

## DSC AS A PROBLEM-SOLVING TOOL: CHARACTERIZATION OF TONERS

### Problem

A chemist has a need to analyze the thermal properties of toner resins used for copying purposes in order to improve the end use characteristics of the toners. He wishes to be able to measure the properties of the toners in both standard, as-received form and from the paper after photocopying has taken place. The latter application requires the use of a high sensitivity differential scanning calorimeter (DSC) since the amount of toner relative to the paper is very small.

### Solution

The Seiko EXSTAR DSC6100 provides the necessary high degree of sensitivity required to observe low energy or weak thermal transitions. The Seiko DSC6100 offers the following features and benefits:

- ultra high sensitivity which is on a level of 10 to 30 times greater than other DSC instruments
- extremely stable baseline performance for highly reproducible results
- excellent subambient performance for the detection of weak transitions in the subambient regions
- 20 point temperature calibration for the best possible accuracy over the widest temperature range
  
- 10 point enthalpic calibration for highly accurate heat capacity measurements or heats of transition determinations

The Seiko EXSTAR DSC6100 has been widespread utility in the fields of pharmaceutical and biotechnology applications, where high sensitivity, coupled with ease of use and efficiency, are necessary. However, the high sensitivity characteristics of the Seiko DSC6100 permit it to be used in certain polymer applications where DSC has not been previously successful due to the sensitivity limitations of most commercial instruments. Polymer applications where high sensitivity DSC will be of utility include:

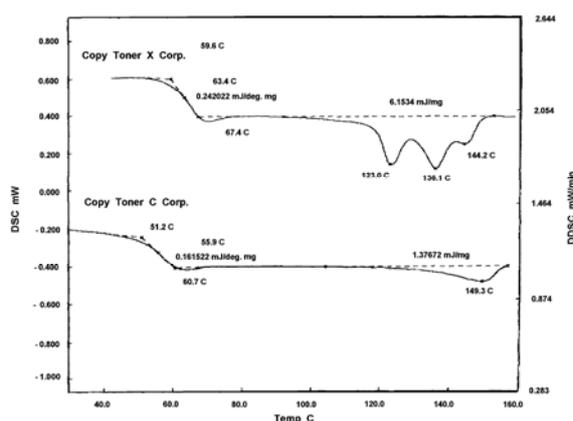
- the measurement of the weak glass transition of highly crystalline polymers
- the detection of weak transitions associated with highly filled samples, such as composites

- the observation of weak high history or processing pre-melting endothermic transitions associated with fibers, such as nylon 6
- the measurement of the transitions associated with a coating on an inert substrate.

The DSC6100 will be of use in the characterization of toners on paper, which is equivalent to the measurement of a polymeric

coating on a substrate. In the case of toners, the weight of the toner on a paper substrate comprises only about 10% of the total sample mass, and thus a high sensitivity DSC is necessary to detect the thermal transitions associated with the toners.

In the study of the toners and the toners on paper, the samples were heated in a crimped aluminum pan at a rate of 10°C/min using the Seiko DSC6100. The DSC was purged with nitrogen gas at a flow rate of 40 mL/min.



**Figure 1**

Displayed in Figure 1 are the DSC6100 results obtained on two different toners, Toner X and Toner C. Toner X exhibits its T<sub>g</sub> at 63.4°C and yields multiple melting endothermic peaks at 123.0, 136.1 and 144.2°C. The total heat of melting of Toner X is 6.15 mJ/mg. Toner C yields a T<sub>g</sub> of 55.9°C and a single melting endothermic peak at 149.3°C. The heat of melting of Toner C is 1.37 mJ/mg.

The toners on paper, after copying, were characterized using the DSC6100. A 5 mm square of the paper, with toner, was cut and placed into a DSC pan. The total mass of the sample was approximately 1.6 mg which gives an effective weight of the toner of only 0.16 mg.

Displayed in Figure 2 are the DSC6100 results obtained on the toners on paper. Toner X yields a T<sub>g</sub> of 63.4°C and multiple melting peaks at 123.0, 135.9, and 144.4°C while Toner C has a T<sub>g</sub> of 57.9°C and a single melting peak at 148.8°C. The results obtained

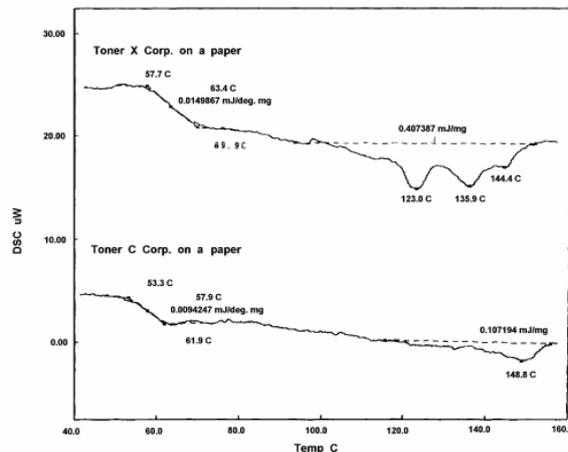


Figure 2

from the toner-paper specimens are remarkably consistent with the DSC results obtained from the neat toner samples. These results demonstrate the very high sensitivity characteristics of the Seiko DSC6100. No other DSC instrument on the market could yield these high quality data under the same experimental conditions.

### **Summary**

The Seiko EXSTAR DSC6100 has the highest sensitivity of any commercially available DSC instrument which makes it useful for polymer applications where high sensitivity is required. Such an application is the measurement of the properties of a coating on a substrate. In this study the properties of two toners were tested both in the neat or as received form, as well as from the photocopied document. The DSC6100 has the necessary high degree of sensitivity to observe the weak transitions (T<sub>g</sub> and melting) of the toners on the photocopied paper. This is outstanding performance given that the effective mass of the toner on the paper was only 0.16 mg.