Application Brief

Hitachi High-Tech HITACHI

Hitachi High-Tech Science Corporation
RBM Tsukiji Bldg., 15-5, Shintomi 2-chome, Chuo-ku, Tokyo 104-0041
TEL:+81-3-6280-0062 FAX:+81-3-3504-5189
http://www.hitachi-hightech.com/hhs/

DMA NO.31 DEC.1998

Dynamic Viscoelastic Measurements of Thermoplastic Elastomer

Nobuaki Okubo
Application Engineering Section

1. Introduction

Thermoplastic Elastomer (TPE) is the polymer which has the characteristics of both the rubber and the plastic as it shows the rubber elasticity at normal temperature and thermoplasticity at high temperature. TPE is a recyclable material and superior in productivity compared to vulcanized rubber as it can be molded like common plastics, thus it is widely used in various fields such as the automobile, machinery, home electronics, health care, and office supplies as the replacement of the existing vulcanized rubber[1].

TPE comprises soft segment which has the rubber elasticity in the molecule and hard segment which is equivalent to the cross-linking point of the vulcanized rubber to protect from the plastic deformation and gives the reinforcement effect to the material.

Depending on types and combination of the soft and the hard segment, TPE is classified into several groups, styrene (SBC), olefin (TPO), vinyl chloride (TPVC), urethane (TPU), ester (TPEE), and amide (TPAE)[1]. The soft segment and the hard segment are mutually immiscible, and in any TPE, they have microphase-separated structure or mutually penetrated network structure. These structures greatly affect the mechanical properties of entire material.

Dynamic viscoelastic measurement is widely used as a method of measuring mechanical property of various polymer materials and of obtaining information of the polymer molecular structure and the molecular motion.

In this brief, a measurement example of SBC, the most common TPE, is introduced.

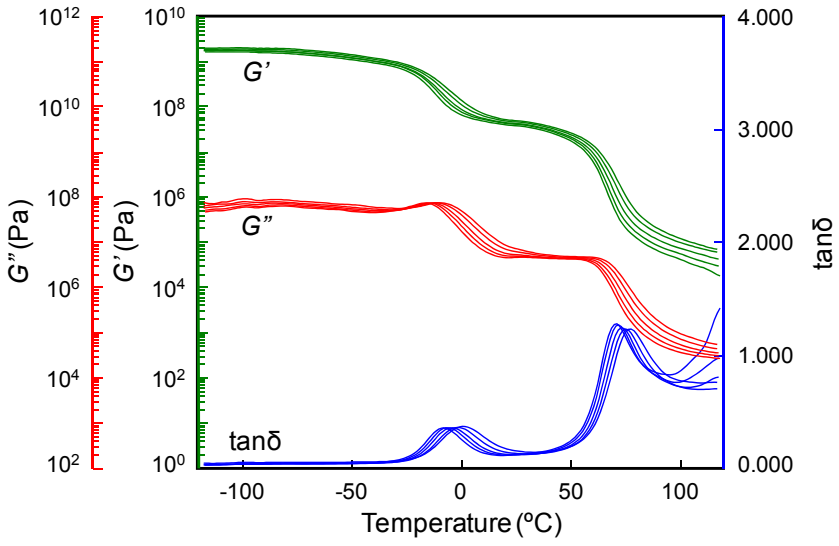

Figure 1 Dynamic viscoelasticity spectrum of SBC

2. Experiment

Ultrasol (acrylic styrene copolymer TPE) from GANZ CHEMICAL CO., LTD is used for a sample. The instrument used is DMS6100 Dynamic Mechanical Spectrometer with PC Station.

The measurement is carried out from -120 to 120°C with heating rate of 2°C /min. Film shear mode used and five different frequencies 0.5, 1, 2, 5, and 10Hz are applied.

3. Measurement results

Figure 1 shows the viscoelastic spectrum of the SBC. The results are simultaneous measurements of temperature dispersion and frequency dispersion. It shows *G'*, *G"*, and tanδ curves at the five frequencies 0.5, 1, 2, 5, and 10Hz. Figure 2 shows *G'* and tanδ curve at 1Hz only. In Figure 1 and Figure 2, there are two peaks on tanδ curve, one in between -30 to 10°C and the other in between 50 to 100°C along with decrease of *G'*. It is considered that the first peak is the primary dispersion (glass transition) of the soft segment and the second one is the primary dispersion of the hard segment. Figure 3 shows the analysis of apparent activation energy *ΔE* [2] calculated from the dispersion peaks of the tanδ curves at each temperature region. It is assumed from the value of the apparent activation energy that both relaxation phenomena are primary dispersion.

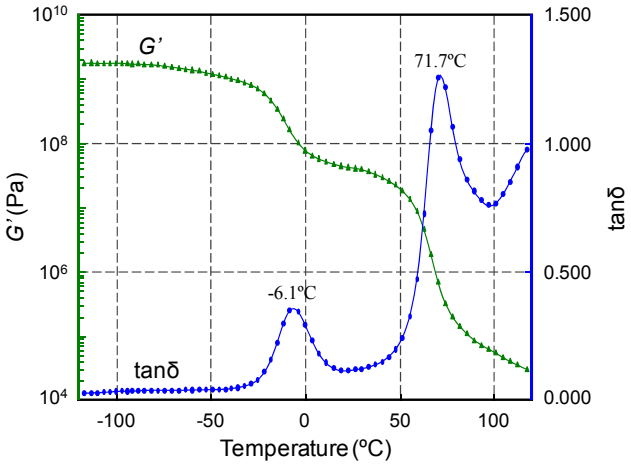

Figure 2 *G'* and tanδ curves of SBC

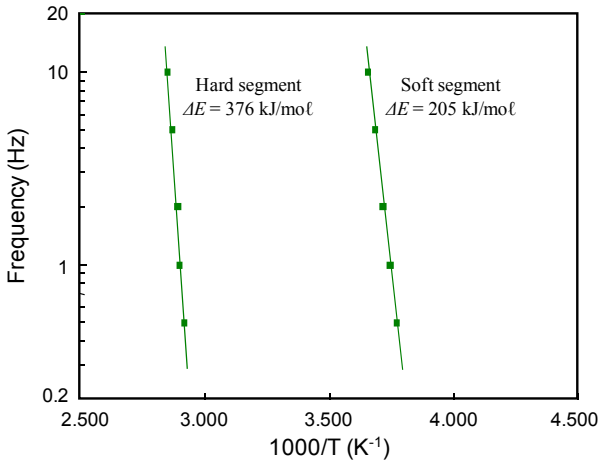

Figure 3 Analytical results of *ΔE*

References

1) Engineering Materials, **44**, No.7, Nikkan Kogyo Shimbun, Ltd.(1996)
2) N. Okubo, Application Brief DMA No.7, Hitachi High-Tech Science Corporation (1990)