Experimental Report

16/05/2014

Proposal: **9-10-1298** **Council:** 10/2012

Title: Micellar quasicrystals with lattice parameters in the range of visible light

This proposal is continuation of: 9-11-1431

Researh Area: Soft condensed matter

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Samples: PI-PEO D2O

Instrument	Req. Days	All. Days	From	To
D11	3	3	24/05/2013	27/05/2013

Abstract:

The proposed experiment is dedicated to block copolymer micelles capable of forming quasicrystalline structures at high volume fractions. The block copolymers of interest consist of a PI (poly-isoprene) core-forming block and a significantly longer PEO (poly-ethyleneoxide) block which forms the micelle corona. Besides FCC type structures, 12-fold and 18-fold symmetric structures are expected to be found upon shear orientation depending on temperature and concentration.
The block copolymers we want to analyze in this experiment are significantly larger compared to polymers used in our previous experiments. The main objective of the proposed experiment is the identification of quasicrystalline structures with lattice constants in the visible wavelength regime.

Micellar quasicrystalls with lattice parameters in the range of visible light

During the experiment two types of Pi-PEO micelles were investigated. One with large lattice constants of about 400nm and also a system comprised of smaller micelles. Both systems were sheared using the Anton paar system utilizing the titanium rotating cylinder and a hollow quartz cylinder as stator. During the three days of measuring time different concentrations of pre-prepared polymer- D_2O gels were sheared to form fcc type crystalline structures and subsequently cooled and sheared to obtain quasicrystalline phases. The large micelles proved particularly difficult in this respect as the mixture would crystallize only very slowly and also the phase transition took very long. Due to this fact we were not able to obtain a scattering pattern that shows 12 equidistant peaks as one expects for a quasicrystalline phase with the large micelles. But we could show that also these micelles crystallize under shear and as can be seen in Fig.1 the onset of at least two peaks at the expected positions is visible. With the second set of smaller micelles we wanted to further investigate the phase-transition from fcc to Q12 and in this we were successful. We were able to record six different scattering patterns showing the transition from fcc to Q12 while cooling and shearing as well as for cooling alone. These experiments showed that the phase- transition is mainly governed by temperature and shear only helps to find the optimal positions of the micelles faster.

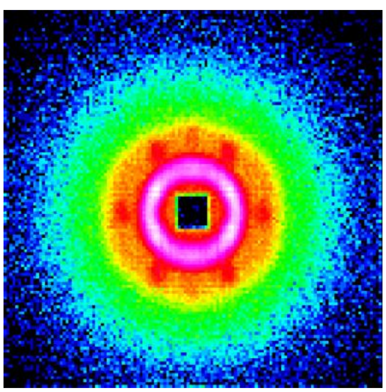

Figure 1: Onset of Q12 phase with large micelles

The experiments show very nicely that given enough time also very large very soft micelles can arrange in the same way as their smaller counterparts. The main influence to the formation of the 12-fold quasicrystalline phase is the size and stiffness of the PEO shell which changes slightly with temperature. Further proposals and experiments with different sized PEO shells are planned in the future.

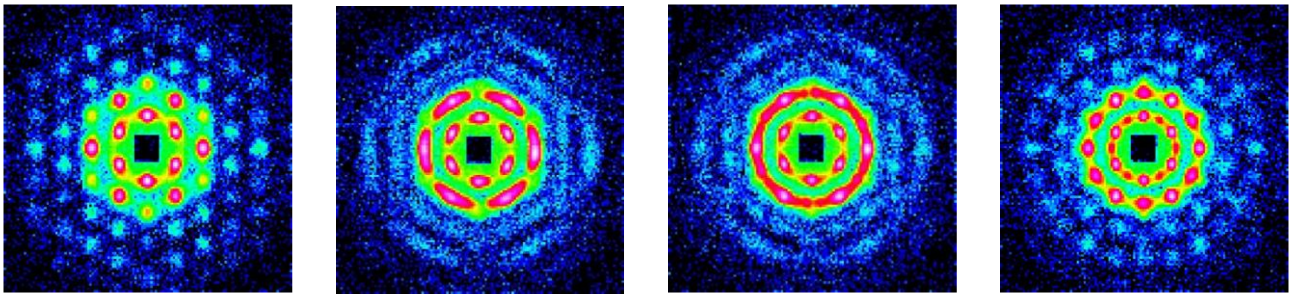

Figure 2: The development of the quasicrystalline phase out of an fcc phase. The temperatures from left to right are 35,25,20 and 10°C. After cooling the sample was sheared for 300s.

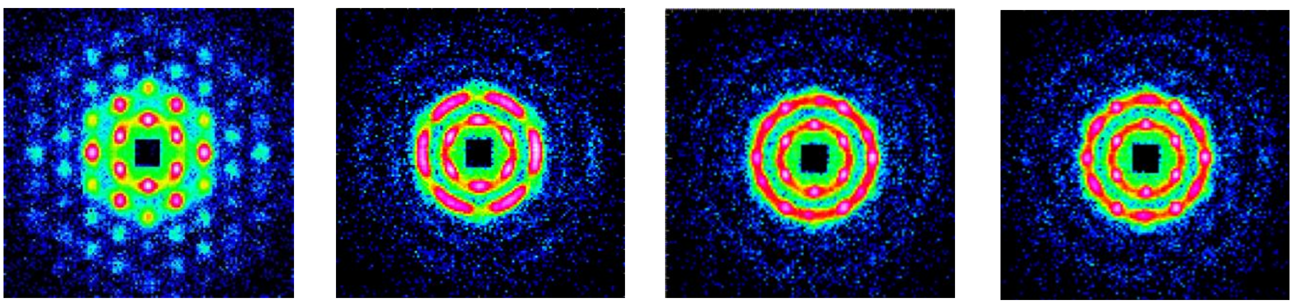

Figure 3: The development of the quasicrystalline phase. The temperatures from left to right are 35,25,20 and 10°C. This sample was not sheared after the initial fcc structure was obtained.