Abstract

Recent developments in the design of bone replacement materials have been directed towards the use of materials which allow bone to grow and attach onto their surface. Hydroxyapatite (HA) shows this characteristic and has been extensively used in biomedical applications. However, HA is a fairly inert material when compared to Bioglasses, and is limited to low load applications due to its inadequate mechanical properties. Therefore, there is a need to improve the mechanical properties of HA, and to develop composites which can behave between a fairly inert to a totally degradable biomaterial. According to K. De Groot et al "the aim is to produce a composite material out of HA+Bioactive glass, via a simple sintering process in a dense form" (1).

This thesis describes the reinforcement of HA by soluble phosphate glasses chemically related to its composition, and Bioglass®, through a sintering process. Three phosphate based glasses were fabricated, based on J. Burnie's work (2). These glasses differ fundamentally from conventional glasses in that they are not based on silicates but instead have a network forming structure composed of phosphates into which can be incorporated almost any inorganic element. Their chemical composition can be closely approximated to the inorganic constituent of bone. Bioglass® was obtained from Bioglass® Research Centre, University of Florida.

Dense HA-phosphate glass composites could be fabricated, showing a large improvement in mechanical properties relatively to those of HA. A brief literature survey is initially presented, concerning chemical, physical and mechanical characteristics of natural and synthetic materials with a summary of the conventional techniques to produce and mechanically test dense HA. In the experimental part, HA starting powder and dense HA samples are firstly characterised, with the final part being focused on the glass and HA-composites fabrication techniques. Discussion and conclusions are oriented towards the biomedical applications of these materials.

These composites have shown to be of great interest, and a British Patent was claimed under the control of "Interdisciplinary Research Centre (IRC) in Biomedical Materials", Queen Mary & Westfield College, University of London, where all the experimetal work was developed: "Densified Hydroxyapatite", by the authors, J. D. Santos, J. C. Knowles, G. W. Hastings, W. Bonfield, British Patent Nº 9213774.4 filed on 29th June 1992. Publications were also made based on parts of this work and are enclosed as annexes.