Injectable peptidic hydrogels for bone tissue repair and regeneration

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The ongoing growth in the incidence of bone injuries and diseases is producing an increment in the demand of medical and healthcare resources, with an urgent need to identify suitable alternatives to current common clinical treatments. In this context, bone tissue engineering is part of an emerging interdisciplinary field that applies the principles of engineering and life sciences towards the development of biological substitutes. Peptide hydrogels may be used in this context as biocompatible and biodegradable materials suitable for cell encapsulation and for the controlled spatial and temporal delivery of biomolecules (e.g. growth factors) able to direct cell differentiation.

Recently, we developed an enzymatic approach for the preparation of injectable, self-assembling materials based on Fmoc-oligopeptides[1]. The reaction products (Fmoc peptides) spontaneously self-assemble in water to originate fibrils, that become entangled to form a three-dimensional structure of fibers with a diameter of approximately 7 nm, as evidenced by atomic force microscopy (AFM) measurements. Macroscopically, a stable, self-supporting hydrogel material is produced. These materials can be used as controlled drug delivery systems for a wide spectrum of bioactive molecules[2] and may enhance cell production of growth factors[3]. Our results suggest the possibility of using Fmoc oligopetides as building blocks for a new class of injectable scaffolds that could play an important role in bone regeneration, i.e. to reconstruct anatomical defects caused by cancer surgery, malformations and trauma. We employed such hydrogels for the preparation of composite materials specifically designed for bone tissue regeneration. These tailor-made hydrogel systems contain biopolymeric spheres delivering bioactive molecules, as well as pure and substituted calcium phosphate (CaP) nanoparticles to provide bioactivity, osteoconductivity and improved mechanical properties. The morphological and viscoelastic properties of the synthesized hydrogels were investigated and their biocompatibility with different mammalian cells was assessed. Ongoing work is aimed at investigating the biological properties of the composite hydrogel systems, in terms of adhesion, growth and differentiation of human mesenchymal stem cells.

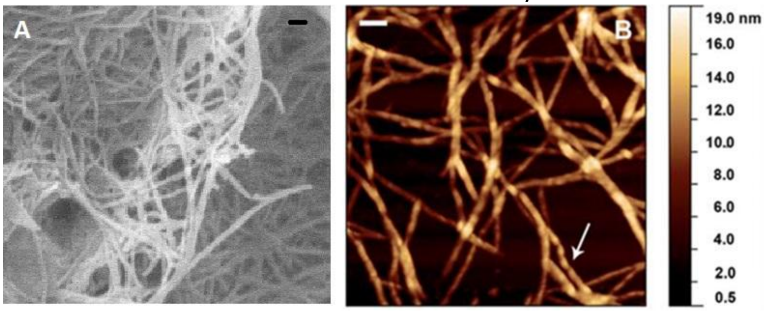

Fig.1 SEM (A) and AFM (B) images of Fmoc-Phe_3 hydrogels. Scale bars = 100 nm.

[1] L. Chronopoulou et al. *Soft Matter,* 2010, **6**, 2525.
[2] L. Chronopoulou et al. Soft Matter, 2014, **10**, 1944.
[3] L. Chronopoulou et al. *Soft Matter*, 2012, **8**, 5784.