Bioceramic materials with multimodal porosity obtained by means of stereolithographic 3D printing

Authors

Mrs. Snezhana Tikhonova - Lomonosov Moscow State University

Dr. Pavel Evdokimov - Lomonosov Moscow State University

Mr. Pavel Milkin - Lomonosov Moscow State University

Mr. Dmitry Zuev - Lomonosov Moscow State University

Prof. Valery Putlayev - Lomonosov Moscow State University

Abstract

The main properties of materials (scaffolds) for bone tissue engineering are biocompatibility, resorbability and osteoconductivity. The material shouldn't be toxic and should have resorption (dissolution) rate comparable to that of bone growth. In this way, nowadays the most promising materials for bone implantation are calcium phosphates (e.g. tricalcium phosphate $Ca_3(PO_4)_2$(TCP)).

Osteoconductivity is the ability of a material to provide the bone growth and proliferation of blood vessels and nerves into the implant. Osteoconductive properties are mainly determined by total porosity of the material, pore size and distribution and the scaffold architecture. As well known, the total porosity should not be less than 70%, and size distribution of pores should be at least bimodal to provide the scaffold permeability and surface roughness. Moreover, to increase the permeability, it is necessary to have an additional pore system (with a diameter at least 500 μm) in the form of straight channels in several directions. Production of porous materials with complicated architecture is possible only using additive manufacturing techniques including stereolithography, which is one of the most universal and precise methods.

In this work, we propose a new type of osteoconductive scaffolds, which have ultra-porous (the porosity more than 85%) specific architecture with a multimodal system of pores of at least three levels.

Such kind of ultra-porous ceramic scaffolds based on tricalcium phosphate $Ca_3(PO_4)_2$ should provide good resorbable and high osteoconductive properties and can be suggested as a bone regenerative material.

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