ESRF	**Experiment title:** Alignment and disalignment in complex flow fields	**Experiment number**: MA-580
Beamline: ID11	**Date of experiment**: from: 15 April 2009 to: 21 April 2009	**Date of report**: January 2010
Shifts: 18	**Local contact(s)**: Jon Wright	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Professor Adrian Rennie*, Department of Physics, Uppsala University, Sweden

Dr Jeremy K. Cockcroft*, Department of Chemistry, University College London, UK

Mr Junaid Qazi,* Department of Physics, Uppsala University, Sweden

Alignment of plate like particles under flow has been measured for different materials and flow geometries. The two sizes of particles were studied independently and as mixtures. High energy diffraction allows the orientation to be mapped for each material with a resolution under 10 μm. Results from a single scan are shown in the attached report to illustrate the analysis. Full details will appear in a forthcoming manuscript.

Aims and scientific background

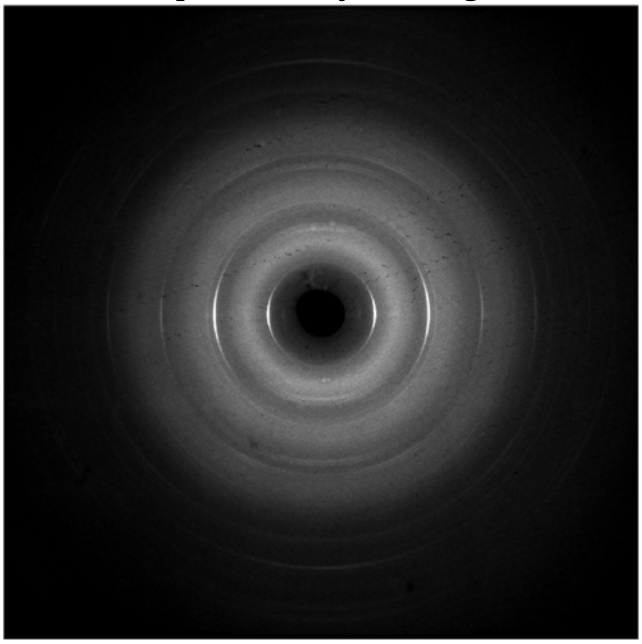
Many challenges in process engineering arise from transport of materials. Understanding flow can lead to both enhanced materials as there is control of interactions and energy savings. High energy X-rays have been demonstrated to be a powerful tool as they can be used to penetrate thick samples under realistic flow conditions. Previous work has studied dispersions of kaolinite in various engineering flows such as through a nozzle and at a bend in a pipe [1, 2]. Other studies have looked at the flow in conditions of simple shear [3]. The present experiment was devoted to studies of rectangular section pipes (see Figure 1) and nozzles with samples that consisted of approximately cylindrical plates of different sizes

(small $Ni(OH)_2$ particles and larger kaolinite crystals) used separately and in a mixture. The particles are all single crystals with a defined orientation with respect to the morphology. Diffraction intensity from particular Bragg peaks is therefore an excellent means to determine the alignment distribution. High energy photons diffract at low angles and are able to penetrate thick samples. The small spot size (16 µm horizontal by 8 µm vertical) allows scans of flow cells to be made and the effects of geometry near the wall and in the vicinity of a nozzle to be determined.

Results

Figure 1. Uniform Rectangular flow cell made of polycarbonate. The cell thickness is 3 mm, width is 10 mm and the length is 50 mm. Other measurements were made with nozzles of different dimensions at the centre of the cell.

The sample was recirculated through the cell and data collected in different orientations and in different positions by scannig the cell across the beam.



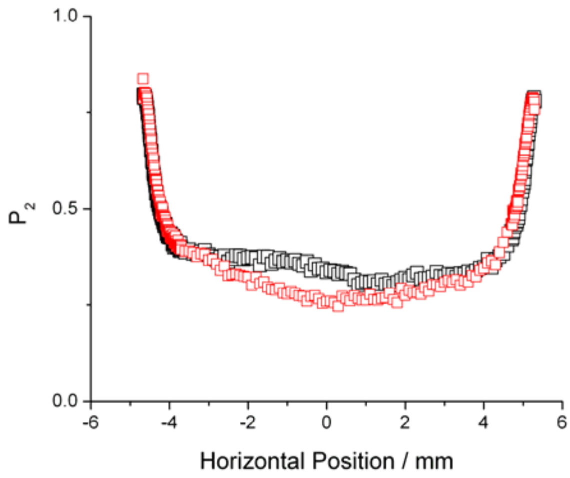


Figure 2 (a) Typical diffraction from 8% kaolinite in water at a flow rate of 1.5 ml s^{-1}

(b) Order parameter P_2 calculated for diffraction patterns in a scan across the cell for conditions as in (a). Red: 10 mm from inlet. Black: across centre of cell.

The data shown are being compared with finite element simulations so as to correlate alignment and order with the flow. Measurements with single and 5 nozzles as well as different flow rates will be described in the forthcoming manuscript.

References

1. Rennie, A. R., Barè S., Cockcroft J. K., Jupe A. C. J. Colloid Interface Science **293**, 475-482 (2006).
2. Report on ESRF Experiment MA-160. A. R. Rennie et al.
3. A. B. D. Brown, S. M. Clarke, P. Convert, A. R. Rennie, J. Rheol. **44**, 2000.