Conductive properties of hybrid TiO_2/bacterial cellulose fibres by electrostatic force microscopy

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Nowadays new research area focused on hybrid inorganic/organic fibres materials based on bacterial cellulose and inorganic nanoparticles paid attention of many researches. It is well known that homogeneously dispersed nanoscale inorganic particles in a polymer matrix improve the mechanical properties of the resulting nanocomposites. Hybrid materials containing metal or semiconductor nanoparticles are interesting from the point of view of nanotechnology due to inorganic-organic composites gather together typical advantages of organic polymers like flexibility, formability, toughness with the ones displayed by typical inorganic nanoparticles like optical, magnetic and electrical properties, luminescence, ionic conductivity and selectivity, as well as chemical or biochemical activity.

Instead of the typical polymeric matrix we propose bacterial cellulose to be used as template for preparation of novel hybrid inorganic-organic composites. Bacterial cellulose can be produced by Gram-negative, acetic acid bacteria *Gluconobacter xylinus*. The formation of cellulose by laboratory bacterial cultures is an interesting and attractive biomimetic access to obtain pure cellulose with excellent properties such as good biocompatibility, high tensile strength, high water retention capability, high hydrophilicity and high crystallinity. Additionally, the chance to obtain cellulose by laboratory bacterial cultures allow us to control the molar mass, molar mass distribution and the supramolecular structure by selecting the substrates, cultivation conditions, various additives, and finally the bacterial strain.

In this work, we used sol-gel method to synthesize titanium dioxide (TiO_2) nanoparticles based on titanium isopropoxide precursor. It should be pointed out, that a good-dispersion of nanoparticles is the key issue to take fully advantage of nanoparticles. From this point of view it is essential to develop a processing method to uniformly disperse nanoparticles in the polymer matrices with high particle loadings in order to maximize their effects. The sol-gel method allows the preparation of hybrid inorganic/organic materials due to the in-situ generation of inorganic particles, which are uniformly dispersed at the nanometer scale as a result of hydrogen or covalent bonds. Thus, using titanium isopropoxide as sol-gel precursor, inorganic network having hydroxyl groups on the surface can be generated. These inorganic networks surrounded by hydroxyl groups can interact with hydrophilic bacterial cellulose.

The aim of the present work was focused on the study of the conductive properties of both bacterial cellulose and generated hybrid TiO_2/BC fibres by electrostatic force microscopy (EFM) measurements. This technique allows to measuring qualitatively the electric field gradient distribution above the sample surface, which consequently allows distinguishing different conductive parts of the sample. Different voltages have been applied to check conductive properties of designed systems. Additionally, the influence of the sign (positive or negative) of the applied voltage on the response of the samples has been also investigated.

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