DEVELOPMENT AND CHARACTERIZATION OF INNOVATIVE PCL-BASED COMPOSITES FOR BONE TISSUE REGENERATION

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ABSTRACT

Poly-ε-caprolactone-based materials are widely investigated for bone regeneration techniques, because of interesting properties of PCL, such as degradability and biocompatibility. For bone repair applications, PCL has been reinforced with phosphate glass fibres, for use as fracture fixation pins, and applied in tissue engineered constructs for craniofacial repair. PCL-based composites are widely reported in literature, in particular composites with hydroxyapatite (HA), which is the natural occurring mineral phase of bone. The limitation of PCL is its hydrophobicity, which prevents good interfacial adhesion and dispersion of inorganic filler. It is possible to lower polymer hydrophobicity by inserting polar groups onto the chain backbone in a controlled amount. In this work, PCL was modified by N-dimethylamino-ethyl acrylate (PCL-DMAEA) and glycidyl methacrylate/maleic anhydride (PCL-MAGMA) and HA/functionalised PCL composites were prepared in form of microporous membranes, by solvent-non solvent phase inversion methodology. The morphology of membranes, obtained with either the plain polymers or their composites, were investigated by Scanning Electron Microscopy (SEM) (Fig.1).

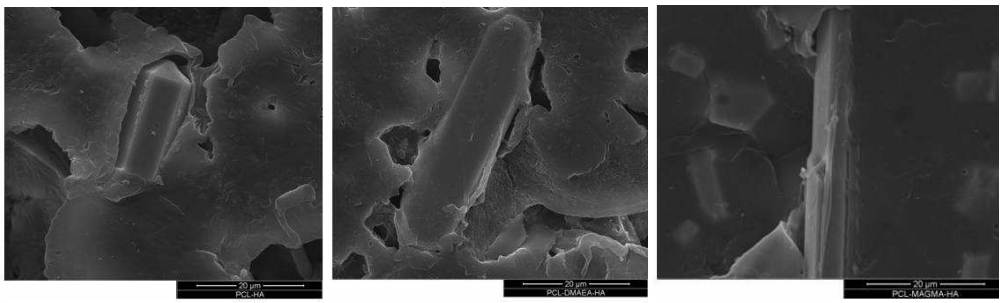

Fig. 1: SEM micrographs of PCL composite membranes

HA particles are uncoated and detached from the matrix in the case of PCL composite, while a polymer coating on their surface is evident in functionalised PCL composites. The influence of HA on hydrophilicity, mechanical properties and *in vitro* degradation kinetics of plain and functionalised PCL was evaluated. To assess hydrophilicity, static contact angle measurements were performed on neat polymers and composites. Functionalised PCLs were more hydrophilic than neat PCL, as a result of the presence of amino and carboxylic groups. On the other hand, the addition of HA reduces hydrophilicity of functionalized PCL composites. Polymer and composite degradation was evaluated over a 12-month period by soaking samples in PBS. Thermal properties, swelling, weight loss and molecular weight decrease were evaluated, during the degradation. The different hydrophilicities and morphologies, found for the polymers and composites, cause different degradation behaviors for the materials, as a function of their ability to hydrate in the degradation medium. Even mechanical parameters (e.g. Young modulus) are affected by the functionalization and by the presence of HA nanoparticles. Upon HA addition, Young modulus slightly increases for PCL and PCL-DMAEA matrices, while in the case of PCL-MAGMA it strongly decreases, because of the addition of inorganic nanoparticles which break the dense structure of PCL-MAGMA.