INDUSTRIAL PILOT PROJECT

Exploring Rheo-SANS for deducing structure and orientation of particles in paints under flow

THE INDUSTRIAL CHALLENGE

Linking the nano-scale structure to the macroscopic flow behavior is believed to be an important guide in the development of coatings for specific applications, for example when producing acoustic surfaces. For Saint-Gobain Ecophon there is therefore a need for industrially useful advanced tools for characterizing thixotropic industrial paint systems.

WHY USING A LARGE SCALE FACILITY

Small angle neutron scattering (SANS) allows for structure characterization on the nano-scale, 1 nm - 1 µm. Due to the isotope dependence of neutron scattering it is possible to effectively hide or highlight certain parts of an aqueous formulation, such as a water-based paint, by partially exchanging the H2O with D2O. At only a few neutron facilities, a combination of SANS experiments and rheological measurements is available (Rheo-SANS), enabling information gathering on nano-scale structures formed in the paint under flow.

HOW THE WORK WAS DONE

A model system of an industrial paint with relevant rheological behavior was investigated by Rheo-SANS at the SANS1 beamline at the Swiss neutron spallation source (SINQ), Switzerland, with assistance of instrument scientist Joachim Kohlbrecher.

Figure 1. Rheo-SANS experiment with a white paint under shear in the central upright standing cylinder. The neutron beam comes from the right side through the red and blue colored apperature and continues through the sample. Scattered neutrons pass the left circular window before detection by a 2D detector.

A stress-controlled rheometer was placed in the neutron beam on a movable table, enabling scattering measurements at different positions of the sheared sample. The H2O/D2O composition of the samples were chosen to highlight the scattering signal from the latex binder.

THE RESULTS AND EXPECTED IMPACT

At applied continuous shear, a weak anisotropic scattering pattern was visible. Figure 2 shows the angular dependence of the scattered intensity in the velocity-vorticity plane.

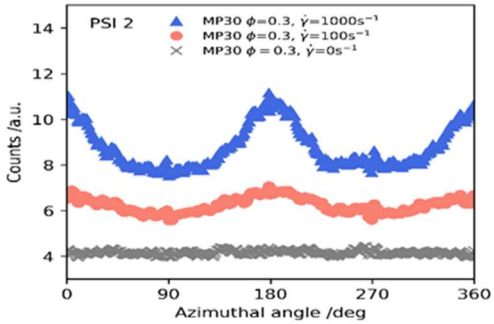

Figure 2. Ordering of particles in the paint was demonstrated as an anisotropic scattering pattern. The graph shows the radially integrated scattering intensity as a function of azimuthal angle.

This shows that the applied shear induces an anisotropy in the binder particles of the model paint on the 100 nm length scale. The specific ordering of the binder particles has not yet been possible to deduce, but the extension of binder material occurs along the flow direction. Upon the cessation of shear, the anisotropy is gone within a single frame of a scattering experiment (30 s). It became clear that previously non determined parameters play a large role in the collective rheological behaviour of the paints.

A specific set of measurements were chosen to be implemented in future paint characterization. When the data have been fully analysed the results will be disseminated inside Saint-Gobain Ecophon, which can lead to continued use to develop new sustainable building materials.

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