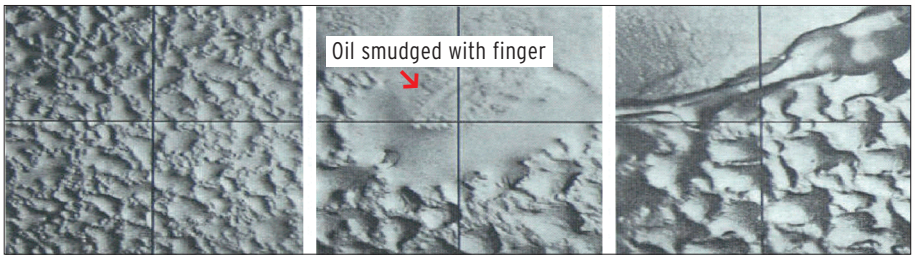
Development of a Test Method for Evaluation of the Sunlight Stability of Styrenic Thermoplastic Elastomers

The Problem

Because of the colorability and other unique properties (including tactile and aesthetic) offered by styrenic thermoplastic elastomers (TPE-S) and their ease of processability, they are frequently incorporated into a variety of automotive interior materials. However, some formulations of TPE-S have been observed to bleed oil to the surface of finished products when exposed to sunlight, compromising their quality.

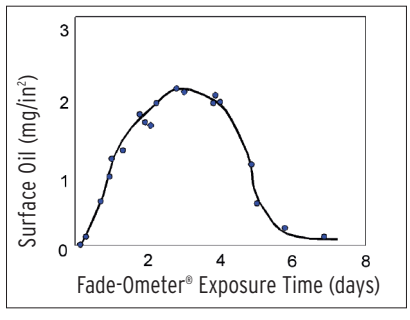


6 hour exposure | 1 day exposure | 3 day exposure

FIGURE 1
Surface of TPE-S molded plaque after UV exposure for 6 hours, 1 day, and 3 days at 225x magnification. Virgin unexposed surface (not shown) is featureless.

FIGURE 1 is a visual demonstration of this phenomenon in which the oil can be seen to erupt onto the surface of samples under the influence of UV light. FIGURE 2 shows that the actual amount of oil can be measured and that it gradually recedes back into the polymer matrix over time.

FIGURE 2
Example oil bleed out profile of unoptimized TPE-S formulation.



To date, this behavior has only been qualitatively observed and no test method exists to differentiate good TPE-S formulations from those that are unacceptable. Kraton Polymers approached Atlas® Consulting to collaborate on the development of such a test.

The Process

Kraton Polymers was able to provide a variety of sample polymer formulations, some known to bleed oil, others known to be acceptable, having been used in commercial products over the years. The objective was to develop a test that could not only distinguish unequivocally between these two extremes, but also provide a method of evaluating new formulations for their degree of stability and level of Oil Bleed Out (OBO).

FIGURE 3
Atlas Ci5000 Weather-Ometer

Test Program

Using an Atlas Xenon Arc Weather-Ometer®, hundreds of samples were exposed using an automotive standard exposure method (SAE J 1885 / J 2412 conditions with Boro S/SodaLime filter combination to simulate sunlight behind window glass), which imposes cyclic levels of radiation, temperature, and relative humidity for specified terms of exposure.

The samples were exposed to increasing intervals of irradiation up to the longest of 1241 kJ/m² (measured at a wavelength of 340 nm).

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Test Conditions

At each exposure interval the samples were examined and evaluated for development of tackiness, increase in gloss, blisters, blotches or significant oil exudation.

It was discovered that, for the samples most susceptible to the OBO phenomena, significant OBO could be observed at the earliest levels of exposure (150 kJ/m²). The "known to be acceptable" samples were also shown to exhibit no symptoms of OBO after 1241 kJ/m² of exposure.

Exposure

A negative control and two acceptable formulations were injection molded to determine the effect of surface grain using the General Motors Interior Color Submission GLA Plaque. Four different surface grains were evaluated. The presence of surface graining extends the onset of oil bleed out in the negative control to later exposure durations; however, its visibly increases at 600 kJ/m². No evidence of oil bleed out or tack for the acceptable Kraton Polymers formulations were observed through the full exposure period. It was ultimately recommended that a glossy surface and a deeper grained surface be tested to confirm acceptable performance in most potential interior applications.

Test Results

The results realized by this work:

1. A methodology was developed that can determine, in the laboratory, the tendency toward OBO of any formulation

2. Numerous good and bad formulation combinations have been identified

3. The sunlight exposure durability of any particular TPE-S for use in interior automotive applications can be assured

The Solution

As a result of this research, Kraton Polymers is now able to sell its TPE-S elastomers with full confidence that they will not exhibit OBO in any anticipated end use application. The ability to predict this behavior was not available previously.

Now, through collaboration with Atlas Material Testing Technology, an internal standard has been created to provide proof to automotive and other end users that the TPE-S materials will perform as required.

Reference: Wright, K. J., Dumbleton, D., Cordo, O. "Understanding UV Induced Oil Bleed Out in Styrenic TPEs: Test Method Development" SPE Annual Technical Conference (2008) p. 1103–1108.

The Ci5000 is approved by many OEMs in the automotive, paints & coatings and plastics industries as the exclusive platform to deliver accurate, repeatable, and reproducible results for predicting service life.

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