Experimental Report

11/02/2015

Proposal:	**9-13-545**	**Council:**	4/2014

Title: Specific Adsorption of Backbone-Binding Antibodies to PEG Polymer Brushes

This proposal is a new proposal

Researh Area: Soft condensed matter

Main proposer: **SCHNECK EMANUEL**

Experimental Team:
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Local Contact: FRAGNETO Giovanna

Samples:
NaCl
Hepes
PEG lipids
Phospholipids (DSPC)
octadecyltrichlorosilane
silicon blocks
backbone binding PEG antibodies (IgG)

Instrument	**Req. Days**	**All. Days**	**From**	**To**
D17	4	4	04/12/2014	08/12/2014

Abstract:

Protein adsorption to material surfaces causes problems in numerous medical applications. A favoured approach in order to prevent protein adsoprtion is to decorate surfaces with brushes of terminally anchored, neutral water soluble polymers (NWSP). But despite the great importance of NWSP-functionalization, the interaction of proteins with NWSP is not fully understood. In particular, little is known about the role of specific protein adsorption in the regularly observed "brush failure", where protein adsorption occurs despite NWSP functionalization. Here, we propose a systematic investigation of this phenomenon on a detailed structural level. Anti-PEG proteins specifically binding to the backbone of PEG polymers will be localized using neutron reflectometry (NR) with contrast variation. The results will provide a valuable basis for the "rational design" of protein-repellent surface functionalization.

EXPERIMENTAL REPORT

EXPERIMENT N° **9-13-545** INSTRUMENT D17

DATES OF EXPERIMENT 28/11/2014 to 02/12/2014

TITLE Conformation of Hydrophilic Polymer Brushes under Confinement

NOTE: “Specific Adsorption of Backbone-Binding …” was performed instead on FIGARO, **9-11-1679**

EXPERIMENTAL TEAM
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Date of report 10/02/2015

Soft interfaces constituted by molecular assemblies in interfacial geometries are key components of biological and technological soft matter [1-3]. The term “soft interfaces” broadly covers flexible interfaces and interfaces composed of molecular groups with considerable conformational degrees of freedom.

In contrast to the case of “rigid” interfaces, the interaction characteristics of soft interfaces are always the result of a subtle interplay of molecular forces of various types, including electrostatic forces, dispersion forces, inter- and intramolecular hydrogen bonding, solvation and steric forces [4]. Individual contributions can be of enthalpic and entropic nature and their weights depend on supramolecular organization and molecular conformations. Of special interest is the interaction between polymer-decorated surfaces, where the global characteristics of the interaction in terms of interaction pressures and mechanical properties crucially depend on the distance-dependent conformation of the polymers. This problem has been intensively addressed by theory, but accurate experimental data [5, 6] are rare, because characterizing the structure of interacting and thus necessarily buried soft interfaces is difficult and basically only possible by neutron scattering.

The very recent experiment 9-13-545 was aimed at the structural characterization of solid-supported hydrophilic polymer brushes in an aqueous environment while interacting with a second brush (Fig. 1 left). Brushes were first created at an air/water interface as water-insoluble lipid (DSPC) monolayer incorporating defined mole fractions of lipid-anchored PEG polymers. A first brush was attached to the substrate by the Langmuir-Schaefer (LS) technique following hydrophobic substrate functionalization. The second brush was then transferred by the Langmuir-Blodgett (LB) technique. We focused on polyethylene glycol (PEG) brushes of defined length and lateral density (In 2013 an 2014 we had already demonstrated that NR precisely reveals the conformation of single PEG brushes [7, 8].). The two brushes were brought to a defined interaction distance via controlled dehydration using a humidity chamber and by exertion of defined osmotic pressures using hygroscopic polymers (PEG20000). Sensitivity to the conformation of individual brushes was achieved by letting a hydrogenated PEG brush interact with a brush formed by PEG lipids with deuterated PEG chains.

Fig. 1 (right) shows neutron reflectivty curves obtained with two interacting PEG brushes of polymerization degree $N = 114$ and 10mol% of lipid-anchored PEG polymers hydrated with H_2O. The feature-rich reflectivity curves obtained in a wide range of osmotic pressures, ranging from very low values achieved in contact with polymer solutions to high values corresponding to 86% relative humidity, show the resulting pronounced changes in the interaction distance (i.e., the swelling). They further demonstrate the great potential of our sample architecture and suggest that the polymer conformation can be monitored in dependence on the interaction distance.

This is only a preliminary report. A complete report will be provided after careful data analysis involving model-based simultaneous reflectivity fits along the line presented in [7] and [8].

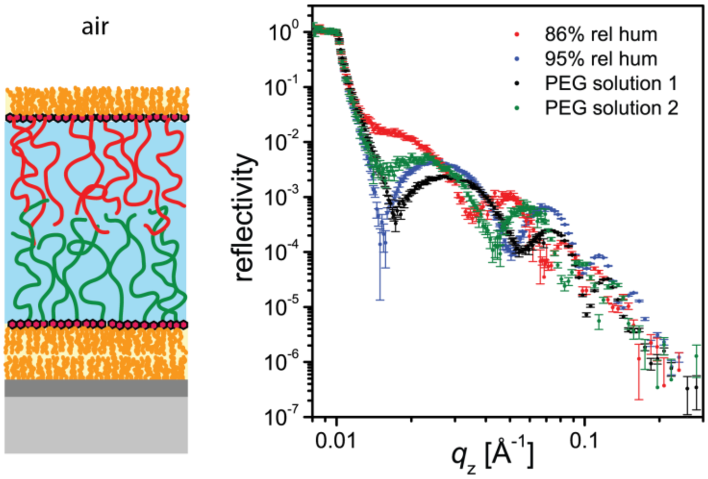

Figure 1: (left) Sample architecture for neutron reflectometry experiments on interacting polymer brushes at controlled osmodic pressures. (right) Neutron reflectivity curves obtained with interacting PEG brushes (polymerization degree $N = 114$, 10mol% lipid-anchored PEG polymers) at various osmotic pressures ranging from very low values achieved in contact with polymer solutions to high values corresponding to 86% relative humidity.

[1] Mouritsen, *Life - as a Matter of Fat*. Springer (2005).

[2] Norde, *Colloids and Interfaces in Life Sciences*. Marcel Dekker (2003).

[3] Evans & Wennerström, *The Colloidal Domain.* VCH (1994).

[4] Israelachvili, *Intermolecular and Surface Forces*. Academic Press (1991).

[5] Hamilton et al., *J. Polymer Sci. B* **42**, 3290 (2004).

[6] Mulder & Kuhl, *Soft Matter* **6**, 5401 (2010).

[7] Schneck, Schollier, Halperin, Moulin, Haertlein, Sferrazza, Fragneto, *Langmuir* **29**, 14178 (2013)

[8] Schneck, Berts, Halperin, Daillant, Fragneto, *Biomaterials* **46**, 95 (2015)