Experimental report

16/01/2020

Proposal: 9-10-1583 **Council:** 10/2018

Title: Understanding the formation of colloidal quasicrystals

Research area: Soft condensed matter

This proposal is a new proposal

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Samples:
1wt (50% (C5H8)210(C8H8)154OH und 50% (C5H8)210(C8H8)154C13H19O3N5) in C12D14O4
0.5wt (50% (C5H8)210(C8H8)154OH und 50% (C5H8)210(C8H8)154C13H19O3N5) in C12D14O4
25wt (C5H8)210(C8H8)154OH in C12D14O4
20wt (70% (C5H8)210(C8H8)154OH und 30% (C5H8)210(C8H8)154C13H19O3N5) in C12D14O4
25wt (C5H8)210(C8H8)154OH in 80%C12D14O4 und 20%C12H14O4
25wt (C5H8)210(C8H8)154OH in 60%C12D14O4 und 40%C12H14O4
25wt (C5H8)210(C8H8)154OH in 40%C12D14O4 und 60%C12H14O4
25wt (C5H8)210(C8H8)154OH in 20%C12D14O4 und 80%C12H14O4
20wt (50% (C5H8)210(C8H8)154OH und 50% (C5H8)210(C8H8)154C13H19O3N5) in C12D14O4
15wt (50% (C5H8)210(C8H8)154OH und 50% (C5H8)210(C8H8)154C13H19O3N5) in C12D14O4
10wt (50% (C5H8)210(C8H8)154OH und 50% (C5H8)210(C8H8)154C13H19O3N5) in C12D14O4
5wt (50% (C5H8)210(C8H8)154OH und 50% (C5H8)210(C8H8)154C13H19O3N5) in C12D14O4
0.25wt (50% (C5H8)210(C8H8)154OH und 50% (C5H8)210(C8H8)154C13H19O3N5) in C12D14O4
17.5wt (50% (C5H8)210(C8H8)154OH und 50% (C5H8)210(C8H8)154C13H19O3N5) in C12D14O4
12.5wt (50% (C5H8)210(C8H8)154OH und 50% (C5H8)210(C8H8)154C13H19O3N5) in C12D14O4
7.5wt (50% (C5H8)210(C8H8)154OH und 50% (C5H8)210(C8H8)154C13H19O3N5) in C12D14O4

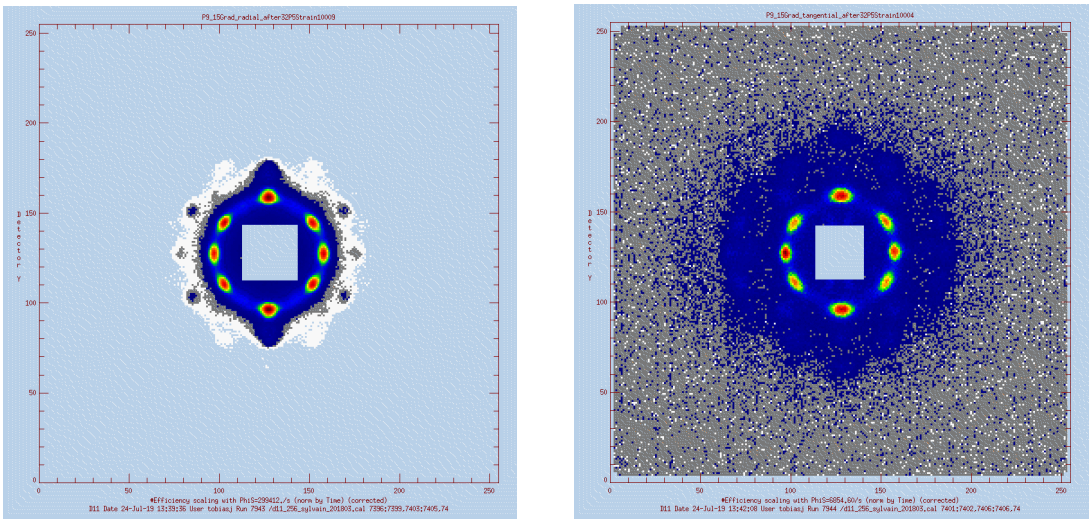
Instrument	Requested days	Allocated days	From	To
D11	2	2	23/07/2019	25/07/2019

Abstract:

Soft quasicrystals extend the length scale of quasicrystals from the atomic scale for metallic quasicrystals to the mesoscopic scale, and are interesting because the underlying principles governing quasicrystal formation might be much simpler to identify compared to metallic systems. We plan to study the formation of colloidal quasicrystals with Rheo-SANS using a Couette cell, where radial and tangential scattering patterns can be measured. Concentrated solutions of the block copolymers (PI-b-PS-OH, PI-b-PS-UPY) will be prepared in diethylphthalate d14. To measure the form factor in concentrated solution we will prepare samples in concentrated solution which contain different ratios of diethylphthalate d14 and diethylphthalate h14 (contrast variation). A concentration series from concentrated to dilute solution of the block copolymers (PI-b-PS-OH, PI-b-PS-UPY) will be prepared for the PI-PS system in diethylphthalate d14 (determining the ratio λ and determining the type of structure factor for the PI-PS system).

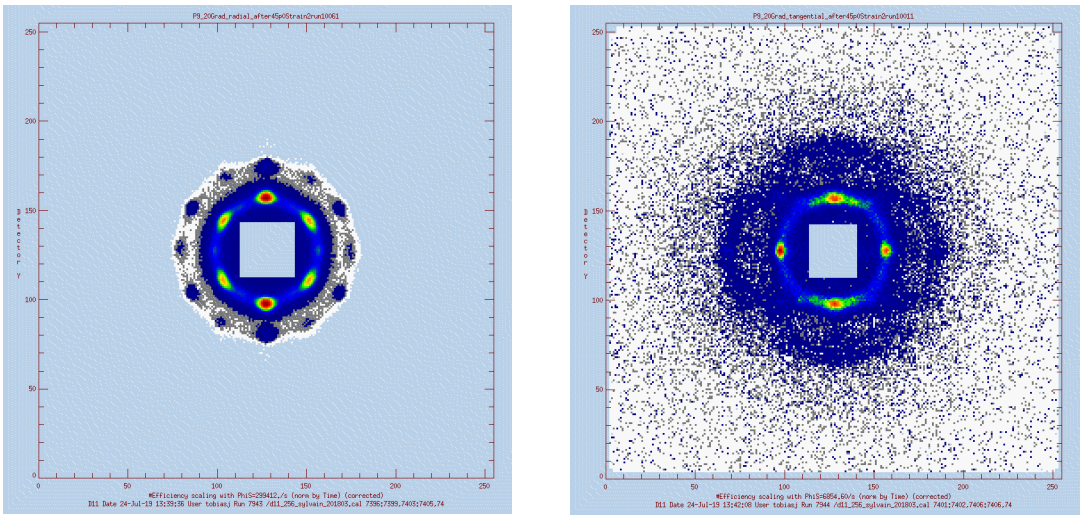
Polyisoprene-b-Polystyrene (PI-b-PS); 2-ureido-4[1H]-pyrimidinone (UPY)

We prepared concentrated samples of PI-b-PS-OH blockcopolymer and of a mixture of PI-b-PS-OH blockcopolymer and PI-b-PS-UPY blockcopolymer in diethylphthalate D14 (DEP D14). These samples were measured in-situ and ex-situ with the Anton Paar Rheometer. We always started to measure at 15 °C and finished at the latest at 65 °C. We chose 5 °C as interval steps. At each temperature we performed oscillatory shearing with a fixed frequency. The applied strain was varied in a certain range. With these experiments we obtained more than 1200 scattering images. We were able to follow the formation of the dodecagonal quasicrystal beginning from the fcc structure. Because of the Couette cell we were able to measure the tangential scattering patterns as well. There are exemplary two scattering images at 15 °C (radial and tangential) in Figure 1 and two scattering images at 20 °C (radial and tangential) in Figure 2 which are all from a concentrated solution of a mixture of PI-b-PS-OH blockcopolymer and PI-b-PS-UPY blockcopolymer in DEP D14.



a) b)

Figure 1: a) The 2D scattering image (radial) at 15 °C from a concentrated solution of a mixture of PI-b-PS-OH blockcopolymer and PI-b-PS-UPY blockcopolymer in DEP D14; b) The 2D scattering image (tangential) at 15 °C from a concentrated solution of a mixture of PI-b-PS-OH blockcopolymer and PI-b-PS-UPY blockcopolymer in DEP D14.



a) b)

Figure 2: a) The 2D scattering image (radial) at 20 °C from a concentrated solution of a mixture of PI-b-PS-OH blockcopolymer and PI-b-PS-UPY blockcopolymer in DEP D14; b) The 2D scattering image (tangential) at 20 °C from a concentrated solution of a mixture of PI-b-PS-OH blockcopolymer and PI-b-PS-UPY blockcopolymer in DEP D14.

The Rheo-SANS measurements (including building up the Rheometer, the adjustments, sample changes and adjusting the necessary temperature) took the whole beamtime. There was no time left to carry out the other planed experiments.

The Rheo-SANS measurements of the concentrated solutions of the blockcopolymers (PI-b-PS-OH, PI-b-PS-UPY) have been a great success.

We thank Ralf Schweins, Lionel Porcar, Sylvain Prevost and David Bowyer for the entire support during the beamtime (also for processing the data).