Shearing colloidal vapour - liquid interfaces: Phase separation and fluctuations

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We present a real space study of phase separating colloid-polymer mixtures undergoing shear flow. The interfacial tension associated with the interface between the colloidal gas phase (poor in colloids, rich in polymers) and the colloidal liquid phase (rich in colloids, poor in polymers) in these mixtures is ultra low (nanoN/m – microN/m). This gives rise to a slow de-mixing process on one hand, and very large interfacial fluctuations, on the other hand. Both these properties make the system very suitable for a study by means of a confocal microscope, which we use in combination with a homebuilt counter rotating shear cell.

First of all, we will focus on the de-mixing process while a shear flow is applied. The system is quenched from an initially almost homogeneous state at very high shear rate to a much lower shear rate. A spinodal decomposition pattern is observed. The domains become highly stretched along the flow direction, and the domain width along the vorticity axis reaches a stationary size: The higher the shear rate, the thinner the bands.

In the second part, we investigate the effect of shear on the interfacial fluctuations after the phase separation process is completed. It will be shown that, surprisingly, flow strongly suppresses thermal interfacial fluctuations. To explain this, a simple model based on the idea that shear mostly affects the slow fluctuations, is presented.