Experimental report

01/06/2020

Proposal: 9-13-855 **Council:** 4/2019

Title: Nanogel surface templating for nanogels-proteins interaction study

Research area: Biology

This proposal is a new proposal

Main proposer: Ali ZARBAKHSH

Experimental team: Pengfei LIU
Ali ZARBAKHSH

Local contacts: Armando MAESTRO

Samples: N-Isopropylacrylamide

Instrument	Requested days	Allocated days	From	To
FIGARO	0	3	08/07/2019	11/07/2019
D17	3	0		

Abstract:

The interaction of proteins with solid surfaces is a fundamental phenomenon with implications for nanotechnology, biomaterials and biotechnological processes. Self-assembled nanogel monolayers coated at sapphire is potentially good surface model for the protein-adsorbed layer interaction study because of its unique cross-linked 3D internal network as well as stimuli responsiveness. The ultimate goals of this proposal would be to measure, predict and understand the protein conformation, surface coverage, superstructure of the protein-surface interaction.

1 PRINCIPAL INVESTIGATOR
Name and institution of the Principal Investigator
Dr A Zarbakhsh Department of Chemistry Queen Mary University of London UNITED KINGDOM

2 EXPERIMENT DETAILS	
Experiment: 9-13-855	
Title: Nanogel surface templating for nanogels-proteins interaction study	
Instrument: FIGARO	
Dates scheduled: 8th July 2019 to 11th July 2019	No. Days allocated: 3
Date of experimental report: 1st June 2020	

3 EXPERIMENT OBJECTIVES

Protein adsorption at solid surfaces plays a key role in many processes including medicine, pharmaceutical sciences, analytical sciences, biotechnology, cell biology, or biophysics, and has therefore been an extremely active area of research for the past several decades. Self-assembly monolayers (SAMs) are suitable for studying correlations between protein responsiveness and surface properties. The ordering of the adsorbed layer at the interface is thought to be the driving force for protein adsorption below the monolayer toward the aqueous bulk phase. It was also reported that the behaviour of protein is highly dependent on the outermost functional groups of SAMs.

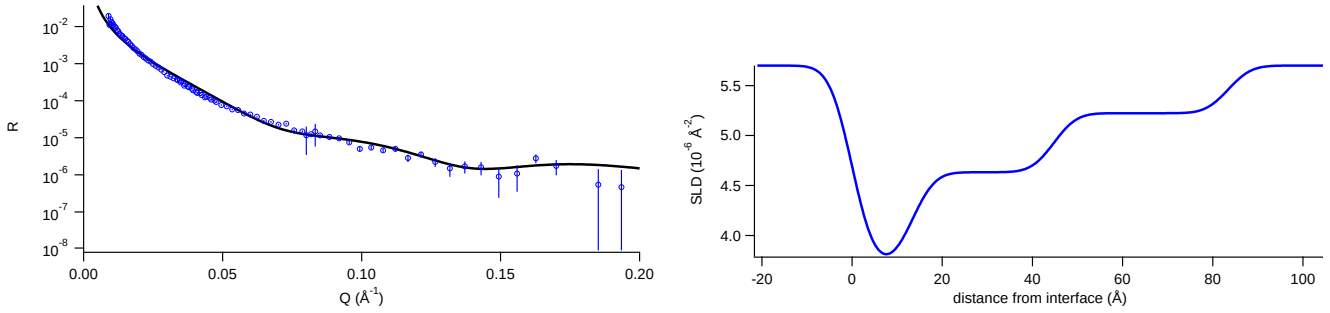
Nanogels are commonly defined as organic spherical cross-linked polymers with a 3D internal network structure. They are prepared by high dilution radical polymerization using a combination of functional monomers and cross-linkers in varying proportions. Important characteristics of these type of materials include high surface to volume ratio, low viscosity and polydispersity and tunable chemical structure, obtained by changing the cross-linker and chemical structure of the monomer Despite considerable achievement in this field, there are still poor understanding of factors controlling protein adsorption on a molecular level, and even contradictive opinions on how to explain the frequently observed phenomena such as structural rearrangements, cooperative adsorption, overshooting adsorption kinetics.

The proposed project has two key objectives: a) to study the behaviour of self-assembled nanogel layer at a sapphire-water interface by resolving its structure; b) to correlate the interaction of protein with nanogels with the key driving forces for the formation of protein-nanogels complexes. In this experiment, we mainly focused on the first objectives and then the second one in a later continuation experiment.

4 EXPERIMENT REPORT

We firstly have investigated the structural properties of N-n-propylacrylamide (NPAM) base nanogels with 20% crosslinker (MBA) at the sapphire-water interface as a function of temperature. The subphase was contrast matched to sapphire (CMSa) water and the concentration of nanogels was fixed at 0.1 mg ml-1. Figure 1 shows an example of both NR and SLD profiles of 80%NPAM-20%MBA nanogel at 25 °C. A three-layer model was applied to fit the NR data, indicating a self-assembled multilayer was deposited at the sapphire substrate. The total layer thickness was ~100 Å and the volume fraction of nanogels in the upmost layer adjacent to the sapphire was the

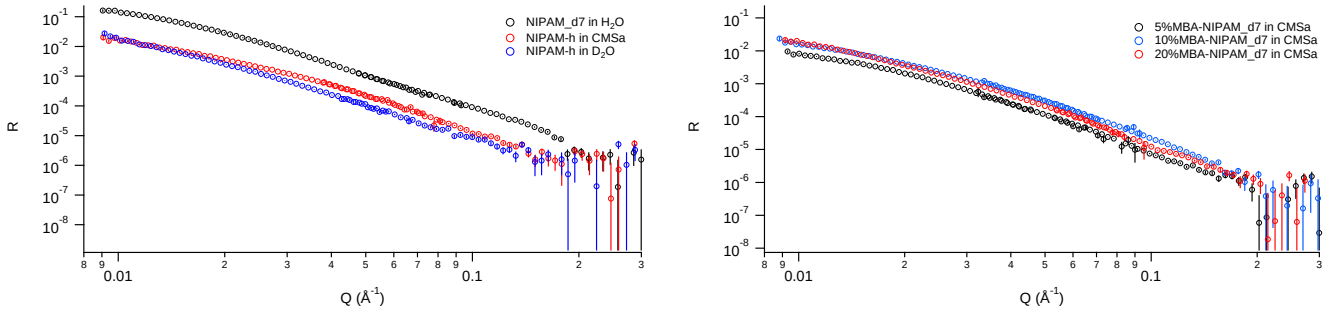
highest (~50%) and then decreased when moving from the interface towards the bulk phase.



(a) (b)

Fig. 1. (a) NR profile and (b) scattering length density profile of 80%NPAM-20%MBA nanogels at the sapphire-water interface at 25°C. The subphase was contrast matched to sapphire water whose SLD=5.70 ×10 $^{-6}$ Å^{-2}. The concentration of nanogel and lysozyme are 0.1 mg ml^{-1}

We have also investigated interfacial properties of nanogels polymerised from N-isopropylacrylamide (NIPAM), which is the isomer of the NAPM monomer. We explored the impact of the crosslinking content and temperature on influencing their structure of adsorbed layer at the interface. Original NR profiles of these nanogels at the sapphire-water interface are presented in Figure 2. Like NPAM nanogels discussed above, NIPAM self-assembled onto the sapphire-water interface, forming a layer thin film which can be acted as the functional templating surface. In addition, the layer structure can be easily tuned by modifying the chemical structure of the nanogel or changing the temperature of bulk water.



(a) (b)

Fig. 2. NR profiles for (a) 80%NIPAM-20%MBA nanogels (D/H) in sapphire-water (H_2O, CMSa water and D_2O) and (b) 5%, 10% and 20% crosslinked deuterated nanogels in sapphire-CMSa water interface at 25°C.The concentration of nanogel is 0.1 mg ml^{-1}.

5 LIKELY OUTCOMEs FROM EXPERIMENT *Please indicate what the experiment is likely to lead to by putting an 'x' next to one or more of the possible outcomes below.*	
Likely outcome	
Journal publication	*x*
Data for thesis	*x*
Follow-up experiment at ILL	-
Follow-up experiment at another facility	*x*
Other	*x*
No outcome anticipated	-

6 SUGGESTIONS FOR IMPROVEMENTS TO YOUR EXPERIMENT, EQUIPMENT OR THE FACILITY
NA