EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office via the User Portal:

https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do

Reports supporting requests for additional beam time

Reports can be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Local probing of the structural properties in the working OFET devices	**Experiment number**: SC 3830
Beamline: ID 13	**Date of experiment**: from: 16 July 2014 to: 21 July 2014	**Date of report**: 27 February 2015 *Received at ESRF:*
Shifts: 15	**Local contact(s)**: Manfred Burghammer, Thomas Dane	

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Report:

We studied real size functioning thiophene based organic field effect transistors (OFET) by nanobeam grazing incidence X-ray diffraction (nanoGIXD). The pronounced changes of the conductive polymer channel and, in particular, at the polymer/gold electrode interfaces as a function of applied voltage have been found. A manuscript for publication of the results is currently in preparation.

Experimentals:

Poly(3-hexylthiophene) P3HT/ chloroform solution (2 mg/ml) was drop cast onto thermally oxidized silicon substrates with interdigitated gold electrodes (Fraunhofer-Institut für Photonische Mikrosysteme, Dresden, Germany). The studied channel lengths were in the range of 10 µm to 20 µm, see Fig.1.

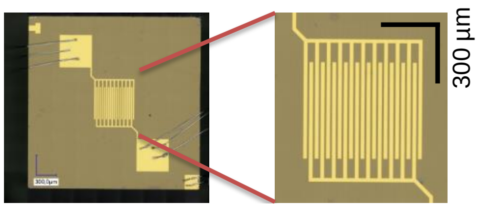

Figure 1: Commercially available OFET substrates with 10 µm channel length

The samples were scanned through the nanobeam (< 200 nm in size, energy 14.9 keV) for spatially resolved examination of the active polymer channels and polymer/gold electrode interfaces undervoltages in the range of 0 V to 100 V which were applies using a Keithley 2612A sourcemeter. Diffraction images were captures with a FReLoN detector. Exposure times were kept short (≤ 1 s) to avoid radiation damage.

The grazing incidence geometry allowed for a spatial resolution of approx. 200 nm in the vertical and 43 µm in the horizontal direction (beam footprint on sample).

Results and Discussions:

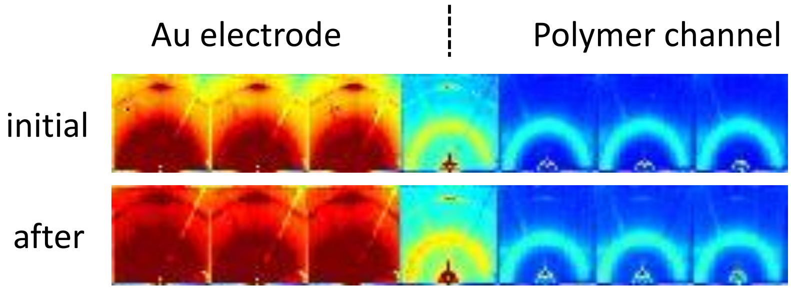

Figure 2: Diffraction patterms in the electrode/polymer channel border region before (top) and after applying voltage.

In case of top-contact geometry, it is well known that gold can diffuse into the polymer layer especially when thermally treated. In our experiment we used OFETs with a bottom-contact geometry to avoid this problem. The spatially resolved nanoGIXD mappings of the pristine OFET device show little variation of the diffraction patterns within the polymer channel regions and electrode regions, respectively, with well defined borders.

Application of a source drain voltage V_{SD} leads to irreversible changes as shown by the nanoGIXD mappings that were done at V_{SD} = 10 V, 50 V and 100 V with stronger variations and less defined borders. Interestingly, some diffraction patterns contained contributions from gold amidst the polymer channel. Fig. 2 shows a strong change of initial diffraction pattern under applied voltage.