CALCIUM HYDROXYLAPATITE AS MATRIX FOR BURIAL OF RADIO-ACTIVE WASTES

Karbivskyy V.L., Kurgan N.A., Shpak A.P.
G.V. Kurdyumov Institute for Metal Physics NAS of Ukraine, 36 Vernadsky blvd., Kiev, 03142 Ukraine
E-mail: karb@imp.kiev.ua

Currently calcium hydroxylapatite, among other applications, examined as a matrix for the burial of radio-active wastes and store ecologically dangerous of heavy metals compounds. A high specific surface in a few hundred of square meters on a gramme of matter determines high reactionary ability of nano-dispersed calcium hydroxylapatite (HAP) [1-2].

In this work synthesis is conducted and morphology of nano-dispersed calcium apatite is described by zol-gel method technology. Its adsorption ability is studied. The changes of electronic structure of calcium apatite, initiated isomorphous modification by strontium, are investigations. Researches were conducted by the X-ray photoelectronic spectroscopy method, IR spectroscopies, and atomic force microscopy method with bringing of quantum-mechanical modeling in LMTO approaching.

Consequently of the conducted researches has been found that isomorphic substitution of calcium ions by the strontium ions in calcium hydroxylapatite results in decrease of electronic density on the calcium and oxygen atoms, specifying on increase a part of covalent constituent in general balance of chemical bond. Correlation of positions and form of lines of calculations and experimental dates testifies to the preferable including of strontium ions in $Ca_{(2)}$ - position of apatite structure. It is found that to convert to nano-dispersed state of calcium hydroxylapatite there is a considerable increase of symmetry of PO_4– tetrahedrons.

The monomodal distribution of the nano-dispersed calcium hydroxylapatite particles with the middle size of particles 40 nm is certain by the atomic forces microscopy method. There is a characteristic form and texturing of apatite particles. The nano-size apatite crystals possess high sorption ability to H_2O and Sr-90, that is determined by both the small particles sizes and non-stoichiometric composition. The coefficient of of Sr-90 radioisotope distributing between an apatite and solution (Kd) does not depend on the concentration of Sr-90 in an interval 4.2 – 61 Bq/ml. Considerably more high values of desorption size for the nanocrystal apatite samples is indication that the Sr^{2+} ions are formed by the loosely coupled bonds with the apatite structure, possibly, adsorbed on a surface in place of OH-groups protons and/or form the aqua-complex of $Sr^{2+}{\cdot}nH_2O$.

Conclusions

It was established that the sorption Sr-90 on the nanodispersive HAP with the subsequent annealing at 650 ºC (transfer in a crystal condition) leads to thirty-fold decrease of the parameter of isotope desorption from the structure of apatite at insignificant decrease Kd. The Sr-90 radioisotope, adsorbed on nano-dispersed apatite, firmly holds out its structure at the thermal transformation HAP into the crystalline state. For the reliable deleting of Sr-90 radionuclide from water solution and withholding of it in the apatite structure, adsorption must be conducted on nano-dispersed HAP with its subsequent transformation into the crystalline state.

References

1. Kanazava T. Inorganic phosphate materials. Elsevier science Publishing B.V., Amsterdam, 1989.
2. Shpak A.P., Karbovskii V.L., Tratchevskii V.V. Apatites. Kiev: Academperiodika, 2002.- 414 p.