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CHARACTERISATION OF HYDROXYAPATITE AND SUBSTITUTED-HYDROXYAPATITES FOR BONE GRAFTING

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ABSTRACT:
Currently, autografts and allografts are the preferred choice of bone grafting materials, with synthetic materials representing only a small percentage of the total number of procedures. Although, hydroxyapatite has received significant attention as a synthetic bone substitute material, its clinical use has been limited. Specific disadvantages encountered with hydroxyapatite bone grafts include poor mechanical properties and unpredictable rates of osseointegration compared to autografts and allografts. A number of factors such as phase purity, ionic purity, crystallinity and microstructure have been reported to influence the solubility and bioactivity of hydroxyapatite ceramics, yet in many *in vitro* and *in vivo* studies of hydroxyapatite, these properties are not reported. Recent studies at improving the bioactivity of hydroxyapatite implants have focussed on the substitution of physiologically relevant ions into the hydroxyapatite lattice. In particular, the substitution of carbonate and silicate ions has been reported to significantly enhance the bioactivity of hydroxyapatite implants, however the mechanisms by which these substituted ions enhance the bioactivity of hydroxyapatite are not fully understood. It is accepted however, that a clear knowledge of the chemical and physical properties of these materials remains an important precursor step to a systematic understanding of the inherent bioactivity of hydroxyapatite and substituted hydroxyapatite implants. The aim of this paper is to provide a review on some of the chemical, physical and biological properties of HA, with particular emphasis on carbonate-substituted and silicate-substituted HA ceramics.

KEYWORDS: Hydroxyapatite, carbonate-substituted hydroxyapatite, silicate-substituted hydroxyapatite, chemical characterisation, physical characterisation, *in vivo* bioactivity.

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PRINCIPLES OF DESIGN AND SYNTHESIS OF IRON OXIDE MAGNETIC NANOPARTICLES FOR BIOMEDICAL APPLICATIONS

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ABSTRACT:

Nanoparticles of magnetic materials exhibit magnetic properties significantly different from those exhibited by bulk samples of the same materials. Some of these magnetic properties, in particular the combination of high magnetic susceptibility with low magnetic remanence, enable the particles to be manipulated by external fields and to be sensed remotely thus making them suitable for technological applications. By preparing the particles with suitable surface coatings, biocompatible magnetic colloidal suspensions can be synthesised that have potential for biomedical and biotechnological applications. Principles of design and synthesis of iron oxide based nanoparticulate colloids are reviewed with particular reference to optimisation of the magnetic properties, and chemical and structural stability of the particles. Suspensions of such particles have potential in cell and biomolecular separations, magnetic resonance imaging contrast agents, magnetically targeted drug delivery, magnetic labeling of cells, and magnetic hyperthermia therapy.

KEYWORDS: iron oxide nanoparticles, synthesis, stabilization, nano-scale magnetism, biomedical applications.

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$BaTiO_3$-COATED TiO_2 WORKING ELECTRODES FOR USE IN DYE-SENSITISED SOLAR CELLS

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ABSTRACT:
Nanostructured TiO_2 working electrodes were coated with thin films of $BaTiO_3$ using the sol-gel technique. These core-shell electrodes were made and compared against the control samples (bare TiO_2). The electrodes were characterized using scanning electron microscopy (SEM), energy dispersive X-ray Spectroscopy (EDX), powder X-ray diffraction (XRD), X-ray photoelectron spectroscopy and used in the construction of dye-sensitised solar cells (DSSCs). It was found that all the $BaTiO_3$-coated samples resulted in an increase in the open circuit voltage (V_{oc}) from 735mV to 818mV. However, the short circuit current (J_{sc}) was lower than the control samples with a decrease from 5.6mAcm^{-2} to 4.3mAcm^{-2}. The combination of these changes resulted in a decrease in efficiency from 2.6% to 2.3%. However, when a 2.45GHz microwave heat treatment was used instead of the conventional heat treatment the efficiency rose back up to 2.5%. This increase was due to a further increase in the V_{oc} up to 823mV but still a lower current.

KEYWORDS: Core-shell nanostructure, TiO_2 working electrodes, barium titanate, dye-sensitised solar cells, electrode post-treatment.

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THE EFFECTS OF THE RATE OF KILN FIRING ON CRYSTAL DEVELOPMENT IN HIGH-TEMPERATURE CERAMIC GLAZES

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INTRODUCTION

International interest in crystalline glazes was rekindled in the 1980s when significant increases in kiln technology occurred which allowed studio potters and ceramic artists access to these developments. This was linked with a search for a new individuality of expression, especially as many of the once-treasured and beautiful Chinese celadons, chuns, hare's fur, ox-blood and oil spot glazes were available within the grasp of every virtually every potter via the internet. For ceramicists however, there is more to a glaze than a recipe, and factors such as the clay body, thickness of glaze application and the type of kiln and firing conditions, fuel used and kiln atmosphere are as important as the glaze recipe itself in achieving a certain glaze quality.

This paper examines aspects of the kiln and firing procedures that affect the growth of crystals in high-temperature glazes. In particular, it addresses the influence of the glaze recipe and firing cycle on crystal development and ways to manipulate these to develop a desired technical and aesthetic outcome.

KEYWORDS: kiln, glazes, crystalline, high-temperature.

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NEUTRON DIFFRACTION COMPARISON OF BONE DERIVED AND SYNTHETIC HYDROXYAPATITE

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ABSTRACT
This paper reports neutron diffraction data and its analysis of bone derived hydroxyapatite and synthetic hydroxyapatite (HAp). FTIR spectroscopy showed a number of changes in the bone derived hydroxyapatite as a function of temperature, and that firing at 600°C provides an increased crystallinity without decomposition of the HAp. The neutron diffraction data has elucidated the crystal structure of both materials, and enabled the positions of the hydrogen atoms to be accurately determined, and the lattice parameters to be compared. The only noticeable difference was a slight reduction in the lattice parameter *a*, and an increase in *c* in the bone derived HAp material. This can be attributed to the residual carbonate phase. The data also shows the improvement of crystallinity of the bovine bone during the heat treatment process.

KEYWORDS: bovine bone, hydroxyapatite, neutron diffraction, bioceramic.

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MECHANICAL PROPERTY DEVELOPMENT IN ISOTHERMALLY SINTERED MECHANICAL BLENDS OF HYDROXYAPATITE AND FLUORAPATITE

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ABSTRACT

Hydroxyapatite and fluorapatite have been known to co-exist in the skeletal system making the resultant apatitic assembly as a potential biomaterial for bone regeneration and growth. Development of the mechanical properties of mechanical assemblies of hydroxyapatite and fluorapatite sintered at 1200°C and 1250°C for different sintering times were investigated. The study was focussed on two main compositions of the mechanical assemblies of hydroxyapatite blended with 60 and 80 wt% fluorapatite. The microstructural characteristics such as density and grain size were determined prior to investigation of hardness, elastic modulus, fracture toughness and brittleness from indentations. Increase in sintering time and temperature is associated with an exponential increase in density, hardness, elastic modulus and brittleness. The increase in mobility of the fluoride and hydroxyl ions into the adjacent crystallites results in an increase in the densification and an associated increase in the hardness, elastic modulus and brittleness of the sintered blend. Fracture toughness increases with the porosity and fluorapatite content of the sintered mechanical blend.

KEYWORDS: fluorapatite, isothermal sintering, mechanical properties, biomedical application, hardness.