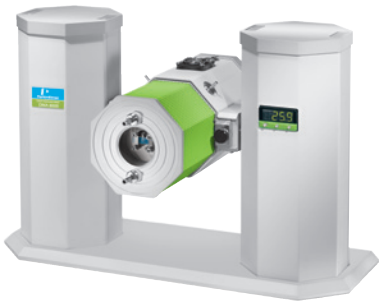
APPLICATION NOTE

Thermal Analysis

# QC Information for Modified Bitumen Blends




## Summary

Bitumen shingles are used as a common roofing material. Polymer additives are frequently used to enhance the performance and durability of the product. This application note will show the DMA response from two shingles with different additives. Two relaxation events are observed in both samples but at different temperatures. The position of the relaxations will have an impact on the performance of the shingles when they are exposed to various temperature profiles. The information from the PerkinElmer® DMA 8000 can be used as a QC technique to quickly evaluate the properties of the material.


## Introduction

Dynamic Mechanical Analysis (DMA) is one of the most appropriate methods to investigate relaxation events. In terms of a multi-component system like bitumen shingles, individual relaxation events can be observed in the sample as discrete events. The experimental procedure is relatively rapid, allowing several samples to be analyzed in one day. This lends itself to being a good quality control technique for this material.

DMA works by applying an oscillating force to the material and the resultant displacement of the sample is measured. From this, the stiffness can be determined and the modulus and tan δ can be calculated. Tan δ is the ratio of the loss modulus to the storage modulus. By measuring the phase lag in the displacement compared to the applied force it is possible to determine the damping properties of the material. Tan δ is plotted against temperature and glass transition is normally observed as a peak since the material will absorb energy as it passes through the glass transition.

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This application note will describe an experiment on two different modified bitumen samples both with a polymer additive. The Tg of the polymer additive is clearly defined in both although at different temperatures. A broad relaxation/ softening of the bulk bitumen is observed at a higher temperature.

## Experimental

### Thermal scan of bitumen sample.

The sample was mounted in the Single Cantilever Bending clamps and cooled to -80 °C. The oven was removed and the sample reclamped (as the cooled material was now glassy). The temperature was stabilized at -80 °C and the thermal scan initiated.

| Equipment | Experimental Conditions | |
|---|---|---|
| DMA 8000 1L Dewar | Sample: | Bitumen shingle with polymer additives (a) and (b) |
| | Geometry: | Single Cantilever Bending |
| | Dimensions: | 5.5 (l) x 5.0 (w) x 4.5 (t) mm |
| | Temperature: | -80 °C to 100 °C at 2 °C/min$^{-1}$ |
| | Frequency: | 1.0 Hz |

## Results and conclusion

Figure 1 shows the thermal scan of the two bitumen samples. From -60 °C the modulus decreases steadily over the temperature range of these experiments. A similar response in modulus is observed for both the bitumen samples. However, the tan δ response shows marked difference between the two samples. Both display a Tg corresponding to the different polymer additives at about -20 °C. As the additive is different in each sample, both the magnitude and position of the Tg differs.

The second event in the tan δ is the response from the bulk bitumen. It could be due to the physical softening (partial melting) of the sample, relaxation events in the sample or, more probably, a combination of the two. As tan δ gives an indication of the mechanical damping properties of the material, it is clear that from these two very different profiles totally different practical properties will result as a function of temperature. This is important information for these materials as they are exposed to a variety of temperature profiles when applied to roofing structures.

Although these experiments took 45 minutes to complete, it is possible to increase the temperature scanning rate without too much impact on the peak positions. Cooling to -80 °C using the PerkinElmer DMA 8000 is very rapid, taking only 2-3 minutes and uses a minimum of liquid nitrogen (ca. 0.25 L). The rapid cooling makes this type of experiment ideally suited to QC analysis of this product.

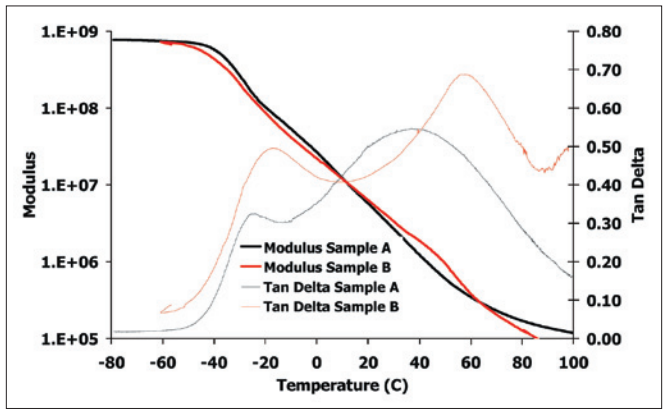


*Figure 1.* Thermal scan data from two bitumen samples.

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