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ULTRA-POROUS BIOCERAMIC MATERIALS WITH PREDEFINED ARCHITECTURE FOR BONE TISSUE ENGINEERING

S. TIKHONOVA [1], P. Evdokimov [1,2], P. Milkin [1], D. Zuev [1], V. Putlayev [1,2]

[1] *Lomonosov Moscow State University - Materials Science Department, Moscow, RUSSIA*
[2] *Lomonosov Moscow State University - Department of Chemistry, Moscow, RUSSIA*

The regenerative approach in medicine requires the creation of tissue engineering constructs (TEC) for recovery of biological functions of damaged tissue. The basis of TEC in bone implantation is represented by biodegradable porous scaffolds, which are populated by bone-forming cells. The main properties of these scaffolds are biocompatibility, resorbability and osteoconductivity. Calcium phosphates are biocompatible due to the similarity with inorganic part of the native bone, and their resorption ability depends on the Ca/P ratio. Ideally, the material should have a resorption rate comparable to that of bone growth. Therefore, the most promising and useful calcium phosphate is tricalcium phosphate Ca3(PO4)2 (TCP).
Osteoconductivity of material for implantation is the ability to provide the bone growth and proliferation of blood vessels and nerves into the implant. Nowadays there is a well-established point of view that osteoconductive properties are characterized by the presence of the system of interconnected pores with a bimodal distribution: 1) the first mode – pores with the diameter more than 100 μm, to increase the permeability of biological streams into material, as well as the size of “connections” between such pores should be at least 50 μm, for the migration of the cells throughout material; 2) the second mode – pores with the diameter less than 10 μm, to increase the cell adhesion by increasing the surface roughness. At the same time, the total porosity should not be less than 50%.
To increase the permeability of the material, it is necessary to have an additional directed pore system in the form of straight channels (with a diameter at least 500 μm) in several directions; and the fraction of pores should be at least 70% of the total material volume. Creation of porous ceramic materials with high permeability is possible only using additive manufacturing. Stereolithography is one of the most universal and perspective methods, in which 3D-object is created using photopolymerization of individual suspensions.
The aim of our research activity is the creation of resorbable highly permeable ultra-porous ceramic scaffold based on tricalcium phosphate Ca3(PO4)2 with pre-defined architecture using the stereolithography method for bone tissue engineering.
In this work, we propose a new type of osteoconductive scaffolds, which have a more permeable specific architecture and accelerate the regeneration of native bone tissue. Such materials have ultra-porous (the porosity more than 85%) specific architecture with a complex (multimodal) system of pores of at least three levels.
Created ultra-porous ceramic scaffolds based on tricalcium phosphate demonstrate good resorbability and high osteoconductivity and can be used as a part of tissue engineering constructs in bone implantation.
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