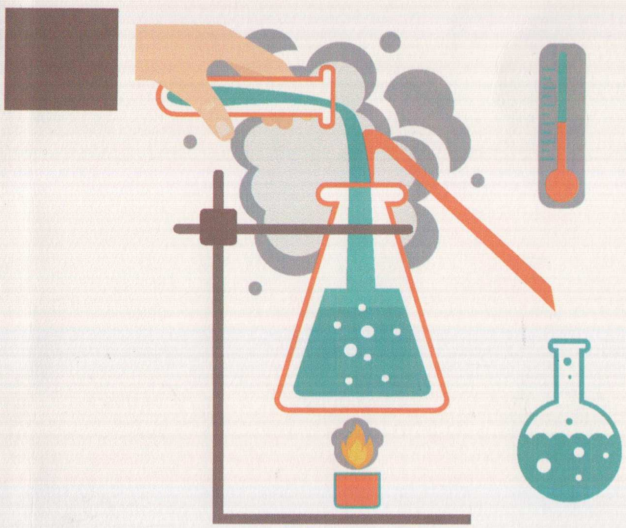
VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ FAKULTA CHEMICKÁ

Studentská odborná konference
Chemie je život
21. listopadu 2019

Sborník abstraktů



Vysoké učení technické v Brně • Fakulta chemická

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Indirect 3D Printing of Bioceramic Scaffolds with Structured Macro Channels

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Porous materials are currently a subject of interest in modern tissue engineering. Scaffolds, made from ceramic materials, provide unique properties, such as biocompatibility, bioactivity, and biodegradability. A very important feature of the bioceramic bone scaffold is to support vascularisation, adhesion, and proliferation of bone cells. Nowadays, materials, that can release calcium and phosphate ions are bioactive and became very attractive in medical applications. The most used ceramic materials with these properties are hydroxyapatite, β-tricalcium phosphate, and whitlockite.

The ideal scaffold should have a pore size at least 200 μm for successful bone cell overgrowth (macro channels), but also smaller pore sizes are an advantage. The patient's bone is a three-dimensional virtual model that is easy to obtain using scanning techniques and then to print using additive technology. It is possible to prepare various constructions with defined channel geometry and shape. However, to achieve high porosity, mechanical stability, and defined macro channel geometry is still challenging.

Therefore, various 3D meshes were designed in the graphical editor with different arrangements of the macro channels. The 3D mesh was implemented to the form before freezing and casted by hydroxyapatite suspension. The mesh was removed by a sintering process and the macro channels were created by the presence of the 3D mesh. Various types of inner structured scaffolds with the same diameter in the green state were successfully prepared with diameter of macro channels in the range 540-600 μm.

It was experimentally found that the type of 3D mesh has an impact on the final mechanical stability of bone scaffolds. The mesh with helical structure has no significant effect on the mechanical stability of the resulting scaffold, it only influences the crack in the direction of the helix.

The porous scaffolds have a crucial problem in the bad mechanical properties, therefore they are used in low-loads places. Scaffolds with mechanical pressure of 0.2-0.7 MPa were prepared. The selected program did not achieve high porosity values than could be achieved with other rapid prototyping techniques.

The combination of these methods shows very good manageability with the controlled macro channels in the resulting highly porous structure (porosity over 70%). It is an extremely promising method for the preparation of bone scaffolds with different structures in the future.

Preparation and properties of poly(3-hydroxybutyrate) aerogels

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Poly(3-hydroxybutyrate) (P3HB) is a biodegradable semi-crystalline biopolyester synthesized and accumulated in bacterial cells in nutrient deficient conditions, except for carbon. Its biocompatibility renders P3HB also a promising material for tissue engineering, either in pure form or as constituent of a hybrid or composite material. However, besides biocompatibility, cell scaffolding materials need to meet a series of further prerequisites which include chemical, nanotopological, micromorphological and mechanical aspects. Interconnectivity, size and shape of voids for example are of immense importance for cell viability, ingrowth, signaling and propagation as well as diffusion of gases and metabolic products.

This presentation communicates the results of a study that investigated the preparation of free-standing shaped translucent gels from dilute solutions of P3HB and their onward conversion to P3HB cryogels and aerogels. Aiming to employ non-toxic and less volatile solvents, we tried to circumvent the use of common P3HB solvents like chloroform, dichloromethane or cyclohexanone and explored the solubilizing potential of DMSO in combination with a green cosolvents instead.

This approach turned out to afford nice colorless and translucent free-standing gels with solid contents of 2-2.5 % and porosities of up to 98%. The obtained products were converted to cryogels (after solvent exchange to water and fast freezing at -80°C) or aerogels (after solvent exchange to ethanol) using supercritical carbon dioxide (45°C, 9.5 MPa, 4h).

Preliminary nitrogen sorption experiments at 77K suggested a high interconnectivity of the voids and surprisingly high specific surface areas. These values will be verified till mid of November and will be supplemented by scanning electron microscopy and uniaxial compression testing of both cryogels and aerogels. *In vivo* degradation of the prepared P3HB scaffolds will the subject of future research.

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