Small-angle neutron scattering as a powerful tool for investigation of the biological, chemical objects and functional materials

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Small-angle neutron scattering (SANS) is a traditional technique for investigation of the nano-objects with sizes in range of 10 – 1000 Å. A range of such objects is rather wide: polymers, micelles, lipid membranes, porous media, precipitate, etc. The undoubted advantages of the method are the obtaining of integral information about the investigated system in comparison with, for example, microscopy and the deep penetration into the substance, in contrast to X-rays. The possibility of creating a contrast between the investigated object and the matrix by partially or fully isotopic substitution of hydrogen for deuterium makes SANS the unique method for obtaining information on the internal structure of the matter.

The challenge of this work is presenting the advantages of the SANS technique as an independent method, and a complementary tool for complex investigation in condensed matter research. An examples of the SANS investigations for biological, chemical objects and functional materials will be illustrated. The experiments were performed on YuMO time-of-flight spectrometer at the IBR-2 pulsed reactor (Dubna, Moscow region, Russia).

The investigation of the lipid membranes surrounded by ions is actual problem still nowadays. It was shown that the structure of the phospholipid membranes depends on

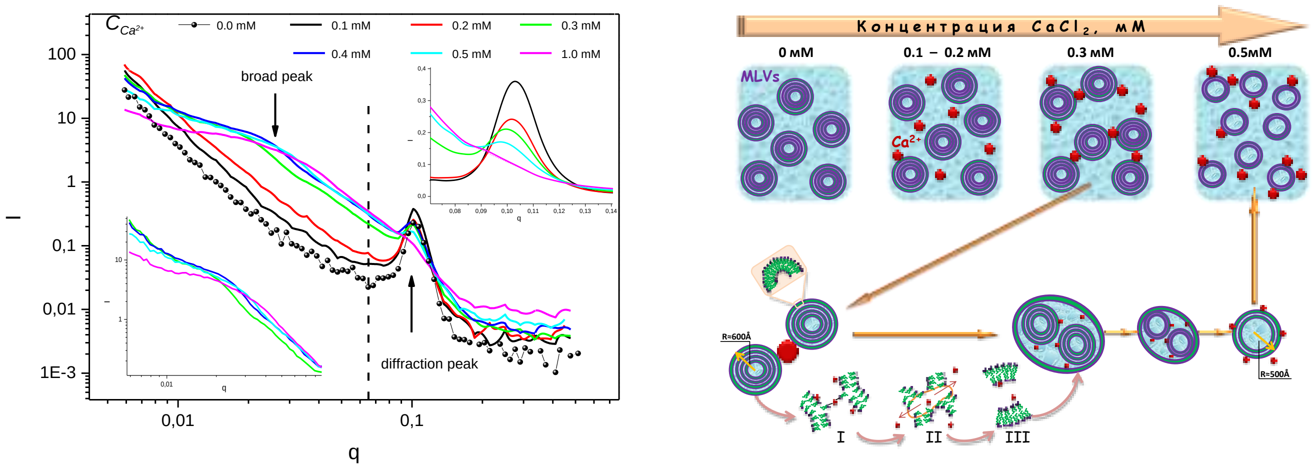
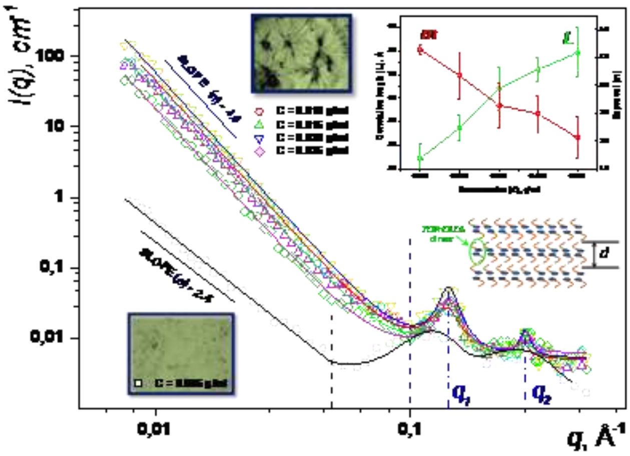
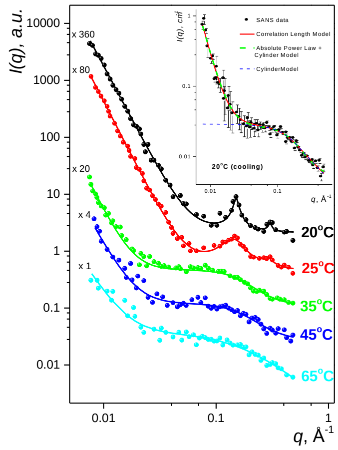


Fig.1. SANS curves for DMPC (1 wt.%) in dependence on Ca^{2+} ions concentration in liquid-crystal phase (left) with schematical presentation of the membrane fusion (right)

Ca^{2+} ions concentration in- and outside of the membranes. The fusion of the membranes induced by increasing of the Ca^{2+} ions concentration are discussed (Fig.1).

The next encourage example is SANS investigation of the structure, morphology (Fig.2) and reversible gel-sol-gel transition of a new low molecular mass organic gelators 7OPhOLCA. The SANS results are compared with DSC and FTIR data.





Proposed Sol – Gel transition scheme for the 7OPhOLCA in DMSO-d$_6$ determined by SANS

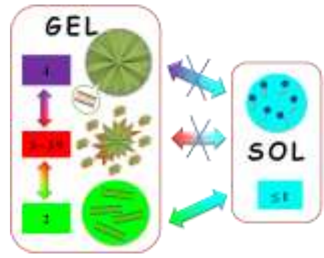


Fig.2. SANS curves with fits for 7OPhOLCA in DMSO-d$_6$ at different concentration *C*. Inset: variation of the correlation length *L* and exponent *m* with concentration.

Fig.3. Variation of the SANS spectra with temperature increase for 7OPhOLCA in DMSO-d$_6$ with *C*=0.015g/ml. Inset: SANS spectra at *T*=20°C during cooling fitted by different models.

And finally, the SANS investigation of TRIP-steel before and after plastic deformation is presented (Fig.4). It was shown that austenitic matrix undergoes phase transition to cubic α- and hexagonal ε- martensites during plastic deformation which affects significantly mechanical properties of the material. The obtained results are in good agreement with neutron diffraction data.

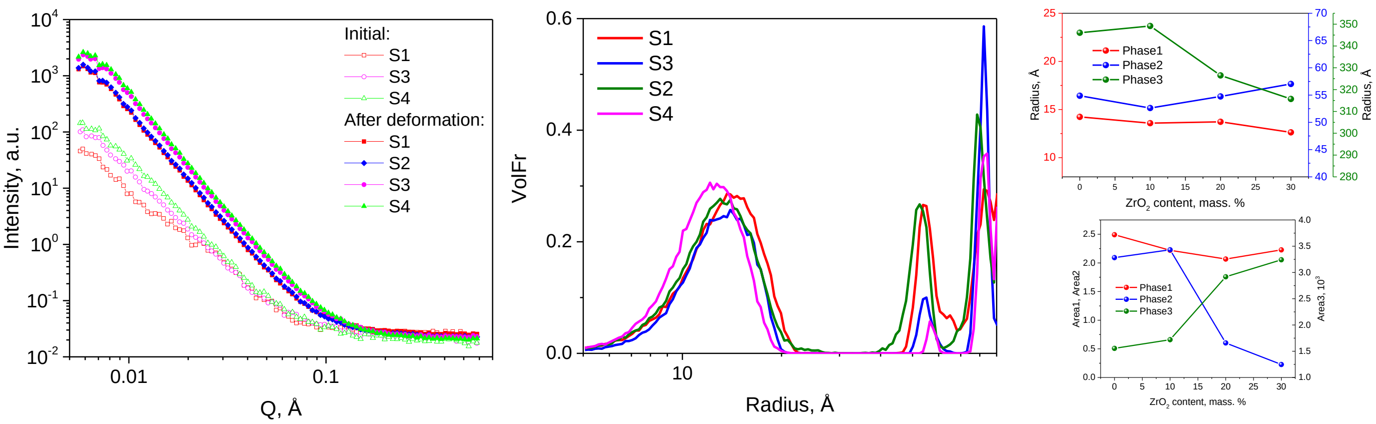


Fig.4. SANS curves for TRIP-steel before and after plastic deformation (left) with volume fraction (middle) and size (right) distributions in dependence on ZrO_2 concentration.

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