Initial investigations of organic ferroelectric memory devices

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Organic electronics has emerged as a promising technology for low-cost, large-area micro-electronic applications, such as flexible displays, or electronic paper, and contactless radio-frequency identification tags, or electronic barcodes. Most of these applications require memory, preferably a non-volatile memory that does not lose its data when the power is turned off and that can be programmed, erased and read electrically. A memory is based on a physical property that displays hysteresis in response to an applied electric field.

We have made initial investigations of the copolymer P(VDF-TrFE) \[\text{poly(vinylidene fluoride-trifluoroethylene); (CH}_2\text{CF}_2\text{)}_n-(\text{CHFCF}_2\text{)}_m\]. at the diffractometer station at BW2 using our own Pilatus detector mounted on the detector arm of the diffractometer. The thin film samples were equipped with electrodes and connected to a function generator. The devices were characterized by grazing incidence X-ray diffraction and the experimental conditions needed for in-situ investigation of the structural switching of the active PVDF polymer were determined.

The Bragg reflection originating from stacking layers parallel to the film surface (Fig. 1A) was investigating during structural switching of the film at 100 Hz. A gradual disordering of the stacking layers into two phases of less pronounced order was observed through decomposition of the Bragg reflection into two weak features at different scattering angle (Fig. 1B/C). The effect can be attributed to simultaneous switching and radiation by X-rays. The results enable to design devices and an experimental setup which are suited for studying selectively the switching process in organic memory devices. This is the target of ongoing experiments at BW2.

Figure 1: (A) GIXD pattern measured at 0.7° incidence angle from a P(VDF-TrFE) capacitor. Large rings represent Debye-Scherrer rings from allowed (blue) and forbidden (gray) reflections of a Gold powder originating from the electrical contacts. Small blue circles represent the simulated positions of a 2D-powder of gold crystals that are oriented with the 111-direction in direction perpendicular to the sample surface plane. (B) Diffraction profiles from a P(VDF-TrFE) capacitor device in specular geometry as function of the total exposure time by the X-ray beam at beamline BW2. (C) Several profiles from (B) at characteristic values of the total exposure time showing the splitting of the Bragg reflection after a slight shift towards lower scattering angle 2θ.