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Dynamic Viscoelastic Measurements of ABS Resin

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1. Introduction

ABS resin is widely used in the various fields such as the auto parts and the home electronics as one of the universal polymer.

The improvement of impact resistance by blending rubber component with amorphous polymer such as Polystyrene was finished in 1940s and the impact resistance polymer material such as ABS resin was developed. The impact-resistant polymer materials is the two-layer phase-separated structure which comprises the glassy polymer continuous phase (matrix resin) such as Polystyrene and the disperse phase of rubbery polymer.

ABS resin comprises acrylonitrile (A), butadiene (B), and styrene (S) as Figure 1. As in Figure 2, it is the phase-separated structure (sea-island structure) of polymer alloy. AS resin (copolymer of acrylonitrile and styrene) forms the continuous phase. Polybutadiene rubber phase which is the graft copolymer of acrylonitrile and styrene forms the disperse phase. The material characteristics such as the impact resistance and the rigidity of ABS resin can be changed by controlling the content rate of polybutadiene or acrylonitrile, or the molecular weight of acrylonitrile-styrene resin phase.

In this brief, as an application of the polymer blend characterization by dynamic viscoelastic measurement, ABS resin is measured.

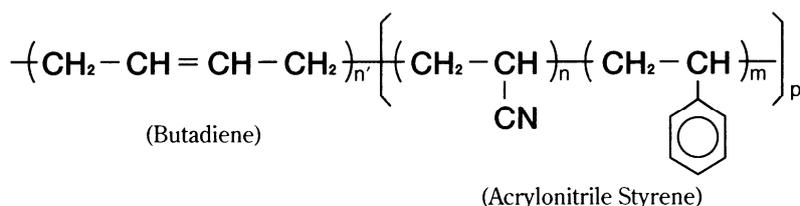


Figure 1 ABS resin chemical structural formula

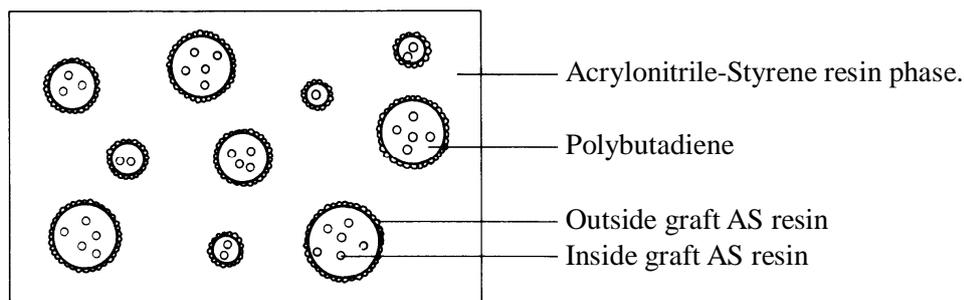


Figure 2 ABS resin phase-separated structure

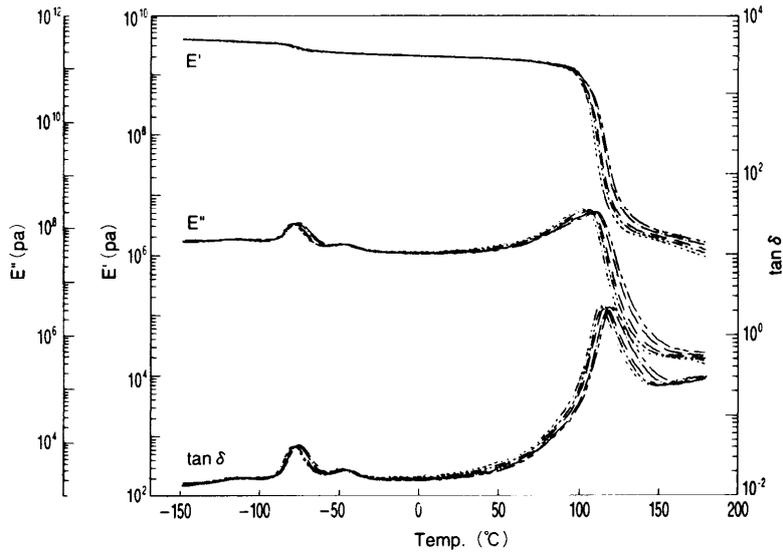


Figure 3 Dynamic viscoelasticity spectrum of ABS resin -A

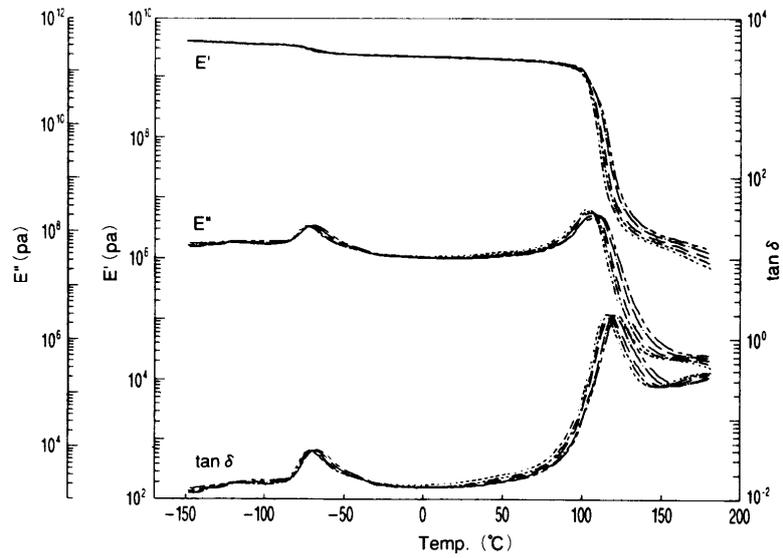


Figure 4 Dynamic viscoelasticity spectrum of ABS resin -B

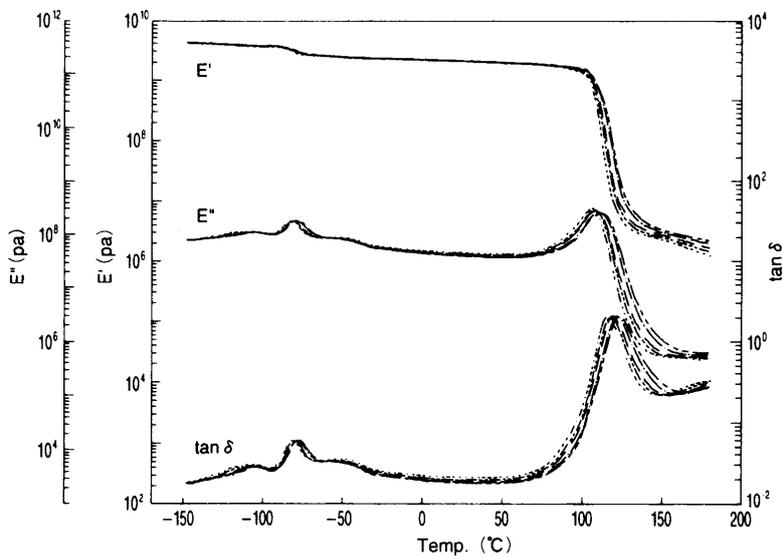


Figure 5 Dynamic viscoelasticity spectrum of ABS resin -C

2. Experiment

Sample is the three kinds of ABS resin from three makers. Sample is the plates (moldings) with 2-3mm thickness.

DMS120 Dynamic Mechanical Spectrometer (Bending Module) connected to a SDM5600H Rheol. Station is used for the measurements. Measurement condition is bending mode and 5 frequencies of 0.5, 1, 2, 5, and 10Hz. The measurement temperature range is -150 to 200°C and the heating rate is 2°C/min.

3. Measurement results

Figure 3, 4, and 5 show three kinds of the ABS resin viscoelasticity spectrums. The results are simultaneous measurements of the temperature dispersion and frequency dispersion. They show E' , E'' , and $\tan\delta$ curve for 5 frequencies from 0.5Hz to 10Hz. At all measurement results shown in the Figure 3 to 5, the peaks of E'' and $\tan\delta$ curves are observed with the decrease of the triple-digit E' in the vicinity of 100 to 200°C. This is considered by the main dispersion (glass transition) of AS resin phase which is the matrix component in the ABS resin. Through -120 to -40°C with the slight decrease of E' , three tiny peaks of E'' and $\tan\delta$ curve are observed. As the frequency dependence is observed from each peak, they are considered three kinds of relaxation phenomenon the different attribution.

Figure 6 shows E' and E'' curves at 1Hz of each measurement shown in Figure 3 to 5. With regard to the E' decrease and the peaks of E'' curves in the vicinity of 100 to 120°C which likely due to the main dispersion (glass transition) of AS resin phase, the amount of E' change, E'' peak temperature and modulus show almost the same. Thus AS resin phase in all samples are estimated to have the same composition.

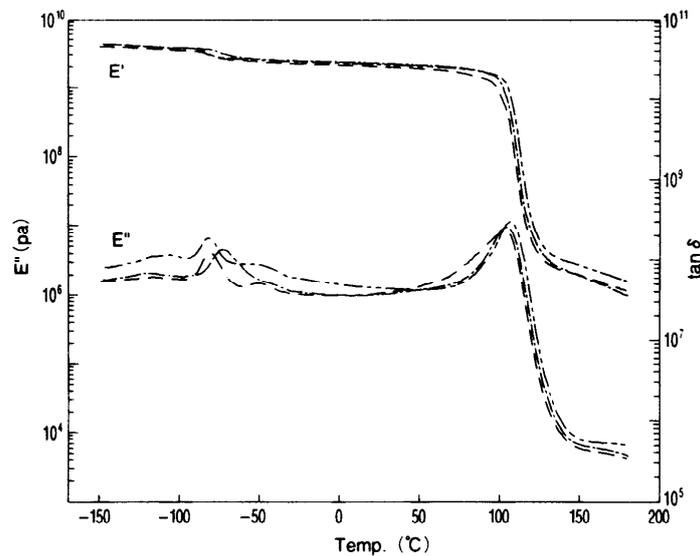


Figure 6 Comparison of E' and E'' curves of each sample

Frequency: 1Hz

----- : A

-.-.-.-.- : B

-.-.-.-.- : C

