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CHARACTERIZATION OF THE STRUCTURAL, THERMAL, MECHANICAL AND ELECTRICAL PROPERTIES OF BACTERIAL CELLULOSE

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KEYWORDS

Bacterial Cellulose (BC), water desorption, mechanical properties, electrical properties

INTRODUCTION

Although chemically similar to plant cellulose, bacterial cellulose (BC) produced by Gluconoacetobacter xylinum, a strict aerobe bacteria, is chemically pure, as is deprived of non-cellulosic polysaccharides (Jonas *et al.*, 1998; Vandamme *et al.*, 1998; Klemm *et al.*, 2001; Amano, *et al.*, 2005; Helenius *et al.*, 2006). Its unique properties include high water holding capacity, high crystallinity, ultrafine fiber network, high tensile strength in the wet state, the ability to be shaped into 3D structures during synthesis (in-situ moldability) and excellent shape retention (Klemm *et al.*, 2001; Helenius *et al.*, 2006).

The unique properties provided by the nanomeric structure of BC offer a wide range of applications such as in the human and veterinary medicine, odonthology, pharmaceutical industry, acoustic and filter membranes, biotechnological devices and in the food and paper industry.

This work is focused on the production and characterization of bacterial cellulose from *Gluconoacetobacter xylinus* (ATCC 53582 and ATCC 10245 strains) concerning its structural, thermal, mechanical, electrical and morphological properties.

MATERIALS AND METHODS

The BC pellicles were produced in static and purified with NaOH.

The FTIR transmission spectra were obtained between 650 cm^{-1} and 4000 cm^{-1}, with 16 scans.

Thermogravimetric analyses (TGA) were done using scanning temperatures between 35 ºC and 400 ºC, using a heating rate of 10 ºC/min.

Isothermal tests were performed at 27 ºC, 34 ºC, 40 ºC and 60 ºC.

Dynamic Mechanical Analysis (DMA) tests were performed in tension mode. The values obtained for the tan (δ) were calculated by the following expression:

$$\tan(\delta) = \frac{E''}{E'}$$

where:

tan (δ) is the damping, E' (MPa) is the elastic modulus and E'' (MPa) is the loss modulus.

The measurements of the dielectric constant were performed with frequencies were between 20 Hz and 1 MHz. and the temperatures between -30ºC and 80ºC, using a heating rate of 2ºC/min. The applied voltage was 1 V.

The measurements were done in volume with rectangular electrodes. In these tests, only freeze dried samples were used.

Further, the effect of lyophilisation on the above-mentioned properties of BC pellicles was evaluated.

RESULTS AND DISCUSSION

The FTIR analysis of the non-freeze dried BC evidenced two main peaks, 1162 cm^{-1} that corresponds to C_1OC_4 and 3400 cm^{-1} that corresponds to the hydroxyl groups displacement of the bands, as recorded in an other study (Surma-Slusarska *et al.*, 2008). Following freeze drying an intensive peak near 1490 cm^{-1} was evidenced.

The TGA analysis showed that the non-freeze dried BC lost of 95% of its weight by the effect of temperature. This variation in the mass of the sample in due to the lost of the water bound to the fibers surface. The isothermal analysis made by TGA suggested that desorption present in the BC pellicle is linearly dependent on the temperature.

The frequency and temperature dependence of the elastic modulus obtained by DMA and also the high capacity to recover energy of freeze dried BC, which is evidenced by its very low damping value. This mechanical analysis also suggests that the water present in pellicle has a plasticization effect on the mechanical properties that is suggested by the fact that the freeze dried BC has a bigger elastic modulus.

The value obtained for the dielectric for a frequency of 1 KHz and 80ºC constant was 60. The determined dielectric constant is frequency dependent but does not show significant temperature dependence.

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