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Synthesis of nano $CaCO_3$ and hydroxyapatite by sol-gel methods, on spores and in 3D-printed Ca^{2+}-crosslinked PVA hydrogels and their use in bone regeneration

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Some have used sol-gel synthesis to give injectable hydroxyapatite (HAp) nanoparticles (NPs) using aqueous solutions of $Ca(CH_3COO)^2.2H_2O$ to which was added 1,2-ethandiol, chelator ethylenediaminetetraacetic acid (EDTA), triethanolamine and then Na_2HPO_4 that could be spin- or dip-coated on various substrates . Others suggest that inorganic-organic combinations are better for initiating bone replacement treatments. Some have chosen HAp deposited on bacterial-cellulose, but that required cellulose treatment with citrate ions to increase Ca^{2+} take-up and even then the product had a low (1.2) Ca:P ratio. Here we compare HAp that is 1. sol-gel-derived nanoparticles (NPs). 2. generated on the surface of organic harvested Portobello mushroom spores (PMS); after PMS washing in water and then acetone, they were infiltrated with 5 mL (55mM) $CaCl_2$ solution for 1h with stirring at 310K to give Ca^{+2}/PMS, filtered, dried, and then infiltrated with a 55mM Na_2CO_3 to give $CaCO_3$/PMS and finally with a 13mM Na_2HPO_4 to give HAp/PMS with Ca:P=1.7. 3. ultrasonically removed from the surface of the HAp/PMS and is then dip- or spin-coated onto a range of substrates. 4. produced in 3D printed PVA hydrogels that are pre-crosslinked by Ca^{2+} [4,5] and then converted to HAp/PVA by alternate infiltration with aqueous solutions (120mM) of Na_2HPO_4 and $CaCl_2$ at pH=7.4 and 310K [6]. Product HAp was characterized by FTIR (where peaks at 873cm^{-1} (vibration stretching mode of P-O) and 559 and 433 cm^{-1} (vibration bending mode of O-P-O in the PO_3^{-3} were seen), Raman, TEM, SEM-EDX (Ca:P), XRD and TGA-DSC and biocompatibility with body fluids and enhancement of bone growth with improved mechanical properties. The wider opportunities for nanomaterials synthesis using bio templates and 3D printed PVA hydrogels are considered.

Biography

Professor Paul A. Sermon was born in Caversham in 1945. He was educated at Westminster City School, Bangor University and University of Bristol (PhD, DSc). He was Professor of Physical Chemistry at the University of Surrey, where his research concentrated on bottom-up nanotechnological routes to catalysts, sensors and biofuels, until the autumn of 2010. He then became Professor of Nanomaterials at the Wolfson Materials Processing Centre in 2011. His research is now focused in nanomaterials and biomimetic nanomaterials with useful forensic, catalytic and photocatalytic properties. This research is supported by Government Agencies and the Royal Society. On Thursday 10th November 2011 at a dinner at the Royal Society, it was announced that he was a recipient of a Royal Society Brian Mercer Feasibility Award.

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