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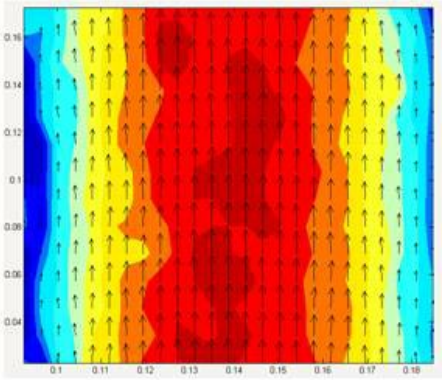
Fundamental Engineering Science

a) Understanding interfacial phenomena is the key to controlling the microstructure of solids and fluids and for ensuring stability. Current projects examine:

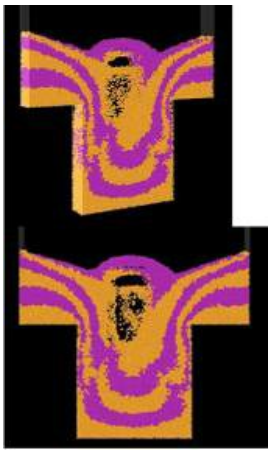
- Soft solids behaviour.
- Interfacial and bulk mechanics of particulate systems and thin films of structured fluids. Real-life applications range from high-throughput screening for rheology through to human skin tribology.
- Fundamentals of how geometric confinement affects structured fluids and thin film rheology.
- Measurements and theory of liquid bridges, including the first demonstration and theoretical explanation for hysteresis.



Velocity contour of a fluid inside a rectangular micro-channel (cross section 100 μm). Data obtained by micro PIV in order to study deviations from what would be expected in large channels.

b) In particulate processing, the application of Discrete Element Method (DEM) and Birmingham's unique Positron Emission Particle Tracking (PEPT) equipment are key techniques for providing fundamental scientific insight into particulate behaviour. Projects and achievements include:

- The use of coupled DEM/CFD for understanding granular flow and agglomerate impacts, through incorporating true contact physics.
- Validation of DEM and CFD codes.
- Development of first PEPT tracer below 100 um and the world's first mobile PEPT facility, which has allowed on-site industrial evaluation of mixing, fluidisation, agglomeration, and vibrating bed behaviour.

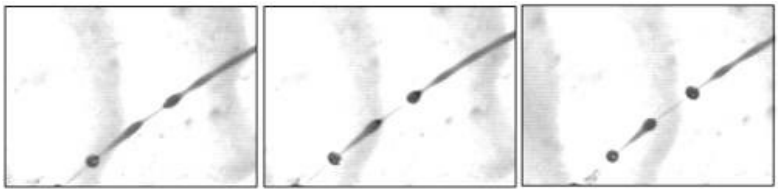


Our other key research areas relating to particulate behaviour and properties include the fundamental science of adhesion and self-assembly of particles and the characterisation of soft solids.

The latter currently involves measurements of mechanical properties and structures using micromanipulation and innovative environmentally-controlled nanomanipulation – both techniques were developed within the Department.

c) Flow and mixing research covers both conventional and micro scales and is key to examining everything from in-process behaviour of materials through to cellular interactions within the human body. Projects include:

- **Fluid Mechanics (/research/activity/chemical-engineering/speciality-products/fluids/index.aspx)**
- Novel uses of PIV (at conventional and micro level) to study gas-liquid capillary flows.
- First exploitation of PEPT to study viscous flows and high solid-fraction pipe flows.
- Experimental and modelling studies of two-phase flows, especially thin-film coating and droplet jets.



Break-up of non-Newtonian spiralling liquid jets

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