As the beam size is small, it is very important to confirm the irradiated area of the X-ray microbeam on samples. An optical microscope, which was set on the X-ray beam path, was used to align the sample position roughly. However, more precise alignment of the X-ray microbeam is very difficult using optical microscope for smaller samples such as a polymer single fiber. In this study, we proposed a novel technique by the Thomson scattering method for the precise alignment of the X-ray microbeam position as shown in Fig. 1.

Figure 2 shows the intensity profile of Thomson scattering from a Kevlar single fiber. One-dimensional scans were performed perpendicular to the fiber axis. The intensity of the Thomson scattering is proportional to the number of electrons at the regions where the X-ray penetrated the sample. With changing sample position ((a)-(d)), X-ray diffraction patterns were detected using an imaging plate as shown in Fig. 3. The X-ray exposure time was 600 s per pattern. Judging from the spot-like equatorial reflections (110 and 200 reflections), the degree of the molecular orientation of the skin region (Fig. 3(a)) is higher than that of the core region (Fig. 3(d)).
Figure 4 shows the equatorial diffraction profiles of the Kevlar<sup>29</sup> single fiber at different points ((a)-(d) in Fig. 1) along the fiber axis. In the core region (d) of the single fiber, the peak intensity is $I_{110} < I_{200}$. However, they are reversed when approaching the skin region (a), that is, the peak intensity of 110 reflection gradually increased as the measurement position approached the skin layer. This implies that the b-axis of the Kevlar crystal, which is the direction of a hydrogen bond, is oriented in the radial direction of the fiber [2,3].

According to these results, the X-ray microdiffraction method demonstrated to be a powerful tool for the structural analysis of small areas for polymer materials.

References