

TA NO.24 DEC.1985 $\tan\delta$ Measurement by TMA/SS

1. Introduction

Dynamic mechanical testing measures the strain response of the material when changing the stress periodically. Delay ($\tan\delta$) of the strain against the stress is used as a factor acquires the change of molecular motion of the material.

In this brief, TMA/SS periodic loading mode is used. The $\tan\delta$ of Styrene-Butadiene-Styrene (SBS) is measured by phase difference of stress and strain.

2. Measurements

2-1 Stress-Strain measurement

The sample is SBS Block copolymer. The film sample of 910 μm thickness from the benzene solution is used. Average molecular weigh is 1.2×10^4 for styrene unit, 5.6×10^4 for butadiene unit. Sample size is length 15.6mm \times width 3mm and measured between -120 to 100 $^\circ\text{C}$ at the heating rate of 2 $^\circ\text{C}/\text{min}$.

Figure 1 shows the TMA/SS measurement result in the vicinity of 50 to 70 $^\circ\text{C}$. Measurement condition is frequency 0.01Hz and load (F) 20 \pm 10g. From the amplitude ratio of the load and strain, the value proportional to the complex modulus is obtained. The $\tan\delta$ is calculated from the phase difference of the load and strain.

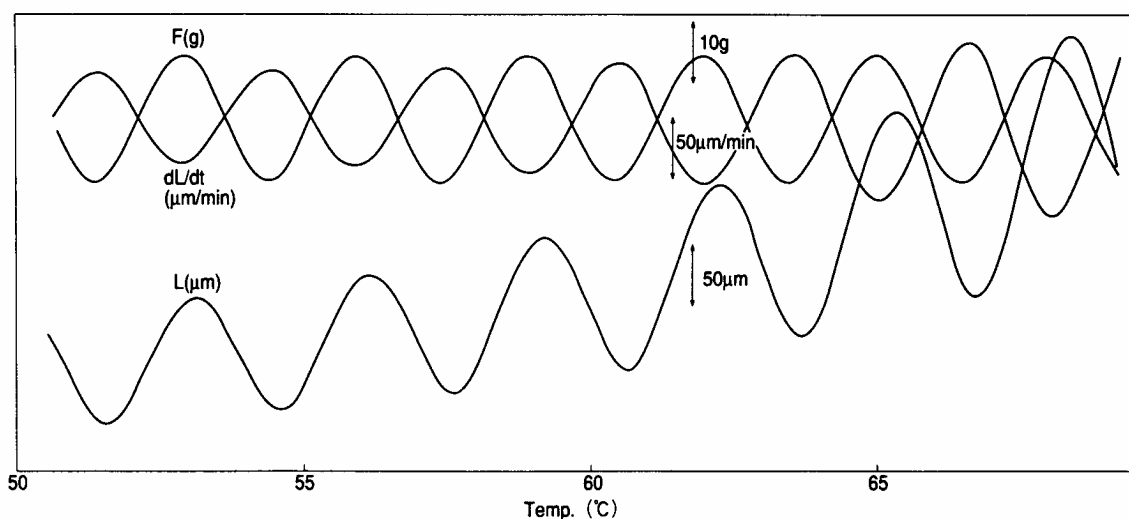


Figure 1 TMA/SS results for Styrene-Butadiene-Styrene film

F(g): load (frequency 0.01Hz, 20 \pm 10g.)

L(μm): displacement

dL/dt: time-derivative of displacement

Figure 2 shows the result of $\tan\delta$ calculated from Figure 1. The peak in the vicinity of 90°C shows the main dispersion of butadiene and the peak in the vicinity of 80°C shows the main dispersion of styrene. Considering the molecular weight and frequency dependence, it shows almost the same that of measurement result by the dynamic mechanical analysis¹⁾.

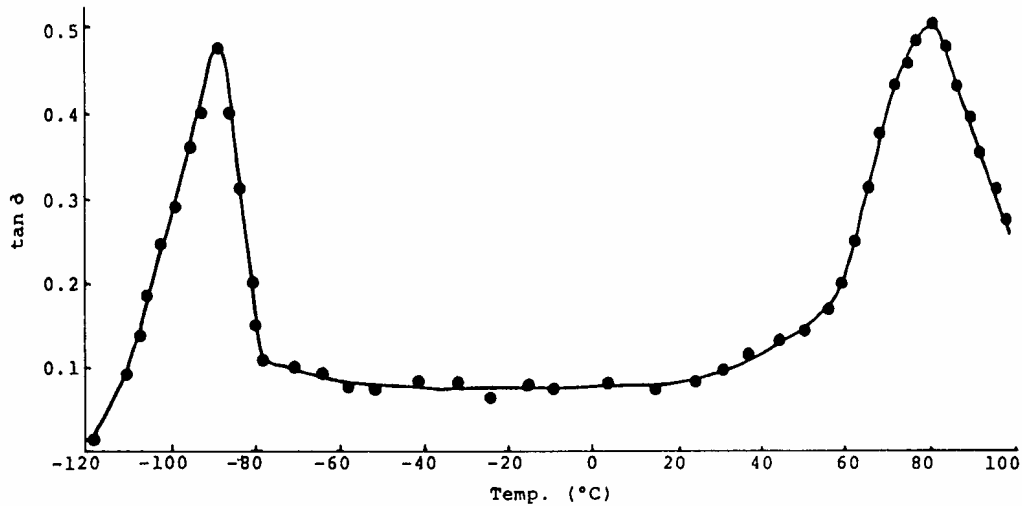


Figure 2 $\tan\delta$ curve for Styrene-Butadiene-Styrene film

2-2 DSC measurement

Figure 3 shows the DSC measurement result of the same SBS sample. Glass transitions in the vicinity of -100 to -90°C and 65 to 80°C are observed. From the result of Figure 2, even the method of the dynamic mechanical testing, the result similar to the one by the DSC measurement is obtained.

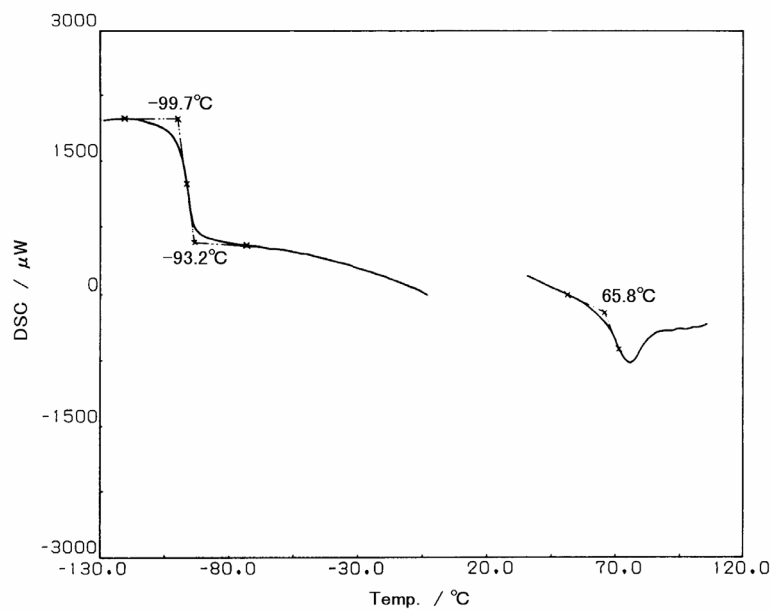


Figure 3 DSC curve for Styrene-Butadiene-Styrene film

Reference

- 1) T.Miyamoto, K.Kodama and K.Shibayama, *J.polym.Sci.A-2*, **8**, 2095(1970)