BACTERIAL CELLULOSE - HYDROXYAPATITE COMPOSITES DECORATED WITH SILVER NANOPARTICLES FOR MEDICAL APPLICATIONS

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Introduction

Bacterial cellulose (BC) is a natural biopolymer with excellent properties, which recommend it as a component in a broad range of organic or hybrid composites [1], as well as a template in the synthesis of nanostructures with tunable properties [2].

Hydroxyapatite (HA) is a mineral phase widely used for medical applications that require both suitable mechanical properties and remarkable biological response when integrated in living bodies; it is approached either for repairing/replacing damaged hard tissues [3] or as bioactive coating on inert implants [4].

Metallic silver (MA) nanoparticles are considered a promising antibacterial agent, being frequently employed for the optimization of implants behaviour in terms of infection prevention [5,6].

In this context, complex composites based on BC membranes, HA phase and MA nanoparticles were produced by two different routes and subsequently characterized in order to demonstrate the potential of such materials to be integrated in the clinical use for hard tissue engineering.

Materials and Methods

The composite samples were synthesized by two different routes. The first one involves the mechanical mixing of blended BC membranes, laboratory synthesized HA powder and MA nanoparticles aqueous suspension. The second one implies the *in situ* deposition of HA phase on the blended BC membranes by immersion in precursor solution containing calcium and phosphate ions, as well as the addition of MA nanoparticles, followed by homogenisation. The weight ratio between BC and HA was set at 1:1, while MA loading was varied: 1, 2 and 5 wt% reported to the other two constituents. All masses were subjected to a freeze-drying procedure in order to preserve a porous *3D* structure.

The specimens were investigated from compositional, structural and morphological point of view through X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM) coupled with energy-dispersive X-ray spectroscopy EDX.

Results and Discussion

BC membranes with fibrillar and spongy appearance (FIG. 1) were obtained with the help of *Acetobacter* sp. strain isolated from traditionally fermented apple vinegar, purified in basic medium, thoroughly washed and then used for both synthesis routes in the blended form.

The preliminary preparation of HA powder and MA nanoparticles in the first case, as well as HA phase *in situ* deposition in the second one were proved through the presence of specific peaks in the XRD patterns. FTIR spectroscopy was approached so as to assess the possible chemical interactions established at the interface between the three components.

FIG. 2 presents the microstructure of one of the final composites, demonstrating the strong adhesion of the mineral and metallic phases to the BC fibres. In addition, the EDX spectra allowed homogeneity to be ascertained throughout the entire sample volume.

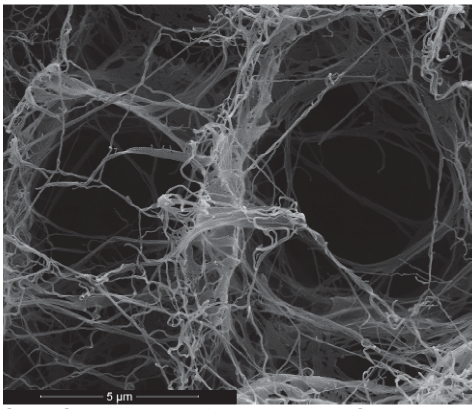

FIG. 1. SEM image of lyophilized BC membrane.

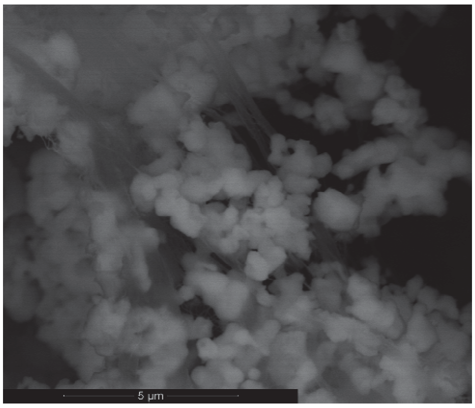

FIG. 2. SEM image of lyophilized BC membrane loaded with two inorganic phases.

Conclusions

Composite materials containing BC, HA and MA were successfully obtained by two straightforward methods. Such biomaterials, achieved by employing low cost precursors, represent important candidates for the development of bone scaffolds with antibacterial properties.

Acknowledgments

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