ABSTRACT SUBMISSION

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Carbon fiber cloth/Calcium-deficient hydroxyapatite: a new bone bandage

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ABSTRACT

Due to their multi-scale organization, breathability and biocompatibility, carbon fiber cloth (CFC) are considered as tissue engineering. However, their poor biological activity limits their extensive use in medical applications and therefore needs to be enhanced. Conversely, owing to high bioactivity, osteoconductivity and biocompatibility, calcium phosphate (CaP) ceramics have received much attention and are clinically employed either as coating or as scaffold in orthopaedics. In this field, CaP-coated carbon fiber cloth appears as promising bioceramic materials for bone repair and regeneration.

In this work, coatings of CaP or strontium-substituted calcium phosphate (Sr-CaP) on CFC are obtained by sono-electrodeposition process using cathodic polarization. It is shown that the current density applied or the constant potential play on the CaP characteristics: amount, microtexture, structure and chemical composition. Structural and physicochemical characterizations show that the CaP coatings consist, -at low current densities, in a mixture of octocalcium phosphate (OCP) and plate-like carbonated calcium-deficient hydroxyapatite (CDA) phases; - at intermediate current densities, in a mixture of plate-like and needle-like carbonated CDA phases; - at high current densities, in a mixture of needle-like carbonated CDA with calcium carbonate phases, and, - at constant potential (-1V), in plate-like carbonated CDA phases. ^{1}H and ^{31}P MAS NMR experiments showed that the CaP particles are composed of an ordered and carbonated CDA core associated with a disordered and hydrated surface layer. These hydrated and carbonated CaP particles are highly biomimetic. It is emphasized that the deposition mechanism depends on the water electrolysis rate. Therefore, sono-electrodeposition is a versatile process allowing tuning the microtexture of the CaP coatings, thereby bringing new insights in the development of such biomaterials for bone repair [1].

In vitro biological tests were performed in using primary human osteoblasts. They highlighted the cell viability, especially on xSr-CaP biomaterials [2]. Indeed, a strong interaction with cells and an increase of cell density and proliferation is emphasized with an increase of strontium in the CDA structure, pointing out that Sr^{2+} promotes osteoblast activity [3]. For *in vivo* biological tests, a bone defect was performed on thighbones of rats. The application of our CDA/ CFC biomaterials on the bone defect showed a major acceleration of the bone regeneration, in particular for xSr-CaP/CFC biomaterials, validating their potential as bioactive materials for bone regeneration. The adorption of drugs (tetracycline, naproxen, aspirin) in each component of the biomaterials was also studied, providing new medical properties to the hybrid biomaterials.

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