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熱可塑性エラストマーのポリマーアロイ構造の分析

Analysis of polymer alloy structure of thermoplastic elastomer

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Keywords：Thermoplastic polyurethane, permanent strain, SAXS, WAXD

1. Background and research objectives

Thermoplastic polyurethane elastomers (TPU) are recyclable from the perspective of SDGs, and are expected to be used for automotive components instead of thermoset silicone elastomers that are conventionally used. However, the problem is that TPU is subject to high permanent strain under the large deformation. Furukawa[1] has shown that the permanent strain is smaller with a wider distribution of hard segments and with a larger molecular weight of hard segments, but the mechanism is still unclear. In this study, we aimed to measure the polymer alloy structure of hard and soft segments by simultaneous SAXS and WAXD measurements of TPU from Nisshinbo and BASF.

2. Experimental

Experiments were performed with SAXS and WAXD simultaneous measurements, camera length 1958.830 mm, wavelength 1.5 Å, and R-AXIS IV. The samples used were Nisshinbo (Mobilon bands Blue and Brown) and BASF (70 and 80).

3. Result and discussion

Fig. 2 and Fig. 3 show the SAXS and WAXD results, respectively. Since only an amorphous halo is observed in Fig. 3, the hard segment is not crystallized, and no crystallization of the soft segment is observed in the unstretched state, there is no significant difference in molecular structure between the Nisshinbo and BASF products. The structure should be verified by NMR in the future. On the other hand, SAXS of Fig. 2 shows that the Nisshinbo product has almost no peaks originating from the hard segment, while the BASF product has clear peaks. We will now consider what is meant by the distance of 18 nm observed in the Nisshinbo product and 13 nm clearly observed in the BASF product. Some have suggested that this peak corresponds to the distance between hard segments, while others have suggested that it is the distance between the MDI phases that make up the hard segments in the domains where the hard segments aggregate and form cross-links, as shown in Fig. 1. The rationale is that if this peak is the distance between hard segments, then stretching the TPU should increase this distance. However, since this peak position is only slightly larger when the TPU is stretched, this hypothesis is incorrect.

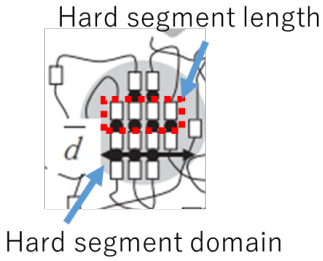

Fig.1 TPU Structure

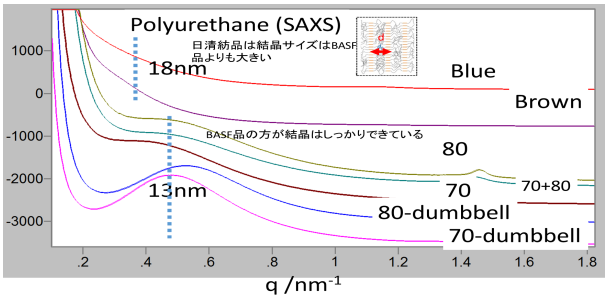

Fig.2 SAXS profiles of TPU

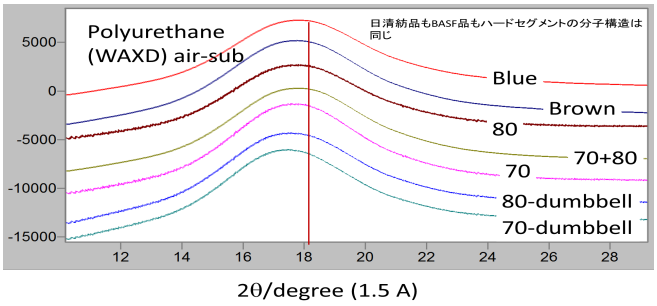

Fig.3 WAXD profoiles of TPU

4. References

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