THERMAL ANALYSIS OF POLYANILINE AND CELLULOSE/POLYANILINE COMPOSITES SYNTHESIZED IN THE AQUEOUS SOLUTIONS OF ORGANIC ACIDS

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The physicochemical properties of obtained composites and efficiency of deposition of polyaniline (PAn) on cellulose (Cel) surface depends on conditions of the reaction pf chemical oxidative polymerization of aniline (An), namely both the nature of acid-dopant and oxidant, the ratio of monomer/oxidant and An/Cel, temperature of synthesis, degree of dispersion and pre-treatment of Cel etc. Use as dopants the organic acids with different number of carboxylic groups enhances the chemical affinity of components in composites materials of cellulose/polyaniline (Cel/PAn).

An essential characteristic of cellulose-based composites with polyaniline is thermal stability, which determines the range of temperatures on exploitation of such composites, as well as the change of their physicochemical properties with temperature.

Aniline, ammonium peroxydisulfate (APS), formic acid (FA), acetic acid (AA), oxalic acid (OA), citric acid (CA), mixture of bleached microfibrillar pulps, such as Linters (ADM, USA, micro-milled, size 1290 μm, viscosity 37050 mPa·s, degree of polymerization 2050), Biofloc HV (Tembec, Canada, micro-milled 1290 μm, viscosity 24700 mPa·s, degree of polymerization 1400) and Biofloc MV (Tembec, Canada, micro-milled, size 1290 μm, viscosity 10530 mPa·s) with mass ratio (in %) 50.0 : 37.5 : 12.5 and distilled water as solvent were used for synthesis of composites.

The samples of polyaniline doped by formic, acetic, oxalic and citric acids (PAn-FA, PAn-AA, PAn-OA and PAn-CA) were synthesized by chemical oxidative polymerization of An using APS in aqueous 0,5 M solutions of these acids. The composites of the microfibril cellulose with PAn doped by abovementioned organic acids (Cel/PAn-FA, Cel/PAn-AA, Cel/PAn-OA and Cel/PAn-CA) were synthesized using the same technique. The structure and properties of the samples has been studied using X-ray phase analysis (diffractometer DRON) and FTIR spectroscopy (spectrophotometer NICOLET IS 10 ATR). The measurements of electrical resistance of the tablets of samples was performed ten times with the use of Rigol DM 3 068 device.

Thermal analysis of the synthesized powder samples was carried out by use Q 1500-D Derivatograph in the 20–900 °C temperature range under the heating rate of 10 degrees/min in air atmosphere. There has been determined the three stage of the weight loss by samples of PAn doped by organic acid and five stage of the weight loss for the cellulose/polyaniline-organic acid composites due to two additional stages of thermal destruction of cellulose according to results of thermogravimetric analysis. The stages of thermooxidative destruction, the temperature limits of these stages and the rates of mass loss during destruction of the samples of PAn and Cel/PAn composites were determined. It has been shown that thermo-destruction of cellulose in composites occurs at much lower temperatures than for pure cellulose. Generally, the thermal destruction of most polyaniline samples (PAn-FA, PAn-AA) to 98–99 % occurs under the temperatures to 800 °C, while for the PAn-CA sample – to 850 °C. The decomposition of cellulose/polyaniline-organic acid composites takes place to 650 °C. The conclusion about the presence of H-bonding between the components of the composites was done according to results of FTIR spectroscopy. Studies of electrical conductivity of the composites has shown, that they are in the form of emeraldine salts of polyaniline and abovementioned organic acids.