

Preparation of gels of a hydrophobically modified polyacrylamide with high molecular weight and high content of hydrophobic units

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Associating polymers represent a very interesting type of macromolecular objects, which can self-assemble in aqueous solutions and form complex structures. Hydrophobically modified polymers, which have a hydrophilic backbone and hydrophobic side chains attached to some monomers, form self-assembled structures due to association of their hydrophobic parts into hydrophobic micellar-like domains. In dilute solutions, such polymers can form “flower-like” micelles with a core formed by hydrophobic moieties, and petals comprised of hydrophilic polymer fragments. Upon the increase of polymer concentration, the solutions enter into semi-dilute regime, and a network of bridged flower-like micelles is formed, resulting in the appearance of viscoelastic properties. The goal of this work is to study the formation, structure and mechanical properties of solutions of a hydrophobically modified polyacrylamide (HM-PAA) with high molecular mass, content of hydrophobic units and degree of blockiness.

It was shown that HM-PAA with high molecular weight (1300000 g/mol) forms semi-dilute solutions already at very low concentrations (about 0.05 wt.%), which are characterized by gel-like behavior: their storage (G') and loss (G'') moduli are independent of frequency in a wide frequency range, and viscosity diverges at low shear rates. The plateau storage modulus of the gels grows with increasing polymer concentration, which is explained by the increase of number of both flower-like micelles and bridges between them. NMR analysis shows that the hydrophobic side chains of the polymer are grouped in blocks of ca. 8 groups along the backbone, and small-angle neutron scattering (SANS) data confirm that around 70 hydrophobic units (e.g. 9 hydrophobic blocks) form one micellar domain. At the same time, the conformation of hydrophilic parts of the polymer in micellar shell is described by a model of a polymer in a good solvent. Addition of surfactant results in the increase of the plateau storage modulus of the gels due to the formation of “hybrid” micelles comprised of surfactant molecules with hydrophobic polymer groups embedded inside them. Acknowledgement. This work was financially supported by the Russian Science Foundation (project № 18-73-10162).

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