SII NanoTechnology Inc.

DSC AS PROBLEM-SOLVING TOOL: DETECTION OF FIBER HEAT SET TEMPERATURES

Problem

A customer at a textile plant, using textured polyethylene terephthalate (PET) fibers, found that one yarn exhibited good dyeing properties with a satisfactory level of dye uptake and dye uniformity. A second PET yarn did not yield the desired dyeability characteristics and showed a significant amount of non-uniformity (streakiness). The customer wished to have a simple test to examine incoming PET yarns for the dyeability performance.

Solution

Differential scanning calorimetry (DSC) provides a sensitive and easy to use technique for the detection of small transitions, including the heat set temperature endotherm. This heat set endotherm is oftentimes related to the dyeability of the textured PET yarn.

Texturing is a process step frequently used in the textiles industry to achieve desired properties such as bulkiness and textural feel. It involves placing a twist into the yarn on a hot surface under controlled conditions (tension, degree of twist, temperature of hot surface and time on hot surface). If the processing conditions are not within certain tolerance levels, problems can occur in the finished textured yarn, such as dye streakiness. The streakiness problem is generally found to be due to morphological or structural differences in the textured yarn. These differences are often due to variations in the maximum effective temperature that the yarn is exposed to, or experiences, during texturing.

The ability to easily estimate this heat set temperature after texturing and prior to further processing and dyeing can aid in:

- better control of the texturing process
- quantitative assessment of the texturing conditions on subsequent yarn dyeability
- assistance in the determination of the cause of defects in fabrics
- quality assurance in textile plants

One easy means of assessing the heat set temperature is with DSC. A sample amount of yarn is placed into a DSC pan, crimped and then heated from ambient conditions to 300°C at a rate of 10°C/min. The test is straightforward and takes less than 30 minutes to perform. The robotic DSC (RDC) provides a means of analyzing many yarn specimens overnight and unattended which is ideal for quality assurance purposes.

One PET yarn (Good) exhibited satisfactory dyeability while the other yarn (Bad) showed a significant level of the undesirable streakiness. Both specimens were analyzed on the Seiko Instruments DSC220C which provides the necessary high level of sensitivity to detect the small heat set endotherm.

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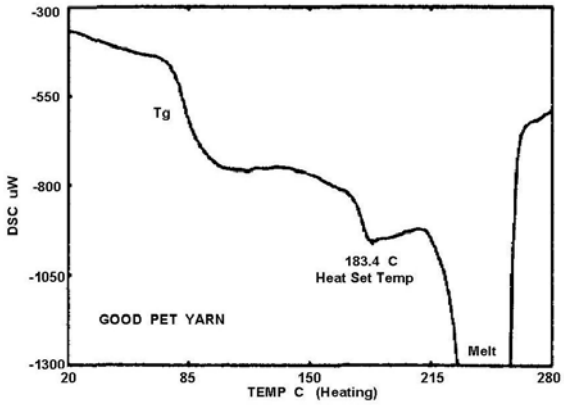

Figure 1

Displayed in Figure 1 are the DSC results obtained on the 'Good' yarn sample. This material shows the glass transition event (Tg) at 83°C and the melting point at 250°C. The important heat set temperature is observed as the peak temperature of the small endotherm at 183°C for the 'Good' yarn.

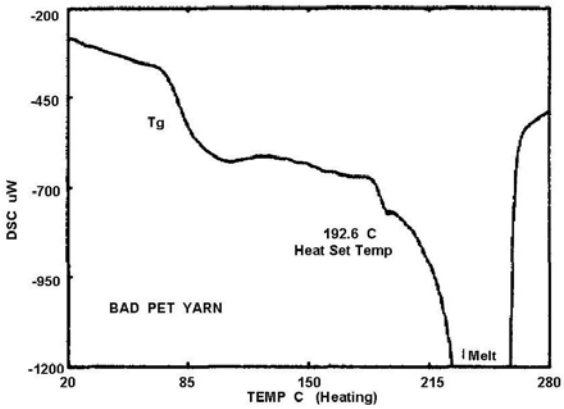

Figure 2

The DSC data for the 'Bad', streaky yarn is displayed in Figure 2. The heat set temperature for the bad yarn is significantly higher (193°C).

Shown in Figure 3 is a direct comparison of the DSC results for both the 'Good' and 'Bad' yarns. The significant difference in the heat set temperatures was no doubt related to the

dyeability performance differences between the two yarns. The DSC22OC is easily able to make a clear distinction between the two yarns.

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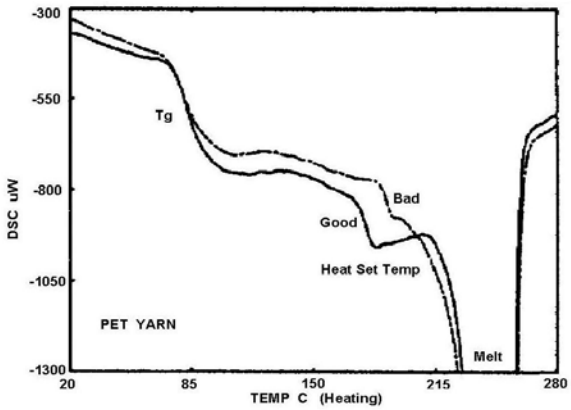

Figure 3

Summary

DSC can be used to detect the heat set temperature associated with textures PET yarns in a straightforward test. The heat set conditions are often related to the end-use performance of the yarn in terms of its dyeability. In this study, one yarn (Good) yielded a heat set temperature of 183°C and exhibited satisfactory dyeability performance. The other yarn (Bad) showed undesirable streakiness, after dyeing, and its heat set temperature was significantly higher (192°C).

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