ESRF	**Experiment title:** **Electric field-induced Phase Transitions in Block Copolymers**	**Experiment number**: SC-2497
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Report:

This report deals with the beam time of the project SC-2497. We investigated the behavior of a lamellar and a gyroid-forming toluene solution of polystyrene-*b*-polyisoprene (PS-*b*-PI) block copolymers ($S_{43}I_{47}^{108}$, $S_{67}I_{33}^{72}$). For these experiments we used a temperature controlled (RT – 90°C) closed sample cell in order to be able to apply high temperature and high voltage over a large period of time without evaporation of the solvent. We applied electric fields up to 11 kV/mm.

First, we found a reversible gyroid-to-cylinder transition under the influence of a high electric field. The shear-aligned gyroid structure can be distorted and realigned by a moderate electric field. As the electric field is increased the free energy of the gyroid increases and forces the system to undergo an order-order transition (OOT) to the cylindrical phase. This cylindrical phase is unstable without an electric field and, as soon as the electric field is switched-off, the cylinders undergo an OOT back to the gyroid phase (see Figure 1). The resulting gyroid phase is highly aligned in the direction of the former cylinder orientation.

In addition we investigated the order-disorder transition (ODT) behavior of a lamellar block copolymer in a 33.5 wt.% solution dissolved in toluene. Heating the solution through the ODT temperature we find a significant decrease of the critical temperature with increasing field strength. Fast cooling in the opposite direction through the ODT has no influence on the microphase separation temperature. Only for small cooling rates we can reach the temperature regime between the two curves of transition. Hence, we found a temperature regime in which it is possible to switch between the disordered and microphase separated state at constant temperature upon application of a moderate electric field (Figure 2). A manuscript dealing with these results has recently been submitted.

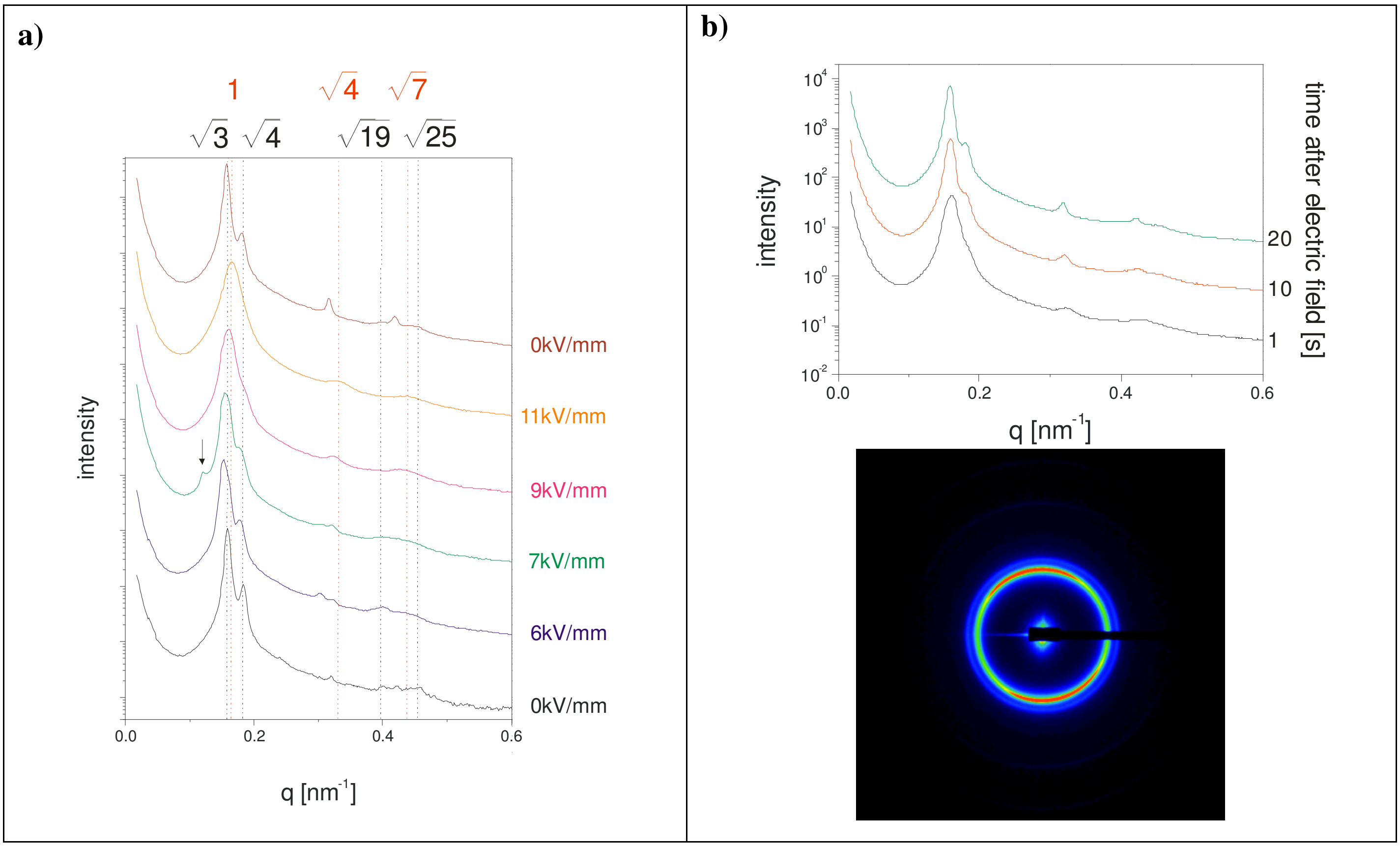

Figure 1: (a) Scattering profiles in dependence of the applied electric field strength. The characteristic reflection for a gyroid structure (black) and a cylindrical structure (red) are indexed. The arrow indicates a new reflection at 0.8q arising from an intermediate morphology. (b) top: Evolution of the scattering profile after switch-off of the electric field with time. bottom: 2D scattering pattern after 160 sec after switch-off of the electric field. The electric field lines run vertical.*

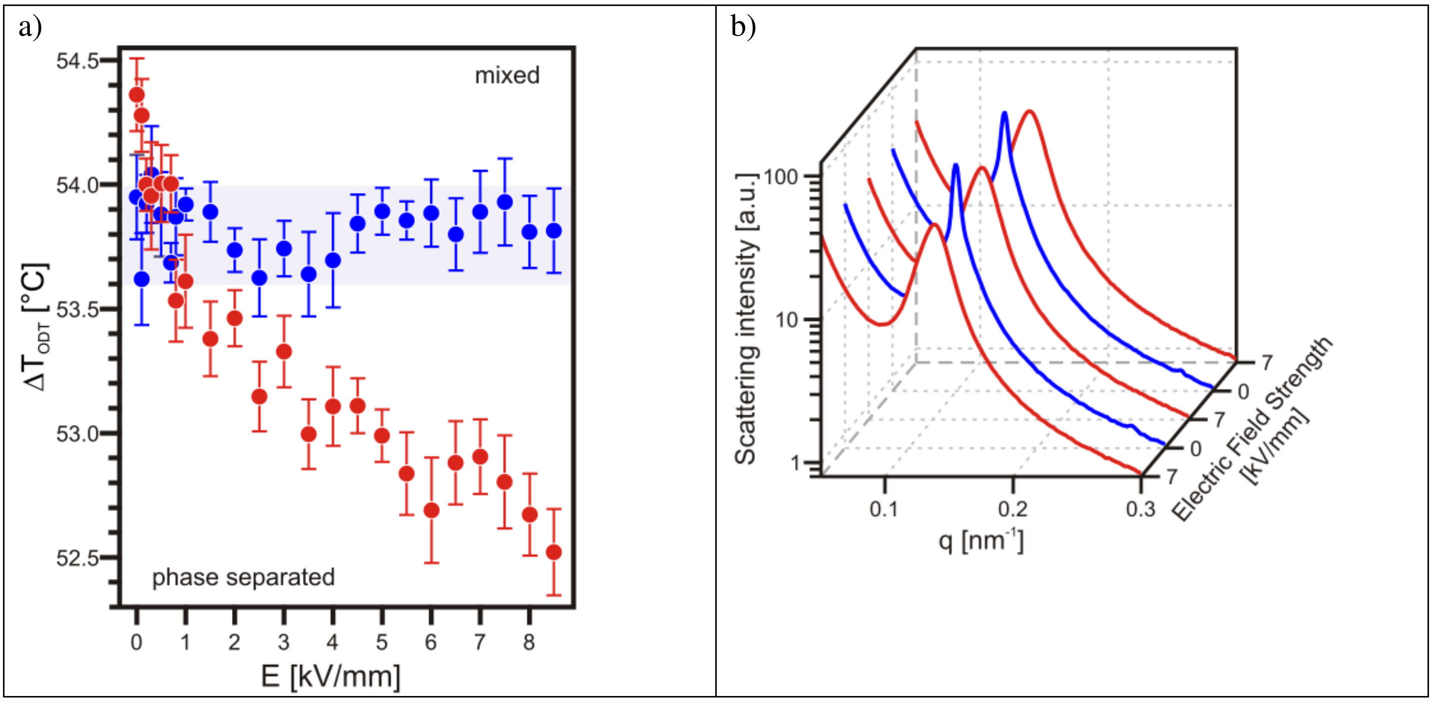

*Figure 2: (**a**) Order-disorder transition temperature as function of the electric field strength. The temperatures have been obtained during cooling (blue) and heating cycles (red) of the solution. (**b**) SAXS spectra at T=53.0°C. The electric field was switched between 7kV/mm (disordered, red) and 0kV/mm (microphase separated, blue).*