Experimental report

25/07/2022

Proposal:	**8-02-934**		**Council:**	4/2020
Title:	Interfacial Structure of the Velvet Worm Prey Capture Slime			
Research area:	Biology			

This proposal is a new proposal

Main proposer:	**Emanuel SCHNECK**
Experimental team:	Samantha MICCIULLA
Local contacts:	Samantha MICCIULLA

Samples: slime of the velvet worm

Instrument	Requested days	Allocated days	From	To
FIGARO	2	2	25/05/2021	27/05/2021

Abstract:

Velvet worms produce a rapidly rigidifying slime to catch their prey. Recent combined SAXS/SANS experiments showed that macroscopic rigidification upon, suggesting that the rigidification may instead be induced by the generation of interface with air (a hydrophobic medium). Here, we propose the use of neutron reflectometry (NR) to structurally characterize the outer surface of slime of the velvet worm when in contact with various hydrophilic and hydrophobic surfaces mimicking the conditions before and after slime ejection from the gland into the air.

EXPERIMENTAL REPORT

EXPERIMENT N°: **8-02-934** INSTRUMENT: **FIGARO**

DATES OF EXPERIMENT: **25/05/2021 to 27/05/2021**

TITLE: **Interfacial Structure of the Velvet Worm Prey Capture Slime**

EXPERIMENTAL TEAM: **Samantha Micciulla (ILL), Alexander Baer (Uni Kassel), Julio M. Pusterla (TU Darmstadt).**

LOCAL CONTACT: **Samantha Micciulla**

Velvet worms produce an adhesive slime to catch their prey, which is fluid in a non-agitated state but self-assemblies into stiff polymeric fibers under mechanical stimulation (e.g. shaking or stretching), resulting in a tensile core and a sticky surface [1-3]. Recent combined SAXS/SANS on the bulk structure of velvet worm showed well-defined contributions from nanoglobules and from free proteins of two distinct size populations (manuscript submitted). These globules contain both proteins and a considerable volume fraction of lipids. In addition, SANS curves also indicated that the macroscopic rigidification is not due to pronounced changes in the bulk structure, but it may rather be due to surface-induced effects.

The aim of this neutron reflectometry experiment was the structural characterization of the outer surface of slime of the velvet worm species Euperipatoides rowelli when in contact with hydrophilic and hydrophobic surfaces, mimicking the conditions before and after slime ejection from the gland into the air. Diluted slime was brought into contact with covalently functionalized silicon surfaces in conventional solid/liquid cells for NR. The hydrophilic surface functionalization, mimicking the epithelial surface in the gland reservoir, was done by covalent binding of phospholipids [more precisely 1-myristoyl-2-(13-carboxytridecanoyl)-sn-3-glycerophosphocholine -DMPC-COOH-] while the hydrophobic surface was prepared by octadecyl-trichlorosilane (OTS)-functionalization.

A preliminary analysis of the slime in contact with the OTS-functionalized silicon blocks was carried out (Figure 1). Fig. 1a shows the reflectivity curves for the OTS-functionalized silicon blocks in D_2O (grey dots) and after the addition of the deuterated slime and rinsing once with D_2O (green dots), which is just one of the analyzed contrast conditions. These curves were fitted (solid lines) with a model which describes the volume fractions of the different components in the system (Figure 1b and 1c). In particular, this model includes the silicon block, a layer of silicon dioxide (Si_2O), OTS, water, lipids, free proteins and an independent entity (which would represent the nanoglobules) that contains lipids and proteins. As it can be seen, the reflectivity curves reveal the formation of a thick protein/lipid composite layer, with a thickness that approximately matches the diameter of the nanoglobules. While there are two protein/lipid distributions that can satisfactorily describe the data, only one of them (in panel c) is consistent with the known high protein content of the globules.

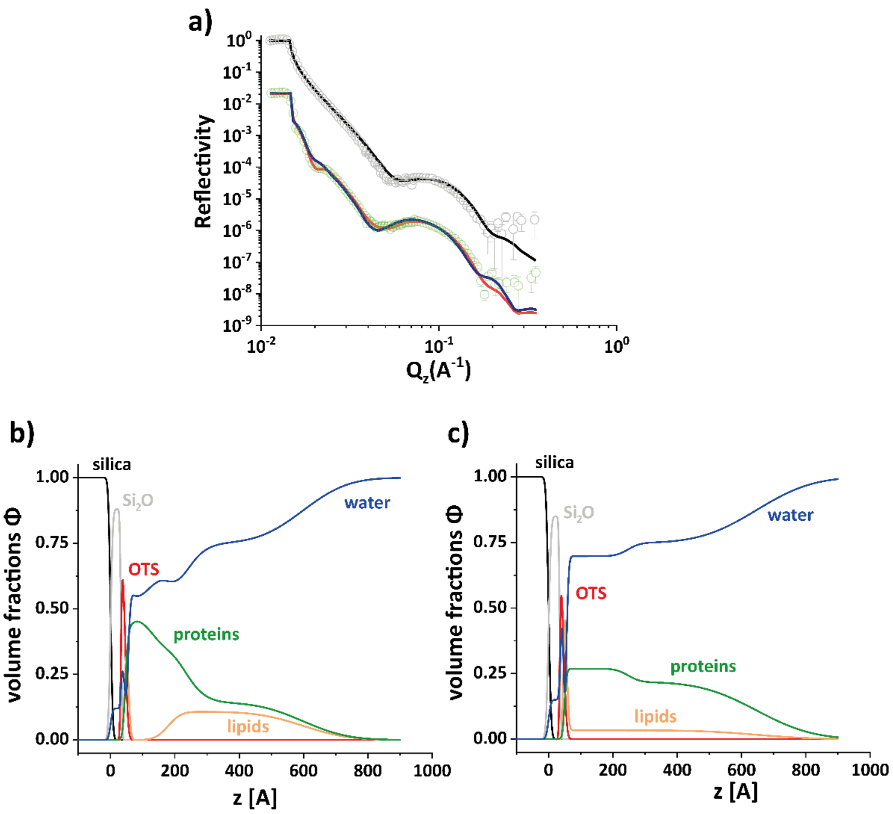

Figure 1: (a) Representative reflectivity measurements for OTS-functionalized blocks in D_2O (grey dots) and OTS + D_2O-slime after rinsing with D_2O (green dots). Solid lines represent the best fitting curves according to our model. (b) and (c) show two possible volume fraction profiles allowing for interfacial roughness (blue -b- and red -c- solid lines in 1a).

The data related with the hydrophilic DMPC-functionalized blocks are currently being analyzed in the same way. The experimental data are shown in Figure 2 and we can see the differences between the reflectivity curves (Figure 2) for the D_2O-slime (after rinsing with D_2O) in contact with OTS (green dots) and DMPC-COOH (blue dots) functionalized silicon blocks.

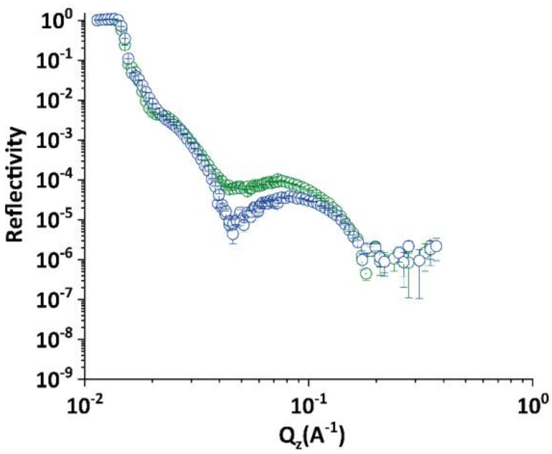

Figure 2: Representative reflectivity measurements for OTS (green dots) and DMPC-COOH (blue dots) + D_2O-slime after rinsing with D_2O.

[1] Read & Hughes, P. Roy. Soc. B-Biol. Sci 230, (1987).
[2] Mayer et al., Integr. Comp. Biol. 55, (2015).
[3] Baer et al., Nature Communications 8, 974 (2017).