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นางสาว ชุตินันท์ พรหมเดช

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สาขาวิชาวิศวกรรมเคมี ภาควิชาวิศวกรรมเคมี
คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

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**TRANSPARENT ALUMINA CERAMIC WITH COMPLICATED SHAPE
PREPARED BY SLIP CASTING**

Miss Chutinan Promdej

**A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Engineering Program in Chemical Engineering**

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ชุนันท์ พรหมเดช: เซรามิกอะลูมินาใสที่มีรูปร่างซับซ้อน เตรียมโดยวิธีการหล่อแบบ (TRANSPARENT ALUMINA CERAMIC WITH COMPLICATED SHAPE PREPARED BY SLIP CASTING). อ. ที่ปรึกษา : รศ. ดร.รัชชัย ชรินพาศิขกุล, อ. ที่ปรึกษาร่วม : อ.ดร. ธนากร วาสนาเพียรพงศ์, 81 หน้า

การพัฒนาสมบัติการส่งผ่านของแสงของเซรามิกอะลูมินาที่มีโครงสร้างผลึกแบบพอลิคริสตัลคือ หัวข้อนำเสนอในงานวิจัยนี้ โดยมุ่งเน้นในการผลิตชิ้นงานที่มีความหนาแน่นสูง และควบคุมขนาดของเกรนให้อยู่ในระดับซึบไมครอน ในงานวิจัยนี้ใช้ผงอะลูมินาที่มีขนาดนาโนเป็นวัตถุดิบ ขึ้นรูปด้วยวิธีการหล่อแบบ ซึ่งผลิตเป็นชิ้นงานที่มีลักษณะต่างๆ โดยวัตถุประสงค์ของงานวิจัยนี้คือ ศึกษาการเติมสารเชื่อมประสานในสารแขวนลอยอะลูมินาที่เหมาะสมกับการขึ้นรูปด้วยวิธีการหล่อแบบ และศึกษาปัจจัยของการเผาเผือกเพื่อให้ได้ชิ้นงานที่มีความหนาแน่นสูงและมีเกรนขนาดซึบไมครอน จากผลการทดลองชี้ให้เห็นว่า ปริมาณที่เหมาะสมของสารเชื่อมประสานพีวีเอที่ใช้ในวิธีการหล่อแบบ มีค่าไม่เกิน 0.2 เปอร์เซ็นต์ โดยน้ำหนัก ที่สารแขวนลอยอะลูมินาความเข้มข้น 75 เปอร์เซ็นต์ และที่ส่วนผสมของสารแขวนลอยอะลูมินานี้ ช่วยในการขึ้นรูปชิ้นงานที่เป็นรูปเหรียญและรูปตัวอักษรด้วยวิธีการหล่อแบบ ได้ อีกทั้งสามารถผลิตชิ้นงานที่ผ่านการเผาเคลือบให้มีความหนาแน่นสัมพัทธ์มากกว่า 58 เปอร์เซ็นต์

ในกระบวนการเผาเผือกชิ้นปฐมภูมินั้น ปัจจัยของชนิดเตา อุณหภูมิ และระยะเวลาในการเผา เป็นปัจจัยที่สำคัญ เพื่อให้ได้ชิ้นงานอะลูมินาที่มีความหนาแน่นสูง ซึ่งพบว่ากระบวนการ โดของเกรนจะเกิดขึ้นทันทีหลังจากที่เกิดกระบวนการทำให้หนาแน่นในระบบการเผาเผือก นอกจากนี้ จากการศึกษาการเผาเผือกแบบสองขั้นตอน ซึ่งเป็นวิธีการเผาแบบใหม่ในการเผาเผือกชิ้นปฐมภูมิ พบว่าวิธีการนี้ช่วยในการผลิตชิ้นงานที่มีความหนาแน่นสัมพัทธ์สูง และยับยั้งกระบวนการ โดของเกรน ชิ้นงานอะลูมินาที่ผ่านการเผาเผือกชิ้นปฐมภูมิ จะนำมาเผาเผือกอีกครั้งโดยการให้ความร้อนทุกทิศทางแบบร้อน เพื่อที่จะกำจัดช่องว่างในชิ้นงานที่ยังเหลืออยู่จากการเผาเผือกชิ้นปฐมภูมิ ชิ้นงานที่ได้จากการเผาเผือกในขั้นนี้จะมีสมบัติการส่งผ่านของแสงที่เพิ่มขึ้น ซึ่งสัมพันธ์กับการที่ชิ้นงานมีขนาดเกรนในระดับซึบไมครอน อีกทั้งพบว่า ชิ้นงานที่มีลักษณะเป็นรูปเหรียญและรูปตัวอักษรสามารถพัฒนาสมบัติการส่งผ่านของแสงได้หลังจากผ่านการเผาเผือกด้วยความร้อนทุกทิศทางแบบร้อน

ภาควิชา.....วิศวกรรมเคมี.....ลายมือชื่อนิติ.....
 สาขาวิชา.....วิศวกรรมเคมี.....ลายมือชื่ออาจารย์ที่ปรึกษา.....
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CHUTINAN PROMDEJ: TRANSPARENT ALUMINA CERAMIC WITH
COMPLICATED SHAPE PREPARED BY SLIP CASTING, THESIS
ADVISOR: ASSOC. PROF. TAWATCHAI CHARINPANITKUL, D.Eng.,
THESIS COADVISOR: THANAKORN WASANAPIARNPONG, D. Eng., 81
PP.

Development of transparent property of polycrystalline alumina ceramic was proposed this research work. Fabrication of full density specimen and control of grain size within submicron order was mainly focused. Commercial alumina nanopowder was employed as a raw material in this work. Various specimens were molded by slip casting method. The objectives of this research were to investigate the effect of addition of binder into alumina slurry for slip casting and that of sintering parameters to obtain the full density and submicron grain. The experimental results show that the optimal PVA binder for slip casting should not exceed 0.2 wt% with 75 wt% alumina content. This well dispersed alumina composition could provide the circular pellet and alphabet-shaped alumina specimens without breakage by slip casting. As a result, the specimens with the relative density up to 58% could be prepared.

In the sintering process, types of furnace, sintering temperature and soaking time in pre-sintering were important factors to gain the fully dense alumina specimens. It was found that the grain growth mechanism immediately occurred after densification in sintering process. Moreover, the two-step sintering proposed as an alternative pre-sintering was employed to get the full density and suppress the grain growth. After pre-sintering, the specimens were subject to the post-sintering by a hot isostatic pressing (HIP) furnace to eliminate the residual closed pores. The HIPed specimens could exhibit transparent property owing to the controlled grain size at submicron level. Both of circular pellet and alphabet-shaped specimens have a high transparency after being HIPed.

Department.....Chemical Engineering.....Student's signature.....*Chutinan Promdej*.....
Field of study.....Chemical Engineering.....Advisor's signature.....*T. Charinpanitkul*.....
Academic year.....2007.....CO-advisor's signature.....*TSP*.....

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NOMENCLATURES

| | |
|-----------|--------------------------------|
| AFM | Atomic force microscope |
| EDS | Energy-Dispersive spectrometer |
| HIP | Hot Isostatic Pressing |
| L_g | Length of green specimen |
| L_d | Length of dried specimen |
| PCA | Poly-crystal alumina |
| PMAA | Polymethacrylic acid |
| PVA | Polyvinyl alcohol |
| SCA | Single-crystal alumina |
| SEM | Scanning Electron Microscope |
| W_d | Dry weight |
| W_{sat} | Saturated weight |
| W_{sus} | Suspended weight |
| ρ | Water density |