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Rheo-ND: Temperature and shear induced crystal transformation of a model triglyceride observed using neutron diffraction.

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Rheo-SANS (rheology and small angle neutron diffraction) is now a well-established technique to probe the shape and size of particles under different shear and temperature regimes [1]. Recent work on WOMBAT [2], the high intensity neutron diffraction instrument at the Australian Centre for Neutron Scattering, has successfully combined rheology and neutron diffraction for the first time. This was used to follow the crystalline phase transformations in a model (deuterated) triglyceride.

The initial impetus for this work was part of a forensic investigation [3] linking the crystallisation of triglycerides under high shear rates that are encountered in motor vehicle accidents. However now the technique has been demonstrated it may be of interest to investigate fat crystallization due to shear in food manufacture. Possible applications might include investigation of detrimental crystallisation during conching or tempering of chocolate or extrusion of foods high in fats (string cheese ?).

![Figure 1 - Diffraction data collected from the shear cell during cooling and shearing at 1000 s⁻¹, colours give the intensity of the diffraction pattern (left axis) and the black squares chart the measured viscosity (right axis). This demonstrates the ability to track crystallisation in situ under high shear rates.][1]

The high neutron flux and detector efficiency available at WOMBAT is instrumental in allowing diffraction patterns to be collected from the small sample volumes available in the Couette cell geometry. The Couette cell used has a sample gap of 1mm and was mounted tangentially to the neutron beam. The shear rate applied to the sample can be varied over a range of 10-2500 s⁻¹ and the temperature can be controlled using an external water jacket from between -10 and 80 °C. We invite other researchers who are interested in this capacity to contact us about possible experiments.

1. Tabor, R.F., Zaveer, M.I., Dagastine, R.R., Grillo, I and Garvey, C.J., Phase Behavior, Small-Angle Neutron Scattering and Rheology of Ternary Nonionic Surfactant-Oil-Water Systems: A Comparison of Oils, *Langmuir* 29(11), 3575-3582 (2013)
2. Studer, A.J., M.E. Hagen, and T.J. Noakes, Wombat: The high-intensity powder diffractometer at the OPAL reactor. *Physica B: Condensed Matter*, 2006. 385-386, Part 2(0): p. 1013-1015.
3. Stuart B, Thomas P, Maynard-Casely H, Booth N, Leung A, A neutron diffraction investigation of shear forces on a model lipid for forensic application, ANZFSS 23rd International Symposium on the Forensic Sciences, September 2016, Auckland

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