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ESRF

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:** Real-time monitoring of diffuse x-ray scattering: Measuring in-plane length scales of binary organic semiconductors	**Experiment number**: SI-2448
Beamline: ID03	**Date of experiment**: from: 18-07-2012 to: 23-07-2012	**Date of report**: 22-02-2013
Shifts: 15	**Local contact(s)**: Jakub Drnec	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

In this study, we have investigated the growth of two popular organic semiconductors, particularly Pentacene ($C_{22}H_{14}$, PEN) and Diindenoperylene ($C_{32}H_{16}$, DIP), as pure and mixed films on SiOx. As stated in the proposal, we are interested in how the film morphology changes during growth of blends with different mixing ratios and substrate temperatures.

All films were grown in a portable UHV-chamber with a base pressure better than 9×10^{-10} mbar. During the deposition of molecules we followed the growth by taking grazing incidence small angle X-ray scattering (GISAXS) snapshots every few seconds. The sample was then post-growth characterized via X-ray reflectivity (XRR) and grazing incidence X-ray diffraction (GIXD) to check for consistency with our in-house *ex situ* measurements and to exclude a time-dependent reorganization of molecules.

Films were grown in a consistent manner, at substrate temperatures of 30°C and 100°C, respectively. The composition of the mixture was changed in the range PEN:DIP 4:1, …1:1, …1:4.

In situ GISAXS-, XRR- and GIXD-measurements were performed with the Maxipix detector. Since the data analysis is still in progress, we present only some preliminary findings.

Figure 1a shows the molecular orientation of the two compounds PEN and DIP within their respective unit cell. As shown in previous studies, both materials favour an intermixed rather than a phase seperated molecular arrangement. In Figure 1b a typical XRR-scan for a PEN1:DIP3-mixture is presented. Pronounced Kiessig oscillations indicate a relatively smooth film growth. Bragg-reflections are measured up to the second order. Both Bragg peaks are accompanied by corresponding Laue oscillations.

Figure 1c shows two snaphots of the GISAXS real-time data, taken at 1.5 monolayer (ML) and 2.5 ML coverage for the mixing ratio PEN1:DIP4, respectively. The main features in the images are a bright central spot, which corresponds to the specular reflection and two side-streaks, due to diffuse scattering of the system. The incident angle of the beam was chosen such that the specular point coincides with the anti-Bragg condition. Due to the large dynamic range of the Maxipix detector we were able to capture the weak diffuse signal without saturating the pixels in the specular spot. Since the absolute intensities in the specular and

diffuse maxima differ by several orders of magnitude, these real-time experiments are challenging. The distance between both streaks, i.e. $\Delta q_{\parallel}$, changes during the film growth, indicating a non-trivial evolution of the in-plane film structure. Moreover, at 1.5 ML a stronger scattering on the specular rod is observed as for 2.5 ML of coverage. This has to be attributed to a modified film morphology between both layer.

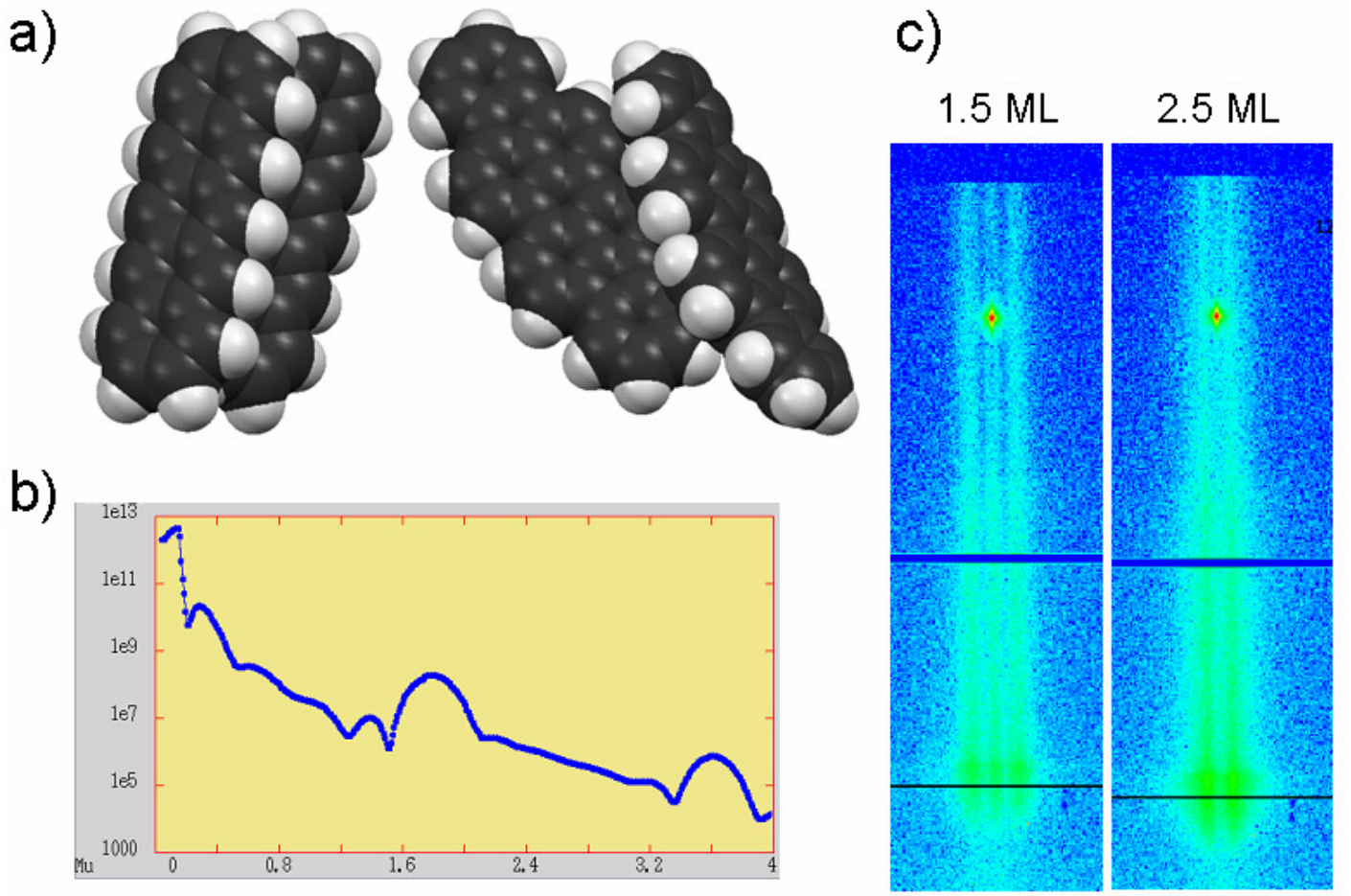

Figure 1: **a)** Orientation of the pure PEN- (left) and DIP-phases (right) in the crystal. **b)** XRR scan of PEN1:DIP3. **c)** GISAXS-images of PEN1:DIP4 taken during growth at nominal coverages of 1.5 ML and 2.5ML, respectively.

We wish to acknowledge the excellent collaboration with our local contact Jakub Drnec as well as the beamline scientist Roberto Felici, which made this experiment such a success.