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# Deformation Process of Polymer Spherulite Observed with Microbeam SAXS / WAXS

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## Introduction

In the field of polymer processing like injection moulding, film inflation and foaming, etc., the understanding of polymer deformation under shear and elongation is very important for the design of polymer with higher functionality.

Especially in the film processing, deformation of polymer spherulite by drawing is the most interesting phenomenon and clarifying the deformation mechanism of spherulite will give a direction for better design of polymer film. Until now, to obtain the essential information about deformation behaviour of crystalline structure, many SAXS/WAXS researches about film deformation by drawing were reported by using synchrotron radiation X-rays[1,2]. However, there is no report which focuses on the inhomogeneous deformation behaviour in *one* spherulite with a method of X-ray scattering.

In this study, we try to obtain the information about local structure of *one* spherulite by using microbeam SAXS/WAXS technique.

## Experimental

We performed microbeam SAXS/WAXS at BL4A. The X-ray flux was about $10^{10}$ photons per second at wavelength λ=1.5Å and the X-ray area was about 5μm*5μm. The camera length of SAXS was 1600mm and that of WAXS was 200mm. The detector used was an XII-CCD which was installed at BL4A[3]. Sample was metallocene synthesized isotactic polypropylene (iPP). Mw of iPP was 400,000 and Mw/Mn was 2.1. Film sample was prepared by isothermal crystallization at 135 C and iPP spherulite with large size was obtained. Tm of spherulite was 170 C. The thickness of film sample was 100μm before drawing. Film samples were uniaxially drawn by hot drawing at 165 C. We scanned spherulite before and after drawing with an X-ray microbeam and observed inhomogeneity of deformation.

## Results

By scanning small deformed spherulites with an X-ray microbeam, we found that the order of crystalline orientation in the up- and down-side area of a spherulite drawn in the horizontal direction became lower and that lamella stacking structure was broken in the initial stage of deformation, while the order of crystalline orientation and lamella stacking in the left- and right-side of a spherulite were kept in the initial stage of drawing. Further investigation is under way.

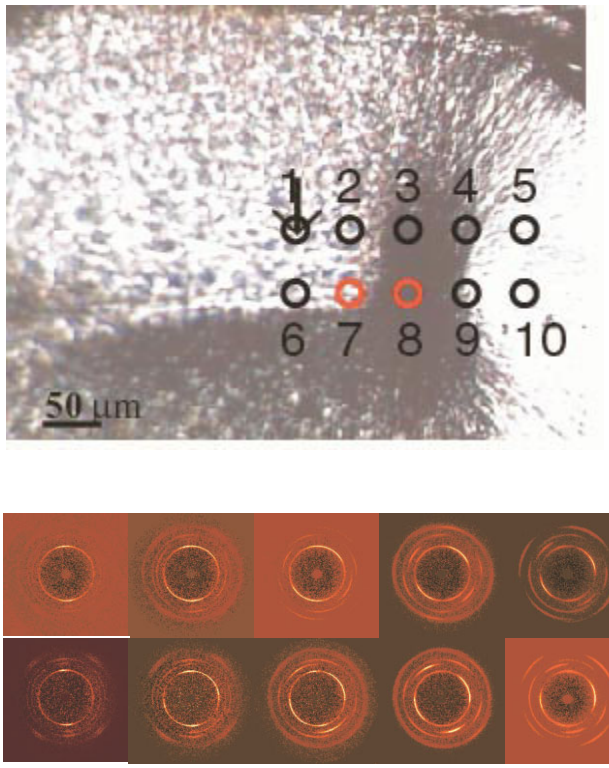


Fig.1 (upper) Picture of deformed iPP spherulite and positions scanned by X-ray microbeam, indicated by circles. (lower) the WAXS patterns corresponding to upper circles

1) Marco Y et al. Polymer 2002; 43:6569.
2) Wiyatno W et al. Macromolecules 2002; 35: 8488.
3) Y. Amemiya et al., Rev. Sci. Instrum. 66, 2290, (1995)