



Experiment title: Flow properties
of soft crystals: the case of a bcc
cubic lattice

Experiment
number:
SC 401

Beamline:

Date of Experiment:

from: April 17 1998 to: April 20

Date of Report:

Shifts:

Local contact(s):

Olivier DIAT

Received at ESRF :

Names and affiliations of applicants (*indicates experimentalists):

| | | |
|---------------------|----------------------------|------------|
| Gregoire PORTE | Universite' Montpellier II | } (France) |
| François MOLINO | Same | |
| Erika EISER | Same | |
| Chris TOPRACKSIOGLU | University of Patras | (Greece) |
| Olivier DIAT | ESRF | |

Report:

The goal of the experiment was to compare the behaviour under steady shear of well ordered cubic mesophases of different symmetries: **fcc** and **bcc** respectively. These cubic phases are obtained from weakly amphiphilic triblock copolymers (polyoxyethylene / polyoxypropylene / polyoxyethylene) which spontaneously self assemble in water into spherical micelle having a dense POP core and a diffuse POE corona. At sufficient concentration these micelles pile up into well ordered cubic mesophases. The nature (**bcc** or **fcc**) of the lattice depends on the relative length of the POE and POP moieties. In a former experiment SC155 conducted in April 1996 we characterized in details the structural evolution under shear of the **fcc** cubic phase obtained from the Pluronic F108-copolymer (see experiment report: SC155): a very progressive alignment of the scattering pattern could be interpreted in terms of a progressive transformation of the initial polycrystalline texture into the so called "layer sliding" regime.

The experiment during run no SC401 worked beautifully. We characterized in a similar manner the response to shear of the **bcc** cubic phase from the Pluronic F68-copolymer. In the radial geometry (X-beam along the direction of the velocity gradient of the shear cell), we distinguish two distinct regimes depending on the imposed shear rate: below 1 s^{-1} , we observe a weakly oriented powdered texture for which the bragg spots have a banana like angular distribution (fig 1a); above 100 s^{-1} , we have a fully oriented sample (fig 1c) with Bragg peaks having sharp angular positions: this is the layer sliding

regime for the **bcc** structure. In the cross over domain (1 s^{-1} to 100 s^{-1}) between the two regimes, the scattering patterns (fig 1b) consist of the weighted sum of the signatures of the two pure regimes: so clearly we have coexistence of the powdered texture and the layer sliding texture in distinct bands inside the sheared sample. Interestingly, the texture coexistence precisely correspond to the shear rate range where the stress response to increasing shear rates levels off and stays nearly constant (fig 2). This texture coexistence at constant stress is thus very analogous to the phase coexistence at constant chemical potential in a binary mixture undergoing a first order phase separation. In this respect the behavior of the **bcc** structure differs markedly from that of the **fcc** structure for which the structural change upon increasing rates is very progressive. This very interesting analogy with a phase transition is under current theoretical investigation.

fig 1

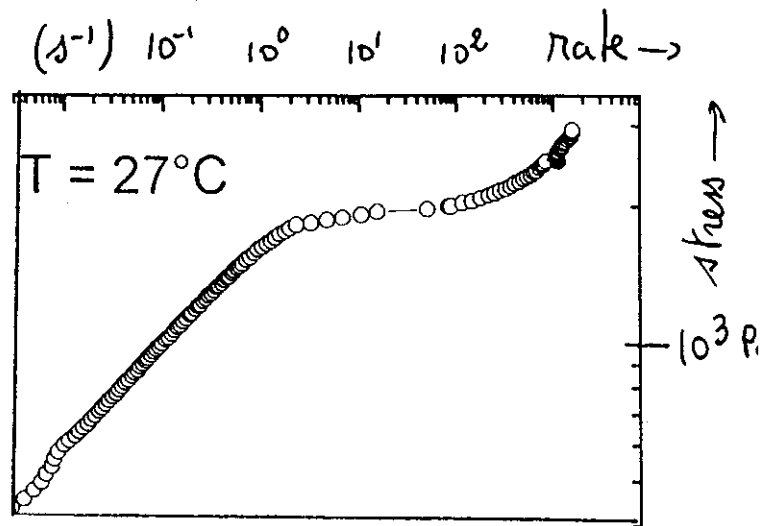
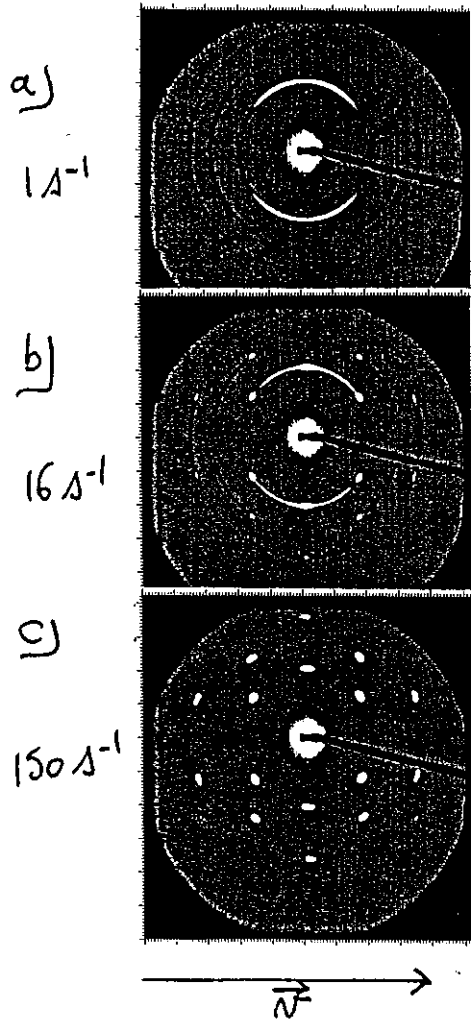


fig 2