LABORATORY OF BIOPHYSICS

WAGENINGEN UNIVERSITY & RESEARCH

Rheo- and flow-MRI of soft dispersions

Unilever BRUKER

Flow of soft particle dispersions through small (sub-mm) channels, is all around us, from blood flow through vessels to extrusion in 3D printing of food or organs. Interestingly, flow in such narrow geometries is prone to instabilities, caused by particles interacting in a complex way that still remains poorly understood. Yet, correctly predicting such flow properties is key for optimizing processing conditions in, *e.g.*, foods or cosmetics industry.

To capture flow-induced microstructural changes in optically-opaque foods or bio-polymers, in our group at BIP we have developed a range of Magnetic Resonance Imaging (MRI) setups equipped with rotational/translational flow geometries (see Fig. 2A), such as Couette cells (CC) and microcapillaries, with gap sizes ≤ 500 µm. We apply our new flow-MRI techniques to study real-life materials, such as fat crystal dispersions, used during production of chocolate. With our setup it has become possible to unravel microstructural changes in these systems *in situ*, under industrially-relevant processing conditions and as a function of crystallization rate. The next challenge is to quantify and discern the effects of fat concentration, temperature and flow confinement.

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

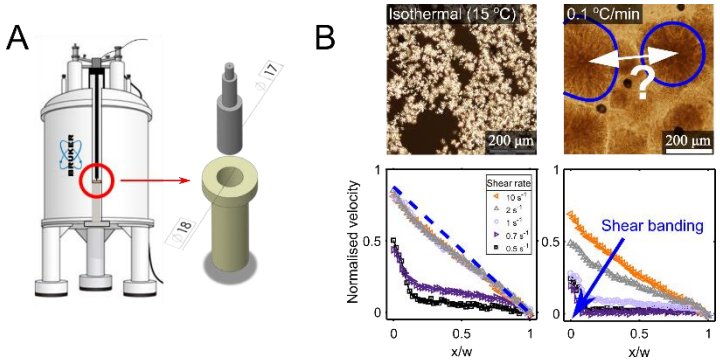

Figure 2 -*: A) Rheo-MRI setup with a 500 µm gap CC; B) micrographs (top) and rheo-MRI velocity profiles (bottom) of two FCD samples*

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 rheo-MRI and standard rheology;
2. optimizing flow-MRI measurements of biological dispersions or emulsions in micro-capillaries with varying diameters.

Data analysis is done using in-house developed scripts (MATLAB). The project offers direct exposure to our industrial sponsors, as well as further opportunities for internships.

References:

1. Milc *et al.* (2021). Validation of temperature-controlled rheo-MRI measurements in a submillimeter-gap Couette geometry. *Magn. Reson. Chem.*, 1.
2. Milc *et al.* Cooperative flow of fat crystal dispersions. In preparation for *Soft Matter.*

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