่าตัวเร่งที่เตรียมจากวิธีการใช้โพลีไวนิลแอลกอฮอล์มีประสิทธิภาพสูงกว่าวิธีการใช้ซีเทรททั้งในด้านความว่องไวและความเสถียร การศึกษาของ Chronoamperometry ช่วยยืนยันถึงอิทธิพลการปรับสภาพคาร์บอนด้วยความร้อนว่าช่วยเพิ่มความว่องไวและความเสถียรให้กับตัวเร่งปฏิกิริยา Au/C

คำสำคัญ: ตัวเร่งปฏิกิริยา Au/C/ วิธีโพลีไวนิลแอลกอฮอล์โพเรทชัน/ วิธีซีเทรทโพเรทชัน/  
กลีเซอรอล ออกซิเดชัน/ เอทีลินไกลคอล ออกซิเดชัน

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