Experimental Report

Proposal: **9-10-1339** **Council:** 4/2014

Title: Probing anomalous (fractional) dynamics in polymer membranes

This proposal is a new proposal

Researh Area: Soft condensed matter

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Samples: PBD46-PEO29

Instrument	Req. Days	All. Days	From	To
IN11	12	7	02/12/2014	09/12/2014

Abstract:

In this project we focus on anomalous and fractional dynamics in polymer membranes, which should occur at finite observation times whenever a system has strong memory and/or a complex dynamical potential energy surface. We propose NSE experiments on diluted suspensions of polymersomes made of poly(butadiene-co-ethyleneoxide) (PBD-PEO) in deuterated water. The elastic properties of these membranes are well known by direct methods, which facilitates the interpretation of the relaxation rates of the fluctuation modes in terms of well-known membrane-supported dispersion equations. Different curvatures will be accessed by varying the thickness-to-radius structural ratio within the preparative range (for vesicle radius 20nm < R < 200nm, one gets curvatures in the range 0.75 > h/R > 0.075) which will change chain entangling, the level of lateral stress and finally the chain mobility.

Aim of the proposal

In this project we focussed on anomalous and fractional dynamics in polymer membranes, which should occur at finite observation times whenever a system has strong memory and/or a complex dynamical potential energy surface. We proposed NSE experiments on diluted suspensions of polymersomes made of poly(butadiene-co-ethyleneoxide) (PBD-PEO) in deuterated water. The elastic properties of these membranes are well known by direct methods, which facilitates the interpretation of the relaxation rates of the fluctuation modes in terms of well-known membrane-supported dispersion equations. Different curvatures were aimed to be accessed by varying the thickness-to-radius structural ratio within the preparative range (for vesicle radius 20nm < R < 200nm, one gets curvatures in the range 0.75 > h/R > 0.075) which was assumed to change chain entangling, the level of lateral stress and finally the chain mobility.

Experimental Results

In spite of the required 12 days on IN11C, we received only 7 days for this experiment, which was insufficient to finish the measurements. In addition, the measurements struggled from field interference with the Perkeo experiment on PF1B. This did not allow us to work at the highest spin-echo times and reduced the polarization by 30-50% at the higher spin-echo times. Despite these technical problems we could show that the measurements are technically feasible, but that higher spin-echo times than the one available on IN11A are required in the q-range, where we have sufficient scattering signal ($q<0.2$ Å^{-1}).

We have obtained NSE spectra for the diluted polymersome suspensions for $0.04 < q < 0.12$ Å^{-1} at temperatures of 5°C, 25°C and 45°C, respectively. For each temperature a separate sample was produced, all with a vesicle density of 15 mg/ml. Correction and comparison spectra were obtained in the same conditions for D_2O and for the bulk polymer and transmission data for all samples. Corrected spectra are shown in Fig. 1.

The data treatment is not yet fully finalized, but it is already evident that the present spectra do not show a sufficient decay to clearly determine the decay rate and even less to obtain the eventual fractal dimension of the relaxation.

Higher resolution IN15 spectra are highly needed to finish this study.

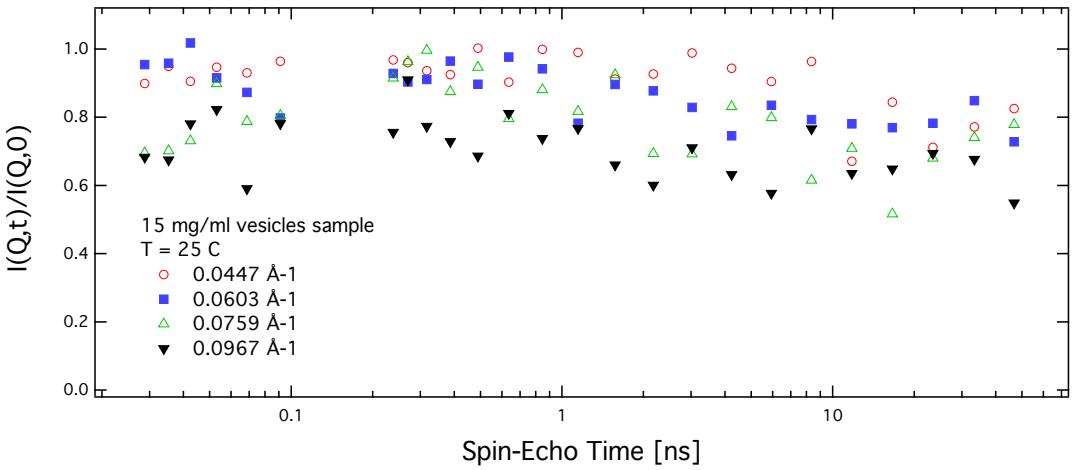

Figure 1: NSE spectra of a 15 mg/ml vesicle in D_2O sample. The data are corrected by spectra obtained for an equivalent D_2O sample.