

PHASE LIQUID CRYSTALLINE TRANSITIONS AND RHEOLOGY OF CELLULOSE DERIVATIVE SOLUTIONS

S.A. Vshivkov, E.V. Rusinova

Ural State University, chemical department, Ekaterinburg, Russia

sergey.vshivkov@usu.ru

Liquid crystals are known to play an important role in science and technology. Liquid crystalline state of solutions and melts of some cellulose derivatives was revealed and was studied in 1960 - 1980th years. Molecules of cellulose and its derivatives have rigid helical conformation, stabilized by intramolecular hydrogen bonds. Therefore the macromolecules of these polymers are capable to be ordered at dissolution and form liquid crystals of holesteric type. The macromolecule orientation in a mechanical field expands area of the existence of LC phases and changes the phase diagrams. However the cited data are related to this problem. The goal of this study was to examine LC phase transitions under static both dynamic conditions and to determine the concentration dependences of activation enthalpy of a viscous flow of these systems.

The LC phase transitions have been studied using the cloud-point method, rheology and polarization microscopy. The solutions were cooled (heated) at a rate of 12 K/h. The observed turbidity was reversible. The phase state and the structure of the solutions was investigated with polarization microscopy method. The type of phase transition was defined with the help of polarization photoelectric setup. The viscosity of the systems was determined using HAAKE MARS viscometer. Hydroxypropylcellulose (HPC) with a degree of substitution 3 and $M=9.5 \times 10^4$, hydroxyethylcellulose (HEC) with a degree of substitution 3 and $M = 6 \times 10^4$, cyanoethyl cellulose (CEC) with a degree of substitution 2.6 and $M = 0,9 \times 10^5$ and CEC/HPC (9/1), CEC/HEC (9/1) blends were studied. DMF, DMA and twice – distilled water were used as the solvents. Polymer solutions were prepared in sealed ampoules for several weeks at temperatures: 298 (water) and 350 K (DMF, DMA).

It was shown, that the deformation of the HPC – water, CEC – DMA, CEC – DMF, CEC/HPC – DMF, CEC/HEC – DMF, HEC – DMF systems leads to increase of the phase transition temperatures. It is caused by the LC type change from holesteric to nematic.

The dependences of viscosity of the systems on shear rate are typical for non-Newtonian systems in which an additional molecule orientation at the flow leads to the viscosity decrease. The concentration dependences of the solution viscosity have extrema. The concentrations of extrema coincide to the concentrations of an anisotropic phase formation. The concentration dependences of the activation enthalpies of a viscous flow of these systems are described by the curves with the maxima caused by the LC phase transition and the change of the flow mechanism.

This work was supported by Federal Agency of Education of the Russia (project no. NK-43P(4), Federal program "Scientific und scientific – pedagogic personnel of Russia") and a grant of the Ministry of Education and Science of the Russian Federation (project no. AVTsP 2.1.1/1535 Development of the Scientific Potential of the Higher School).