Nanocomposites and nanomaterials

The dielectric properties cellulose nanoparticles – water's systems in range 90÷400 K

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Currently, there is interest in the production of bionanocomposite materials with nanosize filling. The usage of cellulose crystallites in the capacity of nanosize additives can significantly strengthen the mechanical properties of the polymer composite and also give it the properties of biodegradation. Nanocellulose (NC) is used as a carrier for pharmaceuticals and biologically active substances, and to produce medical devices.

Cellulose nanocrystals are the rods with the length of 0.1–2 microns and a diameter of 10–40 nm depending on the starting cellulosic material (cotton cellulose for size 0.1–0.2 microns, for cellulose from tunitsin – 1.2 microns). These rod- or needle-like cellulose crystallites usually called "whiskers".

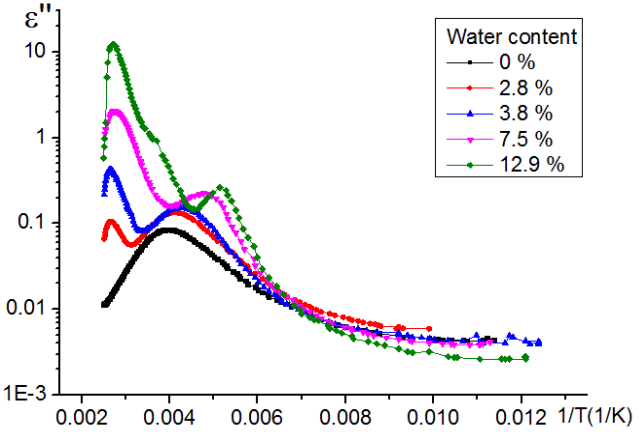

Fig.1 Temperature dependence of dielectric loss factor ε'' (T^{-1}) for NC samples with different water content at a frequency *f*=10kHz.

The literature contains numerous studies of structure, mechanical and thermal properties of NC [1], while the dielectric properties of NC are much less

studied [2]. The aim of our study was to investigate the complex permittivity of samples NC with different water content in the range of temperatures 90÷400 K and at frequencies of 5–50 kHz. The samples NC manufactured by Shin–Etsu Group (Japan) brand Cellets® were used for the study. The measurements were performed on an automated installation using the ac bridge P5083, and the cell allowing to control the thickness of the sample in the measurement process.

At the temperature dependence of ε'' (T^{-1}) relaxation process is observed at low temperatures (observed shift of the maximum ε'' with the frequency) and phase transition at high temperatures (maximum shift is not observed). The change of the water content in the samples leads to a shift of the maximum relaxation to the low temperatures, while the phase transition temperature, however, remains unchanged and the intensity of the transition increases (Fig.1). We assume that both a relaxation process and a phase transition are associated with a change in the molecular mobility in the subsurface areas of NC. The relaxation process is associated with both radical mobility to the surface macromolecules NC and the mobility of water molecules in the hydration shells and water clusters. The phase transition is due to the ordered phase transition swollen in the near-surface areas of NC to the disordered phase.

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1. *Dufresne A.* Nanocellulose: A new ageless bionanomaterial // Materials Today.-2012.-**16**, N 6.-P. 220-227.

2.*El-Anwar I.M., El-Henawii S. A., Salama A. H.* Some dielectric properties of nanosilylated cellulose // IJISR.-2015.-**16**, N 1.-P. 201-209.