

**SYNTHESIS AND CHARACTERIZATIONS OF
POLYBENZOXAZINE-BASED CARBON XEROGELS**

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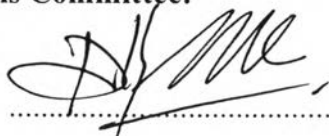
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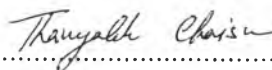


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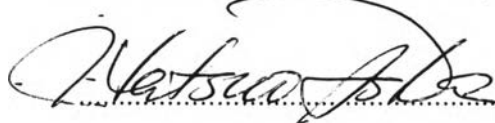
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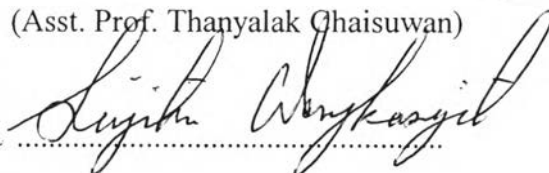
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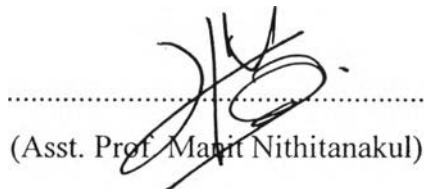
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ABSTRACT

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Keywords: Polybenzoxazine / Carbon xerogels / Cluster / Solvent / DLS / Microwave irradiation / Nanosized ZSM-5 / Microsphere / Nanosphere / CTAB / Silica nanoparticles / Micropore / Mesopore / Macropore / Surface area

In this present work, the porous carbon, called carbon xerogels, derived from polybenzoxazine (PBZ) were prepared via a sol-gel process prior to the carbonization. By using different types of solvents, the cluster growth behaviour of PBZ during the sol-gel process were different due to the differences in solubility parameters between PBZ and solvents, resulting in different porous properties of carbon xerogels. The solvent with low dielectric constant like dioxane provides the slowest rate of cluster growth and also the smallest clusters of PBZ, yielding carbon xerogel with small particles sizes and pore diameter of 40-200 nm after carbonization. This is in part related to the tendency of the oxazine ring-opening in the solvent with large dielectric constant. PBZ-based carbon xerogels obtained through dioxane system were effectively used as a template to control the size of ZSM-5 catalyst into nanoscale (27-70 nm). On the other hand, the nanosphere and microsphere of carbon xerogels were obtained by using cationic (hexadecyltrimethylammonium bromide) and non-ionic (polyethylene glycol nonylphenyl ether) surfactants, respectively. In addition, high specific surface (518-899 m²/g) area and extremely high total pore volume (1.34-6.05 cm³/g) of carbon xerogels could be obtained by varying the amounts of silica loading as a hard template. Mesopore diameter of carbon xerogels was also controlled by varying either the concentrations of cationic surfactant or particle sizes of the silica hard template.

บทคัดย่อ

อุเทน ทับทรวง : การสังเคราะห์คาร์บอนซีโรเจลจากโพลีเบนซอกซาซีนและการพิสูจน์
คุณลักษณะ (Synthesis and Characterizations of Polybenzoxazine-based Carbon Xerogels) อ. ที่
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รองศาสตราจารย์ ดร. สุจิตรา วงศ์เกษมจิตต์ 146 หน้า

งานวิจัยนี้มุ่งเน้นการศึกษาและการพัฒนาคาร์บอนซีโรเจลจากโพลีเบนซอกซาซีนโดย
สังเคราะห์ผ่านกระบวนการโซลเจลและเปลี่ยนเป็นคาร์บอนโดยการเผาที่อุณหภูมิสูงภายใต้
บรรยากาศเฉื่อย ในระหว่างกระบวนการโซลเจลหากมีการใช้ตัวทำละลายที่ต่างชนิดกัน
พฤติกรรมการเกิดเจลและการขยายตัวของคลัสเตอร์ของโพลีเบนซอกซาซีนจะแตกต่างกันอัน
เนื่องมาจากค่าดัชนีการละลาย (Solubility parameter) ที่แตกต่างกันระหว่างตัวทำละลายและโพลี
เบนซอกซาซีน อัตราการขยายตัวของคลัสเตอร์จะช้าและมีขนาดคลัสเตอร์ที่เล็กในตัวทำละลายที่มี
ค่าคงที่ไดอิเล็กทริกต่ำเช่น ไดออกเซน ดังนั้นหลังจากการเผาจะทำให้เกิดคาร์บอนที่มีขนาดคลัส
เตอร์เล็กและมีรูพรุนในระดับนาโนเมตร (40-200 นาโนเมตร) ปรากฏการณ์นี้สามารถอธิบายได้
โดยพฤติกรรมการเปิดวงออกซาซีน ซึ่งถูกเปิดได้ง่ายในตัวทำละลายที่มีค่าคงที่ไดอิเล็กทริกสูง
เช่น ไดเมทิลฟอร์มาไมด์ มากกว่าตัวทำละลายที่มีค่าคงที่ไดอิเล็กทริกต่ำ เช่น ไดออกเซน คาร์บอน
ซีโรเจลที่ได้จากระบบของไดออกเซนถูกนำมาใช้เป็นแม่แบบที่มีประสิทธิภาพในการสังเคราะห์
ตัวเร่งปฏิกิริยา ZSM-5 ที่มีขนาดอนุภาคระดับนาโน นอกจากนี้ขนาดคลัสเตอร์ของคาร์บอนซีโร
เจลยังสามารถถูกควบคุมให้เป็นทรงกลมที่มีขนาดเล็กในระดับนาโนและระดับไมครอนได้โดยใช้
สารลดแรงตึงผิวที่มีประจุลบ (Hexadecyltrimethylammonium bromide) และสารลดแรงตึงผิวที่ไม่
มีประจุ (polyethylene glycol nonylphenyl ether) ตามลำดับ ปริมาตรของรูพรุนและพื้นที่ผิวของ
คาร์บอนซีโรเจลยังสามารถถูกพัฒนาให้มีค่าสูงขึ้นได้ถึง 1.34-6.05 ลูกบาศก์เซนติเมตรต่อกรัม
และ 518-899 ตารางเมตรต่อกรัม ตามลำดับ โดยการใส่อนุภาคซิลิกาเป็นแม่แบบในการสร้างรูพรุน
อีกทั้งขนาดรูพรุนในระดับเมโซ (2-50 นาโนเมตร) ของคาร์บอนซีโรเจลยังสามารถถูกควบคุมได้
โดยการเปลี่ยนแปลงความเข้มข้นของสารลดแรงตึงผิวที่มีประจุลบและขนาดอนุภาคของแม่แบบซิลิกา

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