Advances in testing weathering resistance

How can you be sure that your latest formulation will maintain its properties when exposed to UV radiation? **Jennifer Markarian** looks at the latest developments in testing weathering resistance

For many applications it is important to measure how well plastics parts resist degradation and colour change when exposed to temperature changes, moisture, and light – especially ultraviolet (UV) light. Examples include building materials, automotive components, outdoor furniture and packaging.

Formulators must be sure their materials will perform – without breaking or fading – for their intended lifetime. If a supplier develops a new formulation or changes the type, amount, or even the supplier of an existing resin, additive, or colour, they should measure weatherability to ensure performance.

Although it would be a simple matter to put a plastic part in an intended end-use environment and wait to see what happens, developers don't have the luxury of waiting for years to be sure the product will perform adequately. And so the industry uses accelerated tests.

Outdoor tests in desert climates can be accelerated using devices that track the sun or use mirrors to concentrate reflected sunlight onto test specimens. In addition, the industry uses artificial accelerated weathering testing in which test specimens are exposed to light, and sometimes moisture, in a laboratory.

Artificial test methods typically accelerate weathering approximately six times faster than real-time outdoor weathering, depending on test conditions and sample characteristics, says Allen Zielnik, senior consultant of weathering science at **Atlas Material Testing Technology**. A common method is to test in the lab for 2,000 hours, which is approximately equivalent to two years outdoors, and then extrapolate to predict results for five to six years.

Zielnik notes that because weathering tests are so material dependent, an understanding of material

Simulating and measuring the long-term effect of the power of the sun on plastics is a complex science

Outdoor seating is just one example of the many plastic products that demand tried and tested resistance to weathering

chemistry is key to interpreting weathering testing results. Confirming accelerated test results with natural outdoor weathering results is also important.

Historical data is often used to correlate accelerated results with what is acceptable for a particular application, especially in mature industries such as automotive or wire and cable, comments Jim Galipeau, general manager of **Polymer & Plastics Services (PTL) Intertek**.

BASF, which operates one of the largest artificial weathering labs worldwide, commonly uses combinations of different test methods. "Each method may contribute differently to a problem or project," comments Dr. Jurgen Marquardt, head of lab operations at BASF's Color & Additives Technical Centre in Europe.

Lighting options

Two key types of artificial accelerated weathering testing based on two different light sources – xenon-arc or fluorescent, short-wave UV – are often used to complement each other. Xenon-arc light sources, such as those employed in Atlas's Weather-Ometer and **Q-Lab**'s Q-Sun Xenon Test Chamber, are widely used for testing colour change resistance. Fluorescent lamps, such as those used in Q-Lab's QUV Weathering Tester and Atlas's UVTest, produce only UV light, but provide a more stable UV spectrum over time, making them useful for testing physical property changes. Fluorescent lamps can also be used to measure colour change in some plastics, particularly when the colour change is the result of plastic UV-yellowing, although it may not be as useful for changes to colorants such as pigments, says Zielnik.

The key in any accelerated testing is using test methods that match what happens in actual outdoor or indoor conditions. While in the past, artificial testing did not necessarily correlate to specific outdoor climates, advanced testing technology and methods now enable more accurate correlation. The data obtained from testing has also increased in scope and detail, further improving the ability to analyze and correlate material behaviour.

For example, Atlas recently introduced its S^3T (Specimen Specific Surface Temperature) technology to provide accurate surface temperature measurements of specimens under a wide range of weathering test conditions in an Atlas Weather-Ometer. While temperature is a primary cause of degradation in an accelerated test, measuring actual specimen temperatures has been difficult and usually required interrupting the test cycle. Atlas's new system uses a non-contact thermal infrared sensor or pyrometer that faces the exposed specimen surface to provide accurate temperature profiling during test exposure. The technology uses an RFID system for automatic sample indexing and identification, and displays temperature data on a new full-colour touch-screen display.

Standard challenges

Although the plastics industry has greatly increased its understanding of weathering and how to simulate conditions and measure changes, the process of changing testing standards to reflect new knowledge and technology has been moving slowly, comments Atlas's Zielnik. He notes that the process of revising standard test methods is sometimes encumbered by the desire to be compatible with previous generations of test data.

However, a number of automotive companies have made a break with the past in order to develop proprietary, in-house standards using the latest technology that meets their needs for more accurate prediction of service conditions. Atlas recently participated in the development of a new standard for automotive exterior weathering in conjunction with Ford, for example. The

Concerned About ***Plastic:***

Weathering & Light Stability?

Simulate • Accelerate • Correlate

The QUV® Weathering Tester:

- Reproduces shortwave UV sunlight
- Realistically simulates outdoor moisture attack
- Accelerates many types of physical property changes

The Q-SUN® Xenon Test Chamber:

- Reproduces full-spectrum sunlight
- Is the only xenon tester with dual solution spray capability
- Provides an excellent way to accelerate visual changes, including color

Q-Lab Corporation www.q-lab.com

Q-Lab Headquarters
Westlake, OH USA
Tel: +1-440-835-8700
info@q-lab.com

Q-Lab Europe, Ltd.
Bolton, England
Tel: +44-1204-861616
info.eu@q-lab.com

Q-LAB

Atlas developed its S^{3}T technology to provide accurate surface temperature measurement of specimens

new method includes higher irradiance levels that further accelerate the test and new filter specifications for the xenon light source that better match sunlight in the shorter wavelengths, explains Matthew McGreer, product manager for weathering instruments at Atlas. The method also takes into account the effect of moisture on the material system more reliably, particularly in coatings. While the method is currently proprietary, it is expected to be adopted as a new ASTM standard.

New methods for interior automotive applications, developed in the past five to 10 years and now coming into use by suppliers, are also designed to better simulate actual conditions. These are important because of the increasing use of panoramic roof systems and larger windows, which increase the exposure of interior cabins to the potentially damaging effects of sunlight, notes Zielnik. On the other hand, old testing methods may result in over-engineering, because these methods don't take into account modern glazing technologies that filter out some of the damaging UV wavelengths.

A key aspect of the new test methods, says Zielnik, is to match the test light spectra to actual conditions by using specialized optical filters or by using actual glazing materials. In addition, new test methods use higher temperatures, more realistic relative humidity levels, and cycles of light/dark and temperature/humidity in some cases.

In China, where the automotive industry is booming, weathering testing for automotive applications has been a key focus for testing suppliers. While international automotive OEMs generally use weathering standards from their home countries, local Chinese automotive OEMs have used a variety of in-house methods. However, since 2009, a group of 20 companies in China – including testing equipment suppliers, automotive OEMs, and tier 1 and tier 2 suppliers - have been working on developing a national GB standard for both interior and exterior automotive parts (GB standards are the Chinese national standards issued by the Standardization Administration of China).

A key aspect of the project has been comparing QUV and xenon-arc accelerated testing to "real-world" outdoor testing in Arizona, Florida, and China's sub-tropical location on Hainan Island in the South China Sea, says Ron Roberts, vice president of sales at Q-Lab, one of the project's leaders.

Taking the global view

Another trend among international automotive OEMs is development of global standards, in which tests of all types are uniform. "What is important is that test methods are developed that can meet the need for data on a global basis and provide information that is applicable to the location and climate where the product is being used," adds Galipeau.

Other industries besides the automotive sector are also working on new weathering test methods that will better correlate to the field. Jeffrey Quill, director of technical applications at Q-Lab, notes that in the wind turbine industry, catastrophic failure is simply not an option, and so suppliers are developing strict physical property testing protocols and new test methods based on fluorescent light sources.

Q-Lab recently started a joint development program with the US Department of Forestry that will develop a QUV test method to link field failures of wood-plastic composite products to performance in accelerated tests. "The goal for any application is to be able to use weathering tests to

Q-Lab offers weathering testing systems based on xenon-arc and fluorescent light sources with its Q-Sun and QUV product lines

Outdoor testing typically takes place in "benchmark climates" such as Arizona, US, where this Atlas laboratory is located

develop formulations that both increase product quality and decrease product cost. With accelerated performance data that more reliably correlates to the field, engineers can hone in on the most cost-effective formulations," explains Quill.

In addition to improved test methods and technology, another way to better simulate real-life weathering is to use complete products rather than small plaques. These larger, full-scale samples can identify issues such as warping that might not turn up in small samples. Testing equipment suppliers have built larger chambers to accommodate these pieces in artificial weathering testing. Atlas has built chambers big enough to test entire roof-racks or instrument panels, for example. Atlas also equips large-scale test chambers like wind tunnels, so that OEMs can measure the response of entire vehicles to UV exposure as well as other factors. Atlas also recently introduced new sample holders that will accommodate a wide range of specimen sizes and thicknesses on the rotating rack of its Ci Series Weather-Ometers.

The primary factor in deciding whether a company should invest in its own artificial weathering testing equipment or use an external testing service is an economic decision based on the volume of samples they need to test. "In general, if you are testing on an ongoing basis or have enough samples to make up a year's worth of external, commercial testing, it's worth buying your own," says Zielnik. Contract labs are useful for running a limited number of tests or for temporary, additional capacity when a company's in-house lab equipment is full, adds Quill.

Other reasons to purchase equipment would be to avoid the time and expense of sending samples back and forth, or to have the flexibility to run non-standard experiments for research and development work. "In commercial labs, companies generally share space in equipment running standard methods, which may not really be optimal. Non-standard methods may be more cost-effective to do in-house," explains Zielnik.

Equipment companies work with customers to help them develop methods, so the technical aspects of running the equipment should not be a hindrance. Atlas also recently introduced a one-piece Sealed Lamp assembly for its 6.5KW xenon-arc compatible weathering instruments. The Sealed Lamp eliminates the need for an operator to assemble all the components when replacing a filter or lamp. Less handling leads to improved repeatability and decreased failures due to

Solar Light focuses on speeding outdoor weather exposure

Solar Light has developed filters to tune the light source in its solar simulator so that it only simulates the UV portion of the spectrum. This has the advantage of minimizing the temperature increase of the sample to only a few degrees above ambient temperature.

Because its instrument sends light through a lens, it can amplify irradiance by reducing the area of the sample that is exposed. Drew Hmiel, a physicist at Solar Light explains, "Using a standard exposure of normal solar UV irradiance, we can produce six years of exposure in one year of accelerated testing time. However, by reducing the area to a 20 mm diameter we can further accelerate six years of exposure to only one month of testing."

The company is currently correlating accelerated laboratory results to outdoor exposure for a wide range of polymers. It measures the colour and appearance change of weathered samples using colorimetry as well as reflectance and transmission spectrophotometry.

In the past few years Solar Light has seen increasing requests for its testing services, especially in the simulation of indoor exposure of plastics. Exposing a sample behind glass simulates sun coming through a window, and using a fluorescent lamp to generate UVA light simulates exposure to indoor fluorescent lighting, such as in a retail display case. Solar Light is currently working on accelerating this type of exposure and correlating it to actual "shelf-time", says Hmiel.

www.solarlight.com

assembly issues, says the company.

Economic decisions aside, contract labs are important when a user needs independent certification. For example, automotive company Renault requires samples for weathering testing to be submitted to an independent, "third party" laboratory, says Quill. He notes that these labs should have ISO 17025 accreditation, which means they have been audited and demonstrated that they run their test methods properly, in addition to ISO9000 certification guaranteeing that they follow documented processes.

In addition to the major weathering equipment suppliers who also run testing services, Intertek Plastics Technology Laboratories offers testing services globally. Earlier this year, it expanded its weatherability testing programs for the automotive industry using international and OEM specific standards. "Virtually everything in an automobile that is polymer-based requires some weathering data to even be considered for use," notes Galipeau.

Most companies use commercial labs for outdoor testing. While outdoor testing is relatively inexpensive, commercial labs are located in "benchmark climates", such as South Florida, Arizona, or the Kalahari Desert, and continuously collect the required weather data at the test site, such as humidity and UV exposure.

More information

Allen Zielnik of Atlas Material Testing will give a presentation at AMI's conference on Plastics in Photovoltaics, which takes place on 20-21 September 2011 in Philadelphia, PA, USA.
Click here for details.
- **www.amiconferences.com**

Click on the links for more information:
- **www.atlas-mts.com**
- **www.intertek.com**
- **www.basf.com**
- **www.q-lab.com**

The latest Atlas sample holder can handle a wide range of specimens