Abstract

In this work, we present a study of water dynamics in the case of hydrated Bacterial Cellulose (BC) over a wide range of compositions. BC, also known as Microbial Cellulose, is an organic compound [$(C_6H_{10}O_5)_n$], which is produced by some types of bacteria and subjects to polysaccharides. The main experimental techniques employed are Differential Scanning Calorimetry (DSC), Dielectric Relaxation Spectroscopy (DRS), and Thermally Stimulated Depolarization Currents (TSDC). Measurements of Equilibrium Sorption Isotherms, also took place at room temperature (RT). BC gels were removed from strained *Gluconacetobacter saccharivorans*. The samples were in the form of films (compressed BC gel) and their hydration was succeeded through immersion in deionized water or through vapor adsorption over saturated solutions of salts in sealed jars. This way, a broad hydration range was achieved from dry films up to 40wt%.

DSC measurements allow us to study the crystallization and melting effects of water, as well as glass transition phenomena. No crystallization effects of water were observed for the dry sample and for water fractions up to 4wt%. Crystallization and melting of water occurs for water fractions from 4wt% up to 40wt%. Two main crystallization peaks of water were recorded during cooling. The first one was detected in the range from 6wt% up to 40wt% with a crystallization temperature T_c ~ -40^{o}C and its crystallization enthalpy is not strongly affected by hydration level increase. A second more pronounced crystallization peak was detected in the range from 8wt% to 40wt% with T_c ~ -20^{o}C. The crystallization enthalpy of this peak increases with water fraction increase. The first peak is attributed to primary forms of ice crystals, while the second to larger ice crystals. During heating, a melting peak centered at about 0^{o}C was detected for all the samples for which crystallization took place during cooling. The glass transition of BC has not been detected for none of the samples.

ESI measurements have shown a hysteresis in desorption, which means that the hydration level of the material during desorption is higher when compared to the respective one during sorption. This fact implies either that hydration induces irreversible conformational changes, or that water molecules are trapped in the network of BC. In addition, a critical water content, namely 0.02 (g of water/g of dry

BC) was estimated, which corresponds to the amount of water molecules which are attached to primary sorption sites and are not entangled in the formation of extended water clusters

Water dynamics has been studied by two dielectric techniques, Broadband Dielectric Spectroscopy (DRS) and Thermally Stimulated Depolarization Currents (TSDC).