Efficient Polymer Analysis
for Your Continued Success

Polymer DSC
Polymer DSC R
Production Optimization
Rapid Quality Analysis
Failure Analysis
Realize Cost Savings with Minimal Effort

The Polymer DSC is an efficient tool used to monitor quality parameters when working with polymers. It reliably recognizes changes to manufactured materials due to differences in raw material properties or manufacturing processes. If you are already utilizing other measurement techniques to monitor quality control parameters such as the MFI (melt flow index), this is a good first step but only the Polymer DSC can meet all of your quality control needs.

The Polymer DSC can quickly and with minimal effort help you gain control in the following areas:

- Receipt of raw materials, additives and chemicals
- Prototypes and tool making
- Manufacturing control
- Quality assurance and delivery of finished products

If you answer yes to one or more of the questions below, then the Polymer DSC is the right instrument for you:

- Does your final product need to be of a specified quality? □ Yes □ No
- Are you interested in verifying the quality of your starting material? □ Yes □ No
- Do you want to optimize process parameters during molding? □ Yes □ No
- Would you like to avoid assembly line downtime? □ Yes □ No
- Would you like to minimize rejection rates? □ Yes □ No
- Would you like to recognize differences between batches? □ Yes □ No
- Do you need to know if enough additive was mixed in? □ Yes □ No
- Are you interested if the degree of cross-linking is within specification? □ Yes □ No
- Is the reason for a material failure of interest? □ Yes □ No

Polymer DSC – Applications at a Glance

- Rapid quality determinations by direct comparison with the results of a known material
- Valuable information on the identification of raw materials
- Discover the thermal influences from processing the material
- Optimize production processes
- Analysis of failed products
- Purity of polymers (recycled proportion)
- Material mixing control
Polymer DSC Measurement System
Easy, Efficient, Robust and Compact

Large Measurement Range for Different Polymer Types
As the most frequently employed method of thermal analysis, differential scanning calorimetry (DSC) efficiently helps to insure quality during polymer production and processing, minimizing waste and thereby saving money. Working together, the optimized furnace and robust sensor allow for excellent measurement capability.

Easy and Robust – Maximum Lifetime for a Sound Investment
The Polymer DSC was conceived in order to maximize the longevity of the system. The sensor, the heart of every DSC, is one of the most critical components. Our sensor is coated with ceramic, which is resistant to aggressive and reactive substances unlike metallic sensors that corrode when exposed to high temperatures.

Optimal Polymer Testing in the Smallest Space
Eliminate user error when typing in sample mass by hand. With just the click of a button the balance signal (sample mass) is sent directly to the software for effortless operation. The optional XS/XP balance from METTLER TOLEDO can be interfaced directly to the Polymer STaRe software.
Polymer DSC
Made for Efficient Polymer Analysis

- Temperature Range: -90°C or room temperature to 500°C in one measurement
- Large Dynamic Measurement Range: for large or small transitions: ± 300 mW
- High Sensitivity and Resolution: for small or neighboring sample effects
- Large or Small Sample Sizes: for small sample additives and inhomogeneous materials

Save Time, Work Efficiently – Utilize the Autosampler
The Polymer DSC is also available with an optional autosampler: the Polymer DSC R lightens your workload by enabling up to 34 samples to be analyzed automatically. Save time and money from the unique reliability and precision of METTLER TOLEDO instruments.

Different Cooling Options
The Polymer DSC is air-cooled for measurements beginning at room temperature. Upon request, the Polymer DSC can be equipped with an intracooler unit that enables measurements down to temperatures of -90°C. If lower temperatures or more demanding applications are required, METTLER TOLEDO can still provide the right application with our Thermal Excellence DSC1 systems.

Versatile and Intuitive – Polymer STAre Software
It enables the easy and quick measurement of the important characteristics of polymer workmanship and quality:
- Enthalpy of Melting
- Extent of cross-linking
- Glass Transition Temperature (Tg)
- Initial Crystallinity
- Melting Temperatures (Onset, Endset)
- Thermal Stability

At the same time the software offers the ability to automatically evaluate characteristic transitions with an OK-Check (in spec/not in spec). The evaluation macro can even automatically print out the results.

Simply Informative – The Integrated Online Help
Carry out measurements and evaluations with the intuitive software platform. The integrated online-help offers a comprehensive description for each menu choice, including background information for the relevant evaluation function.

Polymer DSC
Take your polymer quality control to the next level.
Polymer DSC R
Quick, efficient, unattended operation optimizes your polymer quality control parameters.
Six Typical Application Examples to Support Your Analysis Efforts

Melting Peaks of Different Thermoplastics
Important properties of polymers, such as the glass transition, the melting temperature and the crystallinity are frequently used for characterization. As the examples of different common materials demonstrate, the melting behavior varies significantly from polymer to polymer. Each polymer can be identified by peak temperature and enthalpy, as well as the initial crystallinity determined from the peak area.

PA6 Fresh and Recycled
The economy of producing molded polymer parts is dependent on the amount of recycled material which can be added and mixed without quality loss. Recycled material often shows a higher crystallinity in comparison to fresh material, as shown in this example of PA6. The higher crystallinity (higher melting enthalpy of recycled material) is most often induced by impurities which act as seed crystals.

DGEBA+DDM: Heating Curves and Conversion
Knowledge of important aspects of the cross-linking reaction such as, heat of reaction, conversion as function of temperature and glass transition temperature after cross-linking are very important for the production of duroplastic materials, e.g. epoxy resins. This information can be obtained quickly by heating up the sample twice.
**PA66 Different Process Control**

Polyamides are produced by the polymerization of different monomer compounds and are widespread in daily use, e.g. for textiles. The small endothermic effect around 100°C in one PA66 sample is due to the melting of alpha-caprolactame. This batch caused sample processing problems (plugging of the tool). Processing problems, and therefore rejection of goods, is avoidable by the use of the Polymer DSC.

**PC and PC/ABS-blend**

Polycarbonate (PC) is an amorphous thermoplastic with a glass transition temperature of around 150°C. The properties of the PC can be influenced by polymeric additives like Acrylonitrile Butadiene Styrene (ABS). In this case, the glass transition of the PC in the example is shifted 3°C to a lower temperature. The poor mixability of both polymers is detected by the glass transition, which allows development of products with defined user properties.

**PET, Thermal History**

Besides certain material characteristics like melting enthalpy, glass transition temperature and crystallinity, changes due to processing or storage are indicative of the material’s behavior. The material’s thermal history can be made visible by a simple heating measurement. In the regions of the glass transition (approx. 80°C) and of the cold crystallization (approx. 150°C) of PET, different storage and processing conditions can be determined.
How to Make a DSC Measurement – Step by Step

- Place 5–20 mg of sample into a pan
- Select the standardized temperature program
- Enter the sample name and mass, press start
- Place sample pan in DSC furnace
- Measurement is performed automatically
- Open measurement curve and evaluate the result

Important Standards for the Polymer Industry

<table>
<thead>
<tr>
<th>Standard</th>
<th>Number</th>
<th>Description</th>
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<tbody>
<tr>
<td>ASTM</td>
<td>D 3350</td>
<td>Polyethylene Plastics Pipe and Fittings Materials</td>
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<tr>
<td>ASTM</td>
<td>D 3417</td>
<td>Enthalpies of Fusion and Crystallization of Polymers by DSC</td>
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<tr>
<td>ASTM</td>
<td>D 3418</td>
<td>Transition Temperatures of Polymers by DSC</td>
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<td>ASTM</td>
<td>D 3896</td>
<td>Oxidative-Induction Time of Polyolefins by DSC</td>
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<tr>
<td>CEI/IEC</td>
<td>1074</td>
<td>Determination of crystallites - Identification of raw materials</td>
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<tr>
<td>DIN EN</td>
<td>11409</td>
<td>Determination of the heats and temperatures of reaction of phenolic resins by DSC</td>
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<tr>
<td>DIN ISO</td>
<td>3146</td>
<td>Determination of the Melting Behavior of Semi-crystalline Polymers (DSC)</td>
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<tr>
<td>ISO</td>
<td>11357</td>
<td>Plastics Analysis Differential Scanning Calorimetry (DSC); Part 1 through 7</td>
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<tr>
<td>DIN</td>
<td>53765</td>
<td>Testing of plastics and elastomers; thermal analysis; DSC-method</td>
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<tr>
<td>DIN</td>
<td>51004</td>
<td>Determination of melting temperatures of crystalline materials using Differential Thermal Analysis (DTA)</td>
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<tr>
<td>DIN</td>
<td>51005</td>
<td>Thermal Analysis (TA) Terms</td>
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<tr>
<td>DIN</td>
<td>57472</td>
<td>Testing of cables, wires and flexible cords; crystallite melting point (Part 621)</td>
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Important Polymers and Thermal Properties

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Tg [°C]</th>
<th>Tf [°C]</th>
<th>Hfus,100% Cryst. [J/g]</th>
</tr>
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<tbody>
<tr>
<td>PA6</td>
<td>(40)</td>
<td>220…230</td>
<td>230</td>
</tr>
<tr>
<td>PA66</td>
<td>(50)</td>
<td>260</td>
<td>255</td>
</tr>
<tr>
<td>PBT</td>
<td>65</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td>PC</td>
<td>155</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PE-HD</td>
<td>(-70)</td>
<td>135</td>
<td>293</td>
</tr>
<tr>
<td>PE-LD</td>
<td>(-100)</td>
<td>110</td>
<td>293</td>
</tr>
<tr>
<td>PEEK</td>
<td>143</td>
<td>335</td>
<td></td>
</tr>
<tr>
<td>PET</td>
<td>69</td>
<td>256</td>
<td>140</td>
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<tr>
<td>PMMA</td>
<td></td>
<td>105</td>
<td></td>
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<tr>
<td>POM</td>
<td>175…180</td>
<td>326</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>(-30)</td>
<td>165</td>
<td>207</td>
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<tr>
<td>PS</td>
<td>90…100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTFE</td>
<td>(-20)</td>
<td>327</td>
<td>82</td>
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Advantages of DSC for Polymer Testing

- Fast quality evaluation by comparing the results to materials of known quality
- Valuable information on the identification of raw materials
- Characterization of manufacturing influences
- Optimization of production processes
- Analysis of defective products
- Polymer purity (fraction recycled content)
- Material mixing control

Standard methods lead to confident comparison of measurement results.