SII NanoTechnology Inc.

DSC AS PROBLEM-SOLVING TOOL: EXAMINATION OF CRACKING IN POLYETHYLENE PRODUCTS

Problem

A customer, producing molded parts from polyethylene, found that some manufactured polyethylene nozzles would undergo cracking during usage while others would not. What the customer desired was a straightforward test for the polyethylene nozzles to determine if significant differences could be observed between the cracked and uncracked components.

Solution

Differential scanning calorimetry (DSC) provides a means of easily characterizing polyethylene materials. With DSC, a small specimen of polyethylene pellets or the end product is heated to observe its melting behavior. The melting characteristics can provide the following valuable parameters:

- percent crystallinity
- effects of thermal history
- presence and concentration of additives.

These characteristics are related to the performance (e.g., toughness, stiffness, optical clarity, cracking propensity) of the end product.

Shown in Figure 1 are the results obtained from the DSC220C for the as-received, cracked polyethylene nozzle. The sample was heated at a rate of 10°C/rnin to determine its melting behavior. The melting response, for the cracked nozzle, is complex and exhibits a

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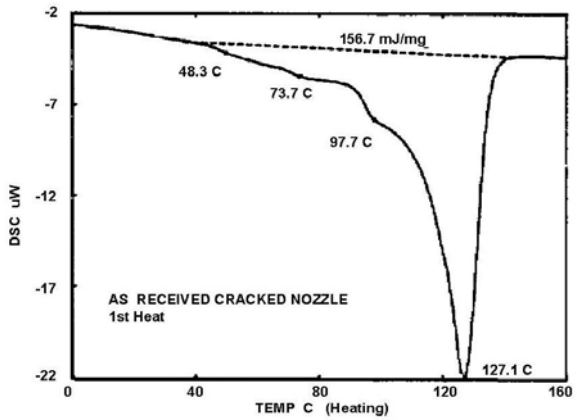

Figure 1

number of endotherms below the main melting peak at 127°C. The total heat of fusion is 156.7 J/g which yields an estimated percent crystallinity of 54.8%.

The occurrence of the multiple endotherms below the main melting peak for the cracked nozzle could be due to one of two factors: prior thermal history or the presence of additives of some sort. The latter effect is associated with the resin's chemistry while the former reflects the material's physics or structure. To determine which is the prevalent effect, the sample is simply cooled from the melt to a temperature below room temperature to permit the sample to recrystallize. If the original endotherms are due to chemistry, they will be seen upon reheating. If they are due to thermal history, or structural effects, they will disappear during reheating.

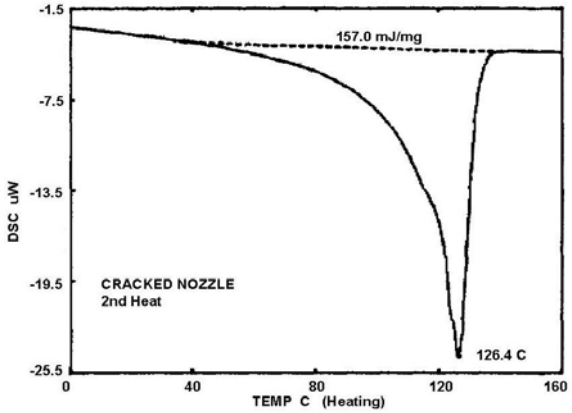

Figure 2

Figure 2 shows the DSC data obtained for the cracked nozzle after melting and reheating. Of the three endotherms observed on the initial heating results, only one remains during

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reheating, which indicates that the sample's thermal history (due to processing conditions) may have lead to the cracking of the nozzle.

The results obtained for the as-received uncracked or 'good' nozzle specimen are displayed in Figure 3. The melting behavior of the good material does not exhibit the complex response obtained for the 'bad', cracked sample.

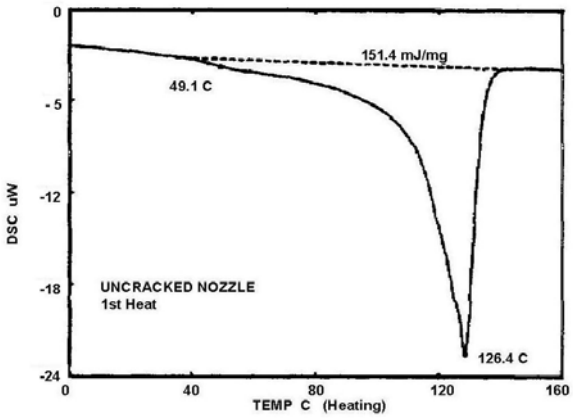

Figure 3

A direct overlay of the melting responses, for the as-received cracked and uncracked nozzles is displayed in Figure 4 (with the data

normalized to a constant mass of 10.00 mg). The thermal responses are significantly different for the two samples, which have identical resin chemistry. These differences appear to be due to the given processing conditions which would be manifested as the occurrence of cracking in the 'bad' molded part.

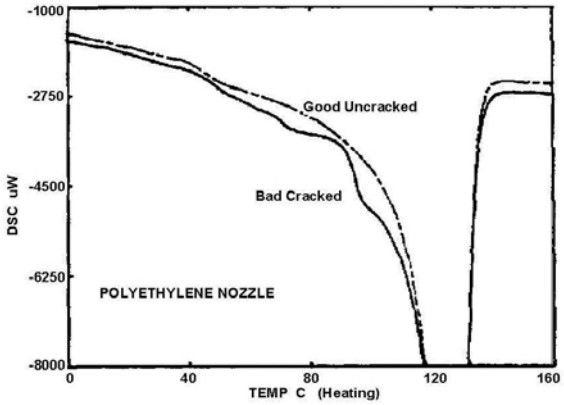

Figure 4

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Summary

DSC provides a means of easily evaluating the performance of molded polyethylene components. The DSC assists in the examination of the resin's chemistry and physics or thermal history. The technique provides valuable information on the material's percent crystallinity and end use characteristics, such as impact resistance, optical clarity and stiffness.

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