Biomimetic strontium-substituted hydroxyapatite deposited on carbon fiber scaffold for bone regeneration

Olivier, F[1], Picard, Q[1], Delpeux, S[1], Chancolon, J[1], Warmont, F[1], Sarou-Kanian, V[2], Fayon, F[2], Drouet, C[3], Rochet, N[4], ***Bonnamy, S[1]***

[1]ICMN UMR 7374, CNRS, Univ. Orléans, France
[2]CEMHTI UPR 3079, CNRS, Univ. Orléans, France
[3]CIRIMAT, CNRS, INPT, UPS, ENSIACET, Univ. Toulouse, France
[4] Institut de Biologie Valrose, CNRS, INSERM, Nice, France

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ABSTRACT:
Due to their multi-scale organization, breathability and biocompatibility, carbon fiber cloths (CFC) are provided for use in tissue engineering. Conversely, owing to high bioactivity, osteoconductivity and biocompatibility, calcium phosphate (CaP) ceramics have received much attention and are clinically employed as coating or as scaffold in orthopaedics. Therefore, CaP-coated carbon fiber scaffolds are promising bioceramic materials for use in the field of bone regeneration. In this work, CaP and Sr-doped CaP coatings were deposited on carbon cloth by sono-electrodeposition process using cathodic polarization. FTIR, XRD, HRTEM, SEM and ^{1}H, ^{31}P MAS NMR were performed to characterize CaP deposits. Three main types of deposits were obtained through variation of electrochemical parameters. At low current densities and at constant potential (-1V) the deposit consists in a biomimetic plate-like carbonated calcium-deficient hydroxyapatite (CDA), while at higher current densities the synthesis leads to needle-like carbonated CDA. At intermediate current density, a mixture of the two morphologies is deposited. CaP characteristics have shown that the coating mechanism is linked to the water electrolysis rate. This establishes that sono-electrodeposition is a versatile process allowing tuning the morphology of the CaP coatings. Biological tests through *in vitro* osteoblast culture evidenced the cell viability on hybrid materials. For *in vivo* biological tests, a bone defect was created on femur of rats. The setting of our CaP/CFC biomaterials on the bone defect showed a major acceleration of the bone regeneration. Furthermore, drugs can be introduced in each component of the CaP/CFC biomaterials accounting for new medical properties.