Experimental report

15/08/2022

Proposal: 9-11-2066 **Council:** 4/2021

Title: SANS with contrast variation measurements of the form factor of soft microgels under flow measured in the 1,2-plane

Research area: Soft condensed matter

This proposal is a new proposal

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Samples: C6H11NO
C6D7H4NO
C6D3H8NO

Instrument	Requested days	Allocated days	From	To
D22	2	2	13/09/2021	15/09/2021

Abstract:

Microgels are soft objects which can deform and/or change their volume depending on the packing fraction they occupy in solutions. This aspect has been largely investigated in bulk by means of SANS with contrast variation to access the form factor of single microgels. The possibility for microgels to be deformed/collapsed also affects the flow properties of these colloidal solutions. For instance, the Cross model, typically used to capture the shear thinning and thickening in colloidal dispersion under shear, fails in reproducing the viscosity vs. shear rate behavior of solutions of ultra-soft microgels. Here, we propose to use small-angle neutron scattering with contrast variation to access the form factors of microgels under shear and verify if deformations of deswelling are present. We propose to use the 1,2-shear cell, available at ILL, to probe the scattering in the velocity ¿ velocity gradient plane that has been shown in the literature to be the experimental set-up more sensitive to bending or deformation of the samples.

Our goal was to use On one hand to probe the structure factors of ultra-soft nanogels under flow and on the other, by means of contrast variation, probe only the form factors of few hydrogenated nanogels in crowded environment. To do so few regular ultra-soft naogels were embedded in a matrix of identical but deuterated nanogels contrast marched in 55 wt% D2O/H2O mixtures. The volume fraction of the hydrogenated ultra-soft nanogels, ζ_H, is kept constant and equals 0.080 ± 0.003 in all the samples measured with SANS with contrast variation. The generalized volume fraction of the deuterated microgels composing the matrix where the hydrogenated ULC microgels are embedded, ζ_D, covers a range of concentrations between 0 and 1.02 ± 0.03. Consequently, the total generalized volume fraction, $\zeta = \zeta_H + \zeta_D$, covers a concentration range between 0.08 and 1.10 ± 0.03.

Due to the low scattering signal in the contrast matched samples, the data were collected for ~ 10 hours during the night. From these data we can extract the particle radius of gyration and observe that no changes in the over all shape is present under flow. In Figure we also reported the evolution of the detector images for the concentrated suspension full contrast. We are currently analysing the 2D and 1D data observing a change in the nearest neighbours distance both in the flow direction and orthogonally to the flow direction. We are comparing our finding with the studies available for hard spheres to understand the role of softness on the flow properties of soft spheres. We are also planning new experiment on D22 using the 1,2-shear cell on other soft nanogels and star-polymers to study shear-induced cristallization under flow.

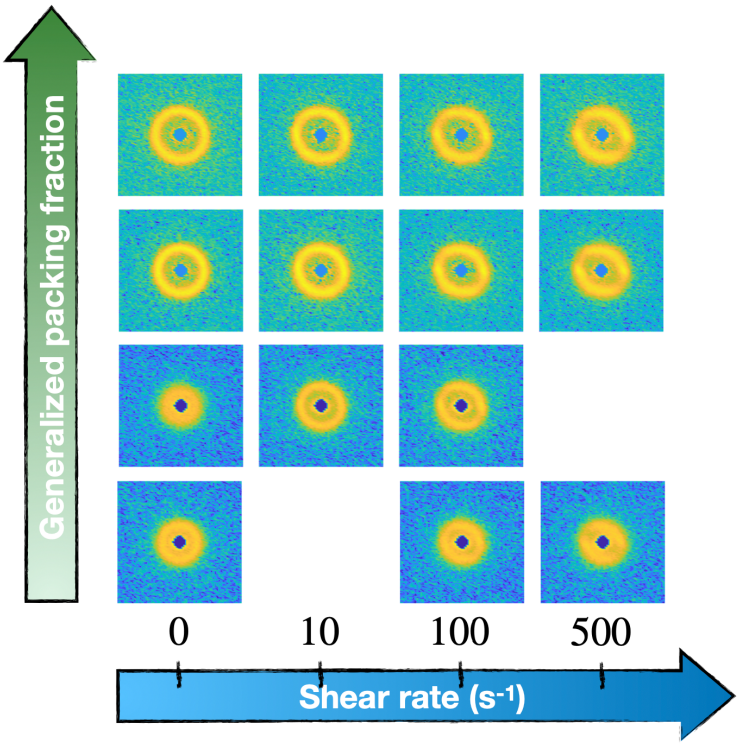

Figure 1 2D SANS detector images as a function of increasing shear rate (left-to-right) and of increasing concentration (bottom to top).