LABORATORY OF BIOPHYSICS

WAGENINGEN UNIVERSITY & RESEARCH

Rheo- and flow-MRI of soft dispersions

Unilever BRUKER

Flow of soft particle dispersions through sub-mm channels, is all around us, with examples ranging from blood flow through vessels to extrusion in 3D printing of food or organs. However, flow in strongly confined geometries is prone to instabilities caused by complex interactions between the dispersed particles. Correctly predicting such flow properties is key for, *e.g.,* enabling designing suitable processing conditions of pressure or temperature, or for preventing clogging effects during flow [1].

Figure 1: *Sub-mm flow of food dispersions.*

In our group at BIP we have recently developed a novel Magnetic Resonance Imaging (MRI) setup able to probe strongly confined flow in optically-opaque biological fluids (see Fig. 2A). Our sub-mm rheo-MRI setup enables reaching MRI resolutions up to 10 μm, and can be used for characterizing flowing food systems with particle sizes of few hundreds of μm [2]. This is the case for fat dispersions (FCDs) used in the production of *e.g.* chocolate (see Fig. 2B). We discovered that flow properties of FCDs depend on the microstructure, and can be controlled by the crystallization rate [3]. We now aim at exploring how these properties depend on fat concentration and temperature during flow.

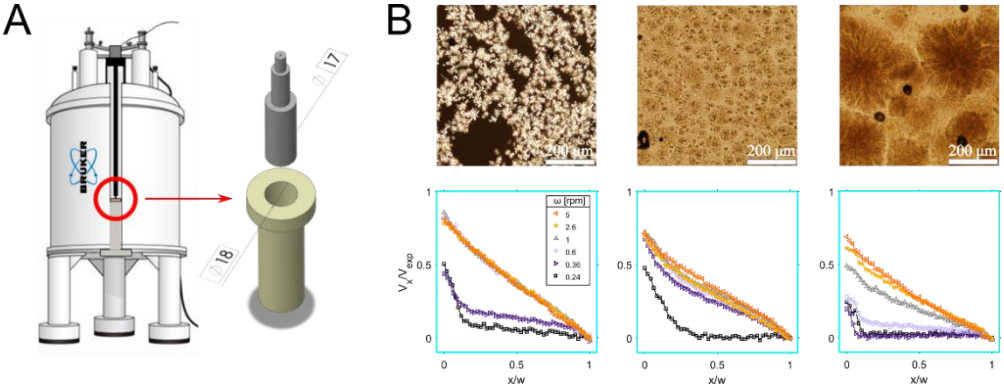

Figure 2*: A) Novel rheo-MRI setup with a sub-mm Couette cell, B) micrographs (top) and velocity profiles (bottom) of FCDs at increasing crystallization rates from left to right.*

We are looking for **BSc** and **MSc thesis** students for:

1. experimentally (and/or theoretically) studying flow in FCDs at varying fat concentration or temperature by sub-mm rheo-MRI and rheology available at WUR;
2. optimizing flow-MRI measurements of biological dispersions or emulsions in microfluidic channels with varying capillary sizes

Data analysis is done using in-house developed scripts (MATLAB). The project offers exposure to industrial partners.

References:

1. Serial et al (2021). Nonlocal effects in the shear banding of a thixotropic yield stress fluid. Accepted in *Phys. Rev. Fluids.*
2. Milc *et al.* (2021). Validation of temperature-controlled rheo-MRI measurements in a submillimeter-gap Couette geometry. *Magn. Reson. Chem.*, 1.
3. Milc *et al.* Cooperative flow of fat crystal dispersions: effect of crystallization rate. In preparation for *Soft Matter.*

Further information:

Klaudia Milc, PhD student

klaudia.milc@wur.nl

dr. Camilla Terenzi

camilla.terenzi@wur.nl