MORPHOLOGICAL PERFORMANCE OF SELF-ASSEMBLED COMPLEX NETWORKS

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Modern soft network structures based on polymer chains, self-assembled surfactant chains, and anisotropic particles attract the attention of researchers as adaptive or stimuli-responsive systems. They are capable of recovering the structure and changing properties under the influence of external factors or small changes in the composition of the system. The mechanism of structure change is usually realized through the influence on physical interactions: hydrophobic, electrostatic, magnetic, etc. This explains the complete reversibility of the processes of rearrangement of nanostructures. Small-angle neutron scattering (SANS) is one of the most important methods for carrying out non-destructive experiments and independently obtaining information about individual components of the system.

An example of the use of the SANS method for nanostructured systems is the study of solutions based on aggregates of surfactants. The main aggregates of surfactants described in the literature are a sphere, a cylinder and a vesicle (bilayer). In our work, we studied the transformation of the structure from cylindrical micelles to vesicles through the formation of saturated networks of branched cylindrical aggregates and perforated vesicles [1]. The latter can be used as nanocontainers with adjustable nanopores.

In another part of the work, we combined worm-like micelles and cellulose nanocrystals to produce novel networks with unique stimulus-responsive viscoelastic properties due to wormlike micelles to vesicles transition [2]. Polymer-like self-organizing chains, worm-like micelles are flexible cylindrical micelles reaching tens of microns in length with a transverse dimension of 4-6 nm. Such micellar chains, like polymer chains, are able to entangle in solution to form a three-dimensional network and impact unique viscoelastic properties. SANS was used to determine the persistent length of wormlike micelles [3]. They are used as thickeners in the oil industry and household chemicals. The structure of such complex networks was studied for the first time using the method of contrast variation by the MRN method.

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[1] W.Hao, Y.M.Chesnokov, V.S.Molchanov, P.R.Podlesniy, A.I.Kuklin, V.V.Skoi, and O. E. Philippova (2024). Cryo-electron tomography study of the evolution of wormlike micelles to saturated networks and perforated vesicles. Journal of Colloid and Interface Science. 672, 431–445.

[2] M.M.Avdeev , V.S.Molchanov, A.I.Kuklin, O. E.Philippova (2026). Cellulose Nanocrystals Enhance the Rheological Properties and pH-Responsiveness of Potassium Oleate Solutions. Polysaccharides. 7.

[3] V.S.Molchanov, A.V.Rogachev, O.E.Philippova (2021). Determination of the local structure and the persistence length of wormlike micelles of potassium oleate by small-angle neutron scattering. Journal of Surface Investigation: X-ray, Synchrotron and Neutron Techniques. 15, 1015–1019.