Experimental report

08/01/2017

Proposal: 9-10-1475 **Council:** 4/2016

Title: A rheo-SANS study on the effect ofaspect ratio and stiffness on shear-induced order in rod-like colloids

Research area: Physics

This proposal is a new proposal

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Samples: fd Y21M
wild type fd
pf 1
M13k04

Instrument	Requested days	Allocated days	From	To
D22	3	3	24/11/2016	28/11/2016

Abstract:

The effect of aspect ratio and flexibility on the flow behavior of colloidal rods will be studied by means of rheo-SANS. The alignment of four different monodisperse rod-like bacteriophages will be mapped by their azimuthal angle distribution as a function of shear rate using the shear cell of d22 that allows for scattering experiments in the flow-gradient plane, rendering the degree of flow-induced ordering and orientation. By using phages with varying engineered aspect ratio and stiffness, we will create a data set that can be used as a hall mark for testing theoretical predictions as well as a starting point for understanding mechanical responses of industrial systems.

The goal of this beam time was to clarify the role of geometry and flexibility on the shear induced ordering of rods. For this purpose, we bio-engineered a library of filamentous bacteriophages with different lengths and thicknesses and investigated their behavior under shear flow using the D22 small angle diffractometer (proposal no.: 9-10-1475).

The available shear cell at the D22 was mounted to the beamline in order to probe the orientational ordering of rods in the flow-gradient plane under steady shear. In figure 1, we show the viscosity of Pf1 virus (flexible) versus orientational order parameter in comparison to that of Y21M phage (stiff). It is seen that the flexibility has a strong influence on the achievable ordering under shear. The corresponding influence on the rheological response is very pronounced.

In order to resolve also the process of ordering under extremely low shear rates, we used a new motor/gear pairing which allowed us to decrease the shear rate to 0.5 ms^{-1}. This could result in a clarification of the underlying orientation process, which we hope to be able to attribute either to shear yielding or shear thinning.

For a closer investigation of the orientation of long flexible rods inside the gap, we used the beam-shear cell triggering to measure the orientation of rods in spatial resolution. This information could enable us to rule out or identify the possibility of shear banding in the system.
The triggering was, furthermore, used for time resolved orientation measurements. The corresponding data could elucidate the dynamics of start-up and stop-flow and can be used to identify the relaxation time of the system.

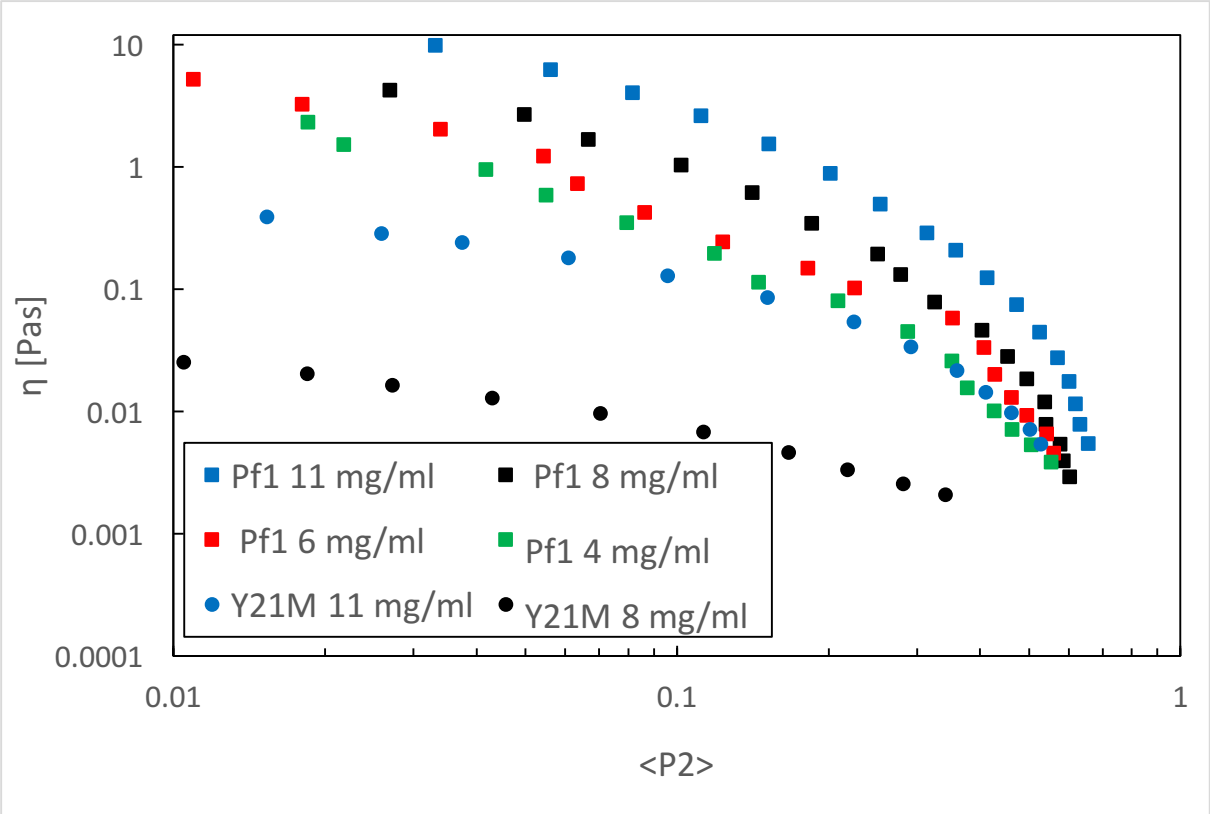

Figure 1 Viscosity vs. Orientational ordering for Pf1 virus (squares) and Y21M virus (bullets).