Characterisation of strontium-substituted hydroxyapatite as potential biomedical material

Marija Đošić*, Jelena Nikolić, Jovica Stojanović, Nikola Vuković, Marija Marković, Veljko Savić and Vladimir Topalović

Institute for Technology of Nuclear and Other Mineral Raw Materials, Belgrade, Serbia

Keywords: Apatite; strontium; bones; bioactivity

Hem. Ind. **78(1S)** 40 (2024)

Available on-line at the Journal web address: http://www.ache.org.rs/HI/

INTRODUCTION: Owing to its similarity to the inorganic part of the natural bone, excellent bioactivity, biocompatibility, and ability to stimulate the osteoconductive process, synthetic hydroxyapatite (HAP) is very often the material of choice for biomedical applications. Diverse ions can be found as substitutes within natural bone structures, each playing a distinct and crucial role in the physiological processes governing the lifecycle of bones [1]. Among them, strontium ion has a very important role for the acceleration of osteogenesis and the inhibition of osteoclasts activity [2]. Current research aims to provide physico-chemical characterization of synthesized HAP and strontium substituted HAP (Sr-HAP) powders obtained by varying strontium concentration (10, 20 and 40 mol.%) in the starting solutions.

EXPERIMENTAL: HAP powder was synthesized by wet chemical precipitation, using aqueous solutions of $Ca(NO_3)_2$ $4H_2O$ (Merck, p.a.) and $(NH_4)_2HPO_4$ (Sigma-Aldrich, ≥99 %). By adding NH_4OH (CENTROHEM, *p.a.*), pH value was adjusted to 10. The obtained precipitate was heated up to 90 °C. The same procedure was followed for Sr-HAP powder syntheses, by adding $Sr(NO_3)_2$ (Sigma-Aldrich ≥99.0 %) and maintaining the (Ca + Sr)/P ratio at 1.67 in the mixed Ca^{2+}/Sr^{2+} solution. Synthesized powders were characterised by FTIR spectroscopy (Nicolet IS-10, Thermo Fisher Scientific), XRD analysis (Philips PW 1710, Philips, The Netherlands), TG analysis (Netzsch STA 449 F5 Jupiter instrument), and FE-SEM analysis (JSM-7001F, JEOL Ltd, Japan).

RESULTS AND DISCUSSION: FTIR spectra revealed the presence of carbonate-substituted hydroxyapatite in both pure and Sr-substituted HAP powders. The powders showed a granular, homogeneous morphology without the Sr separation. XRD analysis revealed that the amount of incorporated Sr in the HAP structure increased with increased Sr concentration in the starting solutions. Thermal stability of the Sr-HAP powders decreased with increased Sr concentration.

CONCLUSIONS: Physico-chemical characteristics of Sr-HAP powders are directly dependent on Sr ion concentration in powders.

Acknowledgements: This research is supported by The Ministry of Science, Technological Development and Innovation, Republic of Serbia, (Contract No. 451-03-47/2023–01/200023).

REFERENCES

[1] I. Cacciotti, Cationic and Anionic Substitutions in Hydroxyapatite, in: I.V. Antoniac (Ed.), Handb. Bioceram. Biocomposites, Springer International Publishing, Switzerland, 2016: pp. 146–188. https://doi.org/10.1007/978-3-319-12460-5_7.

[2] A. Ressler, A. Žužić, I. Ivanišević, N. Kamboj, H. Ivanković, Ionic substituted hydroxyapatite for bone regeneration applications: A review, Open Ceram. 6 (2021). https://doi.org/10.1016/j.oceram.2021.100122.

*Corresponding author E-mail: mdjosic@yahoo.com