ESRF	**Experiment title:** 2D shear-melting and crystallization of infinite surfactant cylinders	**Experiment number**: SC739
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Report:

We are interested in the shear-induced structures of a soft hexagonal phase of surfactant. In previous experiments (SC610), we have shown that a high shear induces the melting of the long-range two-dimensional order of the cylinders, leading to a 2D liquid of cylinders strongly aligned along the flow. Moreover, the abrupt cessation of the high shear results in the formation of a monocrystalline sample of hexagonal phase. In these experiments, we have studied the time evolution of the spectra following the cessation of shear, in order to obtain information on the kinetics of both the crystallization of the 2D liquid of very long cylinders, and of the evolution from a polycrystal to a monocrystal.

Time-resolved scattering profiles were recorded in two planes, one containing the vorticity and the velocity directions (radial geometry), and the other one containing the vorticity and the velocity gradient directions (tangential geometry). We have checked that both configurations give analogous results, as far as the crystallization kinetics is concerned. Results obtained in tangential geometry are commented in this report.

A series of three tangential patterns is reported in Fig. 1, which shows the evolution from a isotropic ring (corresponding to a liquid phase of aligned cylinders) to a 6-fold symmetry, characteristics of a "monocrystal" of hexagonal phase. We have performed azimuthal scans of the patterns at a **q**-vector corresponding to the first order diffraction; the time evolution of width at half maximum $\Delta\theta$ is reported in Fig. 2. At short times ($t<0.3$ sec),

the signal remains isotropic ($\Delta\theta$ =60 deg) while at longer times, a continuous decrease of $\Delta\theta$ is observed, down to value of a few degrees, which corresponds to a monocrystal morphology. Concomitantly, the width Δq of the first order diffraction peak decreases. Δq can be interpreted in terms of an increase of the size of the "crystallites". The time evolution of the domain size is reported in Fig. 3, and shows, for t>0.3 sec, a logarithmic variation with time.

We have always found the same critical time t=0.3 sec (see Figs 2 and 3), suggesting that it is more likely related to an experimental intrinsic time (such as the time to eliminate any backflow afetr cessation of a high shear, of the order of 1200 sec^{-1}) rather than a nucleation time. Thus, our experiments suggests a homogeneous crystallization and indicate that the shear melted phase is indeed unstable. The homogeneous crystallization results presumably from an epitaxial growth starting from the cell walls. The logarithmic increase of the domain size remains to be modeled.

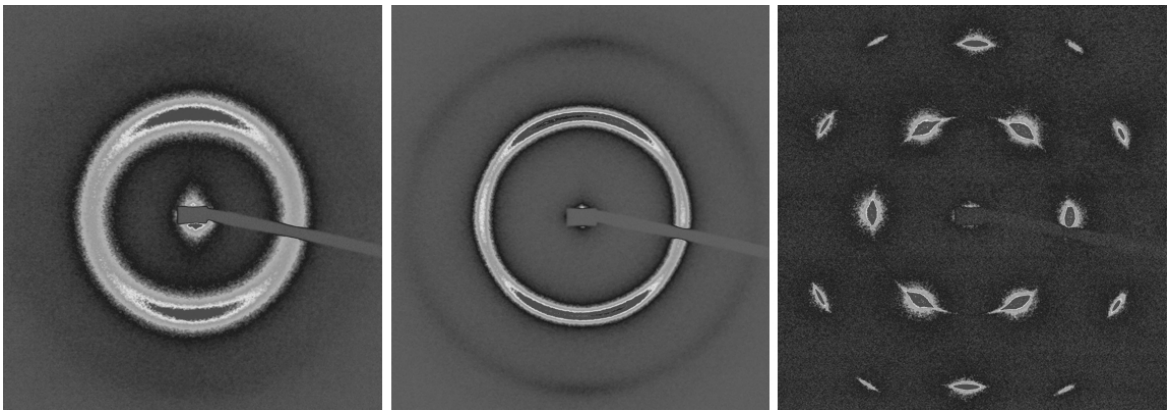

Fig. 1: *Tangential SAXS patterns; the time evolved after cessation of shear is from left to right 35 msec, 425 msec and 131 sec.*

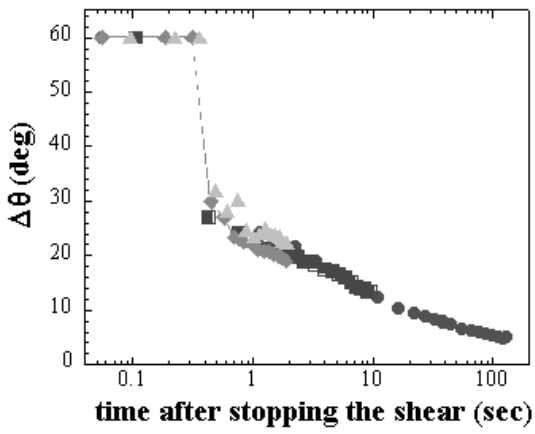

Fig. 2: *Width at half maximum of an azimuthal scan of a tangential pattern as a function of time. Different symbols correspond to different experiments, and show the good reproductibility of the data.*

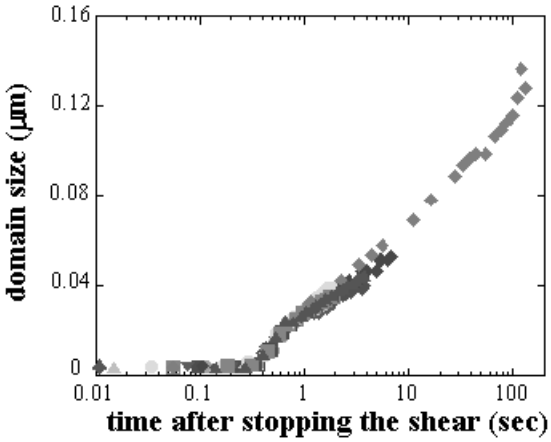

Fig. 2: *Domain size of the crystallites as a function of time. Different symbols correspond to different experiments, and show the good reproductibility of the data.*