Aim of the Project

The main aim of this project is to develop new crystalline calcium phosphates enriched with various ions of potential biomedical importance. The next primary goal of the project is to develop double- and multi-phase materials with different characteristics of releasing these ions.

Basic studies performed as a part of the project:

- Synthesis of various crystalline calcium phosphates: hydroxyapatite (HA), beta-tricalcium phosphate (βTCP), alpha-tricalcium phosphate (αTCP), anhydrous calcium hydrogen phosphate (DCPA) and calcium hydrogen phosphate dihydrate (DCPD) containing admixtures of "foreign" ions: I, II or III-valence cations (e.g. K^+, Ag^+, Zn^{2+}, Mn^{2+}, Mg^{2+}, Cu^{2+}, Ga^{3+}) and various ions (e.g. SeO_3^{2-}, SeO_4^{2-}, SiO_4^{4-}, BO_3^{3-}).
- Analysis of structure and chemical composition of substituted calcium phosphate materials and physicochemical tests of these materials. Planned research methods: X-ray powder diffractometry (PXRD), infrared spectroscopy (FT-IR), Raman spectroscopy (R), solid-state nuclear magnetic resonance (ssNMR), atomic absorption spectrometry (AAS), wavelength X-ray fluorescence (WD XRF) and inductively coupled plasma optical emission spectrometry (ICP-OES).
- Analysis of ion release from obtained materials (inductively coupled plasma – mass spectrometry - ICP MS).
- Development of double- and multi-phase materials based on obtained substituted calcium phosphate materials characterized by various rate of foreign ion release.
- Assessment of biological properties of obtained materials.

Causes of udertaking the research subject:

Calcium phosphates are a group of inorganic materials playing an important role in implantology, regenerative medicine and dentistry. Human mineralized tissues (i.e. bones, enamel, dentin and cementum) contain inorganic matter providing hardness, the so-called biological apatite. Biological apatite is nanocrystalline carbonate hydroxyapatite containing numerous different ion substitutions. Because of that, synthetic bone-replacement materials, such as coatings of metal implants, bone cements or dental materials often contain calcium phosphates which provide biocompatibility, bioactivity and low cytotoxicity. For many years hydroxyapatite, the most popular among synthetic calcium phosphates (HA), as well as the most poorly resorbed is effectively subjected to enrich with various ions in order to add biological, physicochemical or mechanical properties. On the other hand, little is known about the possibility of ion substitutions in other crystalline calcium phosphates, e.g. calcium ortophosphate (βTCP and αTCP form) and calcium hydrogen phosphates (DCPA and DCPD). Few studies on βTCP and αTCP substitution show that such materials dissolve with better solubility and faster foreign ion release than substituted apatites. At the moment, double-phase materials (most often containing pure, unsubstituted HA and βTCP with different proportions) are used in medicine, providing quick osseointegration. Development of new substituted calcium phosphates planned in our project is aimed at broadening knowledge in terms of ion exchange in selected crystalline calcium phosphates. We would like to develop materials characterized by different resorption and various ion release rate. We expect that the results of research planned by us will present particular importance for progress in biology, medicine and biomaterial engineering (development of bone-replacement materials).