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จุฬาลงกรณ์มหาวิทยาลัย

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SYNTHESIS OF NANO-TITANIUM DIOXIDE BY SOL-GEL METHOD  
FOR PHOTOCATALYSIS APPLICATION

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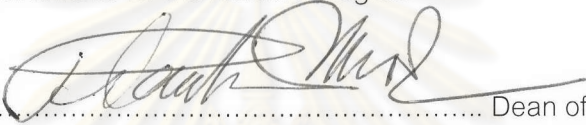
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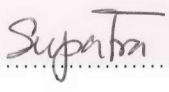
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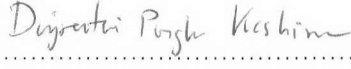
  
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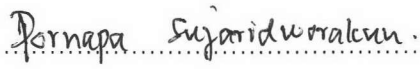
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งานวิจัยนี้เป็นการพัฒนานาโนไทเทเนียมไดออกไซด์สำหรับใช้เป็นตัวเร่งปฏิกิริยาด้วยแสงนาโนไทเทเนียมไดออกไซด์สังเคราะห์ขึ้นด้วยกรรมวิธีโซลเจลจากสารละลายตั้งต้นเตตระบิวทิลออร์โทไททาเนต โดยมีกรดไฮโดรคลอริกหรือกรดไนตริกเป็นตัวเร่งปฏิกิริยา ในกระบวนการสังเคราะห์ได้มีการควบคุมตัวแปรต่างๆ เช่น ความเข้มข้นของเตตระบิวทิลออร์โทไททาเนต ปริมาณน้ำ ปริมาณตัวเร่งปฏิกิริยา ตลอดจนเวลาในการเกิดปฏิกิริยา ให้มีความเหมาะสมเพื่อให้ได้ไทเทเนียมไดออกไซด์ที่มีโครงสร้างและสมบัติที่เหมาะสมในการเป็นตัวเร่งปฏิกิริยาด้วยแสงที่ดี จากการศึกษาพบว่าการเพิ่มความเข้มข้นของเตตระบิวทิลออร์โทไททาเนตมีผลทำให้เกิดอนุภาคไทเทเนียมไดออกไซด์เร็วขึ้นและมีปริมาณมากขึ้น ในขณะที่การมีปริมาณน้ำในสารละลายตั้งต้นมากขึ้นและการเพิ่มเวลาในการเกิดปฏิกิริยามีผลทำให้เกิดไทเทเนียมไดออกไซด์ที่มีโครงสร้างผลึกแบบรูโพลีมากขึ้น ผลึกที่ได้มีขนาดใหญ่ขึ้น นอกจากนี้ยังพบว่าการใช้กรดไฮโดรคลอริกเป็นตัวเร่งปฏิกิริยาช่วยส่งเสริมให้เกิดเฟสที่เป็นรูโพลี ในขณะที่การใช้กรดไนตริกเป็นตัวเร่งปฏิกิริยาส่งผลให้เกิดเฟสที่เป็นอะนาเทสมากขึ้น การเผาไทเทเนียมไดออกไซด์ที่อุณหภูมิ 300-700 องศาเซลเซียส เป็นเวลา 4-10 ชั่วโมง นอกจากจะเป็นการไล่สารอินทรีย์ที่เหลือจากการทำปฏิกิริยาแล้ว ยังเป็นการเหนี่ยวนำให้เกิดผลึกที่สมบูรณ์ โดยอุณหภูมิและเวลาในการเผามีผลต่อโครงสร้างและสมบัติต่างๆ ของไทเทเนียมไดออกไซด์ กล่าวคือมีขนาดผลึกใหญ่ขึ้น มีพื้นที่ผิวจำเพาะลดลง และมีการเปลี่ยนโครงสร้างผลึกจากอะนาเทสเป็นรูโพลีที่อุณหภูมิ 300 องศาเซลเซียส นอกจากนี้ยังมีการนำไปเคลือบบนเม็ดอะลูมินาและท่อแก้วเพื่อเป็นการลดปริมาณการใช้ไทเทเนียมไดออกไซด์ อีกทั้งสามารถลดขั้นตอนการกรองหรือแยกสารที่ผ่านการใช้งานแล้ว ผลการทดสอบประสิทธิภาพของตัวเร่งปฏิกิริยากับสีย้อมชิบราครอนเรดที่ได้จากโรงงานย้อมผ้า พบว่ามีประสิทธิภาพการย่อยสลายสีย้อมที่ดี ซึ่งประสิทธิภาพนี้สัมพันธ์กับองค์ประกอบของเฟส ขนาดอนุภาคและพื้นที่ผิวของตัวเร่งปฏิกิริยา การเติมวาเนเดียมลงไปไนไทเทเนียมไดออกไซด์ช่วยยับยั้งการเปลี่ยนเฟสแต่ไม่ได้เพิ่มประสิทธิภาพการย่อยสลายสีย้อม

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KEY WORD: SOL GEL/  $\text{TiO}_2$  / PHOTOCATALYST / ANATASE / RUTILE

KANNIKAR JUENGSUWATTANANON : SYNTHESIS OF NANO-TITANIUM DIOXIDE BY SOL-GEL METHOD FOR PHOTOCATALYSIS APPLICATION. THESIS ADVISOR: SUPATRA JINAWATH, Ph.D. THESIS COADVISOR : SITTHISUNTORN SUPOTHINA, Ph.D. 101 pp. ISBN 974-14-1846-9.

The purpose of this research was to develop nano-titanium dioxide ( $\text{TiO}_2$ ) for photocatalytic application. The  $\text{TiO}_2$  was synthesized by a sol-gel method from tetrabutyl orthotitanate solution in the presence of hydrochloric or nitric acid. Synthesis parameters such as concentration, water content, aging time, as well as the type and amount of hydrolysis catalyst were manipulated to optimum value in order to obtain desired phase structure and properties of the  $\text{TiO}_2$  photocatalyst. It was found that higher concentration of Ti precursor led to faster sol formation and greater yield of the  $\text{TiO}_2$  particles. Increasing water content and prolong aging time resulted to rapid anatase-to-rutile phase transformation and caused the crystal growth. Hydrochloric catalyst was found to promote the formation of rutile phase while nitric catalyst promoted the formation of the anatase phase. The as-synthesized  $\text{TiO}_2$  powders were calcined at 300 - 700°C for 4-10 h to induce the crystallization as well as to burn out any residual organic matters. The  $\text{TiO}_2$  sol was then coated on  $\text{Al}_2\text{O}_3$  beads and glass tubes to reduce the amount of the  $\text{TiO}_2$  catalyst and for easy recovery. The resulting photocatalyst had good efficiency for Cibracron Red dye removal. The photocatalytic efficiency was found to relate with phase composition, crystallite size, as well as specific surface area. Incorporation of vanadium into the  $\text{TiO}_2$  retarded anatase-to-rutile phase transformation but did not improve photocatalytic efficiency.

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 Field of study.....Ceramic Technology.....Advisor's signature.....*Supatra*  
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