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Book of abstracts contains theses of plenary, keynote, oral and poster presintations which were presented on **Mendeleev 2021**, the XII International Conference on Chemistry for Young Scientists. The Mendeleev 2021 Conference hold in Saint Petersburg (September 6–10, 2021).

Abstracts presented in the original edition

3D-PRINTING OF HYDROGEL/TRICALCIUM PHOSPHATE COMPOSITE

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Currently, there is a growing interest in additive technologies, which are a universal technological platform for computer-aided design and rapid production of materials. In the case of biomaterials, 3D printing provides osteoconductive properties (i.e. associated macropores) and a personalized approach to patient treatment. Hydrogels based on polyethylene glycol (PEG) derivatives can be obtained by the photopolymerization reaction, which is the basis of the stereolithographic 3D printing method [1]. Hydrogels are unique materials for medicine, due to their characteristics, such as swelling and diffusion properties [2]. Hydrogels have a highly swollen three-dimensional structure similar to soft tissues and allow diffusion of nutrients and cellular waste through the elastic network. To create new biomaterials, calcium phosphates are widely used, due to their excellent biological properties [3]. It is possible to create composites based on hydrogels filled with calcium phosphates, which will increase their bioactivity and provide opportunity to control composites properties, such as swelling, degradation rate and strength. This work was aimed at obtaining of hydrogel-based composites, filled with calcium phosphate, with complex architecture through DLP 3D-printing for creating material, which can be used in bone tissue regeneration.

In this work monomers of polyethylene glycol derivatives, such as PEG-methacrylate or PEGMA (M_w=350 Da) and PEG-diacrylate or PEGDA (M_w=575 Da), were chosen, due to its good biological properties, ability to degrade in body environment, commercial availability, and applicable for DLP printing. These monomers are liquids at room temperature and have a good solubility in water. Pre-synthesized calcium phosphate (tricalcium phosphate ($Ca_3(PO_4)_2$, TCP), brushite or dicalcium phosphate dihydrate ($CaHPO_4{\cdot}2H_2O$, DCD), octacalcium phosphate ($Ca_8(HPO_4)_2(PO_4)_4{\cdot}5H_2O$, OCP)) were used for filling hydrogel. Hydrogels and filled composites were obtained by photopolymerization reaction with photoinitiator Irgacure®819. Mixing of all components was performed on a magnetic stirrer for 10 minutes, after which photopolymerization was performed under a household UV lamp and samples with the gyroid structure were obtained at DLP 3D-printer Ember (Autodesk, USA).

It was found that the usage of α-TCP ceramic powder as a filler for hydrogels allowed to increase the filler fraction from 10 up to 60 wt.% in comparison with OCP and DCD without significant thickening of photosuspension for DLP printing. The possibility of TCP conversion into OCP or DCD by soaking of the composite in buffer solutions was tested. Also, the possibility to tune hydrogel properties (such as swelling, degradation rate, photopolymerization time) by using mixture of monomers and filling hydrogels was shown. It was found that the increase of methacrylate content allows obtaining composites with a higher swelling and faster biodegradation behavior, but with long photopolymerization time. Finally, the main parameters of DLP printing for biocomposites based on PEGMA/PEGDA hydrogels were found, and the macroporous biocomposite filled with 60 wt.% α-TCP with gyroid structure was obtained. It was shown that the change in the radiation time of a single layer during 3D printing makes it possible to vary the porosity of the obtained biomaterials. The combination of composites unique properties makes them perspective for further biomedical evaluation as elastic bioimplants for bone tissue recovery.

References

[1] Preobrazhenskiy I. I., Tikhonov A. A., Evdokimov P. V., Shibaev A. V., Putlyaev V. I. *Open Ceramics* **2021**, 100115.
[2] Преображенский И.И., Тихонов А.А., Климашина Е.С., Евдокимов П.В., Путляев В.И. *Известия АН. Серия химическая* **2020**, 8, 1601-1603.
[3] Radwan N. H., Nasr M., Ishak R. A., Abdeltawab N. F., Awad G. A. *Carbohydrate Polymers* **2020**, 244, 116482.

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