TA Instruments

Thermal Analysis & Rheology

THERMAL SOLUTIONS

PIGMENTATION EFFECTS ON POLYETHYLENE CRYSTALLIZATION

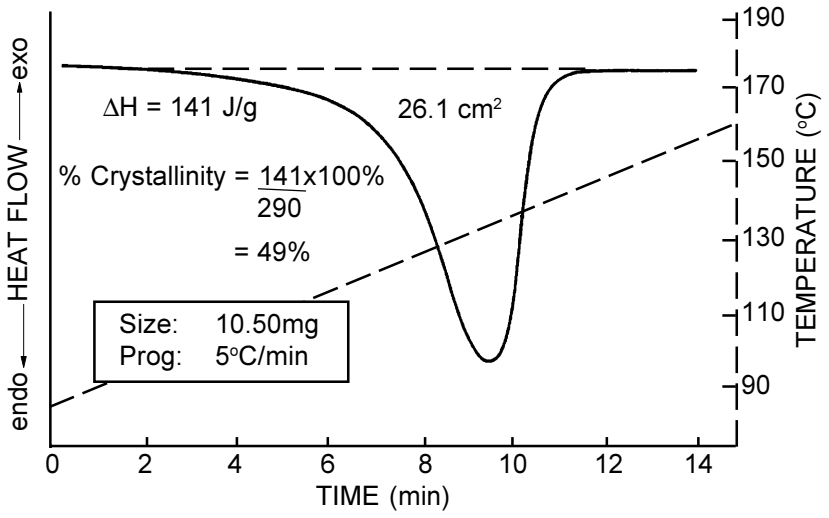
PROBLEM

A manufacturer making polyethylene molded parts found that failure (crazing & cracking) occurred in the parts when subtle changes to the formulation (e.g., pigment used) were made. A rapid test was needed to check the processing impact of such subtle changes so that large amounts of production would not be wasted.

SOLUTION

Differential scanning calorimetry (DSC) is a technique which measures the temperatures and heat flows associated with transitions in materials. Hence, DSC provides a direct indication of the crystalline and amorphous structure in polymers. In the case of polyethylene, which is generally a crystalline polymer, DSC can be used to measure the degree of crystallinity by rationing the heat of melting (fusion) for a specific sample versus that for a 100% crystalline standard (see Figure 1). DSC can also be used, however, to measure the rate of crystallization. Figure 2 shows the comparative DSC crystallization rates of two polyethylene materials containing different pigments. The results clearly indicate that the polyethylene containing Pigment A crystallizes faster on cooling from the melt than the same polymer with Pigment B. Subsequent evaluation of the final molded parts indicates that only the first material (with Pigment A) produces a quality product. Thus, Pigment B needs to be replaced by another pigment which yields a crystallization profile more similar to that for Pigment A, or processing (crystallization) conditions much be changed to change the crystallization rate when Pigment B is present, in order to obtain a good product. Generally, it is easier for the manufacturer to find an alternative pigment.

Figure 1. POLYETHYLENE CRYSTALLINITY



The DSC results shown in Figure 2 were run on a dual sample DSC which allows two materials to be evaluated simultaneously. This arrangement not only increases productivity but also ensures that the two materials have been run under identical conditions. The latter consideration is particularly critical in this application. Figure 3 indicates the excellent reproducibility possible with this technique.

Figure 2. COMPARISON OF POLYETHYLENE CRYSTALLIZATION RATES

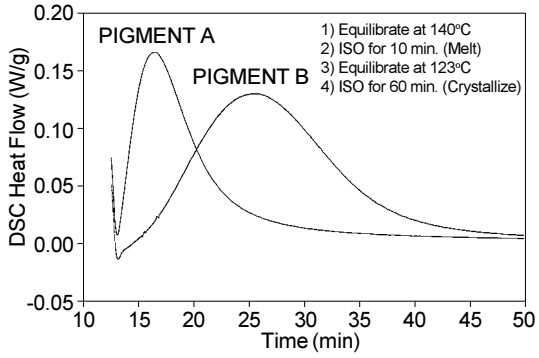
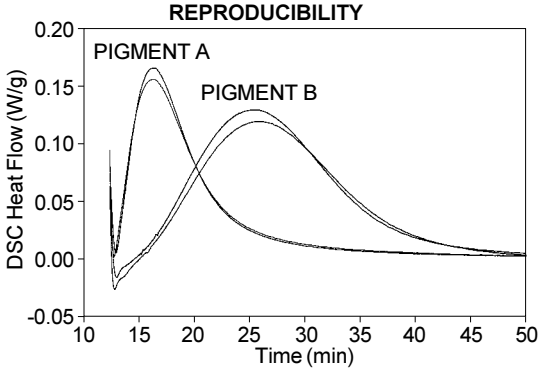


Figure 3. POLYETHYLENE CRYSTALLIZATION - REPRODUCIBILITY



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