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Differential Scanning Calorimetry (DSC) of Rubbers

Differential Scanning Calorimetry (DSC) is usually the first choice when information is needed about the thermal properties of rubbers. DSC measures the amount of energy (heat) absorbed or released by a sample as it is heated, cooled or held at a constant temperature.
DSC is a fast and efficient method for determining crystallisation and melting behaviour, glass transition temperatures, thermal stability and the reaction kinetics of curing processes, to name a few.

What we can do for you?

The DSC technique is used to carry out qualitative product control of ethylene propylene diene monomer (EPDM). The crystallisation behaviour of EPDM, measured by a DSC cooling curve, provides useful information about the composition of the material. DSC cooling and heating curves are both used to identify EPDM, rubber compounds and thermo plastic vulcanisates (e.g. Sarlink).

Sample size

For a DSC measurement 1 - 25 mg of sample is needed.

Measuring the crystallinity of the EPDM

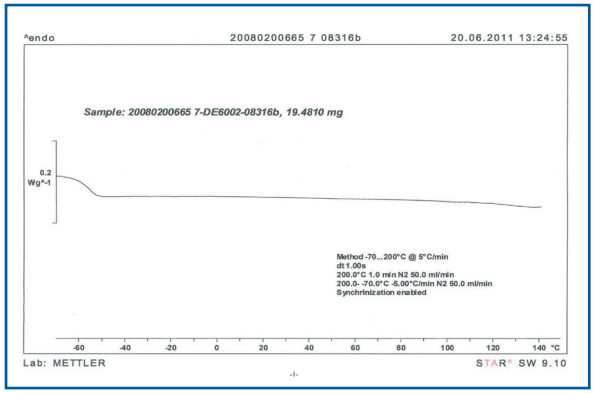
The crystallinity of EPDM originates from ethylene C2 blocks of a certain length. The longer the C2 blocks, the higher the crystallinity of EPDM. This can be monitored by the Tc (crystallisation peak temperature) and the enthalpy (the integral surface under the melting/crystallisation curve). The higher the Tc, the higher the crystallinity of the rubber.

A full amorphous EPDM (ZN) (aless than 53% C2) does not contain any crystallisation peak.
Figures 1 and 2 show the DSC curves of amorphous EPDM and chrystalline EPDM.
Figure 2 shows that the C2 is constructed in two ways:

- longer C2 blocks (higher Tc (40°C). These blocks come in the range of polyethylene
- shorter C2 blocks (Tc=12°C).

In general, when short C2 blocks are built in the Tc <0°C (low crystallinity) and when longer C2 blocks are built in the Tc>0°C (high crystallinity).

Figure 1: Amorphous EPDM: no crystallisation



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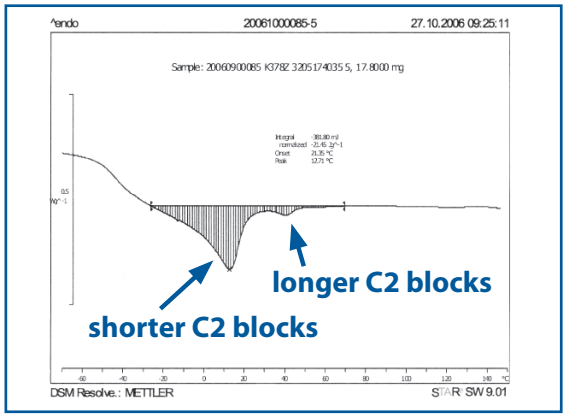

Figure 2: The C2 has been constructed in two different ways: longer C2 blocks (Tc 40°C) and shorter C2 blocks (Tc=12°C) in a high cristalline EPDM .

The glass transition of EPDM

The glass transition (Tg) of EPDM ranges from -50°C to -60°C. When measuring EPDM and compounds the Tg will be influenced by the oil and diene (third monomer) added. However the diene usually has a negligible influence because of its relatively low concentration.
An example of a DSC curve (heat-cool-heat) of an EPDM sample is shown in Figure 3.

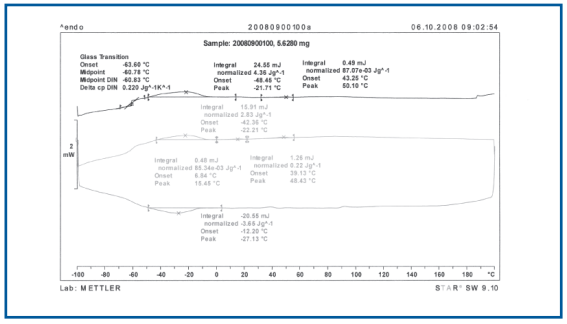

Figure 3: DSC curve (heat-cool-heat) of EPDM (low crystallinity). The Tg of this material is -60.9°C.

DSC measurements on Thermo Plastic Vulcanisate (TPV)

A Thermo Plastic Vulcanisate (TPV) mostly consists of Polypropylene (PP) and EPDM. Besides the EPDM part, the PP is also visible (Tm=+/-152°C and Tc=+/- 108°C) in the DSC curves. An example of a DSC curve of a TPV compound is shown in Figure 4.

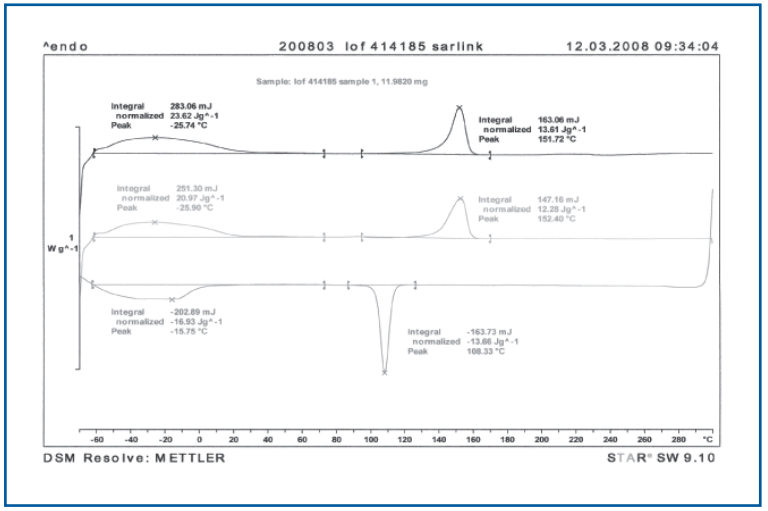

Figure 4: DSC curve of a TPV compound

Stretch your thinking in polymers
We think about polymers differently because we understand the complete spectrum of polymers - from research and development to production and end of life disposal. Credit our decades of experience in materials analysis and processing, chemical engineering and safety testing, as well as product enhancement and polymer recycling issues. We can help you think beyond the way you're currently producing polymers.