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The thermo-mechanical properties of cellulose nitrates – glycol esters compositions

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Abstract

The change in the nature of deformation of cellulose nitrate (pyroxylin No.2) plasticized with ethyl carbitol and ethyl cellosolve in the temperature range from -100 to 120 ºC was studied by the method of thermomechanical analysis with a dynamic load on the sample. The types of relaxation transitions and the temperature boundaries of the relaxation states of the considered compositions are established. It is shown that the compositions have two glass transitions – low-temperature, associated with relaxation processes occurring in the disordered regions of plasticized cellulose nitrate, and high-temperature, associated with the appearance of segmental mobility of cellulose nitrate macromolecules and with the destruction of intermolecular bonds in ordered regions of the polymer. The large temperature interval between the low and high temperature glass transitions indicates the structurally heterogeneous state of the compositions and the average thermodynamic activity of ethyl carbitol and ethyl cellosolve with respect to cellulose nitrate. It was found that compositions of pyroxylin No.2 with ethyl carbitol have lower glass transition and fluidity temperatures in comparison with compositions based on ethyl cellosolve of the same composition.

The similarity of the deformation behavior of the compositions of pyroxylin No.2 with ethyl carbitol and ethyl cellosolve was shown, however, ensuring the same level of plasticity of the compositions in the case of ethyl cellosolve requires the introduction of a larger amount of solvent into the polymer or the use of higher processing temperatures than in the case of ethyl carbitol.

It is shown that during the transition to the viscous-flow state of the composition pyroxylin No.2 – glycol ethers exhibit the properties of viscoelastic fluids, the flow of which is accompanied by the development of highly elastic deformations. Irreversible deformations of the flow to the greatest extent (up to 100%) develop in samples with a high content of solvents-plasticizers: when the content of ethyl carbitol is 70 % mol. and above and with an ethyl cellosolve content of 80 % mol. and higher. Samples with a lower content of solvents up to a maximum test temperature of 120 °C are predominantly deformed reversibly.

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