VARIOUS IONIC SUBSTITUTIONS IN HYDROXYAPATITES - PHYSICOCHEMICAL STUDIES

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[ENGINEERING OF BIOMATERIALS 148 (2018) 45]

Introduction

The mineral part of bone and teeth are mainly composed with biological apatite, nanocrystalline multi-substituted carbonated hydroxyapatite containing various ions (i.e. Na^+, K^+, Mg^{2+}, Mn^{2+}, Zn^{2+}, HPO_4^{2-} or SiO_4^{4-}, etc.) [1]. Hydroxyapatite (HA) with chemical formula $Ca_{10}(PO_4)_6(OH)_2$ is commonly used as bone substitute and biomaterial for orthopaedic and dental applications. The crucial property of synthetic HAs is the ability to ionic substitution. Therefore, ionic substitution may be a tool to synthesize materials with high biocompatibility with mineralized tissues [2].

Moreover, it should be noted that these substitutions may provoke changes in physicochemical and biological properties [3,4].

The main aim of this work was to synthesize HA enriched in different ions (i.e. SeO_3^{2-}, Zn^{2+}, BO_3^{3-}, Sr^{2+}, SiO_4^{4-}) and to provide detailed study on their chemical structure and physicochemical properties.

Materials and Methods

Hydroxyapatites containing various ions were synthesized using two different ways: standard, wet method and solid-state method. The obtained powders were examined using various analytical methods: powder X-ray diffractometry (PXRD), infrared spectroscopy (FT-IR), transmission electron microscopy (TEM) and solid-state magnetic resonance spectroscopy (ssNMR). The elemental analysis were performed by using wavelength dispersive X-ray fluorescence spectroscopy (WD-XRF).

Results and Discussion

PXRD diffractograms have shown the significant differences in degree of crystallinity among the substituted HAs. Different sizes and shapes of crystals were confirmed by TEM microscopy. FT-IR and ssNMR spectroscopy allowed to analyse the location of “foreign” ions. Moreover, the hydrated surface layer was detected using ^{31}P MAS NMR experiments.

Conclusions

The powders of substituted hydroxyapatites were successfully synthesized and detailed physicochemical analysis were carried out. The studies have shown that ionic substitution may have an important impact on the crystal sizes and shapes, crystallinity index or solubility and the development of hydrated surface layer. The obtained results shown that spectroscopic methods may be an appropriate way to study apatitic materials.

Acknowledgments

This work was supported by a research grant (Project NCN UMO-2016/22/E/ST5/00564) from the National Science Centre, Poland.

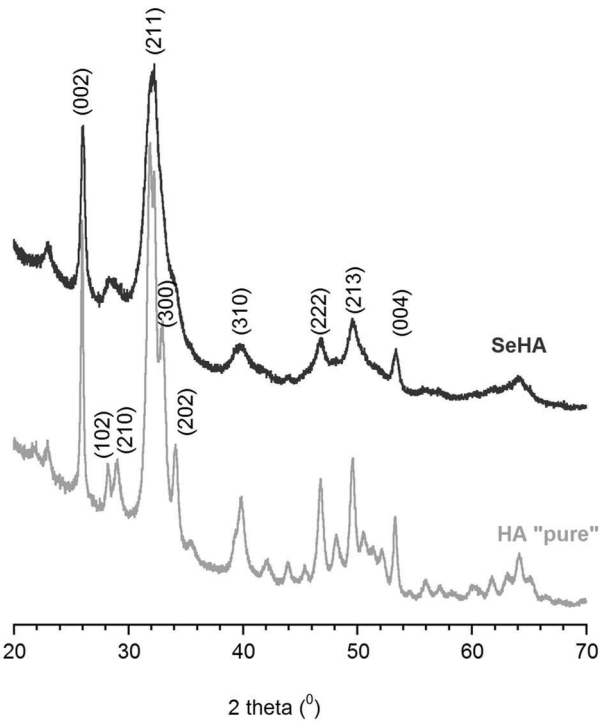

FIG. 1. PXRD of the HA and Se-HA samples.

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