

ผลของลักษณะของฟิล์มบาง ไทเทเนียมไดออกไซด์ที่มีผลต่อปฏิกิริยาโฟโตคะตะไลติกกำจัดชั้นของเฮกซะวาเลนซ์  
โครเมียมโดยใช้ถังปฏิกรณ์แบบแผ่นครึ่ง



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EFFECT OF THIN FILM TITANIUM DIOXIDE CHARACTERISTICS ON PHOTOCATALYTIC REDUCTION  
OF CHROMIUM (VI) USING FIXED BED PHOTOREACTOR

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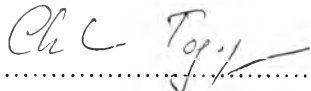
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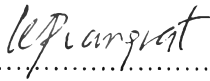
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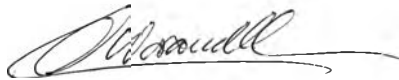
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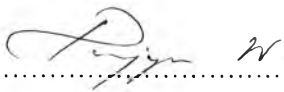
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อภิญา ทิศาวิภาคสกุล : ผลของลักษณะฟิล์มบางไทเทเนียมไดออกไซด์ที่มีผลต่อปฏิกิริยาโฟโตคะตะไลติกรีดักชันของเฮกซะวาเลนซ์โครเมียมโดยใช้ถังปฏิกรณ์แบบแผ่นตรง.

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งานวิจัยฉบับนี้ได้ศึกษาผลของลักษณะฟิล์มบางไทเทเนียมไดออกไซด์ที่ใช้ในการกำจัดเฮกซะวาเลนซ์โครเมียมในปฏิกิริยาโฟโตคะตะไลติกรีดักชันโดยใช้ถังปฏิกรณ์แบบแผ่นตรงซึ่งมีจุดมุ่งหมายเพื่อหาสภาวะที่เหมาะสมที่สุดของฟิล์มบางไทเทเนียมไดออกไซด์ซึ่งเตรียมด้วยวิธีโซล-เจลสำหรับใช้ในถังปฏิกรณ์แบบแผ่นตรง ปัจจัยที่ส่งผลกระทบต่อคุณสมบัติของฟิล์มบางไทเทเนียมไดออกไซด์ คือ การเติมอะซีติลอะซีโตนเพื่อช่วยในการปรับสภาพผิวของฟิล์มบาง อุณหภูมิที่ใช้ในการเตรียมแผ่นฟิล์มไทเทเนียมไดออกไซด์ จำนวนรอบของการจุ่มเคลือบแผ่นฟิล์ม และความยาวคลื่นที่เหมาะสมในการทำปฏิกิริยา อัตราส่วนที่ใช้ในการเตรียมสารละลายไทเทเนียมไดออกไซด์ คือ ไทเทเนียมไดออกไซด์:เอธานอล:กรดไฮโดรคลอริก: อะซีติล อะซีโตน เท่ากับ 1 : 30 : 0.5 : 1 ตามลำดับ จากการวิจัยพบว่า อะซีติลอะซีโตนเป็นสารที่ช่วยป้องกันการเกิดรอยแตกบนผิวของฟิล์มไทเทเนียมไดออกไซด์ และยังช่วยเพิ่มประสิทธิภาพในปฏิกิริยาโฟโตคะตะไลติกรีดักชัน สภาวะที่เหมาะสมที่สุดในการเตรียมแผ่นฟิล์มไทเทเนียมไดออกไซด์บนสแตนเลส คือ เสาที่อุณหภูมิ 500°C และจุ่มเคลือบฟิล์ม 3 รอบ ซึ่งเป็นสภาวะที่ให้ประสิทธิภาพในการกำจัดโครเมียม (+6) ดีที่สุด เพราะที่สภาวะนี้จะให้ผลึกอนาเทสมาทมากที่สุดและมีขนาดของผลึกเล็กที่สุด ทั้งนี้การรวมตัวของอิลกตรอนและโฮล จะเกิดขึ้นเมื่อมีการจุ่มเคลือบ 4 รอบขึ้นไป ซึ่งจะทำให้ฟิล์มมีความหนาแน่นมากกว่า 91 นาโนเมตร ความยาวคลื่นที่เหมาะสมในการทำปฏิกิริยา คือ ที่ความยาวคลื่น 380 นาโนเมตร เนื่องจากเป็นความยาวคลื่นที่ให้พลังงานที่เหมาะสมสำหรับฟิล์มบางไทเทเนียมไดออกไซด์ ในการศึกษาพบว่าปฏิกิริยาโฟโตคะตะไลติกรีดักชันของโครเมียม (+6) ของทุกการทดลองเป็นไปตามกฎ zero-order reaction และยังมีการศึกษาค่า kinetic coefficient (k) ด้วย

สาขาวิชาการจัดการสิ่งแวดล้อม  
ปีการศึกษา 2548

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KEY WORD: THIN FILM TITANIUM DIOXIDE / SOL-GEL PROCESS / PHOTOCATALYTIC REDUCTION / FIXED BED PHOTOREACTOR / CHROMIUM (VI)

APINYA TISAVIPAKSAKUL : EFFECT OF THIN FILM TITANIUM DIOXIDE CHARACTERISTICS ON PHOTOCATALYTIC REDUCTION OF CHROMIUM (VI) USING FIXED BED PHOTOREACTOR. THESIS ADVISOR : ASST. PROF. DR. PUANGRAT KAJITVICHYANUKUL, PH.D., 110 pp. ISBN 974-53-2876-6.

This research focused on the effect of thin film  $\text{TiO}_2$  characteristics on chromium (VI) removal in the photocatalytic reduction using a fixed bed photoreactor. The goal of this work was to verify the optimum synthesis condition of nanocrystalline  $\text{TiO}_2$  thin layers derived from the sol-gel process to be used in the fixed bed photoreactor. The factors influencing the thin layers properties were the addition of acetyl acetone used as an additive, the calcination temperatures, the number of coating cycles and the appropriate wavelengths. The mole ratio of  $\text{TiO}_2$  was titanium (IV) butoxide: ethanol: HCl: acetyl acetone at 1: 30: 0.5: 1, respectively. From this work, It was found that acetyl acetone prevented the cracking of the surface morphology as shown in the SEM micrographs and gave the high efficiency of photocatalytic reduction. The optimum condition to produce the immobilized  $\text{TiO}_2$  on stainless steel was found at 500 °C calcination temperature and the 3-coating cycles which gave the highest photocatalytic activities due to the highest amount of the anatase phase and smallest size of nanocrystalline  $\text{TiO}_2$ . Moreover, the recombination of electrons and holes was found at 4-coating cycles in which the thickness higher than 91 nm. The appropriate wavelength was found at 380 nm provided the optimum energy to the thin film  $\text{TiO}_2$ . Photocatalytic reduction of Cr (VI) in all experiments followed zero order pattern and the kinetic coefficients in all cases were also reported in this work.

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## NOMENCLATURE

AOPs	=	advanced oxidation processes
Cr (III)	=	trivalent chromium
Cr (VI)	=	hexavalent chromium
FeO	=	ferrous oxide
$\text{OH}^\bullet$	=	hydroxyl radical
$\text{OH}^-$	=	hydroxide ion
$\text{TiO}_2$	=	titanium dioxide
UV	=	ultraviolet