TA Instruments

Thermal Analysis & Rheology

THERMAL SOLUTIONS

EVALUATION OF CRACKING IN POLYMERS

PROBLEM

Impact resistance and/or the ability to withstand cracking are properties that are important in many end-use applications for thermoplastic polymers. Hence, manufacturers of those materials would like to have a quick way of differentiating good and bad material with regards to its resistance to cracking.

SOLUTION

Dynamic mechanical analysis (DMA), which measures the modulus (stiffness) and damping (energy dissipation) properties of materials as the materials are deformed under periodic stress, provides a convenient method to make this comparison. The DMA damping curves, in particular, are useful for comparing materials because they are related to molecular motions within the polymer which help absorb and dissipate impact energy. Generally, the more low temperature damping peaks that are present, the larger those peaks are, or the lower the temperature at which the glass transition-related damping peak occurs, the less susceptible the material is to cracking.

Figures 1 and 2 show typical examples. Figure 1 is a polycarbonate material used for collars. Comparison of the DMA loss modulus curves for good and bad material clearly show that the good material has a lower glass transition-related damping peak as well as a subtle secondary damping peak from 40 to 100°C. Figure 2 shows a similar comparison for good and bad polypropylene tubing material. In this case, the good material has a much larger, more well-defined damping peak than the bad material.

The results shown here were obtained at 5°C/minute and took less than an hour per evaluation. With additional effort, it's possible to obtain quantitative correlations with other commonly used impact resistance measurements such as the Drop Weight Index [ASTM Method D-3029]. See Application Brief TA-130.

Figure 1. LOSS MODULUS COMPARISON (Polycarbonate Collars)

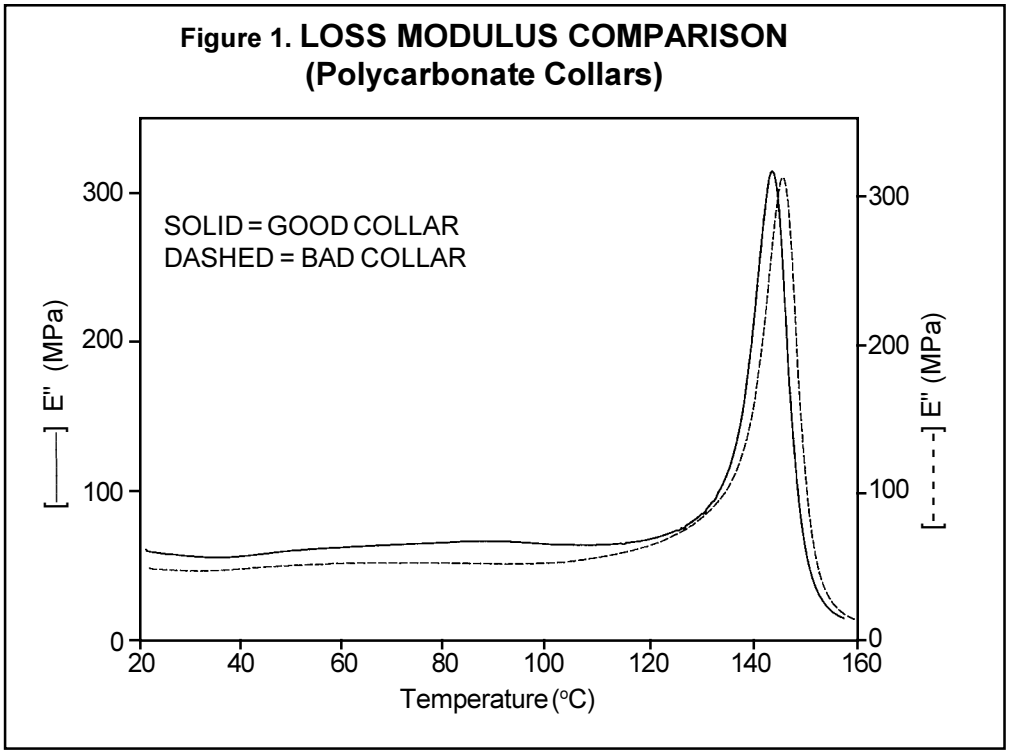
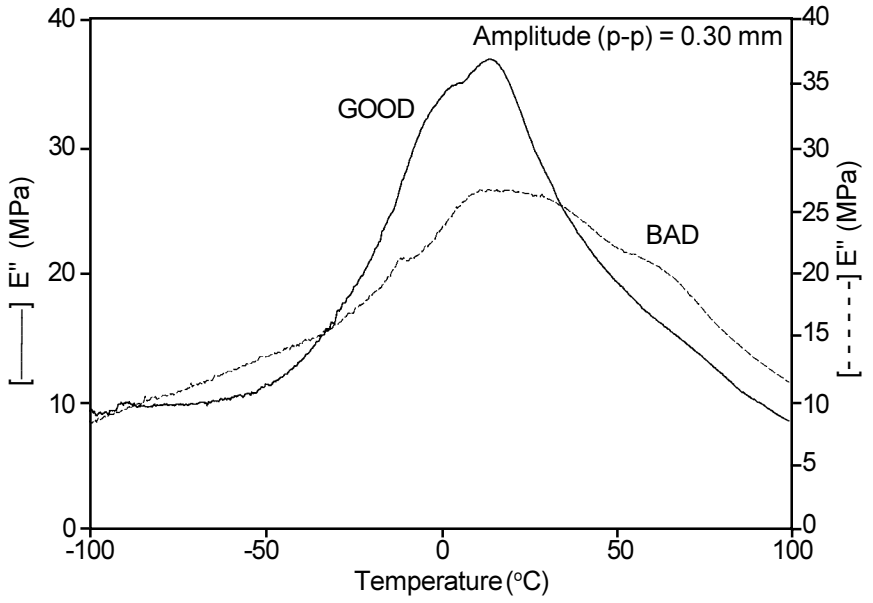


Figure 2. LOSS MODULUS COMPARISON (Polypropylene Tubing)



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