



	<b>Experiment title:</b> Colloid stabilized fluid-bicontinuous gels	<b>Experiment number:</b> SC1856
<b>Beamline:</b> Troika ID10C	<b>Date of experiment:</b> from: 16/11/05                      to: 21/11/05	<b>Date of report:</b> 28/02/06
<b>Shifts:</b> 18	<b>Local contact(s):</b> Dr. Aymeric Robert	<i>Received at ESRF:</i>
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Report:

We are studying silica particles trapped at oil-alcohol interfaces. Many alcohol-oil pairs are immiscible but can be emulsified using colloidal particles. If small particles with a surface that is easily wetted by both liquids are added to the system these particles can replace some of the expensive liquid-liquid interface by positioning itself on the interface. The change of interfacial energy is  $\Delta G = \pi r^2 \gamma (1 \pm \cos(\theta_w))$ . The larger the displaced interfacial area, the stronger the trapping. If  $\theta_w$ , the wetting angle, is  $90^\circ$  the particle has its equator at the interface which is the largest possible area of displacement and hence strongest trapping. For a half micron diameter particle in a system with typical interfacial tension  $\gamma$  of around  $1 \text{ mNm}^{-1}$  the trapping energy is of the order of  $10000 k_B T$ . This energy barrier implies that the particles are irreversibly adsorbed at the interface.

Mechanical agitation allows particles to be collected at the interfaces. Once particles have been trapped on an interface and are jammed against each other it is too costly to decrease the interfacial area any further and a stable emulsion is obtained. Instead of using mechanical agitation we have shown that by exploiting the fact that some liquid-liquid systems exhibit both miscible and immiscible phases, it is possible to use demixing processes to create emulsions by temperature quenching the sample[1]. Additionally, we have shown that it is possible to obtain a novel convoluted oil-alcohol emulsion when using a fast temperature quench to demix the liquids[2].

We are very interested in how the stabilizing particles pack on the interfaces and whether they are a solid, glass or liquid. We are also keen to learn about the dynamics of the particles and how this ties in with the fact that over time the droplets

cream to the surface and start joining together to form a network reminiscent of foam structures. To study these properties conventional light scattering is unsuitable due to the high opacity of the samples. Furthermore it is necessary to have a large Q-range with very good statistics. This is possible at the Troika beamline with 2D-XPCS.

During this initial experiment the aim was to test the feasibility of the measurements. To simplify the experimental method we primarily studied water-dodecane emulsions. Before putting the samples into the beam we examined them under the microscope available at ID10C. We were able to collect data for different sizes of particles allowing us to sample the dynamics from individual particles to the dynamics of emulsion droplets. We intend to elucidate the importance of the size of the particles which is directly related to the energy of trapping.

We characterised the dynamics for wavevectors Q ranging from  $10^{-3}$  to  $10^{-2}\text{\AA}^{-1}$  for six samples. Intensity auto-correlation functions were calculated from the recorded CCD frames using a multi-tau, multi-Q correlator software[3]. They can be fitted with a stretched exponential where the stretching exponent is found to be about 1.1 while Cipelletti et al [4] observed 1.5. This could be an indication that the particles are in a gel state. A typical correlation function is shown in Fig. 1 (left). An initial evaluation of the data shows that the characteristic relaxation time  $\tau$  decreases as  $Q^{-1}$  as presented in Fig. 1(right), which has been previously found for emulsions[4]. The results presented here are only indicative and a more substantial analysis is currently carried out.

The results obtained so far show the extreme suitability of the 2D-XPCS technique (only available on ID10A/C) for the investigation of these dynamic processes. When we changed from water/dodecane to methanol/hexane samples, we had problems with leakages and subsequent drying out of the samples. This could be avoided by using a different sealing agent allowing to measure them in a future experiment.

We received outstanding support and advice from Aymeric Robert during and after the experiment making the measurements the success they are.

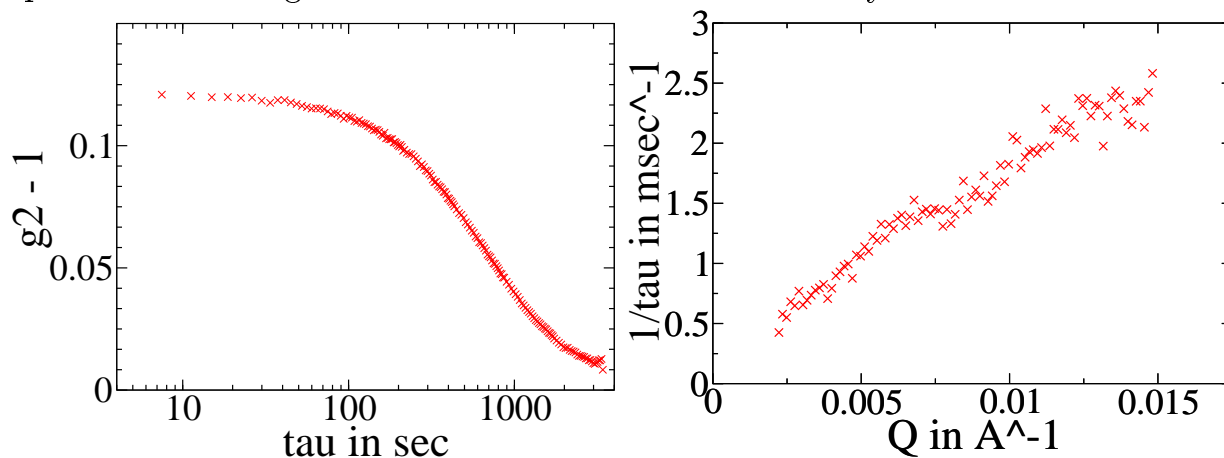


Figure 1. (left) Example of a calculated correlation function for a water/dodecane mixture with 60nm diameter silica particles. (right) Q-dependence of the characteristic relaxation time.

## References

- [1] Clegg et al., J.Phys: Cond.Mat., **17**, S3433 (2005)
- [2] Clegg et al., Phys. Rev. Lett., (submitted)
- [3] Cipelletti et al., Rev. Sci. Inst., **70**, 3214 (1999)
- [4] Cipelletti et al., Faraday Discuss. **123**, 237(2003)