ESRF	**Experiment title:** **Colloidal quasi-crystals with exceptional diffraction symmetry**	**Experiment number**: SC 3366
Beamline: ID02	**Date of experiment**: from: 27.07.2012 to: 30.07.2012	**Date of report**: 25/09/2014
Shifts: 9	**Local contact(s)**: Dr. Peter Bösecke	*Received at ESRF:*

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Report:

Soft colloidal crystals consisting of building blocks, such as micelles or mesogens, can form highly ordered lyotropic and thermotropic liquid phases, thereby tolerating imperfections in size and shape. Such systems are highly susceptible to shear. The aim of the proposal was to study poly(isoprene-*b*-ethylene oxide) block copolymer micelles in the quasi-crystalline phase, which should occur near the order-disorder phase transition. To get a deeper insight into the periodic structure and to distinguish between quasi-crystal and multidomain structures resulting from twinned, nonrotated and rotated fcc layers, measurements normal and parallel to the rotation axis are performed by scanning through the shear cell of the ID02. The beam size was set to ca. 0.2 mm x 0.4 mm.

In the performed shear-experiments on aqueous solutions of PI-PEO block copolymer gels we found highly ordered lyotropic liquid crystalline FCC phases, but no quasi-crystaline order. The mechanical properties of soft crystals are determined by the number and mobility of defects. A special defect is twinning. Usually twins occur as small adjacent grains within multi-domain crystals. By analysing the data we could show that macroscopic Siamese twins can be induced by abrupt cessation after high shear strains. The twin structure of PI-PEO micelles was probed by scanning the gap of the shear cell in detail. The different twins develop from a specific location inside the shear cell (inner and outer region of the gap) and expand over the whole gap. The twin boundary is located in the centre region of the shear cell. The results are used to propose in analogy to the plastic deformation of nano-crystalline metals a mechanism for the twin formation (fig.1). This mechanism heals defects and leads to two twins with a common twin plane. Both twins fill the whole volume of the cell, as observed in our experiments.

The results obtained during this beamtime are published in lit [1]. This article was choosen as blog Hot paper (Soft Matter, August 2013, http://blogs.rsc.org/sm/2013/08/07/hot-papers-for-august/).

[1] Sara Mehdizadeh Taheri, Sabine Rosenfeldt , Steffen Fischer , Peter Bösecke, Theyencheri Narayanan, Peter Lindner, Stephan Förster, *Shear-induced macroscopic "Siamese" twins in soft colloidal crystal, Soft Matter 9,* 8464-8475 (2013)

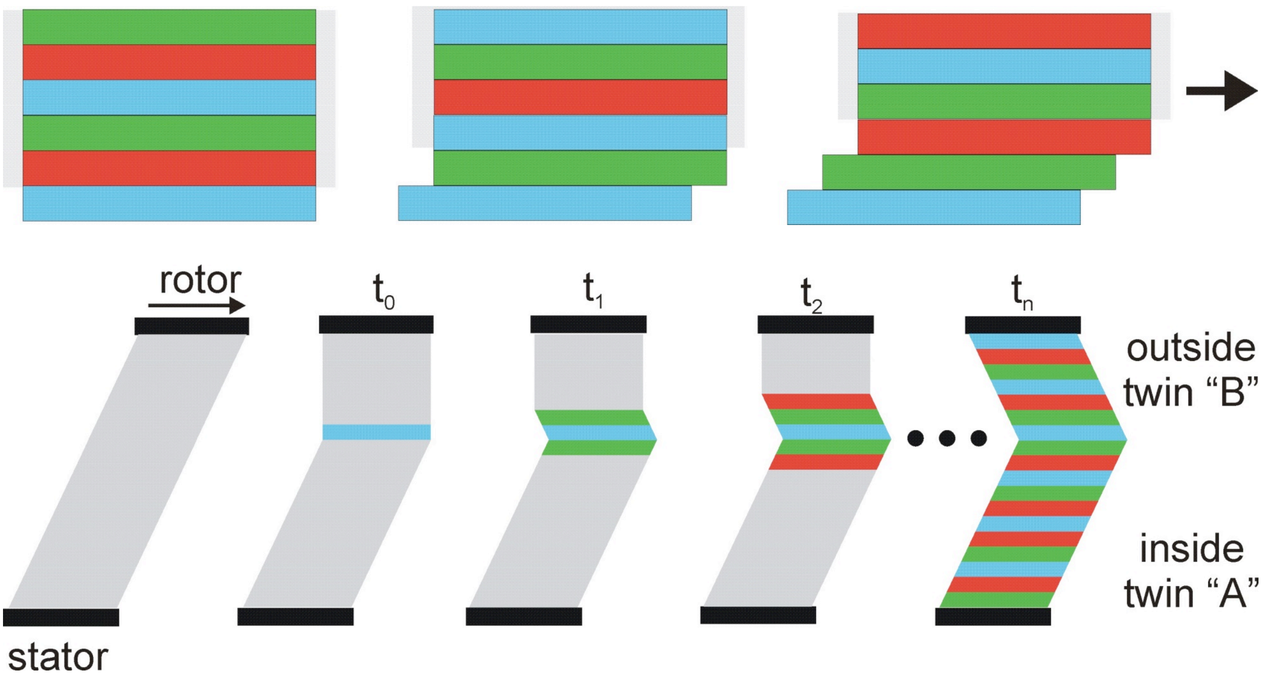

Fig. 1:
Top: Effect of sliding the (111)-layers in (110)-direction. High shear rates in continuous shear result in a constant and stationary velocity gradient. The mutual movement of the hexagonally (111)-layers of the micelles in shear direction [110] can process by layer sliding during the shearing with no defined stacking sequence.
Bottom: Development of a twin after sudden cessation of the shear. The sudden stop of the rotor leads to large shear strains in the still moving layers in the gap center. After stopping the rotor at some position in the gap the strain reach a critical value. At this location deformation twinning is induced, which quickly reveals the local stress. The sliding mechanism will fast and stepwise relief the strain. The resulting stacking sequence corresponds to a macroscopic Siamese twin. With time, the twinning plate grows thicker. The twin grows toward the outer regions until the gap is filled with a macroscopic Siamese twin.