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โดยการเติมซิลิกาและแก้วเพื่อใช้เป็นวัสดุทดแทนกระดูก



นางสาวณัฐกานต์ โกษาจันทร์

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สาขาวิชาเทคโนโลยีเซรามิก ภาควิชาวัสดุศาสตร์

คณะวิทยาศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

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ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย



IMPROVEMENT OF MICROSTRUCTURAL AND PHYSICAL PROPERTIES OF POROUS
HYDROXYAPATITE BY ADDING SILICA AND GLASS FOR USE AS A BONE
REPLACEMENT MATERIAL

Miss Nudthakarn Kosachan

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Ceramic Technology

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By Miss Nudthakarn Kosachan

Field of Study Ceramic Technology


Thesis Advisor Supatra Jinawath, Ph.D.

Thesis Co-advisor Angkhana Jaroenworluck, Ph.D.

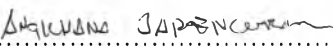
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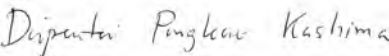

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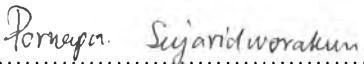
THESIS COMMITTEE


..... Chairman
(Associate Professor Saowaroj Chuayjuljit)


..... Thesis Advisor
(Associate Professor Supatra Jinawath, Ph.D.)


..... Thesis Co-advisor
(Angkhana Jaroenworluck, Ph.D.)


..... Member
(Dujreutai Pongkao Kashima, D. Eng)


..... Member
(Pornapa Sujaridworakun, D. Eng)

ณัฐกานต์ โภษาจันทร์. การปรับปรุงโครงสร้างจุลภาคและสมบัติทางกายภาพของไฮดรอกซีอะพาไทต์ที่มีรูพรุนโดยการเติมซิลิกาและแก้วเพื่อใช้เป็นวัสดุทดแทนกระดูก.(Improvement of microstructural and physical properties of porous hydroxyapatite by adding silica and glass for use as a bone replacement material). อ. ที่ปรึกษา : รศ.ดร.สุพัตรา จินาวัดมน, อ. ที่ปรึกษาร่วม : ดร.อังคณา เจริญวรลักษณ์, 110 หน้า.

งานวิจัยนี้เป็นการปรับปรุงไฮดรอกซีอะพาไทต์ที่มีรูพรุนให้มีความแข็งแรงสำหรับใช้เป็นวัสดุทดแทนกระดูก โดยทำการศึกษาเพื่อปรับปรุงโครงสร้างทางจุลภาคและคุณสมบัติเชิงกลของวัสดุไฮดรอกซีอะพาไทต์ที่ให้ความหนาแน่นสูงในขณะเดียวกันก็ยังคงไว้ของโครงสร้างที่มีความเป็นรูพรุนสำหรับคุณสมบัติทางด้านความเข้ากันได้ทางชีวภาพหรือไบโอแอคทีฟ โดยในการศึกษานี้ได้ทำการเปรียบเทียบผลของการเปลี่ยนแปลงคุณสมบัติของไฮดรอกซีอะพาไทต์ที่ไม่ได้มีการเติมและที่เติมผงซิลิกาและแก้วหลอมในอัตราส่วนตั้งแต่ 0.5 ถึง 20 เปอร์เซ็นต์(โดยน้ำหนัก) ที่ผ่านการเผาเผือกที่ 1150 และ 1300 องศาเซลเซียส ทำการขึ้นรูปวัสดุโดยวิธีการใช้แรงอัดที่ความดันสูงและวิธีการใช้วัสดุโฟมพอลิเมอร์เป็นวัสดุต้นแบบที่ทำให้เกิดโครงสร้างที่เป็นรูพรุน วัสดุที่ได้จากการขึ้นรูปและผ่านการเผาเผือกได้ถูกตรวจสอบโครงสร้างทางจุลภาคโดยการใช้กล้องจุลทรรศน์แบบส่องกราดและเอกซเรย์ดิฟแฟรกโตรมิเตอร์ การเปลี่ยนแปลงหมู่ฟังก์ชันทางเคมีได้ใช้วิธีฟูเรียร์ทรานส์ฟอร์มอินฟราเรดสเปกโตรสโคปีในการตรวจสอบและทำการวัดคุณสมบัติเชิงกลคือวัด ความแข็งแรงเชิงกด และความแข็ง สำหรับคุณสมบัติการเข้ากันได้ทางชีวภาพนั้นทำการทดสอบโดยการนำวัสดุตัวอย่างไปแช่ในสารละลายเอสปีเอฟที่ระยะเวลาต่าง ๆ กัน

จากการศึกษาพบว่าวัสดุไฮดรอกซีอะพาไทต์ที่ขึ้นรูปด้วยการอัดจะมีอัตราการเปลี่ยนแปลงเฟสจากไฮดรอกซีอะพาไทต์เป็นไตรแคลเซียมฟอสเฟตเพิ่มมากขึ้นเมื่อเพิ่มอุณหภูมิและปริมาณของสารเติมแต่งมีผลต่อการเปลี่ยนแปลงคุณสมบัติทางเชิงกลและไบโอแอคทีฟ การขึ้นรูปไฮดรอกซีอะพาไทต์ที่มีรูพรุนโดยใช้วิธีโฟมพอลิเมอร์และเผาเผือกที่ 1300 องศาเซลเซียสจะทำให้ได้ตัวอย่างที่มีขนาดของรูพรุนระหว่าง 100 ถึง 420 ไมครอนและมีลักษณะเป็นรูพรุนที่มีความต่อเนื่องเหมาะกับการนำไปใช้เป็นวัสดุทดแทนกระดูก การเติมแก้วหลอม 0.5 ถึง 20 เปอร์เซ็นต์โดยน้ำหนักในไฮดรอกซีอะพาไทต์ที่มีรูพรุนทำให้ปริมาณของรูพรุนลดลงจาก 85 เป็น 78 เปอร์เซ็นต์ช่วยให้ความแข็งแรงเพิ่มขึ้นจาก 0.67 เป็น 11 เมกะปาสคาล จากผลการศึกษาแสดงให้เห็นว่าไฮดรอกซีอะพาไทต์ที่มีรูพรุนที่มีการเติมแก้วหลอมมีสมบัติที่เหมาะสมในการนำไปใช้เป็นวัสดุทดแทนกระดูกสำหรับการนำไปประยุกต์ใช้งานทางด้านกายภาพ

ภาควิชาภาควิชา...วัสดุศาสตร์.....ลายมือชื่อนิสิต.....*ณัฐกานต์ โภษาจันทร์*.....

สาขาวิชา.....เทคโนโลยีเซรามิก....ลายมือชื่ออาจารย์ที่ปรึกษา.....*Supatra*.....

ปีการศึกษา.....2550.....ลายมือชื่ออาจารย์ที่ปรึกษาร่วม.....*ANGKANA JIRIYAWORN*.....

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NUDTHAKARN KOSACHAN: IMPROVEMENT OF MICROSTRUCTURAL AND PHYSICAL PROPERTIES OF POROUS HYDROXYAPATITE BY ADDING SILICA AND GLASS FOR USE AS A BONE REPLACEMENT MATERIAL. THESIS ADVISOR: ASSOC.PROF.SUPATRA JINAWATH, Ph.D., THESIS CO-ADVISOR: ANGKHANA JAROENWORALUCK, Ph.D., 110 pp.

The aim of this study was to improve strength of porous hydroxyapatite (HA) for use as a bone replacement material. Microstructural and physical properties were also studied and evaluated. Methods of processing the HA ceramic to high density yet retaining the large open pores required for biocompatibility were investigated. Uniaxial pressing, to fabricate standard pellets and the polymer foam technique, were employed to produce the desired structures. Fabrication of porous HA with and without additives using these methods was also undertaken for comparison. Silica (SiO₂) and commercially available glass frit were used as additives. The silica powder and glass frit were added to the HA powder in the range of 0.5 to 20 wt% to fabricate the final ceramic structures. Sintering was done at 1150°C and 1300°C for 4 h. XRD and SEM analysis were used to characterize the sintered HA samples. FT-IR analysis was used for chemical functional analysis. Compressive strength and hardness measured the mechanical properties. The sintered HA samples were immersed in simulated body fluid (SBF) for various periods of time to determine bioactivity. For uniaxially pressed HA, the transformation of HA to TCP occurred at the higher sintering temperature and the amount of additive was related to mechanical strength and bioactivity. For HA doped with the silica or glass frit, < 5.0wt%, faster precipitation of new layers of Ca-P was noted. HA fabricated from the polymeric foam method, after sintering at 1300°C, had a pore size in the range 100-420 μm with interconnected pores suitable for bone ingrowth. HA with glass from 0.5 to 20.0wt% had a slightly decreased porosity from 85 to 78%, and the compressive strength varied between 0.67 to 11 MPa. This study indicates that porous HA with glass additive can be used as a bone replacement material in medical applications due to its combination of attractive properties.

Department.....Material Science.....Student's signature..Nudthakarn Kosachan...

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

Academic year..2007.....Co-advisor's signature....*ANGKHANA JAROENWORALUCK*.....

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