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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 using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now 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:** Chain alignment in semiconducting polymer transistor materials	**Experiment number:** 28-01-699
Beamline: BM28	**Date of experiment:** from: 30 November 2004 to: 06 December 2004	**Date of report:**
Shifts: 18	**Local contact(s):** Dr. Danny MANNIX	*Received at ESRF:*

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Report:

The experiment consisted of two parts:

- investigation of poly (dioctylfluorene-co-benzothiadiazole) (F8BT), semiconducting polymer films and their interface with a gate dielectric
- first structural investigation of a new semiconducting polymer, in which we demonstrate liquid crystalline order without any heat treatment.

poly (dioctylfluorene-co-benzothiadiazole) (F8BT)

F8BT is a significant semiconducting polymer since it is one of few that exhibits n-type conduction in field-effect transistor structures . (Most semiconducting polymers exhibit p-type behaviour.) Divinyltetramethylsiloxane-bis(benzocyclobutene) (BCB) is a recently developed robust crosslinkable gate dielectric with a high dielectric breakdown strength exceeding 3 MV cm^{-1}, and can be solution-cast to form the ultrathin films needed for practical low-gate-voltage plastic transistors [1]. BCB is cured at 250-290°C prior to use – we investigate the effect on the interface with F8BT of this curing process using two samples prepared by H Sirringhaus at Cambridge. Two samples are compared in Fig 1: a F8BT thin film and a bilayer annealed at 260°C. These scans indicate that the crystalline peaks for F8BT occurring in the range Q = 0.3-0.4 $Å^{-1}$ are significantly broadened by the heat treatment. This is observed for both surface and bulk-sensitive scans, indicating that it is not limited to the interface. This effect will be investigated in future experiments.

poly(3,3'''-dialkyl-quaterthiophene)

Over the last five years or so, it has become clear for a variety of conjugated polymers that mobility is significantly improved for films in which molecular alignment occurs. Preferred orientation can be

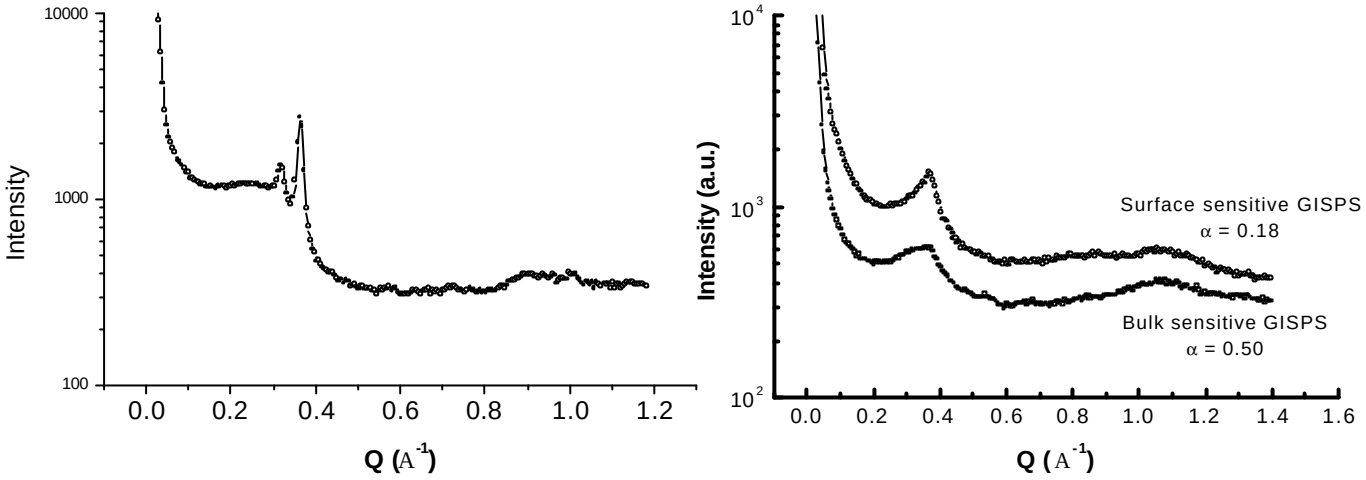

Fig. 1 In-plane diffraction for a (a) spin-cast F8BT ultrathin film. (b) F8BT-BCB bilayer after thermal treatment of the BCB dielectric. The crystalline F8BT peaks have clearly been broadened, possibly due to interdiffusion at the interface.

induced macroscopically by brushing of a polyimide layer prior to spin-coating the polymer. Alignment at the micrscopic level is best attained in liquid crystalline polymers. These require annealing to induce alignment: no conjugated polymer suitable for has been observed to exhibit liquid crystalline order after spin-coating, which is also suitable for FET devices.

Following a recent report of the synthesis of a high performance polythiophene-based liquid crystalline polymer [2], M L Turner prepared similar material at Manchester which we spin-coated into a polycrystalline film. Area detector images of the as-spun films exhibit liquid-crystalline ordering at room temperature, in contrast with ref [2] where thin films needed to be annealed to 120°C to induce liquid crystalline order. This promising material is now being studied at Sheffield and Cardiff to investigate FET behaviour.

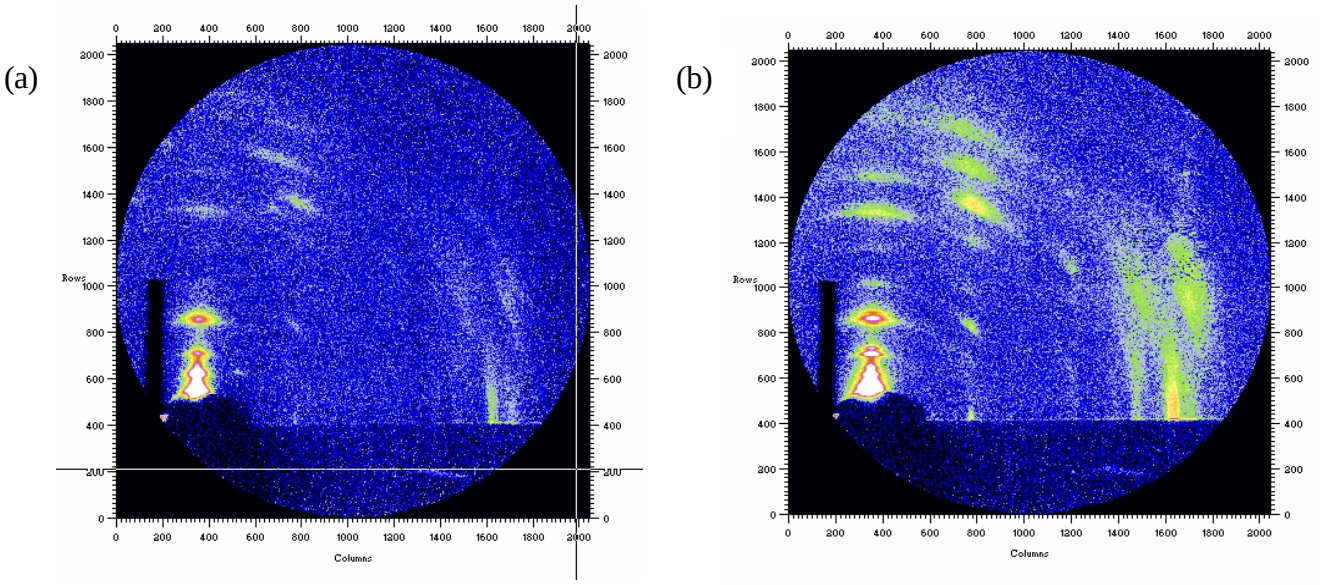

Fig.1 Area detector images of the scattering from the liquid crystalline semiconducting polymer poly(3,3‴-dialkyl-quaterthiophene) for angles of incidence (a) $\alpha_i = 0.10°$ and (b) $\alpha_i = 0.30°$. Analysis is in progress, but it is already clear that the surface-sensitive scattering in (a) differs significantly from the bulk scattering from the film shown in (b).

References

[1] L. L.Chua, P. K. H. Ho, H. Sirringhaus and R.H. Friend, Appl. Phys. Lett. 84 (2004) , 3400–3402.

[2] Beng S. Ong, Yiliang Wu, Ping Liu, and Sandra Gardner, J. Amer. Chem. Soc. 126 (2004) 3378-3379