SII NanoTechnology Inc.

DMA AS PROBLEM-SOLVING TOOL: ISOLATION OF MECHANICAL PROPERTIES OF A COATING

Problem

A thermal analyst was involved in the characterization of a adhesive tape materials. She wished to have the ability to determine the mechanical properties of the adhesive contained on a tape material which her company produced. The substrate-adhesive tape specimens could be analyzed on her dynamic mechanical analyzer (DMA); but, due to the difficulties in handling the unsupported adhesive, she had no way of directly determining its mechanical properties.

Solution

The Seiko Instruments line of dynamic mechanical analyzers features unique DMA Coating software, "Rheo Compo", which permits the viscoelastic properties of a coating to be assessed through the mathematical elimination of the substrate. Using this approach, the mechanical response of coatings, which cannot be directly analyzed by DMA due to the nature of the coating (e.g., brittleness, softness, inability to be removed from the substrate), can be assessed.

The tape sample, consisting of an adhesive on a polyethylene terephthalate (PET) substrate film with a total thickness of 0.10 mm, was heated using the Seiko Instrument DMS200 (auto-tension mode) from –150 to 100°C at a rate of 2°C/min. The tape was tested at frequencies of 0.5, 1, 2, 5, 10 and 20 Hz.

Displayed in Figure 1 are the DMA results obtained on the sample. The plot shows the following viscoelastic quantities:

- tensile storage modulus, E', which represents the stiffness of the material
- loss modulus, E", or damping, which reflects the sample's energy absorbing properties
- tan δ, which is an index of the viscoelasticity of the sample (E"/E').

Thermal Analysis & Surface Solutions GmbH
Pfingstweide 21
61169 Friedberg - Germany

+49-6031-16223-1
+49-6031-16223-29
Info@thass.net
http://thass.net

SII NanoTechnology Inc.

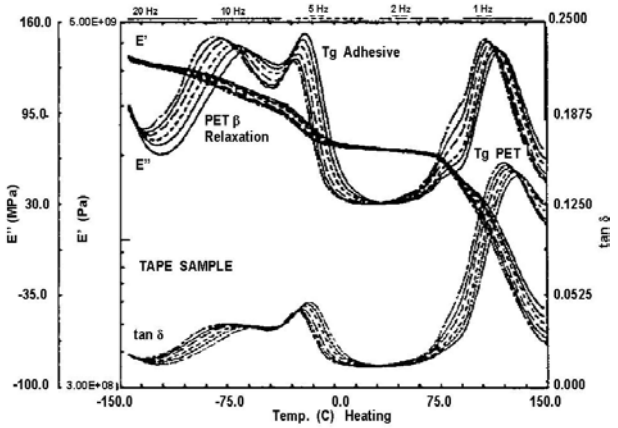

Figure 1

The tape sample exhibits a number of transitions as shown in Figure 1: the ß secondary relaxation associated with the PET substrate at approximately -80°C; the Tg of the adhesive at about -30°C; and the Tg of the PET substrate at 90°C. At the glass transition of the adhesive, the material converts from the hard, glassy state to the soft, sticky rubbery state.

The true nature of the viscoelastic changes which the adhesive undergoes during heating are masked, to a large extent, by the presence of the PET substrate material. By stripping the adhesive from the tape, the substrate base material can be obtained. The base film can be analyzed using the DMA and its mechanical contributions can be mathematically eliminated from those of the tape specimen using the "Rheo Compo" software. This then provides information on the properties of the adhesive itself.

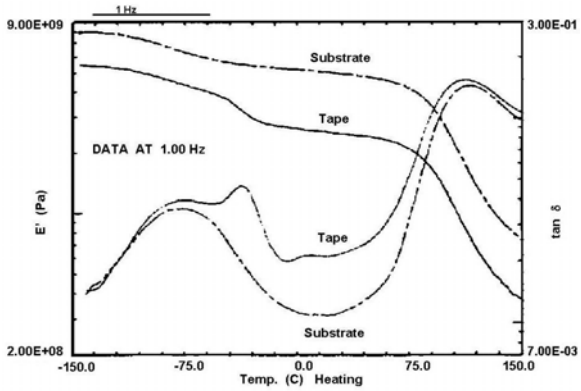

Figure 2

Thermal Analysis & Surface Solutions GmbH
Pfingstweide 21
61169 Friedberg - Germany

+49-6031-16223-1
+49-6031-16223-29
Info@thass.net
http://thass.net

Displayed in Figure 2 are the DMA results (E' and tan δ) at 1.00 Hz obtained on the tape sample and on the PET substrate. The substrate specimen was isolated by placing the tape in acetone, which dissolves only the adhesive layer.

Shown in Figure 3 is the DMA data for the adhesive layer as obtained using the "Rheo Compo" software. The Tg of the coating is observed as the large peak in the tan δ

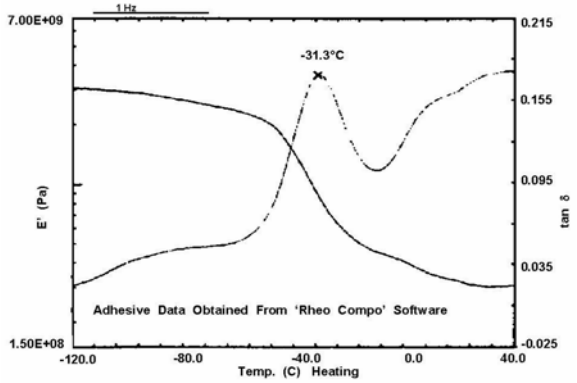

Figure 3

response at -31°C. Above 0^0C, the tan δ response exhibits an increase due to furthering softening of the adhesive resin with increasing temperature.

Summary

The mechanical properties of a tape sample, consisting of an adhesive and a PET substrate, were analyzed using the Seiko Instruments DMS200. The properties of the adhesive itself, without the interfering characteristics of the PET substrate, were obtained using the "Rheo Compo" software.

Thermal Analysis & Surface Solutions GmbH
Pfingstweide 21
61169 Friedberg - Germany

+49-6031-16223-1
+49-6031-16223-29
Info@thass.net
http://thass.net