Application Brief

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Thermoconstrictive stress measurement of shrink film

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1. Introduction

Plastic bottled beverages are on sale in many locations. The labels on these bottles serve as advertising to distinguish them from the other companies' products.

Shrink film is widely used for labels on plastic bottles. Shrink film contracts when it is heated and manufacturers use this characteristic to secure the labels to their bottles.

In this brief, the thermoconstrictive stress of shrink film was measured.

2. Measurement

Two samples of commercially-available shrink film were measured.

The measurements were performed using the TMA/SS6100 Thermo Mechanical/Thermal Stress Strain Measurement Instrument and the DMS6100 Dynamic Mechanical Spectrometer.

For the TMA and thermoconstrictive stress measurements, a metal tensile probe was used. The sample was heated from room temperature to 120 ° C at a heating rate of 5 ° C / min.

The dynamic mechanical analysis was performed using Tension/ Sinusoidal Oscillation mode at room temperature at a frequency of 1Hz.

A 10 mm (Length) x 4 mm (Width) sample was used for all measurements.

3. Results

3-1. TMA measurements

Figure 1 shows the TMA results for the shrink film in the longitudinal and transverse directions. After a slight contraction, both sample A and B expanded in the longitudinal direction. Furthermore, there was approximately 80% heat shrinkage in the transverse direction. It is speculated that the film was stretched in the transverse direction. When it is heated, it shrinks to return to its original dimensions.

From this result, it is known that the stretching process causes shrinkage in the transverse direction but not in the longitudinal direction. The film shrinks and adheres to circumference of the plastic bottle but the longitudinal length stays basically the same.

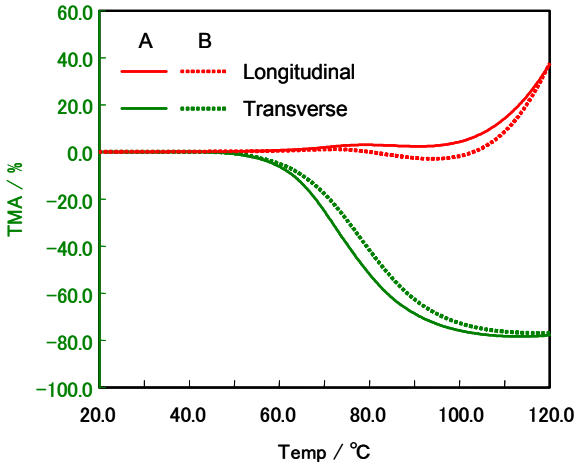

Figure 1 TMA results
Measurement load: 10 mN

3-2. Measuring thermoconstrictive stress

TMA results showed that both samples of shrink film contracted in the transverse direction. Figure 2 shows thermoconstrictive stress of this contraction. The stress increases when the contraction starts around 50 ° C. The stress peaks in the vicinity of 60 ° C and then tapers off.

The shrinkage caused a stress change in Sample A before Sample B. The maximum contraction stress was also larger for Sample A. From these results, it is speculated that Sample A adheres to bottles more strongly than Sample B.

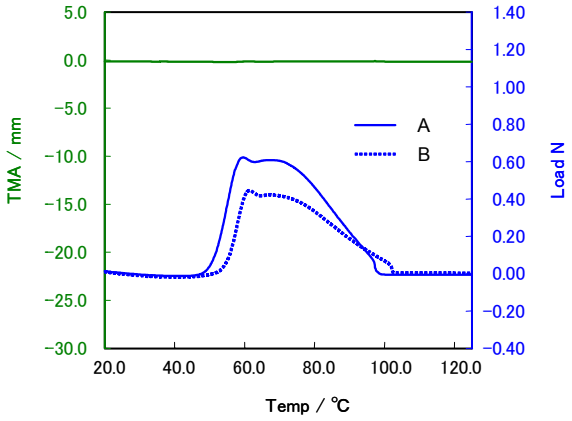

Figure 2. Thermo constrictive stress results for the transverse direction

3-3. Dynamic mechanical analysis

A dynamic mechanical analysis was performed for the two films in the transverse and longitudinal directions. Storage modulus (E') was higher in the transverse direction than the longitudinal direction for both samples. It is surmised that the degree of molecular orientation was higher because the samples were stretched more in the transverse direction than the longitudinal direction.

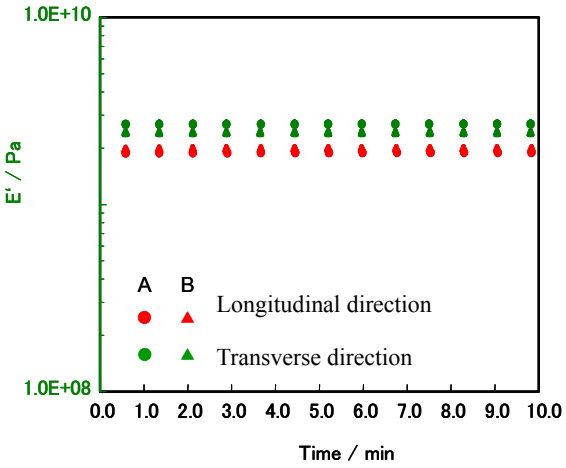

Figure 3. Dynamic mechanical analysis results

4. Summary

In this brief, the thermo constrictive stress of shrink film used for plastic bottle labels was measured.

TMA measurements were performed while the temperature was raised under constant stress control. These results show the heat shrink and expansion of the film in both the stretched direction and in the direction perpendicular to the stretched direction. These results reveal the shrinkage direction of the film.

The thermo constrictive stress measurements were performed while the temperature was raised under constant strain control. This measurement shows the required stress because the temperature change does not change the shape of the sample. Differences in film adhesion to the bottle can be calculated from the differences in shrink stress.

In the dynamic mechanical analysis, the directional differences of the storage modulus can be seen from the differences in the degree of molecular orientation anisotropy.