

**SYNTHESIS OF CERIA-ZIRCONIA MIXED OXIDE VIA SOL GEL
PROCESS AND ITS APPLICATIONS**



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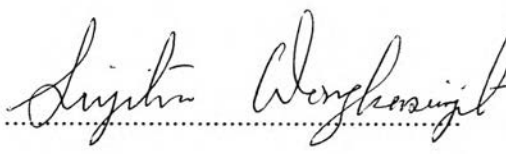
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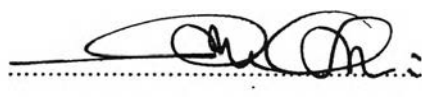

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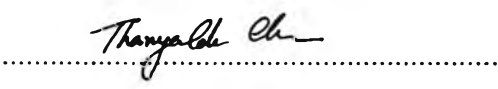
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ABSTRACT

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Ceria-based material is widely used in automotive pollution control because it is an excellent oxygen buffer. Enhancement of its thermal stability can be achieved by introducing zirconia by many synthesis methods. Sol-gel is a versatile technique that allows high-surface-area material to be produced. The aim of the research is to synthesize high-surface-area ceria-zirconia mixed oxides by sol-gel at ambient temperature with the aim of improving the catalytic activity and suitability for environmental applications. It was found that the surface area increases with increasing ceria content, up to 90 mol%, and surface stability is enhanced with increasing zirconia content, up to 40 mol%. The CO oxidation activity was found to be related to its composition. The cubic phase mixed oxides could be reduced easier than the tetragonal phase. The highest surface area (205.6 m²/g) was achieved with Ce:Zr equal to 6:4 with aging for 10 days. Aging time has a significant effect on the texture and structure of the mixed oxides. Heat treatment affects the pore structure. The mixed oxides show good compositional homogeneity and thermal stability. Copper was added to the mixed oxides via the surfactant-aided sol-gel process. Three different CuO species—(a) highly dispersed CuO, (b) copper ion in the solid solution, and (c) bulk CuO species—were produced during the synthesis process. The highly dispersed CuO species is the active phase for CO oxidation. The introduction of 20% Ce_{0.6}Zr_{0.4}O₂ mixed oxides into alumina causes optimized stability, with an acceptable specific surface area at high temperature.

บทคัดย่อ

น.ส. มรกต หุ่มเรืองวงษ์ : การสังเคราะห์สารออกไซด์ผสมซีเรีย-เซอร์โคเนียโดยกระบวนการโซล-เจล และ ประโยชน์ใช้งาน (Synthesis of Ceria-Zirconia mixed oxides via sol-gel process and its applications) อ. ที่ปรึกษา : รศ. ดร. สุจิตรา วงศ์เกษมจิต 135 หน้า ISBN xxx-xxx-xx-x

ซีเรียถูกใช้อย่างแพร่หลายในการควบคุมมลพิษจากยานยนต์ แม้ว่าจะมีความสามารถในการเก็บออกซิเจนที่ดีเยี่ยม แต่การใช้งานถูกจำกัดด้วยเสถียรภาพที่อุณหภูมิสูง เสถียรภาพนี้สามารถปรับปรุงได้โดยการผสมเซอร์โคเนียซึ่งสามารถทำได้โดยหลายวิธี โซล-เจล เป็นเทคนิคที่ใช้อย่างแพร่หลายที่สามารถผลิตวัสดุที่มีขนาดพื้นผิวสูงได้ งานวิจัยนี้มุ่งเน้นที่การสังเคราะห์สารผสมออกไซด์ซีเรีย-เซอร์โคเนียที่มีพื้นที่ผิวสูงด้วยกระบวนการโซล-เจลที่อุณหภูมิห้อง โดยมีจุดมุ่งหมายเพื่อการปรับปรุงความว่องไวทางปฏิกิริยาและความเหมาะสมในการใช้งานทางสิ่งแวดล้อม ผลจากงานวิจัยพบว่าพื้นที่ผิวของสารผสมออกไซด์เพิ่มขึ้น เมื่อปริมาณซีเรียเพิ่มขึ้นจนถึง 90 โมลเปอร์เซ็นต์ และ เสถียรภาพของพื้นที่ผิวเพิ่มขึ้นเมื่อเพิ่มปริมาณเซอร์โคเนียจนถึง 40 โมลเปอร์เซ็นต์ ผลการทดลองแสดงปฏิกิริยาการออกซิไดซ์คาร์บอนมอนอกไซด์ขึ้นกับปริมาณของสารผสมออกไซด์ เฟสคิวบิกสามารถทำปฏิกิริยารีดิวซ์ได้ง่ายกว่าเฟสเตตระโกนอล ผลงานวิจัยพบว่าที่ อัตราส่วนซีเรีย:เซอร์โคเนีย 6:4 และ เผาเป็นเวลา 10 วัน จะได้สารผสมออกไซด์พื้นที่ผิวมากที่สุด (205.6 ตารางเมตรต่อกรัม) โดยที่เวลาในการเผาสารมีผลต่อโครงสร้างและเส้นใยของสารผสมออกไซด์ ความร้อนมีผลต่อโครงสร้างของรูพรุนของสารผสมออกไซด์ ผลจากการสังเคราะห์พบว่าสารผสมออกไซด์มีความเป็นเนื้อเดียวทางส่วนประกอบและเสถียรภาพทางความร้อน ทองแดงถูกผสมในสารผสมออกไซด์โดยกระบวนการโซล-เจล โดยใช้สารลดแรงดึงผิว พบว่ามีสารทองแดงออกไซด์สามชนิด คือ ทองแดงออกไซด์กระจายตัว ไอออนทองแดงในสารละลายของแข็ง และ ทองแดงออกไซด์ การทดลองพบว่า ทองแดงออกไซด์กระจายตัวเป็นตัวเร่งปฏิกิริยาออกซิเดชันของคาร์บอนมอนอกไซด์ นอกจากนี้ การเพิ่ม สารผสมออกไซด์ $Ce_{0.6}Zr_{0.4}O_2$ 20% ใน อลูมินาได้เสถียรภาพดีที่สุดในระดับที่อุณหภูมิสูง ซึ่งอาจเกิดจากการสลายตัวของ $Ce_{0.6}Zr_{0.4}O_2$ การเกิด CeO_2 or $CeAlO_3$ บนพื้นผิวอลูมินา และการใส่สารเติมแต่ง $Ce_{0.6}Zr_{0.4}O_2$ ซึ่งทำให้มีการสัมผัสระหว่างอนุภาคในอลูมินาลดลง

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