APPLICATION NOTE

Thermal Analysis

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Differential Scanning Calorimetry Performance Comparison

Introduction

Differential scanning calorimetry (DSC) is a commonly used technique for studying polymeric, pharmaceutical, and energetic materials. When considering which type of DSC to use to perform a specified measurement one typically chooses either a Power Compensation, or Heat Flux design. These instruments are often referred to as double and single furnace DSC respectively. PerkinElmer is the only vendor to provide both designs to customers, because we believe that both technologies provide unique advantages and users can choose the best type of DSC to meet their specific need. One of the more common questions is how do the instruments data compare when performing a standard measurement? To answer this question, a standard polystyrene (PS) and low-density polyethylene (PE) sample are tested using the conventional heat-cool-reheat method.

DSC 8000/8500

- PerkinElmer's new flagship DSC 8000 and DSC 8500 was developed for the user's need for greater sensitivity and accuracy. They can be used for many applications including QA/QC applications, studying processes in plastics and pharmaceuticals.
- The DSC 8000 provides outstanding sensitivity and reproducibility. It features PerkinElmer's proprietary double-furnace technology, which directly measures the heat flow between two independent furnaces. It provides the most precise energy measurements over the whole temperature range of any DSC in order to meet the most demanding applications. There is an optional 96-position autosampler available and the DSC 8000 can be upgraded to a DSC 8500.
- The DSC 8500, while providing all of the features of the DSC 8000, also offers HyperDSC® heating and cooling with extremely fast controlled scanning rates and in-situ ballistic cooling important for applications such as isothermal crystallization, polymorph/amorphous-material studies and high sensitivity measurements.

PerkinElmer®
For the Better

DSC 4000/6000

- PerkinElmer's new compact, single furnace DSCs, the DSC 4000 and 6000, provide a solution for a wide range of routine applications in the academic, polymer and pharmaceutical markets.
- The DSC 4000 is upgradeable to the DSC 6000 and has the option of a 45-position autosampler. The DSC 6000 gives you all of the advantages of the DSC 4000 but also includes Modulated Temperature DSC (MT-DSC) technology for easier data interpretation and additional capabilities for product development and troubleshooting.

Experimental/Results

In order to demonstrate performance, two standard samples were chosen which demonstrate common transitions measured by DSC. Low-density polyethylene (PE) and polystyrene (PS) were chosen in order to compare the melt and the glass transition. Both DSCs were set up under similar conditions.

- Purge gas was nitrogen at 20 mL/min
- Two point calibration using indium and zinc at 10 ˚C/min
- A typical Heat-Cool-Reheat experiment on PS and PE was measured on both versions of DSC
- Both were equipped with a 2P cooling device, which allows operation temperatures from -60 ˚C to instrument maximum

Polyethylene

- Heat from 0-150 ˚C @ 10 ˚C/min
- Hold for 2 min @ 150 ˚C
- Cool at 50 ˚C/min to 0 ˚C
- Hold at 0 ˚C for 2 min
- Heat from 0-150 ˚C @ 10 ˚C/min

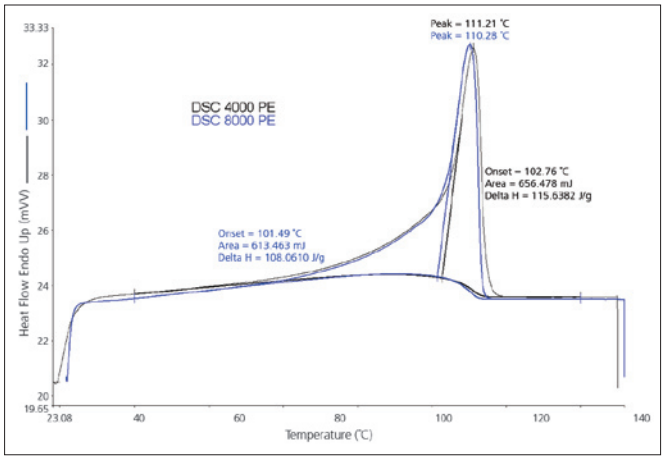

Figure 1. DSC curves for polyethylene acquired using a DSC 4000 and a DSC 8000.

Polystyrene

- Heat from 25-150 ˚C @10 ˚C/min
- Hold for 2 min @ 150 ˚C
- Cool at 50 ˚C/min to 25 ˚C
- Hold at 25 ˚C for 2 min
- Heat from 25-150 ˚C @ 10 ˚C/min

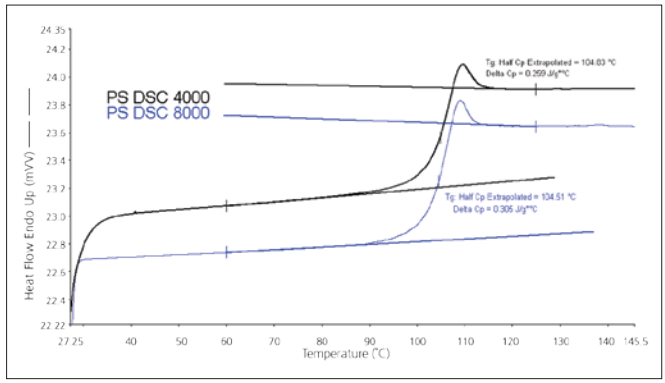

Figure 2. DSC curves for polystyrene acquired using a DSC 4000 and a DSC 8000.

Results/Conclusions

It is clear from this data that there is very little difference between the two types of DSCs at 10 ˚C/min heating. Upon studying the melting peak of PE only a 0.9 ˚C difference can be seen for the sample. When measuring the glass transition of a PS sample only a slight difference of 0.3 ˚C is observed. This larger difference is most likely a result of the cooling step, since the DSC 8000 can more effectively control the cooling of the sample through the crystallization step, which leads to subtle differences in the crystalline morphology of the sample. Nevertheless, it is clear from this data that if you wish to compare two samples by both Heat Flux (DSC 4000) and Power Compensation (DSC 8000) instruments at 10 degrees per minute you will get comparable results, well within the limits of acceptable experimental error.

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