High resolution QENS with the neutron spin-echo spectrometer J-NSE

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Upgrades to correction coils in the "Pythagoras design" mid of 2010 lead to a significant increase of intensity at the detector due to the better transmission of these Al-coils. The instrument has been in regular user operation throughout the year which led to a number of interesting results being published, e.g. concerning the dynamcis of polymers in hard and soft confinement or the membrane dynamics of microemulsions.

Instrument development

The replacement of the last copper correction coil with a coil of the new "Pythagoras" type design (see IFF Scientific Report 2009, p 178) lead to an intensity increase by a factor of 1.7 (at shorter wavelength, more than 2 at the longer wavelength bands), with an improved performance also in terms of resolution. The high intensity was a prerequisite for high precision experiments on proteins in solution, where small deviations from the diffusive behaviour reveal the internal dynamics of the molecules.

Experiments at the J-NSE

The major part of experiments was again, with few exceptions, from the field of soft matter.

Polymers in confinement:

A hot topic, which lead to a number of publications from experiments from the previous years, has been the dynamics of polymers in confinement. There, experiments with polymers with modified end groups have been conducted in Si nanochannels (Fig. 1, A. Kusmin et al.). Previous experiments on this subject have been published in [1, 2]. By studying the confinement in slightly larger pores of anodic alumina oxide (M. Krutyeva et al.) it could be shown that the tube diameter inside the pores does not change dramatically as previously suggested by NMR relaxometry studies ('Corset effect') [3].

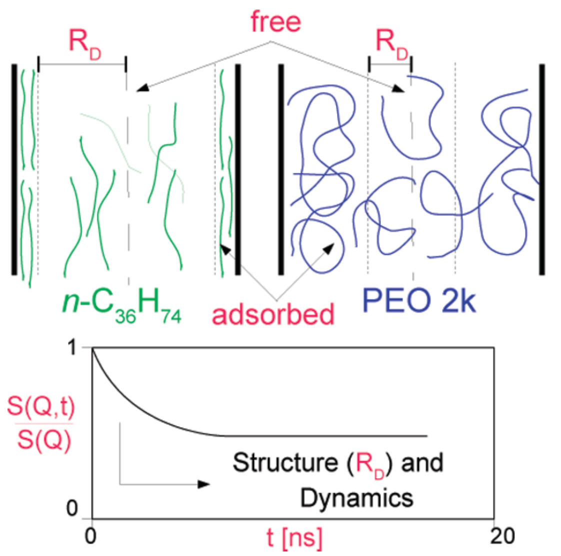

FIG. 1: Polymers confined in nanochannels. NSE experiments showed an absorbed layer, the thickness depending on the details of the interaction between polymer and cylinder (from [2] see [1, 2] for details).

Microgels:

Also on this topic previously started experiments were continued. The studies of Adelsberger et al. [4] have been continued on diblock copolymers [5] revealing a more complex collapse transition with dynamics of the microgel shell than in the case of the first studied triblocks.

Polymer dynamics:

First experiments have been done on PEO ring polymers. A first analysis of the data showed an unexpected fast center of mass diffusion. The interpretation of the results is under progress (A. Bras et al., Exp. Rep. to proposal Nr. 4851, Fig. 2).

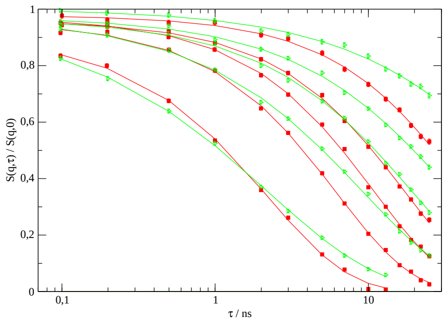

FIG. 2: Intermediate scattering function of ring polymers (red) compared to a linear polymer chain of the same molecular weight (green) for the q-values 0.05, 0.08, 0.1, 0.13, 0.2 $Å^{-1}$. Lines are guide to the eye.

Microemulsions:

Experiments with the aim of studying the membrane dynamics in bicontinuous microemulsions close to a flat interface have been continued with the GINSENG (Grazing Incidence NSE Near Garching) setup (M. Kerscher, H.Frielinghaus, Experimental Report to proposal Nr. 4941). Due to the higher flux with the new correction coil, the statistics of this kind of “low intensity”-experiment could be largely improved in the last series. This certainly opens the possibility to use this technique in a more general context and not only with the best scattering samples (although it will always be a “low intensity” experiment).

Besides this possibility of studying interface dynamics, microemulsions have been studied in different context during the year 2010, e.g. sugar surfactant based microemulsions, which are stable over a very broad temperature range around room temperature [6].

Biological samples:

Several experiments have been conducted by different groups (M. Sharp et al., S. Longeville et al.) on internal dynamics of proteins, requiring precise measurements to be able to separate internal motions from global diffusion of the proteins in solution. It is necessary during these measurements to optimize the intensity by measuring one relaxation curve with different wavelengths using always the most intense (i.e. shortest) wavelength possible. The stability of the J-NSE spectrometer allowed to merge these different wavelengths without any problems. As for the GINSENG experiments, also here the intensity gain due to the exchange of the correction coil was a crucial point.

A variety of scientific issues:

Other experiments of the year 2010 included continuation of the study of spin waves in Nd_2CuO_4 (T. Chatterji) and low temperature spin dynamics in Swedenborgite (W. Schweika). Thus neutron spin-echo spectroscopy contributed to explore a variety of different subjects from “soft-matter” to magnetic fluctuations throughout the year 2010.

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