Material testing method for understanding rubber's mechanical characteristics

Viscoelasticity Measurement Test

1 Outline of equipment

The measurement equipment for dynamic viscoelasticity measurement tests is an upright style and employs the forced vibration non-resonance method. Sine waves or composite waves (strains in time) are provided to a material sample and then the stress responses are detected with a crystal piezoelectric stress detector. By using the dynamic stress wave and dynamic displacement wave, FFT computations and other operations are carried out to evaluate the amplitudes and phase angles for several frequency values. E^*, E', E and tanδ are calculated with the arithmetic expression on the basis of linear viscoelasticity theory.

2 Testing method

Using a non-resonance forced vibration dynamic viscoelsticity apparatus (Rheogel-E4000, UBM Co. Ltd.), temperature and frequency dependent viscoelastic properties were measured.

Reed-shaped specimen of 4mm width, 1mm thickness and 15mm length were used.

The measurements were taken under tensile loading. In the case of measurements for temperature dependency, the frequency and the climbing temperature rate were set at 1Hz and 2 °C/mim, respectively and the temperature range was set from -100 °C to +100 °C. In the case of measurements for frequency dependency, the frequency range was set from 0.1 Hz to 100Hz and the temperature range was set from -100°C to +100°C. The measurement was carried out by 5°C in the vicinity of the glass transition temperature and by 20°C for the others.

A total of 6 kinds of sample materials were selected in the measurements. materials 1 and 2 are natural rubbers with hardness 50 and 65 each (Yamashita Rubber, co.ltd), and material 3 is a silicon rubber with θ-6 and θ-8 (Gel-Techrubα gel series).

3 Specification of apparatus

1. Measuring method
   1) Dynamic viscoelasticity 2) Stress relaxation 3) Creep 4) Stress-Strain

2. Measurement mode

   1) Temperature dependency 2) Frequency dependency
   3) Temperature and Frequency Dependencies 4) Time dependency 5) Strain dependency

3. Measuremtn jigs
   1) Tension 2) Compression 3) Solid shearing4) Liquid shearing 5) Bending

4. Measurement range
   1) Tension elasticity rate 1.E+0.5 to 1.E + 12Pa
      Shearing elasticity rate 1.E+0.1 to 1.E+ 0.6Pa
   2) Viscosity 1.E+00 to 1.E+0.6Pa.s
   3) tanδ 1.E-0.3 to 1.+0.3

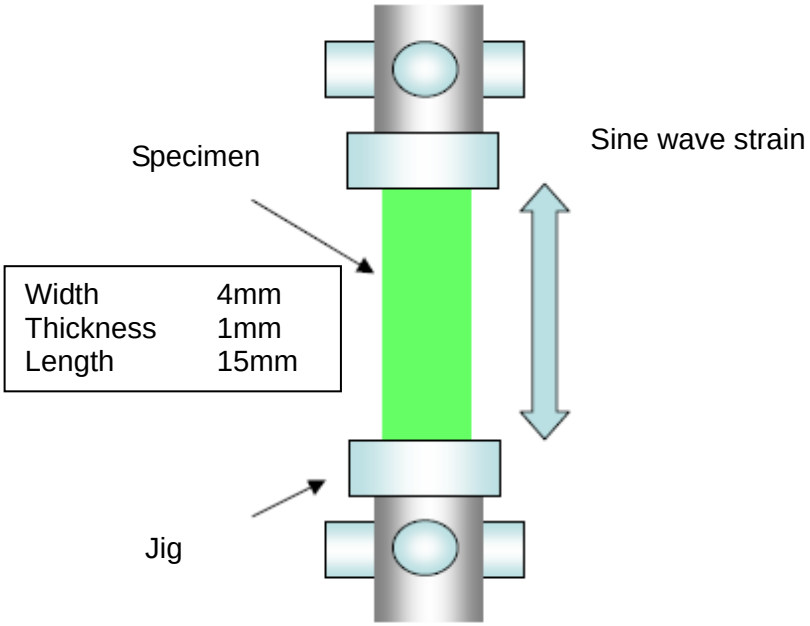
5. Drive range
   1) Frequency 1.E-0.1 to 1.E+0.3Hz
   2) Dynamic strain ±1.E-0.1 to 1.E+0.3Hz
   3) Excitation force ±1.E-0.3 to 1.E+01N
   4) Stroke 0 to 30mm long efficacy with specimen

6. Temperature range
   -150°C to 400°C PID control by a personal computer

temperature detecting element: Pt100Ω

7. Utilities

1) Power supply	AC100V	1ϕ	15A
2) Air	0.2MPa 15L/min		


Specimen
Sine wave strain
Width 4mm
Thickness 1mm
Length 15mm
Jig