

**HYDROGEN PRODUCTION FROM WATER SPLITTING UNDER VISIBLE  
LIGHT IRRADIATION USING SENSITIZED TiO<sub>2</sub>-ZrO<sub>2</sub> MIXED OXIDE  
PHOTOCATALYSTS**



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**ABSTRACT**

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Alternative energy resources, especially hydrogen, are now being considered as an ideal energy supplies. Photocatalytic water splitting is a promising process for producing hydrogen, by using solar light as an energy source and using water as a feedstock. This research was focused on the hydrogen production from the photocatalytic water splitting under visible light irradiation using Eosin Y-sensitized Pt-loaded mesoporous-assembled TiO<sub>2</sub>-ZrO<sub>2</sub> mixed oxide photocatalysts, of which the mesoporous-assembled TiO<sub>2</sub>-ZrO<sub>2</sub> with various Ti-to-Zr molar ratios were synthesized by a sol-gel process with the aid of a structure-directing surfactant. Various parameters affecting the photocatalytic activity, including calcination conditions, phase composition, and amount and method of Pt loading, were studied. The experimental results showed that without Pt loading, the TiO<sub>2</sub>-ZrO<sub>2</sub> photocatalyst with a Ti-to-Zr molar ratio of 95:5 calcined at 800°C provided the maximum photocatalytic hydrogen production activity. Moreover, the Pt loading by a photochemical deposition method (PCD) was found to greatly enhance photocatalytic activity of the TiO<sub>2</sub>-ZrO<sub>2</sub> photocatalyst more than that by a single-step sol-gel method (SSSG).

## บทคัดย่อ

ถาวรณย์ ก๊กพ้อคำ: การผลิตไฮโดรเจนจากการแตกโมเลกุลของน้ำภายใต้สภาวะที่มีแสงในช่วงตามองเห็นโดยใช้ตัวเร่งปฏิกิริยาออกไซด์ผสมระหว่างไททานเนียมออกไซด์และเซอร์โคเนียมออกไซด์ที่เกาะตัวกันจนมีรูพรุนขนาดเมโซพอร์ที่ถูกกระตุ้น (Hydrogen Production from Water Splitting under Visible Light Irradiation Using Sensitized TiO<sub>2</sub>-ZrO<sub>2</sub> Mixed Oxide Photocatalysts) อ. ที่ปรึกษา: ผศ. ดร. ธรรมบุญ ศรีทวงษ์ และ รศ. ดร. สุเมธ ชวเดช 101 หน้า

ในปัจจุบันแหล่งพลังงานทางเลือกใหม่ โดยเฉพาะอย่างยิ่งไฮโดรเจน ถูกพิจารณาว่าเป็นแหล่งพลังงานในอุดมคติ ปฏิกิริยาการแตกโมเลกุลของน้ำโดยใช้ตัวเร่งปฏิกิริยาแบบใช้แสงร่วมเป็นกระบวนการที่น่าสนใจในการผลิตไฮโดรเจน โดยการใช้แสงเป็นแหล่งพลังงานและใช้น้ำเป็นสารตั้งต้น งานวิจัยนี้มุ่งเน้นการผลิตไฮโดรเจนจากกระบวนการแตกโมเลกุลของน้ำด้วยปฏิกิริยาแบบใช้แสงร่วมภายใต้สภาวะที่มีแสงในช่วงที่ตามองเห็น โดยใช้ตัวเร่งปฏิกิริยาแบบใช้แสงร่วมชนิดออกไซด์ผสมระหว่างไททานเนียมออกไซด์และเซอร์โคเนียมออกไซด์ที่มีการเติมตัวเร่งปฏิกิริยาร่วมแพลทินัมและมีการกระตุ้นด้วยสีย้อม โดยตัวเร่งปฏิกิริยาแบบใช้แสงร่วมชนิดออกไซด์ผสมดังกล่าวที่มีอัตราส่วนโดยโมลของไททานเนียมออกไซด์ต่อเซอร์โคเนียมออกไซด์ที่ค่าต่างๆนี้ได้ถูกสังเคราะห์ขึ้นโดยกระบวนการโซลเจลควบคู่กับการใช้สารลดแรงตึงผิวเป็นสารตั้งต้นแบบ โดยได้ศึกษาถึงตัวแปรต่างๆที่มีผลต่อประสิทธิภาพในการเร่งปฏิกิริยาเชิงแสงของตัวเร่งปฏิกิริยา ได้แก่ สภาวะในการแคลไซน์ องค์ประกอบเฟสของตัวเร่งปฏิกิริยาและปริมาณและวิธีการเติมแพลทินัม จากผลการทดลองพบว่าในกรณีที่ไม่มีการเติมแพลทินัม ตัวเร่งปฏิกิริยาแบบใช้แสงร่วมที่มีค่าอัตราส่วนโดยโมลของไททานเนียมต่อเซอร์โคเนียม ที่ค่า 95 ต่อ 5 และแคลไซน์ที่อุณหภูมิ 800 องศาเซลเซียสนั้น มีประสิทธิภาพในการผลิตไฮโดรเจนมากที่สุด นอกจากนี้การเติมแพลทินัมลงบนพื้นผิวของตัวเร่งปฏิกิริยาแบบใช้แสงร่วมด้วยวิธีการยึดเกาะด้วยกระบวนการเคมีโดยใช้แสงร่วม (Photochemical deposition method: PCD) ถูกพบว่าช่วยเพิ่มประสิทธิภาพการผลิตไฮโดรเจนของตัวเร่งปฏิกิริยาแบบใช้แสงร่วมชนิดออกไซด์ผสมระหว่างไททานเนียมออกไซด์และเซอร์โคเนียมออกไซด์ได้มากกว่าการเติมแพลทินัมด้วยวิธีการโซลเจลแบบขั้นตอนเดียวกับการสังเคราะห์ตัวเร่งปฏิกิริยาออกไซด์ผสม (Single-step sol-gel method: SSSG)

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