Experimental report

11/02/2025

Proposal: 9-10-1855 **Council:** 4/2024

Title: Neutron reflectometry to probe thepolymer volume fraction of microgel monolayers in crowded condition at different temperatures

Research area: Soft condensed matter

This proposal is a new proposal

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Samples: C6D7H4NO
C6D3H8NO

Instrument	Requested days	Allocated days	From	To
FIGARO	4	4	01/07/2024	05/07/2024

Abstract:

Microgels are theromresponsive particles which show a volume phase transition (VPT) above 32 ºC. They can be used to stabilise smart, responsive emulsions. Interestingly, micorgels forms stable e emulsions when adsorbed in both their swollen (20 ºC) and collapsed state (40 ºC), however if the emulsion is formed with microgels adsorbed at 20 ºC it can be broken by increasing the temperature to 40ºC. The nature of this instability has not yet been understood, but clearly it is related to the structure of the adsorbed microgels orthogonally to the interface below and above their VPT temperature (VPTT). To complete our previous published studies, where we determined the profiles of the polymer volume fraction of microgels at the interface as a function of crowding and temperature, here, we want to understand the physical reasons for the instability of microgel stabilised interface below and above the particle VPTT. To do so, we will use neutron reflectometry to study the differences in the profiles of the polymer
volume fraction of different monolayers formed by microgels in their collapsed or swollen state that then we will collapse or swell by changing the temperature.

Report on experiment 9-10-1855

To understand why an emulsion breaks when microgels are adsorbed in the swollen state and then collapsed, we have probed the changes in the profiles of the polymer distribution in the direction orthogonal to the interface $\phi(z)$ of the microgels at the air-water interface. We have studied the differences in the $\phi(z)$ of 4 monolayers formed by:

(i) Microgels adsorbed at 20 ºC (swollen) and measured.
(ii) Microgels adsorbed at 20 ºC and then brought at 40ºC (collapsed) and then measured.
(iii) Microgels adsorbed at 40 ºC and measured.
(iv) Microgels adsorbed at 40 ºC and then brought at 20ºC and then measured.

The differences between the $\phi(z)$ of microgels in the monolayers in (i) and (iv) and between those in (ii) and (iii) allowed us to identify the differences in the monolayer structure when it becomes unstable.

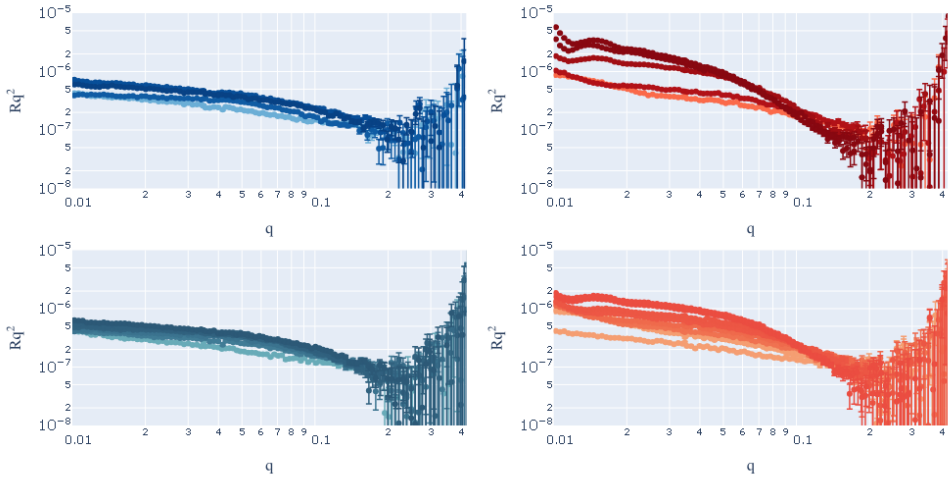

Figure 1 Data collected for case (i) top left, case (ii) top right, case (iii) bottom left, and case (iv) bottom right.

As can be seen from Fig. 1 there are significant differences in the NR data which reveal structural differences in the monolayer. We have then fitted the data using a model [1,2] to quantify these structural differences for the monolayer due to the changes in compression and temperature. These data are currently part of a manuscript that we plan to submit in the next month.

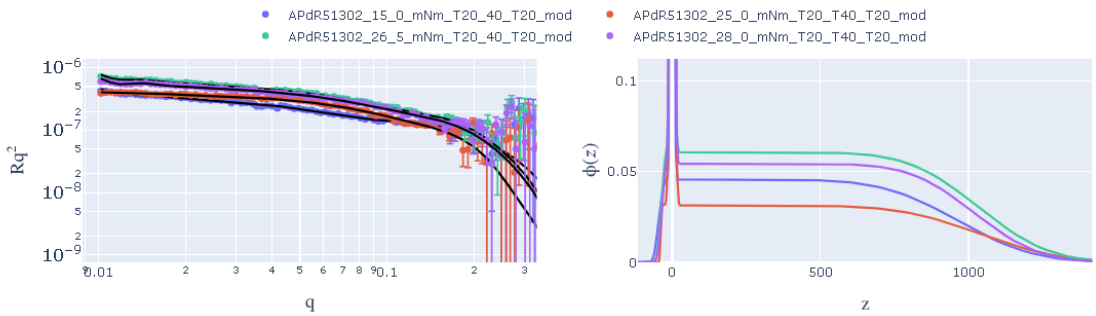

Figure 2 Solid lines represent fit of the data (left) used to obtain the radial distribution in the z-direction (right).

[1] S. Bochenek, **A. Scotti** et al. *Nature Communications* 13, 3744 (2022).
[2] Y. Gerelli, **A. Scotti** et al. *Soft Matter*: 20, 3653 (2024).