ESRF	**Experiment title:** DEFORMATION MICROMECHANICS OF SINGLE RIGID-ROD POLYMER FIBRES	**Experiment number**: SC-709
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Report:

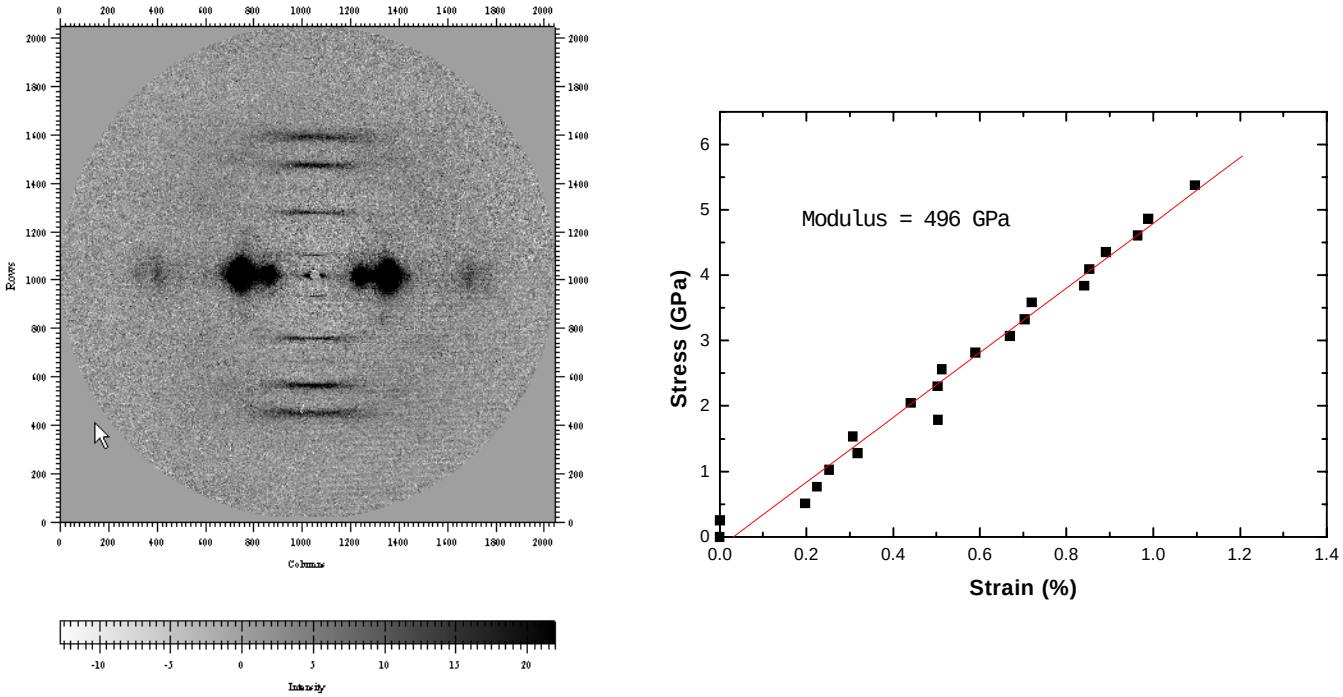
The mechanical properties of high performance polymeric fibres are strongly related to their microstructure. Therefore, crystal modulus, molecular chain orientation and skin-core variations are relevant to both manufacturing (processing conditions) and the final application of these fibres.

In this experiment, various type of rigid-rod polymeric fibres were analysed from the following three generic groups:

- poly(*p*-phenylenebenzobisoxazole), PBO;
- poly(*p*-phenylenebenzothiazole), PBT;
- polypyridobisimidazole, PIPD or M5;

Single-fibre deformation experiments were carried out using a specially designed stretching rig. The rig comprised a piezo-driven loading mechanism and a calibrated load cell. A synchrotron beam of 3 μm spot-size could be accurately focussed on the filaments, which were approximately 12 μm in diameter. Diffraction patterns of the fibres were taken at incremental levels loading, scanning across the fibre at 2 μm intervals for each level. Results were analysed by using the FIT2D software package.

Figure 1 shows a diffraction pattern of the PBO polymeric fibres. Strong equatorial, as well as meridional reflections can be observed [1]. These latter multiple reflections are indicative of good lateral packing of the stiff-molecules, which influences the mechanical properties of the fibres. The crystal modulus of the fibres was determined by measuring the strain of the molecular chains (calculated from the *c*-spacing) as a function of the applied stress. Figure 2 shows an example corresponding to the calculation of the crystal modulus of a PBO filament [1]. Following a similar procedure the crystal moduli of PBT and M5 fibres were found to be 390 GPa and 410 GPa respectively [2]. Full Journal papers are presently in preparation.



Figures 1 & 2: Diffraction pattern of PBO, and the calculated crystal modulus

The analysis of the equatorial reflections enabled the calculation of the crystal orientation during the deformation experiments. It was found that in all fibres, an increase in fibre loading led to an improvement in crystal orientation, demonstrated by a narrowing of the equatorial reflections in their azimuthal directions. This effect was seen to be greater in as-spun fibres than the heat treated fibres, owing to the fact that they had not previously undergone tensile stretching to improve their mechanical properties.

In addition, skin-core differences were evident in some of the fibres tested and these results are worthy of further investigation. It was, however, noted that these differences across the fibre are consistent at different loading levels. Other analyses found that there was no change in the equatorial peak positions with deformation, and also no difference in crystal modulus from fibre core to skin.

1. R. J. Davies, R. J. Young, C. Riekel, 'Deformation studies of PBO fibres', International Conference, *Polymer Fibres 2000.*, UMIST, 5-7 July 2000, Manchester, UK

2. M.A. Montes-Morán, C. Riekel, R. J. Young, 'Deformation studies on PBT and PIPD rigid rod polymer fibres by Synchrotron radiation', International Conference, *Polymer Fibres 2000*, UMIST, 5-7 July 2000, Manchester, UK