ESRF	**Experiment title:** Methods for the improved large scale alignment of block copolymers using electric fields	**Experiment number**: SC-1157
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Shifts: 8	**Local contact(s)**: Thomas Weiss	*Received at ESRF:*

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Report:

Based on previous investigations on the orientation behavior of block copolymer microdomains subjected to an external electric field, we aimed to improve the procedures followed so far in order to achieve a higher degree of order and lower defect density in our block copolymer samples. [1,2,3]

The alignment experiments were performed in home-built capacitors with gold electrodes generating a homogeneous electric field pointing perpendicular to the direction of the X-ray beam (electric field vector in direction of z axis, see Figure 2).

Two different routes were investigated: First a 35 wt.- % toluene solution of the block copolymer (consisting of 52 wt.-% polystyrene and 48 wt.-% polyisoprene with a total number average molecular weight M_n = 80000 g/mol and a polydispersity M_w/M_n = 1.02) was heated above the order-disorder transition temperature (T_{ODT} around 62°C) and then was slowly cooled to room temperature at a rate of 1.5 K/min in an electric field of 1 kV/mm (electrode distance d = 2 mm). Second, we used a field of 5 kV/mm in a capacitor built around rectangular mark tubes, yielding an electrode distance of 3 mm. This setup allowed us to rotate the sample by 90° around the x-axis (see Figure 2) after maximum orientation of the microstructure was reached for a given sample position.

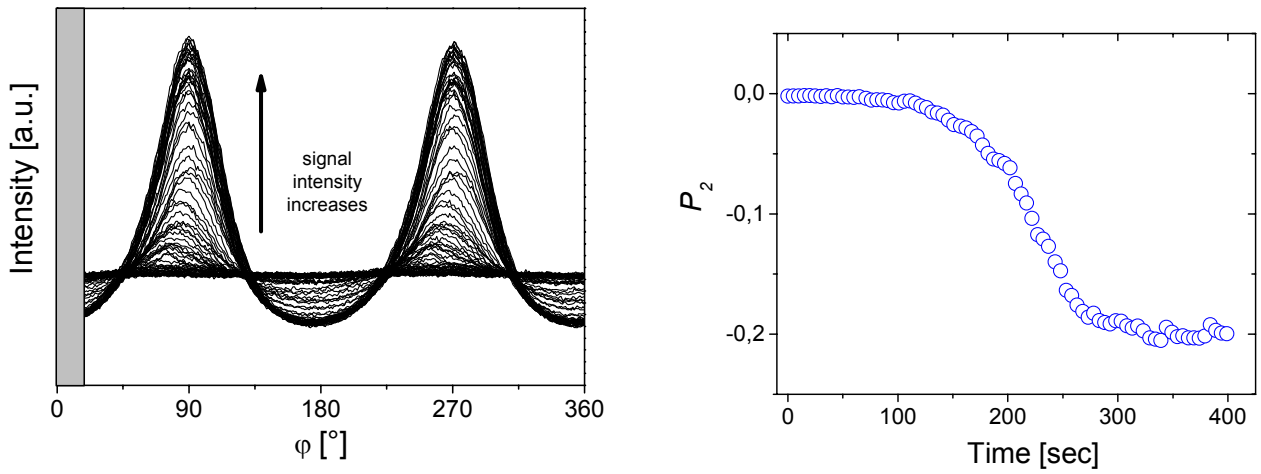

Figure 1: *Evolution of azimuthal scattering intensity (left) and respective orientational order parameter as the lamellar PS-b-PI block copolymer solution is cooled down from 65°C at a rate of 1.5 K/min.*

Figure 1 displays the evolution of the anisotropic azimuthal scattering intensity from the disordered (isotropic) state and the respective orientational order parameter P_2 calculated from the integrated intensity. The peaks observed are still quite broad, which is also reflected in the order parameter which levels off at around -0.20. Obviously, the process is not yet suitable to improve the large scale ordering of the lamellar microdomains.

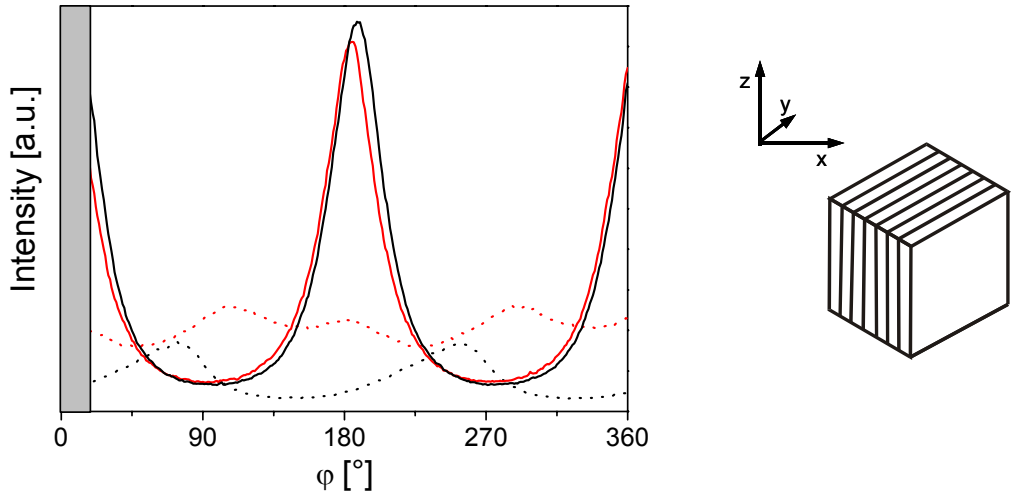

Figure 2: *Orientation of the lamellae after filling the capacitor (.....) and after 4 consecutive rotations. The black and red lines show the lamellar orientation found for the samples rotated by 90° (around x axis), indicating the formation of lamellar sheets parallel to the electric field (z axis).*

The consecutive rotation of the sample by 90° after the maximum lamellar orientation was reached for the respective sample position yields more promising results as shown in Figure 2. After 4 rotations the weakly anisotropic orientation in y and z direction of the sample could be improved to give values of the orientational order parameter P_2 of up to -0.35 in both directions. This set of data indicates that we have

induced a parallel stacking of the lamellar sheets parallel to the electric field (z axis) as depicted schematically in Figure 2.

Further results along these lines and details of the above described experiments will be presented elsewhere.[4]

References

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