Sodium-Substituted and Carbonated Calcium Phosphate Nanoceramics for Bone Substitution

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Bioactivity of bone implants based on hydroxyapatite (HA) depends on their chemical composition and microstructure. Comparative studies on nanocrystalline and conventional microcrystalline ceramic implants in a biological environment have shown that nanoceramics have greater bioactivity and better integrate with bone tissue. Therefore, effective biomaterials structural and chemical characteristics should be similar to bone mineral. In particular, biomaterial based on HA should be nanocrystalline and incorporate impurity ions that are typical of biological apatite. The ions include Na^+, Mg^{2+}, CO_3^{2-}, etc. The effect of Na^+ additions in concentrations ranging from 0.25 to 1.5 wt% on the sintering temperature, crystallinity and characteristics of carbonization of HA powder compacts was studied.

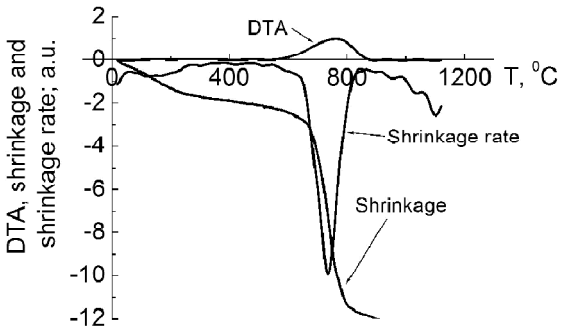

Figure 1

XRD, IR spectroscopy, dilatometric and TG-DTA methods were used.

According to the DTA results a significant exothermic effect associated with solid-state reaction between HA and sodium bicarbonate or nitrate added as a sodium source was found in the temperature range 600-800 °C (Fig. 1). The reaction leads to joint ionic substitutions in cationic (Na^+ for Ca^{2+}) and anionic (CO_3^{2-} for PO_4^{3-}) sublattices of HA. As a result, carbonated sodium-substituted HA (CHA) was formed. The degree of carbonation increased with increasing sodium ion contents. Significant activation in shrinkage of the compacts was also found. The sintered of the finely dispersed sodium-substituted CHA ceramics by microstructure and chemical composition were similar to biological apatite.