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ABSTRACT

Hydrothermal Growth of Hydroxy Apatite Metal Oxide Nanocomposites for Hard Tissue Engineering

In this present work, hydroxyapatite-metal oxides composite was prepared under optimized hydrothermal conditions and its structural, morphological, elemental, thermal, mechanical and biological properties was evaluated. Based on the experimental analysis of prepared HAp-metal oxides composites, cuttlefish bone derived HAp composite scaffolds were developed for bone tissue engineering application. Herein, we report a novel method for the direct synthesis of HAp-metal oxides (Al_2O_3, ZrO_2 and ZnO_2) nanocomposite at different precursor concentrationsin a newly developed continuous stirring hydrothermal vessel. The phase composition of the synthesized materials was determined using X-Ray Diffraction (XRD, Xpert powder diffractrometer, PAN Analytical, Netherland).

The morphological distribution and elemental composition were assessed by transmission electron microscopy (TEM, JEOL JEM 2100, Germany), field emission scanning electron microscopy (FESEM, SIGMA HV – Carl Zeiss with BrukerQuantax 200 – Z10 EDS Detector, United States) and energy dispersive X-ray spectroscopy (EDS) respectively. The thermal behaviour was analyzed using thermogravimetry and differential scanning calorimetry study.The hardness and Young's modulus were determined by nanoindentation.In order to evaluate the *in vitro* biocompatibility of the prepared HAp-metal oxide composites, the viability of MG 63osteosarcoma cell lines againstdifferent concentrationsof synthesized nanocomposites were tested using MTT assay.In the proposed research, hydroxyapatite and its metal oxides (Al_2O_3, ZrO_2 and ZnO_2)composites was successfully prepared under optimized process condition in a customized hydrothermal system. Nanostructures such as rods and spheres of HAp-alumina, HAp-zirconia and HAp-zinc oxide composites around 100 nm were produced in the proposed work. Each composite material was analyzed for structural, morphological, thermo-mechanical and biological properties. The materials show good thermo-mechanical behaviour for load bearing applications process and excellent compatibility with MG-63 osteoblasts like cells. Based on these results, we observed that the prepared HAp-Metal Oxide composites were highly suitable for bone tissue engineering applications. Conversely, the highly channelled cuttlefish bone with unique characteristics was chosen to develop scaffolds for hard tissue engineering. The highly carbonated cuttlefish bone was hydrothermally transformed into hydroxyapatite, the bone forming mineral without affecting the channelled arrangement. To enhance the biological property, the modified CFB scaffolds were coated with the above prepared composite material and sodium alignate, a biocompatible polymer. The surface modifications on these scaffolds were clearly observed from the FESEM analyses and 3D topographic images obtained from nanoindentation study. The *in vitro* biocompatible study on the developed scaffolds against MG 63 osteoblasts like cells shows excellent compatibility (80 %). The mechanical and biocompatible study on these hybrid composite scaffolds shows promising results for hard tissue engineering applications. Thus, the proposed work confirmed the formation of reliable and biocompatible hybrid composite scaffolds for biomedical applications, especially, hard tissue engineering applications.