

**HYDROGEN PRODUCTION FROM THE STEAM REFORMING OF  
METHANOL OVER SUPPORTED AU CATALYSTS**



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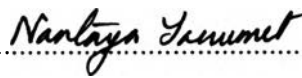
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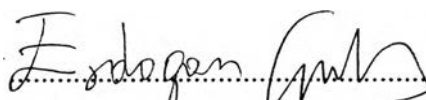
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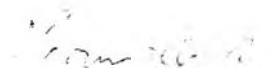
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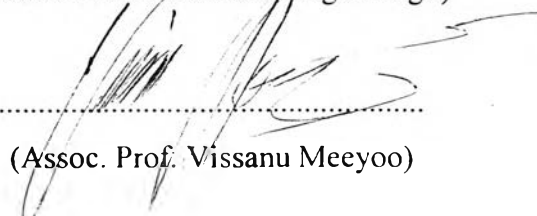
  
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**ABSTRACT**

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Hydrogen production by the steam reforming of methanol (SRM) has been investigated over Au/ZnO and Au/ZnO-Fe<sub>2</sub>O<sub>3</sub> catalysts in the temperature range of 250-450°C. Both catalysts were prepared by a deposition-precipitation method and were characterized by TEM, XRD, TPR, and TPO techniques. The XRD analysis confirms the desired structure and phase purity of ZnO, Fe<sub>2</sub>O<sub>3</sub>, and ZnFe<sub>2</sub>O<sub>4</sub>, and the presence of gold in the prepared samples. TEM observations show that the particle sizes of the gold are smaller than 5 nm for all catalysts except for the 5% atom Au/ZnO calcined at 500°C. For the activity tests, the results show that the catalytic performance of the Au/ZnO-Fe<sub>2</sub>O<sub>3</sub> is higher than that of the Au/ZnO at low temperature range. A maximum methanol conversion of 95.58% was achieved with 5% atom Au/ZnO calcined at 400°C for 4 hours and pretreated with hydrogen, while 5% atom Au/ZnO-Fe<sub>2</sub>O<sub>3</sub> with a 9:1 molar ratio of ZnO to Fe<sub>2</sub>O<sub>3</sub> calcined at 200°C for 4 hours and pretreated with oxygen gave 100% methanol conversion. In addition, no deactivation was observed during 24 hours of testing for both catalysts.

## บทคัดย่อ

สถิตทิพย์ ธารีจิตร : กระบวนการผลิตก๊าซไฮโดรเจนจากปฏิกิริยาเปลี่ยนรูปเมทานอลด้วยไอน้ำโดยใช้ตัวเร่งปฏิกิริยาทองบนซิงค์ออกไซด์และซิงค์ออกไซด์ผสมเฟอร์รัสออกไซด์ (Hydrogen Production from the Steam Reforming of Methanol over Supported Gold Catalysts)  
อ. ที่ปรึกษา : ผศ.ดร. อาภาณี เหลืองนฤมิตชัย ผ.ดร. เอโดแกน กุลารี่ 99 หน้า

ในงานวิจัยนี้ทำการศึกษากระบวนการเปลี่ยนรูปเมทานอลด้วยไอน้ำโดยใช้ตัวเร่งปฏิกิริยา Au/ZnO และ Au/ZnO-Fe<sub>2</sub>O<sub>3</sub> ในช่วงอุณหภูมิในการทำปฏิกิริยา 250-450 องศาเซลเซียส ตัวเร่งปฏิกิริยาทั้งสองชนิดทำการเตรียมโดยใช้วิธี Deposition-precipitation และทำการวิเคราะห์คุณลักษณะของตัวเร่งปฏิกิริยาโดยใช้เทคนิค TEM, XRD, TPR และ TPO จากผลการวิเคราะห์โดยใช้เทคนิค XRD พบว่ามีโครงสร้างผลึกของทองเป็นองค์ประกอบในตัวเร่งปฏิกิริยาทั้งสองชนิด นอกจากนี้แล้วยังพบโครงสร้างผลึกของ ZnO, ZnFe<sub>2</sub>O<sub>4</sub> และ Fe<sub>2</sub>O<sub>3</sub> ในตัวเร่งปฏิกิริยา Au/ZnO และ Au/ZnO-Fe<sub>2</sub>O<sub>3</sub> ตามลำดับ จากผลการวิเคราะห์ TEM พบว่าขนาดของทองในตัวเร่งปฏิกิริยาทั้งสองมีขนาดเล็กกว่า 5 นาโนเมตร ยกเว้นตัวเร่งปฏิกิริยา Au/ZnO ทำการเผาที่อุณหภูมิ 500 องศาเซลเซียส ในส่วนของความสามารถในการเร่งปฏิกิริยา พบว่าตัวเร่งปฏิกิริยา Au/ZnO-Fe<sub>2</sub>O<sub>3</sub> มีความสามารถในการเร่งปฏิกิริยาและความสามารถในการเลือกเกิดปฏิกิริยาได้ดีกว่าตัวเร่งปฏิกิริยา Au/ZnO ที่ช่วงอุณหภูมิต่ำ โดยสภาวะที่เหมาะสมในการเร่งปฏิกิริยาของตัวเร่งปฏิกิริยา Au/ZnO คือ ปริมาณทอง 5% อะตอม ทำการเผาที่อุณหภูมิ 400 องศาเซลเซียส, รีดิวซ์ตัวเร่งปฏิกิริยาด้วยก๊าซไฮโดรเจนที่อุณหภูมิ 400 องศาเซลเซียส 1 ชั่วโมง ให้ผลการเปลี่ยนเมทานอลสูงสุด 95.58% ในส่วนของตัวเร่งปฏิกิริยา Au/ZnO-Fe<sub>2</sub>O<sub>3</sub> นั้นสภาวะที่เหมาะสมในการเร่งปฏิกิริยา คือ 9:1 อัตราส่วนโดยโมลของ ZnO ต่อ Fe<sub>2</sub>O<sub>3</sub>, ปริมาณทอง 5% อะตอม ทำการเผาที่อุณหภูมิ 200 องศาเซลเซียส, รีดิวซ์ตัวเร่งปฏิกิริยาด้วยก๊าซออกซิเจนที่อุณหภูมิ 200 องศาเซลเซียส 1 ชั่วโมง ให้ผลการเปลี่ยนเมทานอลสูงสุด 100% นอกจากนี้แล้วตัวเร่งปฏิกิริยาทั้งสองชนิดยังแสดงความสามารถในการเร่งปฏิกิริยาได้อย่างต่อเนื่องเป็นเวลานาน 24 ชั่วโมงของการทดลอง

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