The influence of nanohydroxyapatite on selected properties of polyurethane-based bone scaffold

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INTRODUCTION

Polyurethanes (PUs) are defined as a big group of synthetic polymers that contains repeated urethane linkage in the backbone. The obtained polymer can differ in shape and properties, depending on the components and the synthesis process. That is why PUs are widely used in a big range of applications. Due to their good biocompatibility, it is possible to manufacture polyurethane-based biomaterials as well. Another big advantage of polyurethanes is the ease of modification, using many types of fillers.

One of the most used fillers in biomedical applications is hydroxyapatite (HAp), a calcium phosphate mineral. HAp-like compounds build around 65% of a bone, therefore HAp is a good alternative for a synthetic bone modifier. PU-based materials with an addition of HAp can exhibit not only enhanced osteogenesis but also improved mechanical properties such as tensile strength and Young modulus.

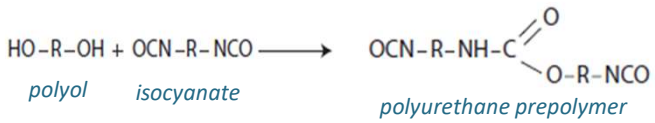
In this work, polyurethane-based bone scaffolds manufactured in the two-step bulk polyaddition process were presented. The influence of various HAp content was investigated. The chemical structure of the samples was checked using spectroscopy (FTIR). Mechanical properties were evaluated by a compression test. Bioactivity of the material was investigated based on SEM images before and after incubation in SBF solution.

AIM OF THIS WORK

Fabrication and examination of polyurethanes modified with nanohydroxyapaptite.
Determining an influence of different concentration of HAp on selected properties of the material.

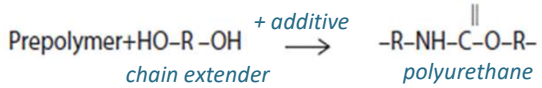
MATERIALS AND SYNTHESIS

I STEP



polyol *isocyanate* *polyurethane prepolymer*

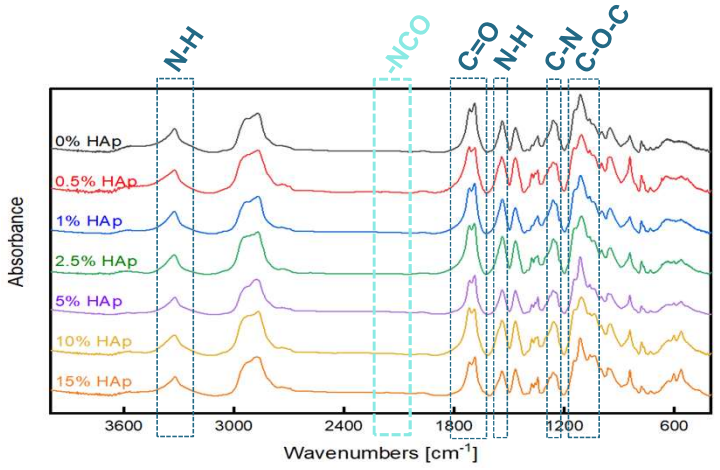
II STEP



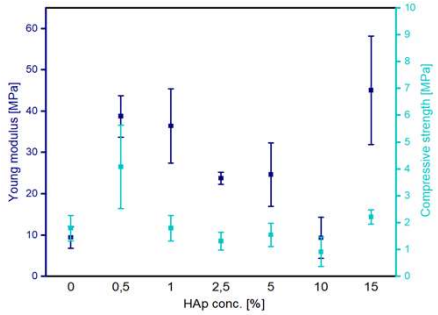
chain extender *polyurethane*

polyol	poly (ethylene glycol) (PEG2000) (*Sigma Aldrich*)
diisocyanate	1,6-hexamethylene diisocyanate (HDI) (*Fluka Analytical*)
chain extender	1,4-butanediol (BDO) (*Sigma Aldrich*) sodium alginate (SA) (*Sigma Aldrich*)
additive	nanohydroxyapaptite (HAp) (*mkNano*)

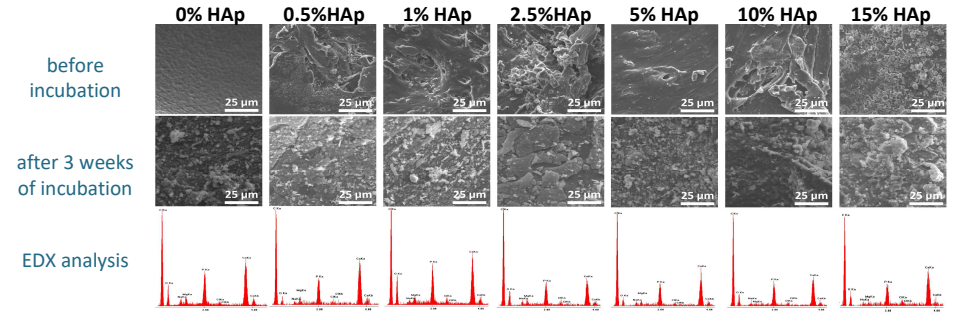
FTIR SPECTRA



COMPRESSION TEST



SEM-EDX OBSERVATIONS



DISCUSSION AND CONCLUSIONS

- The efficiency of the synthesis process was proven by an absence of isocyanate groups (-NCO) in the **FTIR spectra**. Also, characteristic bands corresponding to the stretching of the urethane group were visible. Incorporation of nanohydroxyapatite did not cause significant changes in the structure of polyurethanes, while no band shifts were observed in the spectra.
- **The mechanical properties** of the material were improved with increasing HAp content up to 1%. Above this concentration, the parameters worsened. For the sample with the highest HAp content (15%) calculated Young modulus was the highest. Unfortunately, in this case, the material was brittle and was damaged during the test.
- All manufactured samples exhibit bioactivity. After incubation in SBF, on samples surface the apatite layer was observed in **SEM images** and identified by **EDX analysis**. With increasing HAp concentration, the apatite layer was more abundant, which might indicate enhanced support for bone regeneration *in vivo*.
- Summarizing, prepared polyurethane-based scaffolds demonstrate great potential for bone tissue regeneration. The most promising properties were obtained for the sample with HAp concentration of 1%.

REFERENCES

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ACKNOWLEDGMENTS

Authors are grateful to the Polish National Science Centre for financial support under the Contract No. UMO-2016/22/E/ST8/00048.