IMPACT OF THE ROUGHNESS OF THE WALL ON THE FLOW OF EMULSION IN A MICROCHANNEL

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Soft glassy materials (concentrated emulsion, foams, concentrated polymer solutions…) present rheological properties between solids and liquids. Under small stress they stay elastic but at stress higher than a yield stress they begin to flow as a liquid. Those fluids present great interest for industrial application.
We study concentrated emulsion. Our emulsion is made with droplets of silicone oil in water-glycerin phase. The diameters of our droplet are about 5 µm and the concentration in oil is between 70% and 85%. To get a transparent emulsion we control the water-glycerine ratio to adapt the refractive index of the water-glycerin solution to the oil's index. In wide geometry, the flow of the emulsion is characterized using a classical rheometer and by performing local measurements of the velocity (M.R.I or ultrasound velocimetry).
Using microchannels with a height of 100 µm and a length of several centimetres we can create a poiseuille flow in confined geometry. In this simple geometry, the field stress depends only upon the drop of pressure and on the position in the microchannel. We measure the velocity profiles using a micro-PIV set up. Strikingly, velocity profiles do not correspond to predictions using rheometer measurement. The fluidity –i.e. the inverse of viscosity- obeys to a non-local equation. Rheological properties depend not only on local condition –as we measured in a rheometer- but also on the behaviour of the neighbourhood of the point. Flow in concentrated emulsion occurs through a cooperative process which correlation length is comparable to the size of the droplet (~10 µm).
So walls should have an important impact because they set the boundary condition for the fluidity. To quantify the impact of the walls, we control their roughness by photolithography. When we increase the roughness we decrease the slip velocity but we also increase the fluidity. Furthermore, we performed confocal microscopy. By specific coloration of one phase, we are able to visualise directly the droplets. This new method gives a more precise measurement of the velocity. Stratification of the flow is observed for high stress. In this case, a continuous description of the flow fails in the first ten microns.