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Cotton Cellulose Whiskers Functionalized With Silver Nanoparticles

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Extended Abstract

The use of waste from agriculture in several areas of research can reduce the cost of manufactured products, besides promoting a rationalized destination for the wastes. Cotton fibers have high cellulose and low lignin contents, which make them a rich source of cellulosic nanostructures. Such nanostructures can be obtained by a controlled acid hydrolysis of fibers, yielding nanofibers with rod-like shape, also called *whiskers*. Such whiskers present appealing properties such high crystallinity, high surface area and outstanding mechanical properties (Eichhorn, 2011). Nanocomposites of cellulose combined with other architectures have recently been studied and applied as reinforcement to polymers, thin films to sensors, gels and biodegradable and biocompatibles materials. On the other hand, metal nanoparticles based on gold, copper and silver have attracted great attention in catalysis and sensing applications as a function their electronic, optical and antimicrobial properties (Shin et al., 2008). In this study,we combined both materials (metal nanoparticles and cellulose whiskers) to supply electrical conductivity to cellulose. Cotton cellulose whiskers (CCW) were obtained from acid hydrolysis of cotton fibers (5,0 g) with 60 wt% H_2SO_4 at 45°C, under mechanical stirring for 75 minutes. The aqueous suspension was neutralized by dialysis and then ultrasonicated for 5 minutes. The nanocomposite CCW/Ag was prepared under reflux with addition of 200 mL of AgNO3aqueous solution (1.0 x 10^{-3}mol.L^{-1}), 20 mL of CCW aqueous suspension (5 g.L^{-1}) and 4 mL of trisodium citrate (1.0 x 10^{-1} mol.L^{-1}). The reaction system was stirred during 40 minutes.The presence of silver nanoparticles in the colloidal suspensions was investigated by ultraviolet-visible (UV–Vis) spectroscopy, which allows monitoring the absorption band at λ = 400 nm, from the Surface Plasmon Resonance (SPR) of silver nanoparticles (Krutyakov et al., 2008). The morphologies of CCW were investigated by STEM microscopy, and revealed the formation of elongated nanocrystals, with high aspect ratio (L/d). This rod-like morphology is typical of nanostructured cellulose obtained from hydrolysis with strong acids. The average dimensions found to CCW were 184 ± 32 nm for length, and 15 ±3 nm for diameter. The morphology of CCW/Ag nanocomposite was investigated by FEG-SEM microscopy, what revealed CCW clusters decorated with well-dispersed Ag nanoparticles, with average diameters of 21 ± 6 nm. Two main features contributed to the efficient silver nanoparticle adsorption and dispersion: i) The hydroxyl groups on the CCW surface, which allows the interaction and strong ability to adsorb silver ions (LIU et al., 2011) on its surface, and ii) the sulfuric acid treatment, which allows the incorporation of sulfate esters with negative charge, enhancing the ability of CCW surface to incorporate silver nanoparticles. Such cellulose nanofibers incorporated with silver nanoparticles can be used as active layer in modified-electrode chemical sensors.

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