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# SunSpots®

*Summer 2005*

*New SUNTEST filter system simulates store light*
*See page 15.*

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# Weathering and Lightfastness Testing in the Automotive Industry—Overview and Current Trends

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*This article is based on a paper that was given during the 7th conference on "Weathering of Plastics and Coatings in the Automotive Industry" by SKZ (Süddeutsches Kunststoff-Zentrum) in Würzburg, Germany, on February 16 and 17, 2005.*

## Introduction

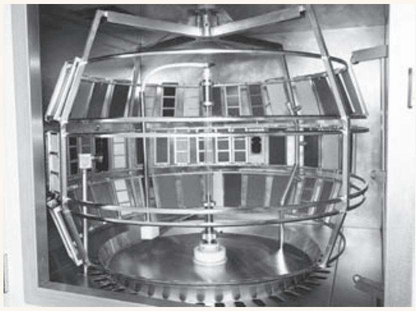

*Figure 1: Atlas Ci5000 Weather-Ometer® interior*

The demands made on the properties, appearance, and durability of materials and components in the automotive industry have increased significantly in recent decades. Simultaneously, increasing competition has forced the industry to progressively reduce costs. In order to meet these changing requirements, testing technology has undergone continuous development. Today, the automotive industry employs numerous advanced methods in both laboratory and outdoor tests.

The purpose of this article is to organize and structure the variety of the existing test methods and highlight differences and similarities. As most automotive companies are basing their company specifications on a few international and national standards, the article focuses on these basic test methods. More detailed discussion of certain test aspects is restricted to xenon only because this is the most advanced and most widely used

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## AtlasSpeaks

# 2005

**Ecological Development from Products**
September 14–15, Bonn, Germany

**Dr. Artur Schoenlein,** Atlas Material Testing Technology GmbH, will present "Ageing by Weathering Tests of Plastics and Coatings."

**Coating Wood and Wood Composites: The Changing Future**
September 26–27, Charlotte, North Carolina, USA

**Al Zielnik,** Atlas Material Testing Technology LLC, will present "Weathering Experimenters Toolbox."

*For the latest on Atlas shows and presentations, visit **www.atlas-mts.com.***

**DEK Symposium on Colour Fastness**
October 10–12, Erding, Germany

**Dr. Artur Schoenlein,** Atlas Material Testing Technology GmbH, will present "Colour Fastness and Automotive Lightfastness with Enhanced Irradiance."

**Robert Lattie,** SDL Atlas, will present on "Objective Measurements of Colour Fastness of Textiles."

**Andreas Riedl,** Atlas Material Testing Technology GmbH, will chair the conference session "Testing Technology."

**IFAI Expo 2005**
October 27–29, San Antonio, Texas, USA

**Matt McGreer** will give an overview of automotive testing standards.

## AtlasShows

# 2005

**Forced Degradation (Large Molecule)**
July 27–29
Bethesda, Maryland, USA

**Chemistry 2005**
September 5–9
Moscow, Russia

**Laborator**
September 12–16
Praha, Czech Republic

**EUROCOAT Lyon**
September 27–29
Lyon, France

**Flanders TEXTILE Valley 2005**
September 29–October 1
Kortriyk, Belgium

**Interplas**
October 4–6
Birmingham, UK

**Rich Mac 2005**
October 4–7
Milano, Italy

**Chemtec Praha**
October 5–10
Praha, Czech Republic

**ITMA Asia**
October 17–21
Singapore

**Fakuma**
October 18–22
Friedrichshafen, Germany

**Test Expo**
October 26–28
Detroit, Michigan, USA

**IFAI**
October 27–29
San Antonio, Texas, USA

**AAPS**
November 6–10
Nashville, Tennessee, USA

**Expoquimia**
November 14–18
Barcelona, Spain

**Food Tech/ Pharma Tech**
November 15–17
Denmark

**ChinaCoat**
November 16–18
Shanghai, China

**AUTO PARTS 2005**
December 6–9
Shanghai, China

# 2006

**3rd Annual Forced Degradations Studies**
February 28–March 2
Location TBA

**SAE**
April 3–6
Detroit, Michigan, USA

**NPE – International Plastics Showcase**
June 19–23
Chicago, Illinois, USA

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light source for accelerated testing of automotive materials. Finally, selected current trends and future prospects in testing technology are presented.

Whether a method is suitable for specific applications—whether laboratory results correlate with those from outdoor exposure or the damages that occur during actual use—depends on several factors such as the material itself, the property selected for evaluation, and, last but not least, on the actual conditions during outdoor or real life exposure. In the end, only testing data can help to decide if a specific test method is suitable or not. As this article does not include data, the methods presented will not be rated against each other.

*Figure 2: SC2000 solar simulation chamber*

## Overview

Weathering tests can be performed during every step in the development and production process. Supplied materials and components can be subjected to a quality inspection. The development of new materials—e.g., plastics for vehicle interiors or modified paint systems—also require significant testing. Finally, complete prototypes as well as vehicles or components from series production undergo weathering testing to obtain insights into the interaction of all components under the influence of solar radiation, heat, and water.

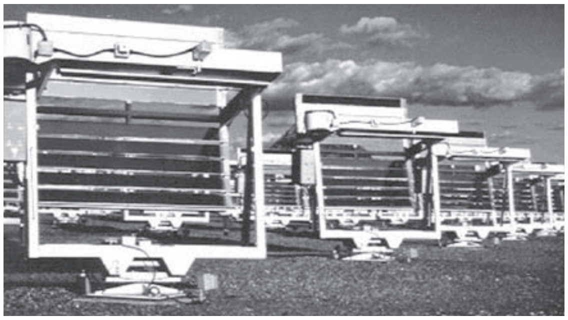

*Figure 3: EMMAQUA devices with Fresnel mirrors*

Various equipment are used for laboratory weathering, employing:

- Different light sources, e.g., xenon, metal halide, fluorescent, or carbon-arc;
- Different geometries, e.g., with a sample rack rotating around the light source (Figure 1), or using a static plane sample area (Figure 2), and;
- Different sizes and sample capacities, e.g., bench top, stand-alone devices, walk-in and even drive-in chambers [1].

*Figure 4: Vehicle exposure on a sun-tracking carousel*

For outdoor testing, sample racks with differing inclinations, with and without glass cover panels, and with open or closed boxes are employed. Fresnel mirrors are used to concentrate the sunlight on the samples (EMMA®, EMMAQUA®), a method which requires efficient sample cooling. With the aid of sensors and mechanical drives, open sample racks, behind glass exposure cabinets, and EMMAQUA devices (Figure 3) can track the sun's path to maximize radiant exposure during a test. In some exposure boxes, the temperature is controlled within specific limits using built-in fans and heaters. Fresnel units can also be equipped with spray systems, which operate at fixed intervals during daytime exposure or at night (NTW, or Nighttime Wetting).

Where entire vehicles are exposed, turntables can be used to track the sun (Figure 4). Overnight exposure using artificial light has not prevailed as a viable testing method, but some automobile manufacturers take advantage of two summers in one year by semi-annually moving vehicles from the Northern to the Southern Hemisphere and back.

Naturally, the specific climatic conditions observed at the selected exposure site play a crucial role in the weathering results. For example, Arizona and the Kalahari have a hot, dry

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*Figure 5: Atlas weathering facility in South Florida*

climate ("arid"), South Florida is warm and humid ("subtropical"), and Jacksonville in northern Florida is known for heavy industrial air pollution. Figure 5 shows an Atlas outdoor exposure facility in South Florida.

The article by Hardcastle and Searle in "Plastics and Coatings"[2] provides an in-depth description of the various outdoor weathering test methods.

In Table 1, a selection of the most important laboratory and outdoor weathering methods are arranged by their application to materials, components, and entire vehicles, differentiated according to their application for vehicle interiors and exteriors.

Table 2 employs the same structure as Table 1, except that it lists the most important standards used in the automotive industry rather than the employed test methods. Individual company specifications are not included.

## Basic ISO Xenon Standards for Plastics and Coatings

The two basic standards, ISO 11341 for coatings and ISO 4892-2 for plastic materials, have recently been revised. As in the past, care was taken during this revision to ensure that the test parameters in both standards are as similar as possible and the two documents do not contradict to each other. Both ISO standards are widely applied globally in the automotive industry and therefore presented in detail.

**ISO 4892-2:2005, Plastics - Methods of Exposure to Laboratory Light Sources - Part 2: Xenon-arc Sources** [3] compiles the test options in a table of eight "cycles," four of which apply to weathering and four to exposure behind window glass. Half of these cycles, nos. 1, 3, 5, and 7, require control of all main parameters:

- E (irradiance);
- BST/BPT (Black Standard Temperature/Black Panel Temperature);
- CHT (chamber air temperature), and;
- RH (relative humidity).

Cycles 2, 4, 6, and 8 do not require CHT and RH control, so that older or technically inferior types of xenon devices may be used. The differences between the 2005 and the 1994 versions are detailed in Table 3 (page 6).

The revised **ISO 11341 Paints and Varnishes - Artificial Weathering and Exposure to Artificial Radiation - Exposure to Filtered Xenon-Arc Radiation** was published in September 2004. The differences between it and the 1994 version are summarized in Table 4 (page 7).

## Laboratory Testing of Automobile Interior Plastics

The so-called "hot lightfastness test" is an exposure method combining relatively high temperatures with the radiation from a filtered xenon-arc lamp. Carbon-arc methods that are still employed in Japan and the United States will not be discussed here, as this technology is being systematically replaced by the technically superior xenon test.

What are "high" temperatures? "Normal" Black Standard Temperatures (BST) are specified, for example, in ISO 105-B02 as a maximum of 50 °C, in ISO 4892-2 as 55 °C for color changes, and in ISO 4892-2 and ISO 11341 at 65 °C. However, on a hot summer day, significantly higher surface temperatures are measured on automobile interiors. The most common BST for "hot lightfastness" testing employed by the European automotive industry is 100 °C (VDA 75202, ISO 105-B06, ISO 4892-2). Opel has the most stringent test requirements at 115 °C (GME 60292 Method 1).

In Japan and in the United States, a Black Panel Temperature (BPT) of 89 °C is generally employed (JASO M346, SAE J1885, SAE J2412). In France, 90 °C BST (ISO 105-B06) was previously common, but most French test methods have changed to 100 °C.

**Table 1**
Weathering Test Methods Used by the Automotive Industry

| Application | | In the Laboratory | Outdoors |
|---|---|---|---|
| **Materials** | Interior | • Hot light with xenon<br>• Xenon with normal E<br>• Xenon with high E | • Under glass, static or with sun tracking<br>• EMMA®, under glass<br>• Open or closed box, possibly heated<br>• Black box under glass |
| | Exterior | • Xenon with normal E<br>• Xenon with high E<br>• Fluorescent/UV test | • Open sample rack, with or without backing<br>• EMMA<br>• EMMAQUA®<br>• Black box |
| **Components** | Interior | • Metal halide solar simulation device<br>• Large xenon device | • Under glass, static or with sun tracking<br>• CTH Glas Trac™<br>• Open or closed box, possibly heated<br>• IP/DP Box®, with or without sun tracking<br>• Black box under glass |
| | Exterior | • Metal halide solar simulation device<br>• Large xenon device | • Open sample rack, with or without backing<br>• Black box |
| **Vehicles** | | • Solar simulation and climate chamber | • Florida, Arizona, Jacksonville, etc.<br>• Static or dynamic (e.g., turntable)<br>• 2 summers per year |

**Table 2**
National and International Testing Standards used by the Automotive Industry

| Application | | In the Laboratory | Outdoors |
|---|---|---|---|
| **Materials** | Interior | • ISO 105-B06<br>• ISO 4892-2<br>• VDA 75202<br>• SAE J1885, SAE J2412<br>• JASO M346 | • ISO 877<br>• ISO 2810<br>• SAE J2229<br>• SAE J2230<br>• ASTM G24 |
| | Exterior | • ISO 11341<br>• ISO 4892-2<br>• ISO 11507<br>• ISO 4892-3<br>• VDA 621-430<br>• SAE J1960, SAE J2527<br>• SAE J2020<br>• JASO M351<br>• ISO 3917 | • ISO 877<br>• ISO 2810<br>• SAE J951<br>• SAE J1961<br>• SAE J1976<br>• ASTM G7<br>• ASTM G90 |
| **Components** | Interior | • DIN 75220<br>• ISO 4892-2 | • SAE J2229<br>• SAE J2230<br>• ISO 877<br>• ASTM G24 |
| | Exterior | • DIN 75220<br>• ISO 4892-2 | • ASTM G7 |
| **Vehicles** | | • DIN 75220<br>• Company specifications | • SAE J951<br>• Company specifications |

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**Table 3**
ISO 4892-2

| | ISO 4892-2:1994 | ISO 4892-2:2005 |
|---|---|---|
| **Spectral Power Distribution** | Based on CIE No. 85, Table 4 | |
| | Specified between 290–800 nm | Specified between 290–400 nm |
| **Filter Systems** | • Daylight (method A)<br>• Exposure behind window glass (method B) | • Daylight (method A, cycles 1–4)<br>• Exposure behind window glass (method B, cycles 5–8) |
| **Tolerances** | Relatively narrow | Significantly expanded based on measurements made with a large number of various xenon units |
| **Test Options** | A total of 6:<br>• Method A (incl. spray) and method B (dry),<br>• 2 different BSTs<br>• 2 different RHs | A total of 10:<br>• Cycles 1–8<br>• Cycles 1 and 5, including high RH option |
| **E** | 550 W/m$^2$ (290–800 nm) | • (60 ± 2) W/m$^2$ (300–400 nm) or 0.51 W/(m$^2$nm) at 340 nm (cycles 1–4)<br>• (50 ± 2) W/m$^2$ (300–400 nm) or 1.1 W/(m$^2$nm) at 420 nm (cycles 5–8) |
| **High E** | Not included | Up to 180 W/m$^2$ (300–400 nm) (cycles 1–4)<br>Up to 162 W/m$^2$ (300–400 nm) (cycles 5–8) |
| **RH** | • (50 ± 5)% or<br>• (65 ± 5)% | • (50 ± 10)% or (65 ± 10)% (cycles 1 and 5)<br>• (20 ± 10)% (cycles 3 and 7)<br>• Not specified for cycles 2, 4, 6 and 8 |
| **BST** | • (65 ± 3) °C or<br>• (100 ± 3) °C | • (65 ± 3) °C (cycles 1, 2, 5, 6)<br>• (100 ± 3) °C (cycles 3, 4, 7, 8) |
| **CHT** | Not specified | • (38 ± 3) °C (cycles 1 and 5)<br>• (65 ± 3) °C (cycles 3 and 7)<br>• Not specified for cycles 2, 4, 6 or 8 |
| **Water Spray** | 18 min wet/102 min dry | |

Table 5 (page 8) provides a summary of hot lightfastness test methods, listed by increasing temperature.

One subject of dispute related to the testing of materials for automobile interiors is the application of a dark phase. In SAE J1885 (Table 6, page 9) and its derivatives, the American automotive industry requires a light/dark cycle. In contrast, most European vehicle manufacturers appear to favor continuous exposure.

The type of sample backing frequently causes errors in hot lightfastness testing as it greatly influences the test results. The existing standards and company specifications do not treat this topic uniformly, if they deal with it at all, so that, when comparing results, the type of sample backing (metal, cardboard, non-woven fiber) should always be agreed upon and reported.

For reference Table 7 (page 9) lists selected company specifications for testing of automotive interiors, which are derived from the basic standards in Table 6 [4].

## Laboratory Xenon Testing of Automotive Coatings

Table 8 (page 10) illustrates the most common methods for testing automotive exterior coatings. Again, company specifications are not included.

**Table 4**
ISO 11341

| | ISO 11341:1994 | ISO 11341:2004 |
|---|---|---|
| **Spectral Power Distribution** | Based on CIE No. 85, Table 4 | |
| | Specified between 290–800 nm | Specified between 290–400 nm |
| **Filter Systems** | • Daylight (method 1)<br>• Exposure behind window glass (method 2) | |
| **Tolerances** | Relatively narrow | Significantly expanded based on measurements made with a large number of test units |
| **Test Options** | A total of 4:<br>• Method 1 (incl. spray) and method 2 (dry)<br>• 2 different BSTs | A total of 8:<br>• Method 1 (incl. spray) and method 2 (dry)<br>• 2 different BSTs<br>• 2 different BPTs |
| **E** | 550 W/m$^2$ (290–800 nm) | • 60 W/m$^2$ (300–400 nm) or 0.51 W/(m$^2$nm) at 340 nm;<br>• 50 W/m$^2$ (300–400 nm) or 1.1 W/(m$^2$nm) at 420 nm |
| **High E** | Not included | Up to 180 W/m$^2$ (300–400 nm) (method 1)<br>Up to 162 W/m$^2$ (300–400 nm) (method 2) |
| **RH** | • (60–80)% (procedure 1)<br>• (40–60)% (procedure 2) | (40–60)% |
| **BST** | (65 ± 2) °C or (55 ± 2) °C | |
| **BPT** | Not specified | (63 ± 2) °C or (50 ± 2) °C |
| **CHT** | Not specified | (38 ± 3) °C |
| **Water Spray** | 18 min wet / 102 min dry<br>For special applications:<br>3/17 | 18 min wet / 102 min dry;<br>For special applications:<br>3/17 or 12/48 |

One characteristic feature of weathering tests according to the United States automotive standards SAE J1960 and SAE J2527 (see Table 6) is simultaneous water spray on the front and back of the samples. This procedure might produce significant mechanical stress due to a more rapid cooling than if merely the front is sprayed. The original goal of generating condensation on the sample surface by means of spraying the back could not, however, be achieved in most cases.

For many years the German automotive industry has employed VDA guidelines for automotive coatings no. 621-429 on "Colour Stability" and no. 621-430 on "Cracking Resistance," even though these two drafts have never been officially published by VDA. Both guidelines represent an "adaptation" of SAE J1960 to the German testing environment during the 1990s. However, it must be remembered that both guidelines are based on the results of extensive ring studies that confirmed the correlation to Florida exposure for the paint systems in use at the time. In July 2004, the responsible VDA Working Group "Outdoor and Accelerated Weathering of Automotive Paints" agreed to recommend the use of ISO 11341 instead of draft guideline VDA 621-429. The VDA WG also intends to replace the second guideline VDA 621-430 by a future ISO standard that has to be developed based on the standard SAE J2527.

It should be noted that all four of the cited SAE standards—both the instrument-specific J1885 and J1960, as well as the performance-based J2527 and J2412—require that any

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**Table 5**
Basic Xenon Standards for Hot Lightfastness Testing

| Standard | BST, in °C | BPT, in °C | CHT, in °C | Dark Phase | Filter System | E level, in W/m$^2$ (300–400 nm) | RH in % | Country |
|---|---|---|---|---|---|---|---|---|
| **ISO 105-B06 Option 2** | 90 | | 45 | No | Behind window glass | Not specified | 45 | France |
| **ISO 105-B06 Option 6** | | 89 | 50 | No | Behind window glass | 162 | 50 | Japan |
| **ISO 105-B06 Option 5** | | 89 | 63 | Yes | Extended UV | 0.55 W/(m$^2$nm) at 340 nm | 50 | USA |
| **SAE J1885** | | 89 | 62 | Yes | Extended UV | 0.55 W/(m$^2$nm) at 340 nm | 50 | USA |
| **SAE J2412** | | 89 | 62 | Yes | Extended UV | 0.55 W/(m$^2$nm) at 340 nm | 50 | USA |
| **JASO M346** | | 89 | Not spec. | No | Behind window glass | 48–162 | 50 | Japan |
| **ISO 105-B06 Option 3** | 100 | | 65 | No | Behind window glass | 45–162 | 30 | Germany |
| **VDA 75202 Option A** | 100 | | 65 | No | Behind window glass | 44–150 | 20 | Germany |
| **ISO 4892-2 Method B** | 100 | | 65 | No | Behind window glass | 50–162 | 20 | Germany |
| **ISO 105-B06 Option 1** | 115 | | 48 | No | Behind window glass | 70–90 | 20 | Germany |
| **VDA 75202 Option B** | 115 | | 48 | No | Behind window glass | 70–90 | 20 | Germany |

test equipment be validated for this application using the “acceptance protocol” according to SAE J2413.

Table 9 (page 11) summarizes some of the major automotive company specifications for testing of automotive coatings [4].

## Current Trends and Future Developments

### *Testing with High Irradiance Levels*

In the preceding chapters we have seen that the most important basic international standards (ISO 4892-2, ISO 11341, ISO 105-B06), as well as many national standards (JASO M346, JASO M351, VDA 75202), now permit the employment of irradiance levels up to three times the maximum solar radiation at ground level (see Tables 3, 4, 5, and 8). While this development is mainly based on Japanese initiatives, the concept is also being examined in several other countries. In Germany, high irradiation levels in conjunction with high temperatures have been successfully used for lightfastness tests of various technical polymers and textiles intended for automobile interiors [5, 6]. This accelerated test method must be very

**Table 6**
Cycles in the SAE Standards

| | SAE J1960 and SAE J2527 | | | | SAE J1885 and SAE J2412 | |
|---|---|---|---|---|---|---|
| | Automotive exterior | | | | Automotive interior | |
| **Phase** | 1 | 2 | 3 | 4 | 1 | 2 |
| **Time, in min** | 60 | 40 | 20 | 60 | 60 | 228 (3,8 h) |
| **E in W/(m²nm) at 340 nm** | Dark | Light 0.55 | Light 0.55 | Light 0.55 | Dark | Light 0.55 |
| **Water Spray** | Front and back | Dry | Front | Dry | Dry | Dry |
| **BPT, in °C** | 38 | 70 | 70 | 70 | 38 | 89 |
| **CHT, in °C** | 38 | 47 | 47 | 47 | 38 | 62 |
| **RH, in %** | 95 | 50 | 50 | 50 | 95 | 50 |

**Table 7**
Company Specifications for Hot Lightfastness Testing

| Parameters / Method | | Ford | Opel | Opel | GM | PSA | Volkswagen | Saab |
|---|---|---|---|---|---|---|---|---|
| | | FLTM BO-116-01 | GME 60292 2000-08 Method 1 | GME 60292 2000-08 Method 2 | GMW 3414TM 2002-04 Cycle A | D47 1431 2002-09 | PV 1303 2001-03 | STD 3159 1994-10 |
| **Based on** | | Modified SAE J1885 | ISO 105-B06, VDA 75202 | ISO 105-B06, VDA 75202 | Modified SAE J1885 | ISO 105-B06, VDA 75202 | ISO 105-B06, VDA 75202 | ISO 105-B06, VDA 75202 |
| **Cycle** | | 3.8 h light/ 1.0 h dark | Continuous light | Continuous light | 3.8 h light/ 1.0 h dark | Continuous light | Continuous light | Continuous light |
| **Filter System** | | Quartz/ Type S Boro plus SF5 lantern | Window glass | Window glass | Cira/Soda Lime plus window glass lantern | Type S Boro/ Soda Lime | Window glass | Type S Boro/ Soda Lime |
| **UV Cut-on** | | 335 nm | 320 nm | 320 nm | 320 nm | 320 nm | 320 nm | 320 nm |
| **E in W/m² (300–400 nm)** | | | 70–90 | 44–62 | 95 | | 60 | |
| **E in W/(m²nm) at 420 nm** | | 1.06 | | 1.0–1.4 | 2.2 | 1.4 | 1.2 | 1.0 |
| **BST in °C (light)** | | | 115 | 100 | 105 | 100 | 100 | 100 |
| **BPT in °C** | **Light** | 89 | | | | | | |
| | **Dark** | 38 | | | | | | |
| **CHT in °C** | **Light** | 62 | | | 65 | 66 | 65 | 60–70 |
| | **Dark** | 38 | | | 38 | | | |
| **RH in %** | **Light** | 50 | 20 | 20 | 25 | 30 | 20 | 20 |
| | **Dark** | 98 | | | 95 | | | |

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**Table 8**
Basic Xenon Standards for Weathering Testing of Automotive Coatings

| Standard | BST, in °C | BPT, in °C | CHT, in °C | Dark Phase | Filter System | E level, in W/m² (300–400 nm) | RH in % | Country |
|---|---|---|---|---|---|---|---|---|
| ISO 11341 Low T | 55 | 50 | 38 | No | Daylight | 60–180 | 40–60 | Germany |
| VDA 621-429 Option 8.1 | | 55 | 36–41 | No | Daylight | 45 | > 60 | Germany |
| VDA 621-429 Option 8.2 | | 55 | 36 | No | Daylight | 80 | > 60 | Germany |
| ISO 11341 normal | 65 | 63 | 38 | No | Daylight | 60–180 | 40–60 | Germany |
| VDA 621-429 Option 8.3 | 65 | | 36 | No | Daylight | 55 | 55 | Germany |
| JASO M351 Normal | | 63 | Not spec. | Optional | Daylight | 60–180 | 50 | Japan |
| SAE J1960 | | 70 | 47 | Yes | Extended UV | 0.55 W/(m²nm) at 340 nm | 50 | USA |
| SAE J2527 | | 70 | 47 | Yes | Extended UV or daylight | 0.55 W/(m²nm) at 340 nm | 50 | USA |
| VDA 621-430 Option 3.1, 3.2 | | 70 | 47 | Yes | Extended UV | 0.55 W/(m²nm) at 340 nm | 50 | USA |
| VDA 621-429 Option 8.4 | | 70 | 47 | Yes | Extended UV | 0.55 W/(m²nm) at 340 nm | 50 | USA |
| VDA 621-430 Option 3.3 | 73–76 | 70 | 47 | Yes | Extended UV | 60 | 50 | USA |
| JASO M351 High T | | 83 | Not spec. | Optional | Daylight | 60–180 | 50 | Japan |

carefully applied in each instance, and must be adjusted to the specific material and properties being examined. High irradiation levels may possibly induce photochemical effects that do not occur under normal conditions. If the results obtained from tests at high irradiance are compared with those obtained at normal levels, all other test parameters—i.e., spectral power distribution, BST/BPT, CHT, and RH—must be identical.

## *Optimizing the UV Cut-on*

Primarily in United States methods, high acceleration in weathering tests is achieved by employing short wavelength xenon radiation that does not occur in solar radiation outdoors. The “traditional” American standards on materials for automobile exteriors and interiors, SAE J1885 and J1960, specify a quartz/borosilicate filter system that contains an unrealistically high UV portion (Figure 6). This filter system, whose cut-on wavelength lies at approximately 290 nm, is indicated by “Extended UV” in Tables 5 and 8.

While SAE J2527, the new performance-based derivative of SAE J1960, now alternatively permits daylight filters, the corresponding method for automotive interiors, SAE J2412, makes no such concession. In contrast, three major automotive manufacturers have, during the course

**Table 9**

Company Specifications for Weathering Testing of Automotive Coatings

| Parameter \ Method | Ford | GM/Opel | Volkswagen | Volkswagen | Saab |
|---|---|---|---|---|---|
| | M2P 180-A 2004-01 | GMI 00002 1996-10 | PV 3929 2004-03 | PV 3930 2003-11 | STD 3159 1994-10 |
| **Based on** | SAE J1960 | | | | |
| **Comments** | | | Dry and hot, "Kalahari test" | Warm and humid, "Florida test" | |
| **Light/Dark Cycle** | 120 min light/ 60 dark | Continuous light | Continuous light | Continuous light | Continuous light |
| **Water Spray** | SAE spray cycle | 102 min dry/ 18 min spray | Continuously Dry | 102 min dry/ 18 min spray | 102 min dry/ 18 min spray |
| **Filter System** | Quartz/Type S Boro | Daylight | Daylight | Daylight | Cira/Type S Boro |
| **UV Cut-on** | 290 nm | 300 nm | 300 nm | 300 nm | 295 nm |
| **E in W/m² (300–400 nm)** | | - | 75 | 60 | |
| **E in W/(m²nm) at 340 nm** | 0.55 | 0.6 | 0.6 | 0.5 | 0.25 |
| **BST in °C (light)** | | 80 | 90 | 65 | 55 |
| **BPT in °C (light)** | 70 | | | | |
| **CHT in °C (light)** | 47 | | 50 | 35–45 | |
| **RH in % (light)** | 50 | 50 | 20 | 60–80 | 70 |

of the past several years, developed their own company specifications for automotive interior materials using a more realistic UV cut-on wavelength than previously specified:

- **Volkswagen PV 1303** (see Table 7)—As of March 2001, a revised version of the xenon test method applies to non-metal materials intended for use in vehicle interiors. This resulted in a change from the previously employed daylight filtration to exposure behind glass (cut-on 320 nm).
- **General Motors GMW 3141 TM** (see Table 7)—In its new test method for artificial weathering of interior materials, General Motors has replaced the earlier quartz/borosilicate system with filters with a UV cut-on at 320 nm.
- **FORD FLTM BO-116-01** (see Table 7)—Ford USA modified the SAE J1885 standard by introducing special filters with a UV cut-on at 335 nm. In doing this, Ford is making allowances for the increased use of tinted automobile glazing (Figure 7, page 12) [7].

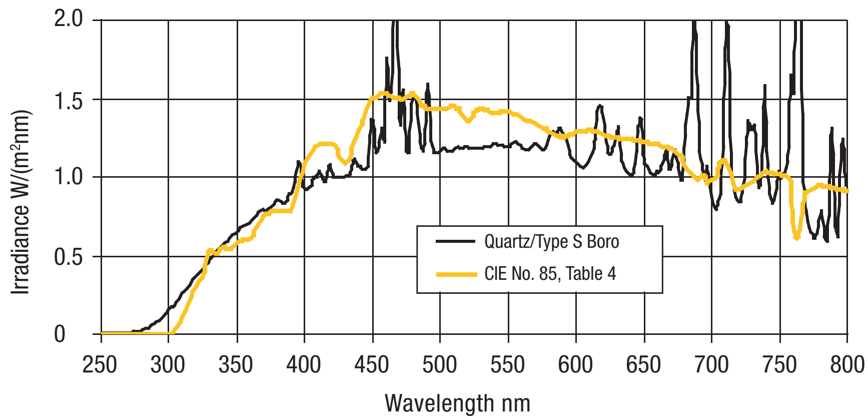



*Figure 6: Quartz/Type S Boro filter system compared with the reference sun, in accordance with CIE No. 85, Table 4*

*Continued on next page*

*Automotive Industry Testing, from previous page*

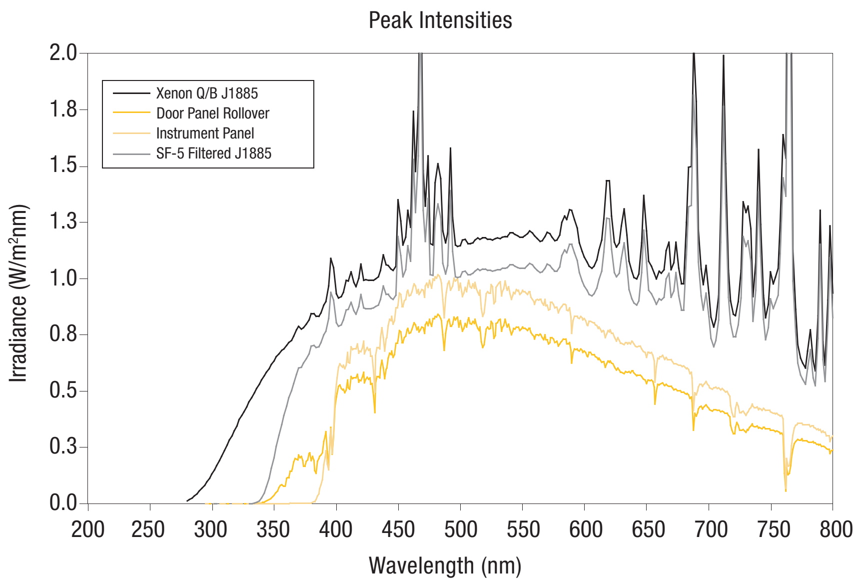



*Figure 7: Spectral distribution in accordance with SAE J1885 compared with the Ford SF5 filter system as well as with spectral measurements on dashboards and door panels made by Ford (from Helms, J., "Redefining Vehicle Interior Weathering Requirements" [7])*

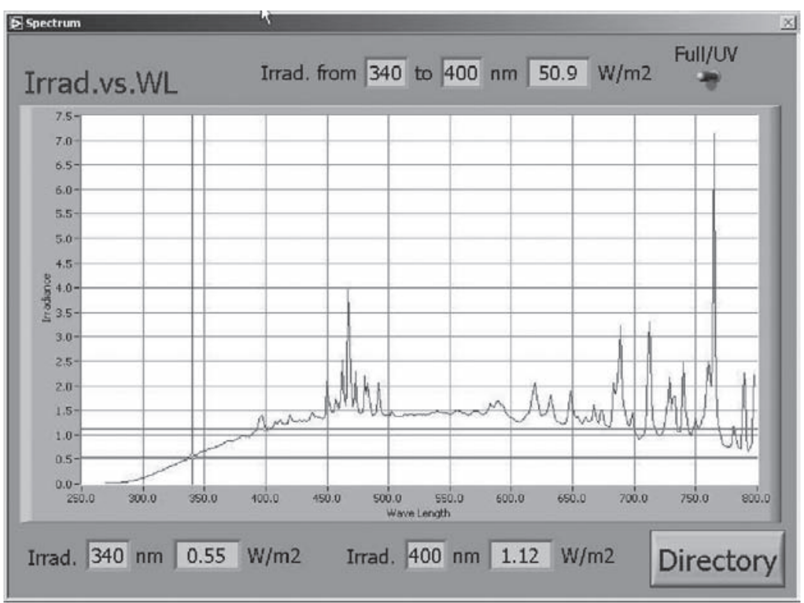



*Figure 8: Full spectrum real-time display [8]*

## Irradiance Control

In the area of instrument technology, it is now technically possible to record the spectrum of the filtered xenon-arc radiance instead of the irradiation level at a single wavelength (340 nm, 420 nm) or a specific wavelength range (300 nm–400 nm, 300 nm–800 nm). This would open new monitoring and control options [8], e.g., free selection of the control range or direct calculation, display, and control of the illuminance in lux. In addition, over-aged filters or lamps requiring replacement could be immediately recognized on the screen.

## References

[1] Riedl A., "Automotive Weathering Test Methods—The Current Status and the Future Prospects," Conference Proceedings, 5th International Symposium on Weatherability, October 24–25, 2002, Tokyo, Japan.

[2] Hardcastle, K., Searle, N., "Weathering Test Methods" in Plastics and Coatings—Durability, Stabilisation, Testing," Rose A. Ryntz, Hanser, München, 2001, ISBN 3-446-19406-1, page 189 ff.

[3] At the time of publication, ISO/FDIS 4892-2: 2005 was available.

[4] Tables 7 and 9 have been developed in cooperation with Bruno Bentjerodt, Atlas Client Education Division.

[5] Boxhammer, J., "Increased Levels of Irradiance in Outdoor and Artificial Weathering as a Measure to Accelerate Weathering Tests," Proceedings of the XXII Colloquium of Danubian Countries on Natural and Artificial Ageing of Polymers, September 16–18, 2001, Berlin, Germany.

[6] Stuck, J.W., "Experiences and New Possibilities for Accelerated Lightfastness Tests," Symposium on "Color Fastness Testing in the Textile Industry," DEK/Atlas-Xenotest, October 22, 1995, Gelnhausen, Germany.

[7] Helms, J., "Redefining Vehicle Interior Weathering Requirements," ATCAE Symposium on "Lightfastness and Weathering Testing in the Automotive Industry," June 12–13, 2002, Bad Orb, Germany.

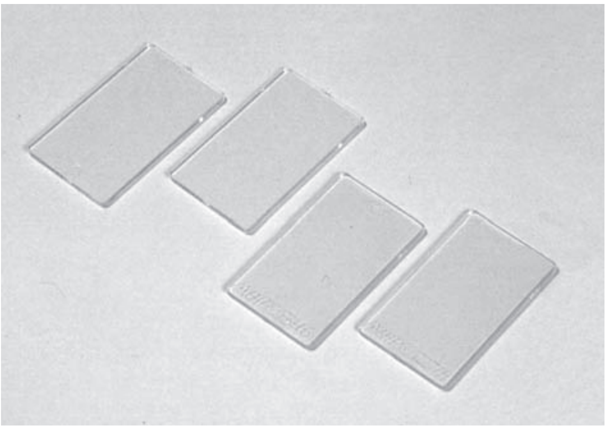
[8] Scott, K., "Next Generation Light Controls for Weathering Devices," 3rd International Symposium on Service Life Prediction, February 1–6, 2004, Sedona, Arizona, USA.

# Polystyrene Chip Shortage Predicted

## *Atlas Proposes Solution*

Standard Reference Materials (SRMs) are a critical component in testing for today's materials suppliers. According to ASTM G-113, an SRM is "a weathering reference material whose well-documented weathering degradation properties have been certified by a recognized standards agency or group, and which are identical when exposed to identical conditions. An SRM is used to monitor exposures in order to establish consistency among tests run under nominally the same conditions."

The polystyrene Standard Reference Material was developed for SAE automotive materials weathering standards. It is a clear plastic chip designed to give reproducible results within a given production batch. The performance targets and tolerances for each batch have to be determined by a robust round-robin test.



*Exposed and unexposed polystyrene chips*

These chips are primarily used in Atlas Weather-Ometers and Fade-Ometers to verify that an instrument is running properly. The chips can be used as a reference for both interior and exterior automotive standards, such as SAE J1960 and J1885. However, Atlas' global customers also use them in many other tests.

Unfortunately, the current batch of polystyrene chips, Lot 6, is close to running out. Without a new IFAI-approved lot of polystyrene chips ready to ship, automotive suppliers may not be able to test their instruments properly. In turn, this would affect the supply of their products to the OEMs.

The current situation is a result of:

- A serious problem reported on the polystyrene performance of two consecutive lots by several of the evaluators when the pre-evaluation of the next batch was almost complete.
- The time taken for the polystyrene producer to provide another batch for pre-evaluation. This batch was delivered on April 27. This batch also showed degradation patterns that limit its suitability as a SRM.
- The fact that Kurt Scott, Atlas' Director of R&D and the Standard Reference Materials Chair who has administered the last several round robins, has been asked by the IFAI committee leadership not to be involved in the upcoming round robin. The new belief is that representatives of instrument manufacturers should not be involved in the process. Consequently, the entire program has recently been turned over to someone new to administering round robins with the potential to cause further delays.

In response, Atlas is developing—with the blessing of Ford and General Motors—an Atlas instrument-only round robin. This will ensure that the OEM supplier base can continue to test and supply product.

The OEMs will accept the use of an interim SRM and tolerances that will allow their material suppliers to continue to run qualification tests and to deliver product uninterrupted. You will be able to purchase these polystyrene chips from Atlas at similar prices to previous batches.

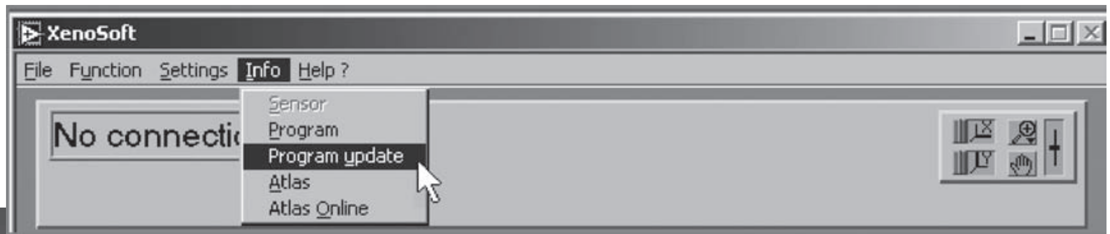
For more information, please contact your local Atlas sales representative. ■

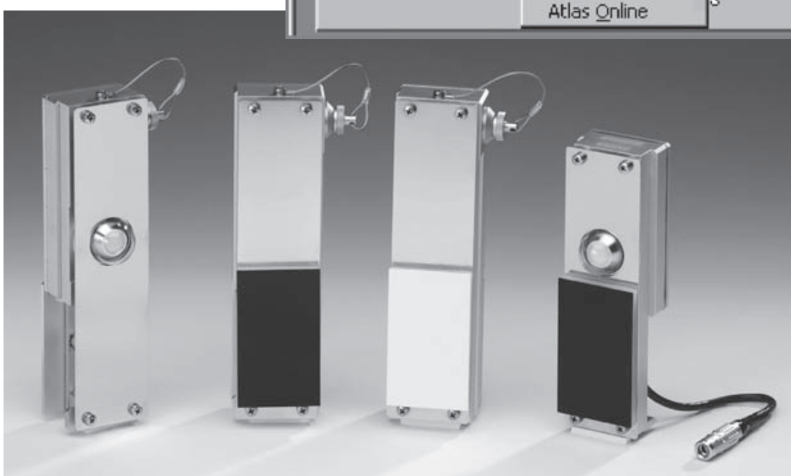
## AtlasTest Instruments Group *continued*

# XenoCal Software Is Just a Click Away!

The XenoCal irradiance and temperature calibration device now has even better capabilities. Atlas is pleased to announce that the software to run the XenoCal has been expanded to include all Atlas Ci Series, Xenotest®, and SUNTEST instruments. The sensors also now feature an improved water-tight housing and modern semiconductor technology.

XenoCal is the most widely used, independent calibration source for light. The irradiance and temperature calibration device measures and stores irradiance E ($W/m^2$) and radiant exposure H ($kJ/m^2$) during light- and weather-fastness tests. XenoCal can also be used to calibrate and adjust the measuring sensor, which is integrated in the test instrument. The XenoCal Temperature device measures and stores the BST (Black Standard Temperature) or WST (White Standard Temperature). This sensor is also used to calibrate and adjust the measuring sensor (BST), which is integrated in the test instrument. Special adapters and a new smaller size make it possible to fit the XenoCal sensors on the sample rack in Atlas Ci3000+, Ci4000, Ci5000, Xenotest Alpha, 150 S+, Beta+, and SUNTEST instruments for real time measurement.



*The Atlas Xenocal is now even easier to use.*

Special software, XenoSoft, enables the user to evaluate and analyze the measured values. The software allows for graphical display with enhanced analytical capabilities. Users can now download the software at no cost by visiting **www.atlas-mts.com/xenosoft.** Existing XenoCal users can easily download the new software version by clicking on “Program update” under “Info” in the XenoSoft software.

For further information, please contact your local Atlas sales representative or e-mail us at **info@atlas-mts.com.**

# New SUNTEST Filter System Simulates Store Light

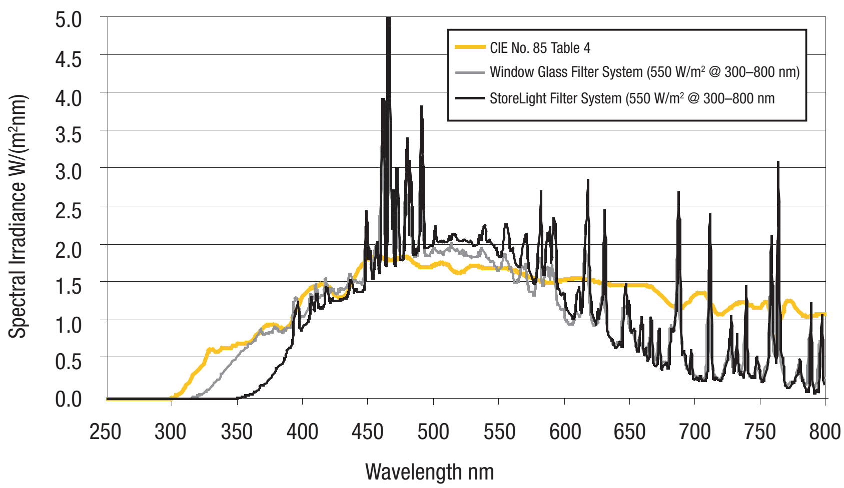
Some products never see the sun during their lifetime, not even through a window; some only get a short glimpse of it. Therefore, producers and distributors of these products have been looking for more realistic test methods in order to save costs by avoiding unnecessary UV stabilizers or expensive packaging. Such products include food and beverages sold in supermarkets, packaged goods marketed in department and convenient stores, or materials and coatings for shelves and other structures used inside stores and supermarkets.

In cooperation with a leading beverage manufacturer, Atlas developed a filter system that exactly simulates the artificial lighting conditions inside a supermarket or department store. The **StoreLight** filter system is available for our bench-top weathering instruments, the SUNTEST CPS/CPS+ and SUNTEST XLS/XLS+.

The StoreLight filter system was developed based on extended spectral measurements within different supermarkets and beverage shops. It has a cut-on wavelength at about 360 nm to ensure that the UV stress on products in the shelf is simulated in a realistic way. The StoreLight filter system is ideal for testing the photostability of beverages, food, packaging, and materials that are used for structures in shops.

For more information about the new StoreLight filter system, please contact your local sales representative or e-mail **info@atlas-mts.com**.

Comparison Between
CIE No. 85 Table 4,
Suntest Filter Systems Daylight Behind Window Glass,
and StoreLight



**Atlas**Commitment to Growth

# Weathering Experimenter's Toolbox: Worst Case Approach vs. Service Life Prediction

After considering the most critical weathering variables, engineers should characterize the end-use environment in terms of these variables. This usually leads to the question "Which end-use environment?" An automobile used in metropolitan Detroit, Michigan area experiences considerably different weathering variables than the same vehicle used in Los Angeles, California or Orlando, Florida. Engineers should design components for robust performance in worst-case end-use markets. By using this design criterion, the probability of satisfactory performance in milder end-use environments (those with milder levels of critical weathering variables) usually increases. Typically, components fail fastest in "worst case" end-use environments. Exposure in these areas accelerates failures due to increased levels of critical weathering variables including irradiance, temperature, and moisture. For these two primary reasons; 1) characterizing performance in "worst case" end use environments and 2) accelerating the rate of failure due to increased levels of critical weathering variables—industries focus material natural weathering exposure tests on two major US locations: South Florida and Central Arizona termed "reference" or "standard" environments. ■

# Atlas Launches Recalibration on the Web

Today's companies need information at their fingertips; the speed at which they conduct business is getting faster and faster every day. In response, Atlas has launched a new service enabling customers to use the Internet to expedite the lamp calibration process. This new service aims to reduce turn around time and make the calibration process easier for everyone.

Weather-Ometer® customers who use a calibrated lamp can now request calibration, print a shipping label, and return the lamp to Atlas for calibration with only a few key strokes. Furthermore, the process is now more transparent than ever before, and can be tracked along each step. This new service went into effect July 1, 2005.

To take advantage of the Recalibration on the Web (ROW) service, please visit **www.atlas-mts.com/recalibration**. Customers must first register their lamp by inputting the lamp serial number and other pertinent instrument data. Once registered, users will have the ability to:

- Request calibration
- Print a UPS shipping label and initiate a pick up and delivery
- Check the status of a current calibration from any computer with an Internet connection

The UPS integration is only available for North American customers at this time. Customers outside of North America can still use the ROW service by utilizing their own third-party logistics carrier. All other features are seamless regardless of your location in the world.

Atlas plans to expand this new online service in the future. Please check our website frequently for future programs and updates. For more information regarding Recalibration on the Web, please contact your local sales representative or visit us at **www.atlas-mts.com.**

## BCX and CCX to Carry CE Mark

Effective July 1, 2005, both Atlas models of cyclic corrosion cabinets are CE approved and eligible to carry the CE label when exported to EU countries or Australia.

This means that any BCX or CCX cabinet designated for shipment on or after July 1 will carry the CE label when the identified end-user is in a country requiring it.

## Atlas Commitment to Education

# International Colorfastness Symposium Scheduled for October

The International Symposium "Colour Fastness Days," part of the 75th Annual Meeting of the German Colour Fastness Committee (DEK), will be held in Erding, Germany, October 10–12, 2005. The symposium is co-organized by the German Bundeswehr (Federal Armed Forces) Research Institute for Materials Explosives, Fuels and Lubricants (WIWEB) and Atlas Material Testing Technology GmbH.

Colorfastness testing is a key method for solving the technical, scientific, economic, and ecological problems related to the development of colored textiles and textile finishing technologies. Adequate in-service test methods on colorfastness ensure that colored textiles are sufficient for use by customers within a particular industry. Colorfastness certificates are also a basis for care labeling of textiles.

Due to the growing European Union, the idea of cooperative projects is of increasing interest. This international symposium on colorfastness will be a platform for scientists, manufacturers, and others in the textile industry to exchange information, knowledge, and state-of-the-art technology.

Presentation topics will include:

- Different light sources, e.g., xenon, metal halide, fluorescent, or carbon-arc;
- Testing the colorfastness of textiles
- Specifications for colorfastness
- Test methods and apparatus
- How to handle complaints, auxiliaries, and standard reference materials for colorfastness testing

For further information and registration, please visit **www.farbechtheit.info.**

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# 2005

**Fundamentals of Weathering I**

August 29
Chicago, Illinois, USA

October 26
Seligenstadt, Germany

November 1
Phoenix, Arizona, USA

**Fundamentals of Weathering II**

July 19
Pune, India

July 22
Bangalore, India

August 30
Chicago, Illinois, USA

October 27
Seligenstadt, Germany

November 2
Phoenix, Arizona, USA

**SUNTEST Workshops**

October 7
Linsengericht, Germany

**Xenotest® Workshops**

October 4–5
Linsengericht, Germany

**VW Seminar**

June 29–30
Wolfsburg, Germany

**Weather-Ometer® Workshops**

*Linsengericht, Germany*

November 30
Weather-Ometer® Workshop

December 1
Weather-Ometer® Workshop

*Miami, Florida, USA*

October 10
Ci4000/Ci5000

October 11–12
Ci35/Ci65

October 13
Advanced Ci35/Ci65

For more information on courses in Europe, contact Atlas MTT GmbH, attention Bruno Bentjerodt, +49-6051-707-245 or clienteducation@atlasmtt.de. For more information on courses in North America, contact Kerry Larmon at +1-773-327-4520 or klarmon@atlas-mts.com. Or visit our website at www.atlas-mts.com.

# Atlas Donates Ci3000+ to North Carolina State University, College of Textiles

*By Emily Parker, North Carolina State University*

The College of Textiles is pleased to announce that Atlas Material Testing Technology LLC has donated a Ci3000+ Xenon Fade-Ometer® to the College. This instrument has been added to a lab that already houses several other pieces of Atlas equipment.

"Atlas has long recognized the quality of this college and the students that attend the College of Textiles. The fact that research can be done with this instrument that will affect real-life problems is such a positive," says Larry Bond, General Manager of National Sales with Atlas.


*Donated Atlas Ci3000+ will advance academic research.*

This latest edition Fade-Ometer will allow college researchers and students to work with state-of-the-art equipment to test the ability of dyes and fabrics to withstand the adverse effects of sunlight. The equipment simulates sunlight through the use of a high-powered xenon arc lamp. In a typical test, fabric samples are placed in the Fade-Ometer chamber for a specified period of time, under controlled light and humidity conditions. This allows researchers to test lightfastness of dyes and changes in fiber strength after the various exposures. The equipment was installed earlier this year and several faculty already have lightfastness-related research that they will begin performing soon; the Ci3000+ will be used in the evaluation phase of those projects.

One such project is headed by Dr. Harold Freeman, Associate Dean for Research and Ciba Professor of Dyestuff Chemistry. Dr. Freeman will use the Fade-Ometer to evaluate the light stability of new dyes synthesized in his laboratory. He will also be comparing the effects of artificial (xenon) light to natural light, to determine how the two light sources impact the rate and mechanism of dye fading in a fiber matrix. This type of research is important for the design of dyes suitable for use in fabrics and carpets for automotive interiors. "The goal is to create superior dyes for end uses requiring high lightfastness, and we plan to judge these dyes with the Fade-Ometer," says Dr. Freeman.

Drs. Gary Mock, Abdelfattah Seyam, and Tom Theyson, along with Amit Gupta, a current graduate student, are working on a NASA-sponsored research project. The ultimate goal of their work is to retain the inherent strength in the cables holding high altitude experimental balloons together in the stratosphere. A key aspect of this study involves determining how to maintain the high strength fibers of PBO when exposed to sunlight. PBO is a polymer that has a strength exceeding Kevlar but is prone to UV-induced degradation when exposed to sunlight for long periods.

Dr. Keith Beck, Department Head for the Textile Engineering, Chemistry and Science Department says, "Textile-related research and education are integral parts of our mission. The Ci3000+ will allow us to evaluate improvements in fibers, dyes, and finishes that are developed by our faculty and to educate students with the latest technology for monitoring lightfastness. We are very appreciative of the support that Atlas has provided." ■

# AtlasMaterial Testing Solutions

To receive Sun Spots electronically, please visit www.atlas-mts.com/newsletter

(If you sent us your e-mail address in response to our Fall 2004 issue, you have been added to our e-mail list and no further action is needed.)


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