University of Colorado
TECHNOLOGY TRANSFER OFFICE

Flexible, Inexpensive Manufacture of Net-Shaped Materials for Orthopedic and Dental Applications

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Ref # 10028B

Background

As the world population ages, the need for biomaterials in orthopedic and dental applications has increased. A significant amount of research into biomaterials for these uses has attempted to address the functional criteria for reconstruction within the human body.

Calcium phosphate ceramics, including Tricalcium Phosphates (TCP) are a preferred material for bone reconstruction in orthopedics and dental restorative and reconstructive surgery. This phosphate occurs in two forms, alpha and beta. Beta facilitates bone remodeling through the dissolution of calcium and phosphate ions, while alpha provides structural stability. Both function as a scaffold upon which bone cells can grow. TCP has been used in numerous applications to match the chemical and structure of natural bone and is capable of being resorbed.

Current processes for the manufacture of TCP materials (including synthesis from aqueous solutions and sintering) are highly energy- and labor-intensive, involving several separate time-consuming operations. Additionally, current processes allow for little control over the porosity of the materials. There is a need for manufacturing methods to make these materials easier and less costly to produce.

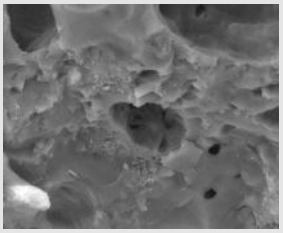
Technology

Collaborators at the Colorado School of Mines and the University of Colorado have developed a combustion synthesis method to produce porous TCP net-shaped materials comprised of alpha or beta TCP mixtures. ("Net-shaped" and "near-net-shaped" materials are those which require relatively little or no post-manufacturing processing such as grinding, polishing, cuffing, deburring, etc.) This improved technique does not require the preparation of intermediate forms or the use of chemical steps to produce the final net-shaped material; rather, this technique provides net-shaped compositions in essentially one step and in a significantly shortened time frame compared to current state-of-the-art. This technique has the added advantage of requiring little to no post-manufacturing processing, an expensive process requiring costly machinery.

Overall, this method allows shaped TCP bodies to be formed easily, inexpensively, under carefully controllable conditions, and with enormous flexibility. Moreover, the microstructure of the inventive materials can be controlled as well, such that they emulate the morphological nature of natural bone.

(above) Optical micrograph showing gradient porosity of SHS produced calcium phosphate with elongated pores on the left and small spherical pores on the right. Pores sizes range from 1 micron to 1000 microns.

(below) SEM image of multi-phasic calcium phosphate showing regions of amorphous and crystalline structures containing a-TCP and b-TCP.



Advantages

- One-step process eliminates need for multiple stages
- Cuts manufacturing and post-manufacturing costs
- Controlled porosity and alpha-to-beta ratio in the final material
- Faster, more labor-efficient