ESRF	**Experiment title:** A study of deformation mechanisms in iPP in situ with μWAXS experiments	**Experiment number**: SC-1099
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The mechanical behaviour of semi-crystalline polymers is greatly influenced by the properties of the crystalline and the amorphous phases. As a result this topic has been the subject of extensive research. However to date, a comprehensive relationship between the structure and mechanical properties for semi-crystalline polymers has yet to be established. This present study concerns the commissioning of a novel method for *in situ* data collection during the deformation of polymers. This involves the combination of three different techniques into a single experiment, namely tensile testing, synchrotron radiation wide angle x-ray scattering, and optical microscopy. For this current investigation, three isotactic polypropylene samples have been studied, produced using different thermal treatments. This enables the influence of thermal treatment on the mechanical properties and crystallographic structure to be assessed. Tensile tests were performed on a custom-made deformation rig, with measurements taken *in situ* during x-ray scattering. The strain rate applied on all samples was 0.3 %/s. The rig consists of two mounting grips, on which the sample is mounted and fixed in position using screws. The grips move in opposing directions at constant speed, and are powered through a single motor. This setup allows observation of the same point on the sample during the whole test period. A load cell is fixed to one sample grip, and the displacement of the grips measured using an electrical inductor (L). All the components of the rig are interfaced with a PC with a data recording frequency of 5 s for all experiments. The measurements from the rig enable nominal force vs. displacement plots to be produced. A camera was also employed to record images of the sample *in situ* during deformation. An on-axis mirror between the final aperture and sample enabled images to be captured along the beam axis direction. Images from the camera were also recorded at 5 s intervals during all experiments. A schematical drawing of the experimental setup is shown in fig 1.

The determination of the variation with respect to applied strain of the FWHM from the $(2\bar{1}0)$ reflection associated with the *β*-phase crystal planes indicates a high level of inhomogeneity in the stress distribution. This is especially apparent approaching sample failure. This result is consistent between samples, irrespective of the thermal treatment conditions(Fig 2).

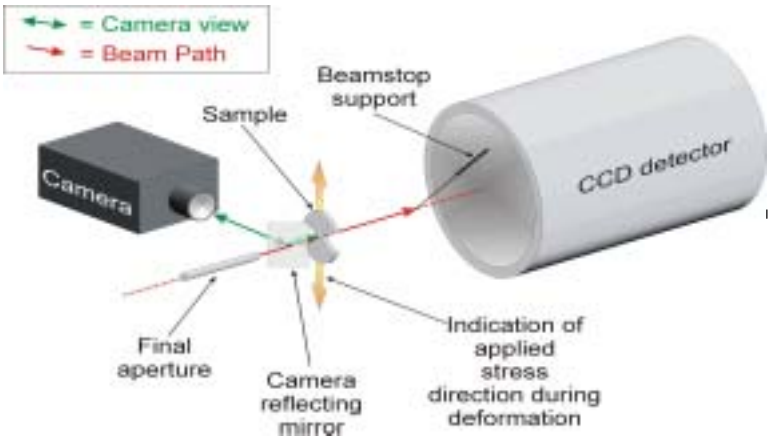

Figure 1. Experimental setup

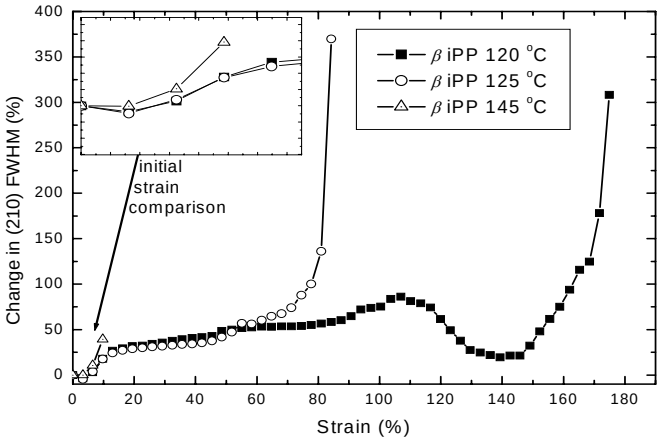

Figure 2. Percentage change during deformation in FWHM of the $(2\bar{1}\,0)$ reflection

In addition, the *β*-phase content is found to decrease during the application of tensile strain (fig. 3). This effect is noted to be of a somewhat lower magnitude than previously reported in literature, presumably due to the samples lower elongation to break. A correlation is observed between the *β*-phase content and yielding during deformation due in part to differences in crystal phase rigidity. Thus, the higher the thermal treatment temperature, the greater the fraction of *α*-phase material and the more brittle the sample during testing. However, it also appears that the deformation behaviour of iPP does not exclusively depend upon the different crystal phases.

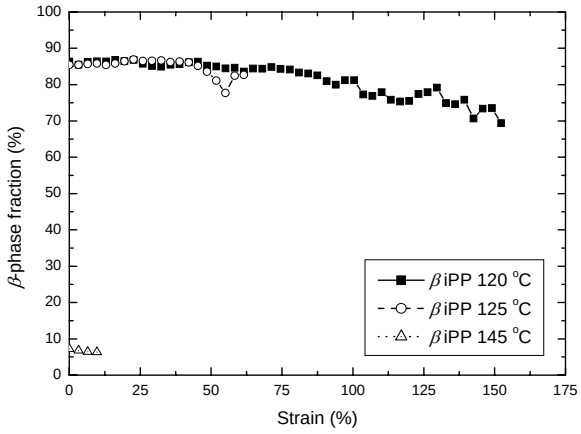

Figure 3. Figure 8: Variation in β-phase fraction with deformation between βiPP samples

References:

1. R. J. Davies, N. E. Zafeiropoulos, K. Schneider, S. V. Roth, M. Burghammer, C. Riekel, J.Kotek, M. Stamm, The use of synchrotron x-ray scattering coupled with in situ mechanical testing for studying deformation and structural change in isotactic polypropylene, Colloid Polymer Science, 282, 2004, 854-866