EUROPEAN SYNCHROTRON RADIATION FACILITY

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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:** In situ and real-time evaluation of the growth of co-evaporated thin films of donor-acceptor complexes	**Experiment number**: SC 4327
Beamline: ID10	**Date of experiment**: from: 04 May 2016 to: 09 May 2016	**Date of report**: 22.08.2016
Shifts: 15	**Local contact(s)**: Andrei Chumakov	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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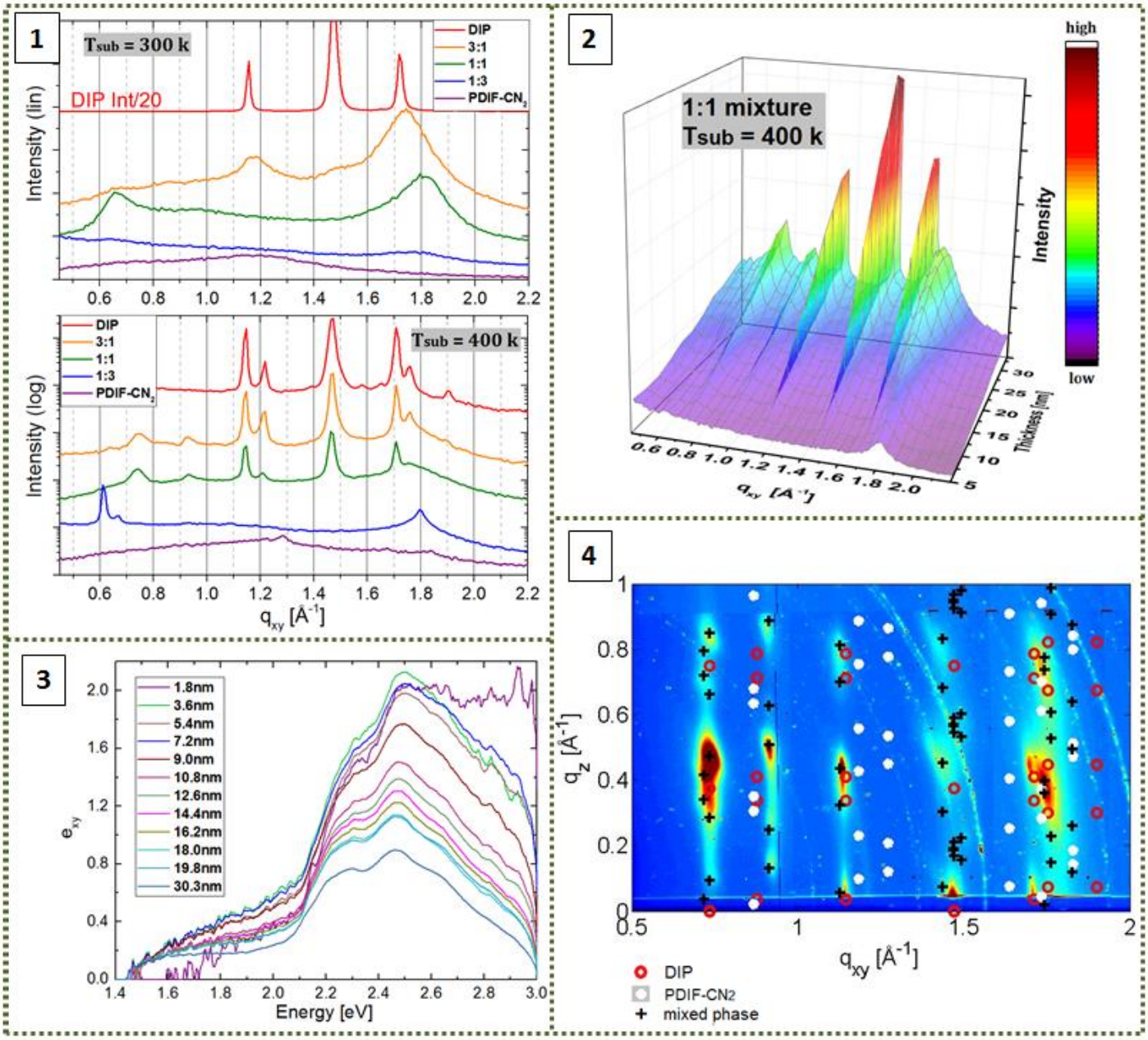
Report:

1. Abstract

At the beamtime we performed *in situ* and real-time investigation of structure evaluation during growth of small-molecule organic thin films combining X-ray scattering methods with differential reflectance spectroscopy (DRS) in the visible range. We found strong changes in structural and optical properties upon mixing of donor and acceptor molecules that evidences the formation of the mixed phase.

2. Experimental Results

We co-evaporated two organic small-molecules DIP/PDIF-CN_2 acting as donor-acceptor pair and monitored in real-time the growth of the corresponding mixed crystal varying mixing ratio and temperature of the silicon substrate. We clearly observed the non-symmetric effect of mixing ratio and the strong temperature influence on the structural properties (GIXD scans of resulting films are shown in Figure 1). Employing GIXD we followed *in-situ* and in real time the evolution of features belonging to the pristine components as well as the mixed phase (Figure 2 shows real-time GIXD scans measured during film growth). Since upon mixing the DIP and PDIF-CN_2 components form a charge-transfer complex with the new optical spectrum (Figure 3), we implemented DRS method during the growth in order to establish the correlation between changes in optical properties due to the intermolecular interaction and structural/mixing behaviour. For each film we implemented a set of postgrowth measurements: GIXD and XRR using point detector and reciprocal space maps using PILATUS detector. The quality of the q-maps is good enough to distinguish reflexion from the new mixed phase as well as from the single components (Figure 4).



Figures. **1.** Postgrowth GIXD scans for 2 films series grown at different substrate temperatures. **2.** Real time GIXD scans of the equimolar mixed film grown at high substrate temperature. **3.** Dielectric constant for a 1:1 mixed film grown at room temperature evaluated from DRS data taken during the growth. **4.** Reciprocal space map of a mixed film (1:1, T_{sub} = 400 k), marks represent potential reflections following from the known unit cell parameters (DIP and PDIF-CN_2) and the asumed parameters of mixed phase.

3. Remarks on quality of measurements

We found the ID10 beamline particularly suited for our real-time experiments with weakly scattering organic materials. We used two kinds of the detectors (PILATUS 300K and point detector) which allowed obtaining excellent results in the framework of our study. In particular we would like to mention the very good beam stability during the whole beamtime.

4. Status and progress of data evaluation

We aim to include these data in a wider publication concerning charge-transfer interactions in donor-acceptor systems, once the dataset is fully analysed.

We thank Andrey Chumakov and Oleg Konovalov for the valuable support as local contacts during the beamtime.