ESRF

ESRF	**Experiment title:** **Compressive behaviour of polymer fibre/polyethylene matrix composites/ Interfacial load transfer in PEEK/PEEK(fibre) composites**	**Experiment number**: ME1194/5
Beamline: ID13	**Date of experiment**: from: 11/11/05 to: 14/11/05	**Date of report**: 24/02/06
Shifts: 9	**Local contact(s)**: Dr Richard Davies	*Received at ESRF:*

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Report:

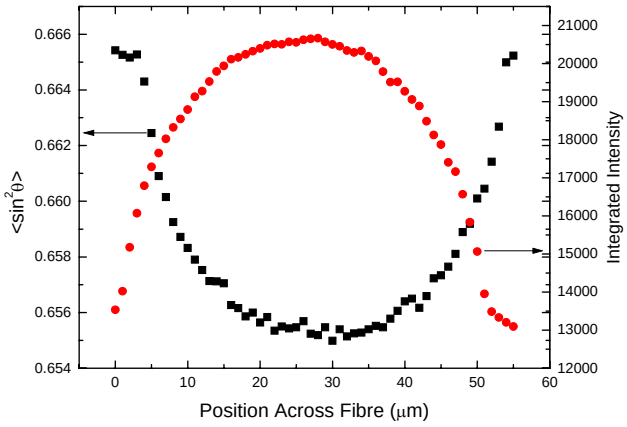
Composite materials are being used increasingly in structural engineering applications, but their performance is limited by the strength of the fibre-matrix interface. In addition to this it is a common observation that failure of the interface, or indeed the fibre, often occurs in compression. This is typically due to the inferior mechanical performance of fibres tested in this regime. The proposal was therefore to investigate the mechanical properties of model composites of fibres in compression. The second aim of our work was to investigate polymeric composite systems where the interface between the two phases is not that clear. In these systems fibres are hot-compacted with each other to provide a single-phase composite material. The original application comprised two proposals which were combined into one experimental period by the panel.

The first part of this study required the use of a customised 4-point bending rig to deform polymeric beams with embedded fibres attached to the surface. It was not possible, given the fact that there was little room in the between the beam exit and the beam-stop to locate this device, to conduct these experiments. We have however managed to adapt the device now so that these experiments can take place, and it is anticipated that these will be conducted using in-house time.

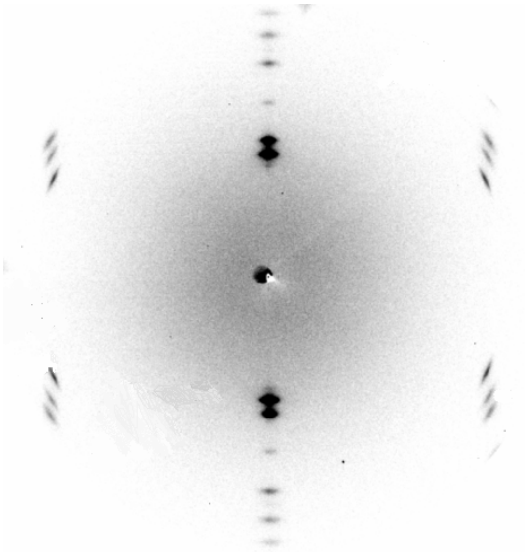
In the second part of this study we made some preliminary investigations on the skin-core morphology of the two types of polyethylene fibres used in hot compaction, and in addition studied the in-situ deformation of a number of PEEK fibres. The PEEK fibres were provided in two forms (thick and slender diameters) and each sample was attached to a fibre card for testing. The orientation distributions ($<\sin^2\theta>$) of both fibres (polyethylene and PEEK) were determined using a 500 nm beam, which correlated well with the integrated intensity of the total fibre diffraction (see Figure 1b for a PEEK fibre). *c*-spacings were also determined as a function of external deformation, and these are being used to determine the crystal modulus of the PEEK samples.

Typical diffraction patterns obtained from single fibres of polyethylene and PEEK are shown in Figure 1c&d. Clear patterns can be obtained, and skin-core orientations were obtained from these materials as a function of deformation. A number of publications are being prepared from this beamtime, including some work conducted at Manchester using Raman spectroscopy to follow the microdeformation of the single fibres.

(a)



(b)



(c)

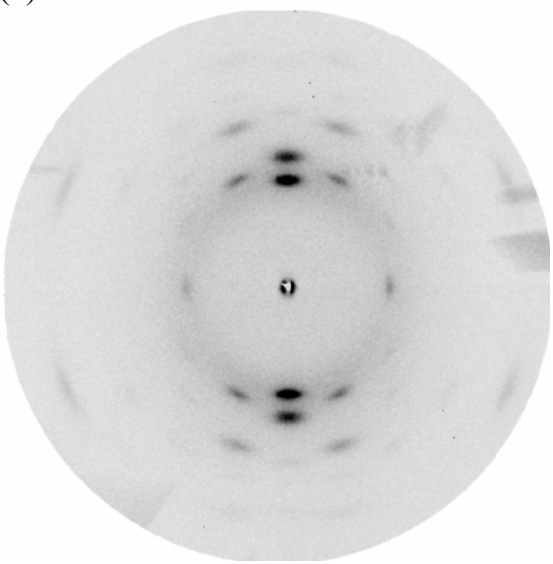


Figure 1 (a) The orientation parameter and integrated intensity as a function of the distance across a PEEK fibre; (b) a diffraction pattern for a polyethylene fibre used for hot compaction and (c) a diffraction pattern for a PEEK fibre.