Application Brief

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Dynamic Viscoelastic Measurements of Magnetic Film II

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1. Introduction

In the Magnetic film coating layer of cassette tape and videotape, powder type magnetic material is coated on the base film made with PET (polyethylene terephthalate) etc. The binders are used to make the magnetic powder fixed on the base film.

In this brief, two kinds of magnetic coating layer binder for videotape are measured.

2. Experiment

Three kinds of samples are used; videotape A, videotape B, and PET base film for these videotapes. The thickness of the videotapes is 18 µm, and PET base film is 16 µm. Magnetic coating layer of videotape A and B comprise around 50 wt% of CrO_2 as magnetic material, small % of binder component, and others such as ZnO, dispersing, and lubricant. Polyurethane binders of the two different kinds of glass transition temperature are used for the videotape A and B.

DMS200 dynamic mechanical spectrometer (Tension Module) connected to a SDM5600H Rheol. Station was used for the measurements. Measurement condition is 5 frequencies of 0.5, 1, 2, 5, and 10 Hz. The measurement temperature range is -150 to 240 °C and the heating rate is 1 °C /min

3. Measurement results

Figure 1 shows the viscoelastic spectrums of PET base film. The results are simultaneous measurements of temperature dispersion and frequency dispersion, and shows the *E'*, *E"* and tanδ curves for 5 frequencies from 0.5 to 10 Hz. The viscoelastic spectrums in Figure 1 shows two dispersions, α and β from the high temperature side. The α-dispersion is attributed to the primary dispersion (glass transition), and β-dispersion is attributed to the local mode relaxation[1)].

Figure 2 and 3 shows the viscoelastic spectrum of videotape A and B. Both measurement results show, in addition to the PET base film α- and β-dispersion, α-dispersion (glass transition) of binder component in the vicinity of 55 to 60 °C for videotape A and in the vicinity of 35 to 40 °C for videotape B.

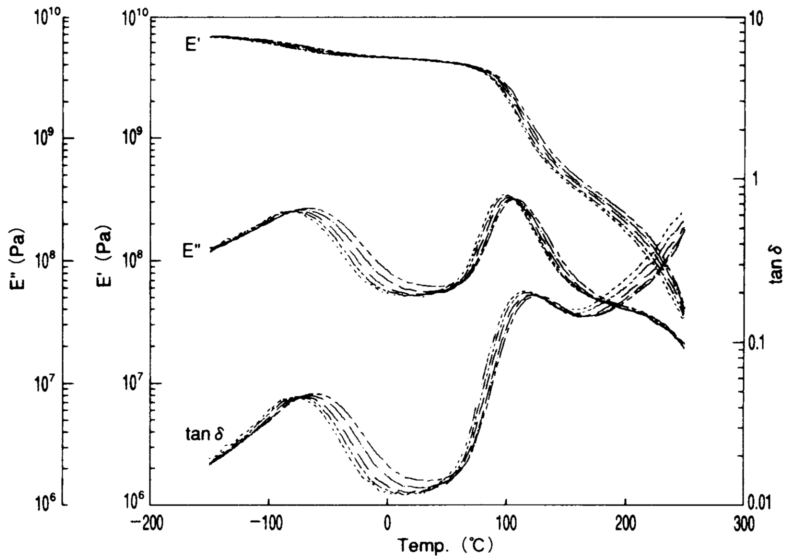

Figure 1 Dynamic viscoelasticity spectrum of PET base film

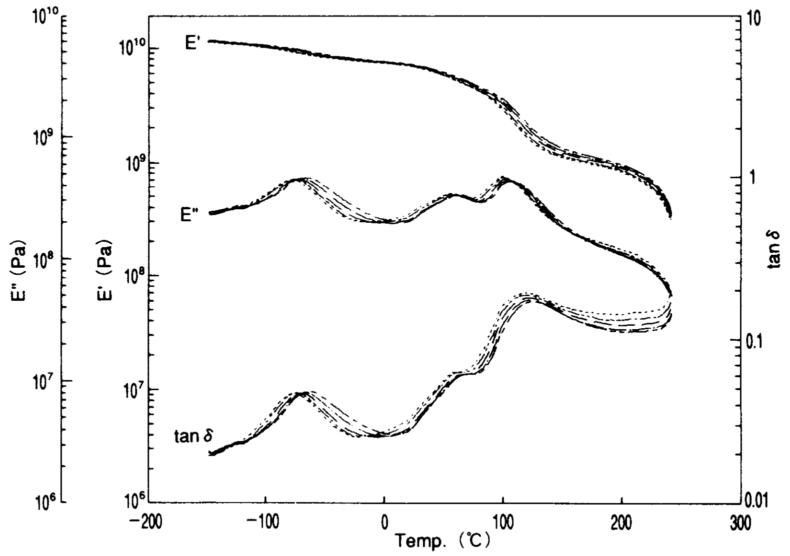

Figure 2 Dynamic viscoelasticity spectrum of videotape A

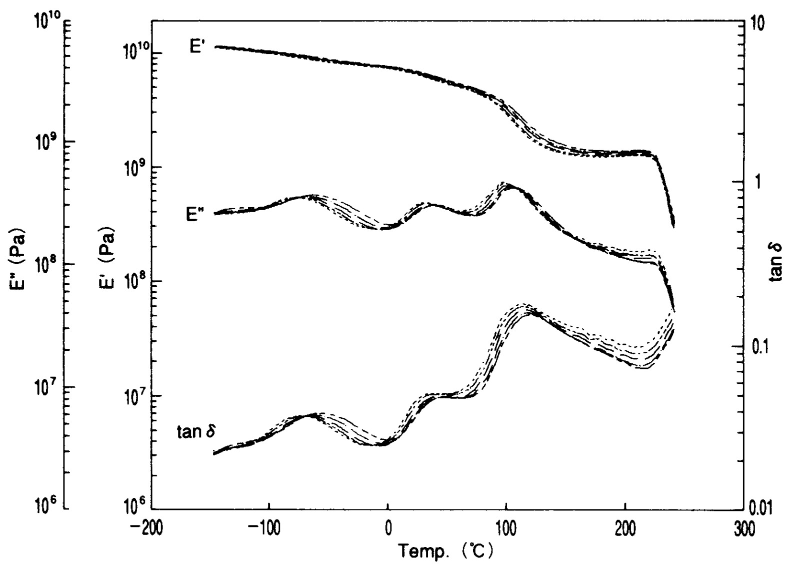

Figure 3 Dynamic viscoelasticity spectrum of videotape B

Figure 4 shows the *E'* curve of the measurement frequency 1 Hz from each measurement result in Figure 1 to 3. This comparison data shows the higher storage modulus in all temperature range for both videotape A and B compared with those of PET base film. The storage modulus of videotape A and B are likely observed higher because the higher storage modulus of magnetic coating layer of videotape A and B are higher than those of PET base film.

Figure 5 shows the tanδ curve of the measurement frequency 1 Hz in Figure 1 to 3. This comparison data shows that the peaks of α- and β-dispersion of PET are observed in the same temperature range. The α-dispersion of the binder component for videotape A and B are overlapped with tanδ curve and are observed in the different temperature range.

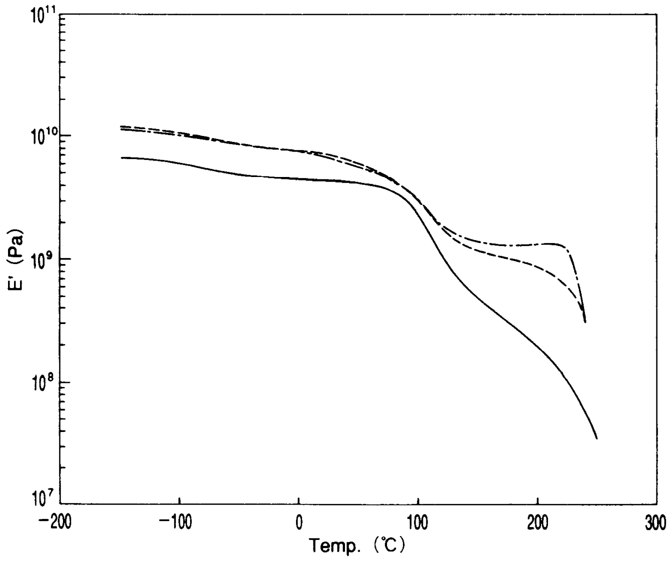

Figure 4 Comparison of *E'* curves for PET base film, videotape A and B
Frequency: 1 Hz
———— : PET base film
-------- : videotape A
-·-·-·-· : videotape B

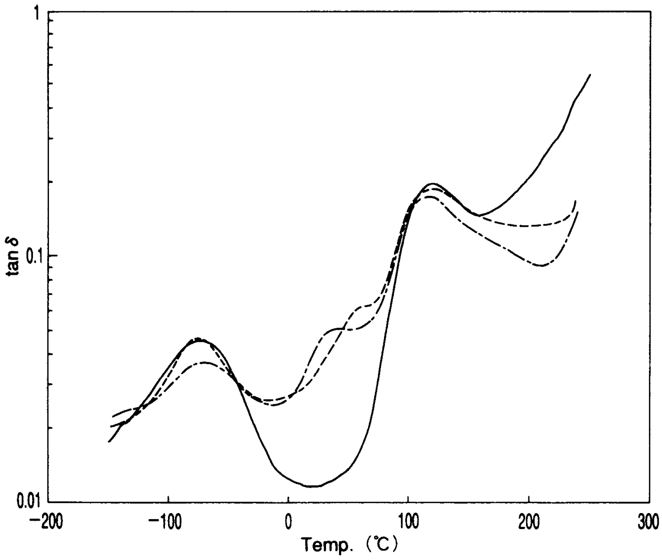

Figure 5 Comparison of tanδ curves for PET base film, videotape A and B
Frequency: 1 Hz
———— : PET base film
-------- : videotape A
-·-·-·-· : videotape B

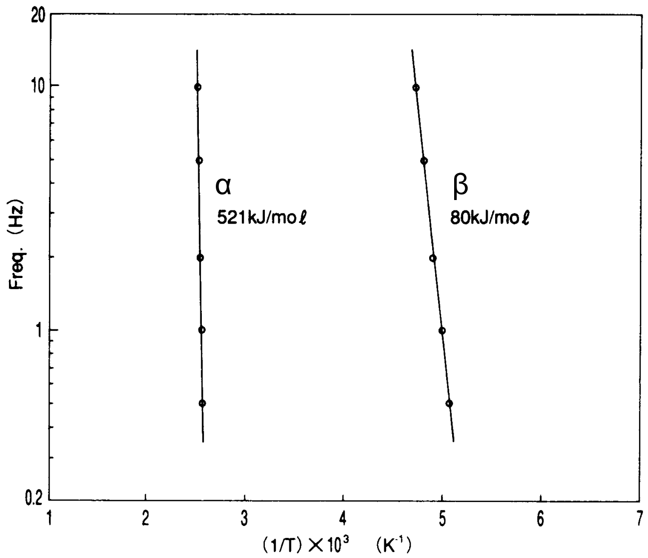

Figure 6 Apparent activation energy of α- and β-dispersion of PET base film

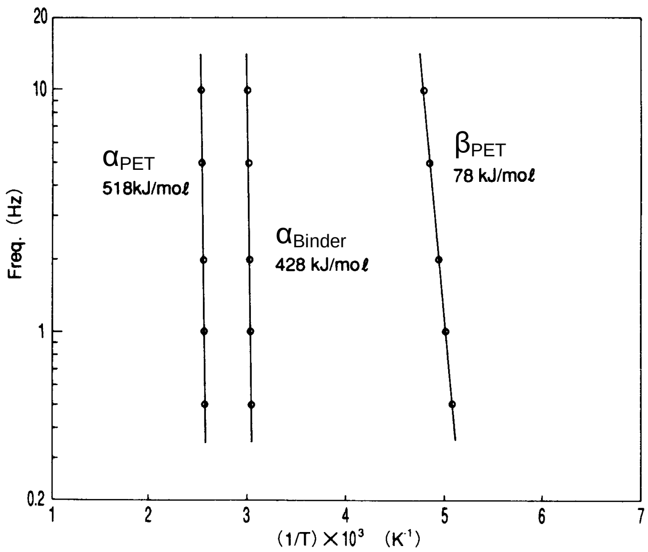

Figure 7 Apparent activation energy for each dispersion of videotape A

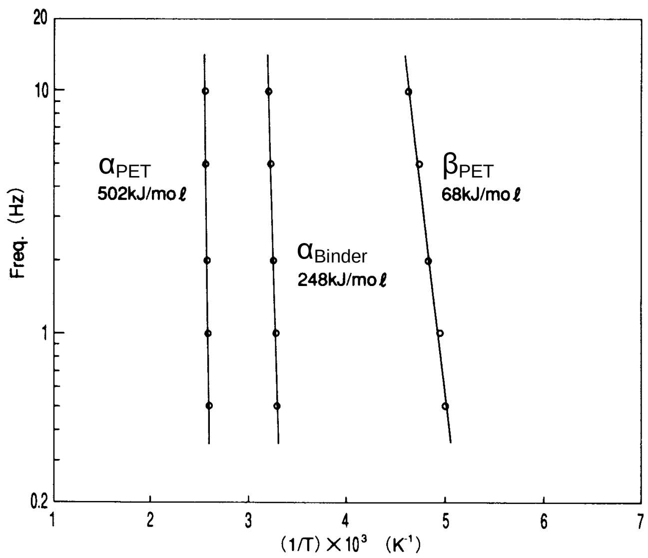

Figure 8 Apparent activation energy for each dispersion of videotape B

Figure 6, 7 and 8 shows the analysis result of the apparent activation energy ΔE [2] in each dispersion obtained from each measurement result in Figure 1, 2 and 3. Almost the same values are obtained as the activation energy of α- and β-dispersion of each PET component. The activation energies of α-dispersion of videotape A and B binders are 428 kJ/mol for videotape A and 248 kJ/mol for videotape B. It is already known regarding the apparent activation energy of the dispersion that the higher the peak temperature of tanδ, the activation energy goes high. The higher the peak value, the activation energy also goes high. Figure 7 and 8 analysis result show this tendency.

4. Conclusion

In this brief, dynamic viscoelasticity measurement is done for the glass transition of the binder which is used in the videotape magnetic coating layer. For the variety of the magnetic film, evaluation of the dynamic properties for the base polymer film can also be measured.

References

1) Yasaku. Wada, “Solid Properties of Polymers”, Baihukan (1971)
2) Nobuaki Okubo, Application Brief DMS No.7, Hitachi High-Tech Science Corporation (1990)