Influence of Electron Beam Irradiation on Dielectric Biocompatible Hydroxyapatite

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Abstract. Hydroxyapatite is a dielectric biomaterial with a high level of bioactivity and a potential of an additional bioacitivity increase when surface modification techniques are applied. Since nanocrystalline hydroxyapatite has osteinductive capability and is very similar to the mineral component of the mammal bone, a strong bond with the bone after implantation of a hydroxyapatite graft is formed. Therefore, it is necessary to use modification techniques that increase the surface bioactivity while maintaining the crystal and chemical properties of the bone-like hydroxyapatite. One possibility is the irradiation by an electron beam which aims to modify the surface charge and surface potential of the dielectric. Bulk hydroxyapatite samples were irradiated in Scanning Electron Microscope by electron beam with energy of 30 keV. Excess trapped charge resulting from the irradiation of the dielectric sample was in the order of 10^{-9} Coulombs. X-ray Photoelectron Spectroscopy was subsequently used to study the chemical changes on the surface of the irradiated samples in comparison with the non-irradiated ones. It revealed an increase of the carbon surface contamination in the irradiated samples, but the calcium to phosphorus ratio remained stable. Moreover, when the surface of the material is irradiated by a flux of accelerated electrons, its temperature rises. The calculated increase of temperature in a single irradiated point is in the order of 1 - 10 degrees Celsius depending on the parameters of the irradiation. Therefore, the crystal structure and chemical composition as functions of temperature were investigated using X-ray Diffraction and X-ray Photoelectron Spectroscopy, respectively. Our results show that the hexagonal phase of hydroxyapatite is stable up to 1100 °C and the lattice undergoes only thermal expansion. The evolution of the chemical composition was studied up to 400 °C. The recorded spectra revealed gradual desorption of the carbon surface contamination, but the Ca/P ratio remained stable. The obtained results suggest that the electron beam irradiation and the resulting heating of the sample influence solely the carbon surface contamination while the chemical and crystal properties of the hydroxyapatite sample are maintained. This work was supported by Comenius University Grants no. UK/158/22 and UK/288/23.