ESRF	**Experiment title:** Development of internal structure during bending of single carbon fibres	**Experiment number**: ME 368
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Report:

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We performed single fibre bending experiments by forming loops of different carbon fibres. The structure of the bent fibres was investigated by scanning across the fibres with a focussed X-ray beam from a waveguide structure. With this equipment, it is possible to measure the atomistic structure (via diffraction) with a spatial resolution of only about 100 nm in one direction depending on the distance of the specimen from the waveguide due to the beam divergence. Fig. 1 shows a comparison of the beam size of the glass capillary with the one of the waveguide used in this study. This figure gives an impression, how small the X-ray beam is, even in comparison to a carbon fibre with a diameter of some microns.
Figure 2, left picture, shows the azimuthal width of the 002-reflection. This width is defined by the orientation distribution of the graphene planes with respect to the fibre axis. The data shown in this figure were evaluated for the PAN-fibre HTA7 with a HTT of 2100 ^{o}C (HTA7-21). Whereas the azimuthal width for the straight fibre (circles) shows no dependence on the scanning position of the fibre, the bended fibre exhibits a strong dependence: In direction towards the tension zone, the distribution of the graphene planes decreases, whereas towards the compression zone a strong increase in the azimuthal width is visible. The orientation with respect to the fibre axis degrades, which is a clear incidence of a buckling of the graphene

planes on a nanoscopic level. The neutral axis is not in the centre, indicating an anisotropy of the tension and compression Young's modulus of the carbon fibres.
In the right picture of Figure 2 the integral intensities are depicted, which follow the volume function (line in Figure 2). As the beam is only 100 nm wide, a convolution correction as performed for the glass capillary is not required any more, as in the works with the glass capillary[1,2].

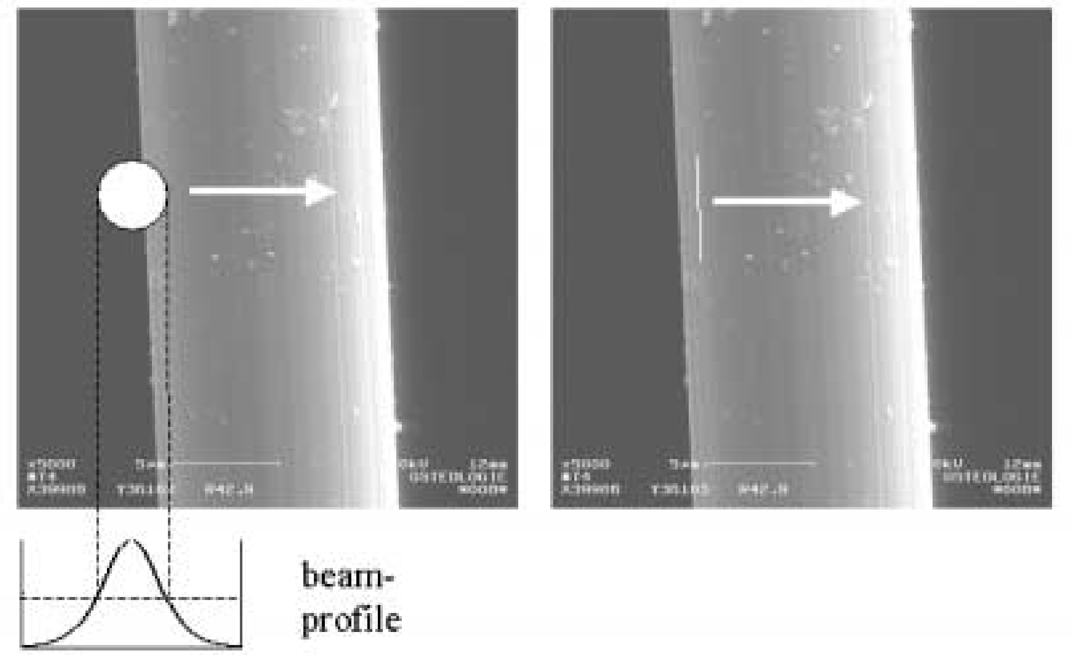

Figure 1 *Comparison of the X-ray beam size of the glass capillary (left) with the one supplied by the waveguide (right): The width of the beam from the waveguide during scanning across the fibre is only 100 nm.*

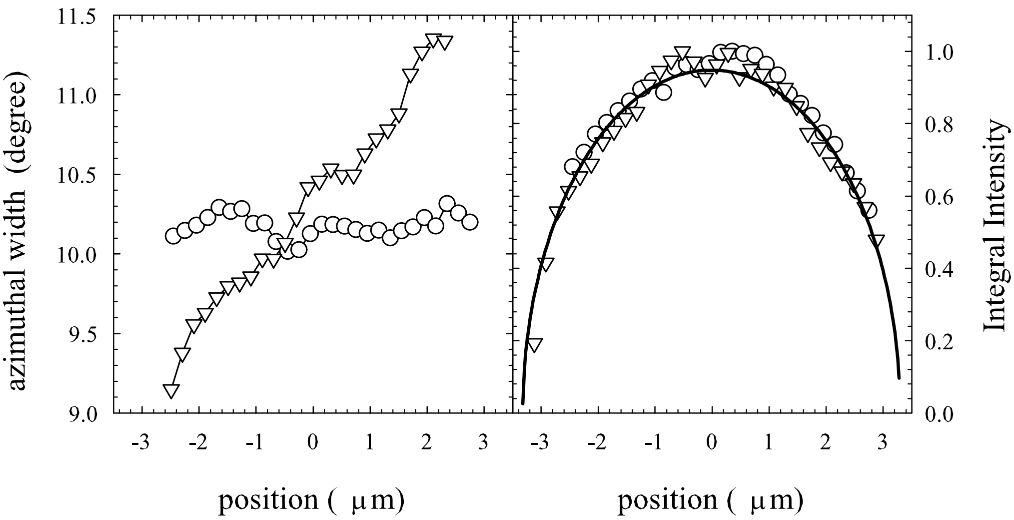

Figure 2 *Left picture: Azimuthal width of 002-reflection with respect to the fibre axis, circles, straight fibre, triangles, bent fibre. Right picture: Both the integral intensities follow the volume function.*

References

1 O. Paris, D. Loidl, M. Müller, H. Lichtenegger and H. Peterlik,, *J. Appl. Cryst.*, 2001, **34**, 473.
2 O. Paris, D. Loidl and H. Peterlik, *Carbon*, 2002, **40**, 551.