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Nanofibrous electrical conductive polymer composites of bacterial cellulose and polypyrrole

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Abstract – This work reports on the preparation of conductive fiber composite composed of bacterial cellulose (BC) coated with conducting polypyrrole (PPy) that can be used in tissue engineering applications. Process parameters for the preparation of BC/PPy composites in aqueous solution through *in situ* oxidative polymerization on the BC fibers were evaluated;physico-chemical properties and the microstructure of the conducting BC were analyzed and compared with PPy prepared by chemical method.

During the last decade modification of electrical properties on cellulosic fibers by conducting polymers to obtain specialized functional properties has attracted great interest [1]. Conductive nanofibers and the use of conducting polymers such as polypyrrole (PPy) supported onto textile surfaces, acting as an active interface for tissue engineering, may be used to regulate cell activity through electrical stimulations [2]. PPy is a conducting polymer that exhibits high electrical conductivity and appreciable environmental stability [2]. Bacterial cellulose (BC) is composed by glucose molecules joined by β(1→4)-glycosidic bonds forming branchless linear chains that comprise microfibrils with a wide range of dimensions (< 100 nm in width) (Figure 1). Due to its unique properties and microarchitecture, BC has currently being investigated for biomedical applications, such as wound dressings, and for tissue regeneration [3-5]. In this work, bacterial cellulose was chemically coated with conducting polypyrrole. Bacterial cellulose membranes were immersed in an aqueous solution of dodecylbenzenesulfonic acid (DBSAt) as surfactant and pyrrole monomer (Py), and ammonium persulfate (APS) as an oxidant agent was added. The monomer:surfactant:dopant mol ratio was 2:1:0.2. The chemical oxidative polymerization was carried out at room temperature using different reaction times (from 0.5 to 6 h) and Py concentrations (from 0.1 to 0.5 mol/L). After polymerization the membranes were thoroughly washed with water in order to remove the polymer excess. The microstructure of the chemically coated BC membrane surfaces is characterized by a uniform, homogenous coating of PPy on the cellulose microfibrils (Figure 2). BC membranes coated with PPy exhibit electrical conductivity in the range of 6.8 x 10^{-2} to 2.1 ×10^{-2} S·cm^{-1}, which lies in the same range of pure PPy [1]. The X-ray diffraction (XRD) pattern of the surface of the bacterial cellulose membrane whit coated PPy is shown in Figure 3, where two main peaks can be identified, which were assigned to the (110) and (200) planes of cellulose I. The results revealed a high affinity of PPy for bacterial cellulose. The unique properties of BC combined with the conductive properties of PPy may be interesting for tissue engineering applications that require electrical conductivity.

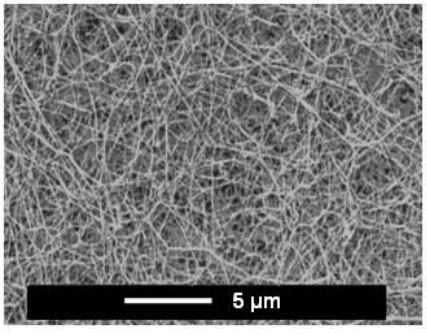

Figure 1: SEM micrograph of BC fibers.

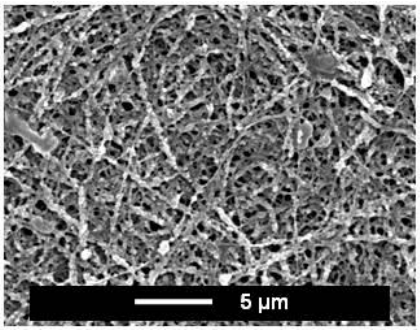

Figure 2: SEM micrograph of BC fibers coated with PPy.

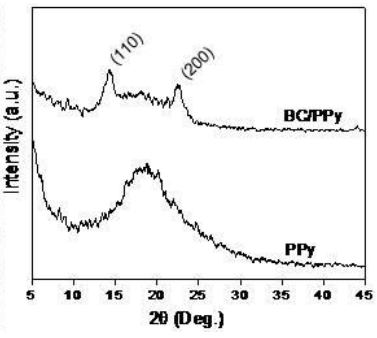

Figure 3: XRD patterns of BC membrane and BC coated with PPy.

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