

Investigation of DMSO influence on the DMPC bilayer via neutron reflectometry

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Dimethyl sulfoxide (DMSO) is widely used in pharmacy and biology as cosolvent in commercially available semisolid formulations and as enhancer of drug penetration through human stratum corneum. The purpose of the present experiment was to apply neutron reflectometry for the characterization of DMSO penetration inside of a single immobilized dimyristoylphosphatidylcholine (DMPC) bilayer.

It is commonly believed that DMSO molecules interact and penetrate to the region of polar head groups of phospholipid membranes. Investigations of DMSO interaction with DPPC membranes via DSC, X-ray and neutron scattering show a negligibly small interaction of DMSO molecules with the polar head groups of DPPC [1]. Recent SANS results on DPPC vesicles demonstrate an increasing DPPC membrane thickness d at presence of DMSO as shown in Fig. 1. Penetration of DMSO molecules into the region of the hydrocarbon chains can explain this increase. Location of DMSO molecules below the head group region was detected in X-ray reflectivity experiments on DPPC monolayers on the air/water interphase (Fig. 2) [2].

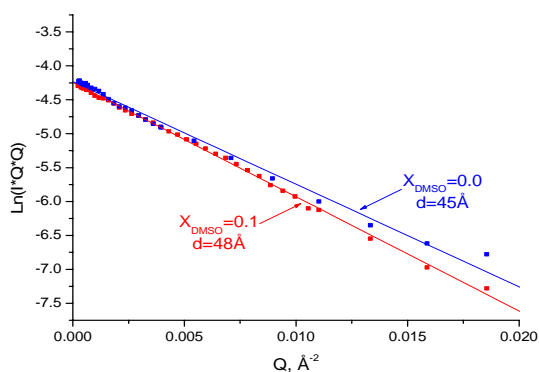


Figure 1: Kratky-Porot plot of the SANS curves on the unilamellar DPPC vesicles in D₂O/deuterated DMSO mixture at different DMSO molar fractions X_{DMSO} . $T=20^\circ\text{C}$.

DMSO interaction and, probably, location depends on the length of hydrocarbon chains [3]. The purpose of our neutron reflectivity experiments was to determine the DMSO molecule location in the single DMPC bilayer using deuterated DMPC and deuterated DMSO. Experiments were carried out at $T=10^\circ\text{C}$, 30°C , and 42°C at DMSO molar fractions $X_{\text{DMSO}}=0$, 0.05, and 0.1. Fig. 3 presents measured reflectivity curves with deuterated and protonated DMSO in D₂O. Unfortunately the large value of instrument and sample background and low intensity of the specular reflected neutrons from the solid/liquid interface limits the collection of reflected intensity at larger values of q_z . Equipment of the instrument with evacuated beam guides to reduce diffuse scattering by air and operation of the two dimensional PSD for more precise measurements of the bilayer form factor should allow to measure the reflectivity necessary for our measurements. It will decrease current background and increase statistics at low values of reflectivity.

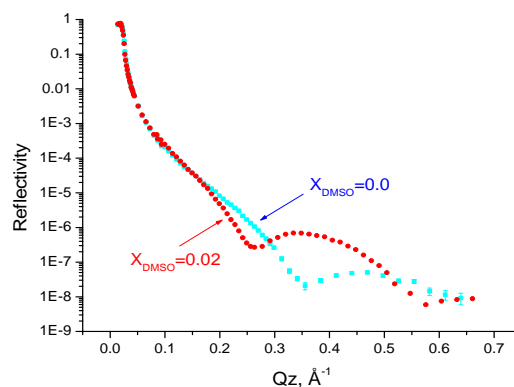


Figure 2: X-ray reflectivity curves of DPPC monolayers on the air/water interphase with different DMSO molar fractions. Surface pressure 2 mN/m, $T=20^\circ\text{C}$.

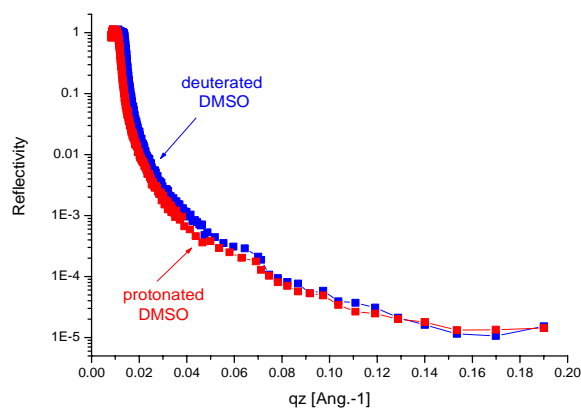


Figure 3: Neutron reflectivity from single adsorbed DMPC bilayer in D₂O on silicon substrate at $T=42^\circ\text{C}$. $X_{\text{DMSO}}=0.1$

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