International Conference

Condensed Matter Research at the IBR-2

Dubna,
Russia

ABSTRACT BOOK

Functional and Nanostructured Materials

Development of Neutron Scattering Techniques and Instruments

Soft Condensed Matter

Carbon-based Materials

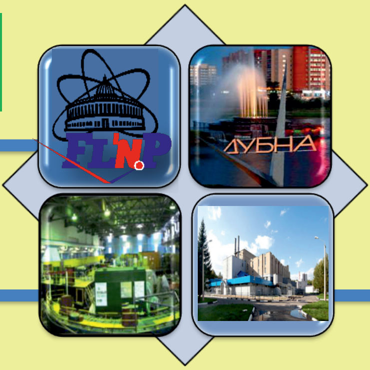
Dynamics of Materials

Magnetic Nanomaterials

Neutron Imaging

Materials under Extreme Conditions

Texture and Stress Investigations of Materials



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PH-TRIGGERED STRUCTURAL TRANSFORMATIONS IN THE MIXTURES OF AN IONIC SURFACTANT AND A HYDROPHILIC POLYMER

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Surfactant molecules can self-assemble and form wormlike micelles in aqueous solutions. Under certain conditions, wormlike micelles become rather long, and they form a network of topological entanglements, which imparts special characteristics to the solution: high viscosity and strong viscoelastic properties. Due to these properties, such solutions find applications in various industries, including oil industry, production of consumer products etc. However, their mechanical strength is limited since surfactant molecules are bound together by weak non-covalent interactions. Therefore, different ways of increasing the mechanical properties of wormlike micellar solutions are proposed. One approach is based on mixing wormlike micelles with polymer molecules [1]. In order to increase viscoelasticity, the addition of polymer should not result in the disruption of wormlike micelles, which may happen, for instance, in the case of weakly hydrophobic polymers. Interaction between the components may be tuned by the change of external conditions, e.g. the change of pH, charge of the surfactant, or temperature. The objective of this work is to study the effect of pH on the mixtures of cationic wormlike micelles and nonionic hydrophilic polymer - polyvinyl alcohol (PVA).

It was shown by small-angle neutron scattering (SANS) that, in the absence of polymer, micelles of cylindrical shape are formed in a wide pH range from 5.5 to 11. Rheological measurements confirm that the micelles are very long wormlike objects, which form an entangled network, and their viscoelastic properties are not strongly affected by pH.

The addition of polymer at low pH leads to the disruption of long wormlike micelles and their transformation into very short cylindrical ones. From SANS data, the average length of such micelles was shown to be approximately 100-150 nm. When pH of the mixtures is increased, the micelles grow in length, and the solutions attain high viscosity and elasticity. This effect was explained by changing of the interaction between polymer chains and micelles at the molecular level. As shown by NMR, at low pH macromolecules contain some slightly hydrophobic acetate groups which may interact with the micelles, leading to the wrapping of the polymer chains around the micelles and to the decrease of their length. Upon increase of pH, hydrolysis of the acetate groups takes place, and interaction between the micelles and polymer chains disappears, which is manifested in the increase of viscosity by several orders of magnitude and appearance of strong viscoelasticity.

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[1] A.V.Shibaev, K.A.Abrashitova, A.I.Kuklin, A.S.Orekhov, A.V.Vasiliev, I.Iliopoulos, O.E.Philippova (2017). Macromolecules, 50, 339-348.