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SunSpots

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Weatherable Copolyester Sheeting:
A Study in the Use of Weathering Tools

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The objective of this presentation is to examine some of the tools in the tool set that one might use to solve weathering problems and to show how those tools were used to solve a weathering problem with copolyester sheeting. The various tools discussed in this presentation are (although not necessarily in this order): literature reports, artificial device exposure, outdoor exposure, controls during exposures, step milling, color data, impact data, IR spectra of surfaces, gel permeation chromatography, chemical analysis to produce unique derivatives for characterization of breakdown products, and combinations of several of the above techniques. Most exposures were done in designed experiments to gain the most information.

With the remarkable growth of polymers since about the 1940s, there has been an ever-increasing desire to use plastics in many outdoor applications. Among these applications are those that require clear and often colorless polymers for such items as displays, signs, plastic windows, vending machine fascia, and others. The requirement for clarity and colorlessness places an extra burden on the polymers for vending machines, since this clarity and colorlessness must be retained even after extensive outdoor exposure. Polymers used for these applications are usually poly(methyl methacrylate) (PMMA), polycarbonate and, more recently, poly(ethylene co-1,4-cyclohexylene terephthalates).

This copolyester (Spectar™) was commercialized by Eastman Chemical Company in the late 1970s and saw a lot of usage in films, some applications in blown bottles and a number of applications in indoor display items. Based on the high levels of UV, high moisture, and warm temperatures, exposure of samples in subtropical Southern Florida seemed like a good way to really challenge this material and determine outdoor usage suitability.

Samples that were placed in Florida showed (Figure 1, page 5) that coloration of unprotected Spectar sheeting was very high even at the first testing interval of 3 mo. exposure. Likewise, the instrumented impact was

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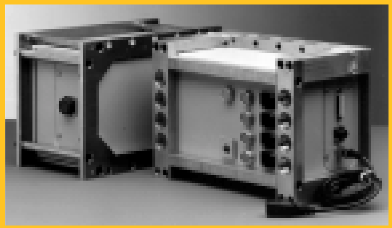

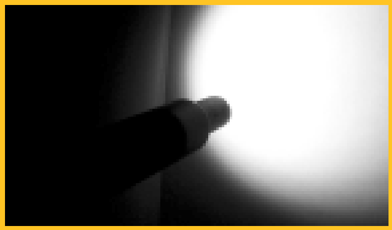

Innovative new product from KHS aids safety testing
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In This Issue

Atlas Test Instruments Group

Atlas UWT now even better

Once again, Atlas has made a good thing better. The focus this time was the UWT Universal Wear Tester. This popular machine is a multi-purpose laboratory abrasion and wear testing instrument that is widely used throughout the textile industry and related industries.

The instrument was originally developed in the 1940s by Dr. R. G. Stoll as part of a research program on wear resistance of the Textile, Clothing and Footwear Section of the Office of the Quartermaster General. In these studies, it was found that the test data correlated well with end use wear. It was manufactured and distributed by CSI as the CS-22. Today, the UWT is used to perform laboratory abrasion testing of woven and knitted fabrics, pile fabrics, hosiery, non-woven and coated fabrics, yarns, threads, and other materials.

Upgrades to a classic bring even better quality and reliability to fabric testing.

The Universal Wear Tester can perform a variety of abrasion tests, surface abrasion, frosting, edge wear, and flex and fold abrasion. In the flex abrasion test, for example, a fabric specimen is rubbed against a small calibrated steel bar until it ruptures. This stops the instrument, and the number of flex strokes is automatically recorded. While a very versatile instrument, the UWT's older mechanical design contributes to high levels of variation in results seen between laboratories.

ASTM Committee D13.60 addressed this problem by forming a task force to investigate causes for variability affected by both the test and machine design, specifically to the instrument's use in the flex and abrasion test. Lead researcher, Dr. Patti Annis, and her associates at the University of Georgia identified and reported back to the Committee on recommended improvements. The new Atlas UWT—to make its debut at the October 2002 AATCC International Conference and Exhibition—incorporates these improvements.

Sources of variability that were identified during the ASTM Ruggedness Test for the Flex and Abrasion Test included specimen positioning, non-uniform specimen tensioning, and table alignment. Based on recommendations of the task force, the ASTM Committee voted to replace the current cam system with grips and a pressure pin to improve specimen tensioning and also to add a centering mechanism for better specimen alignment.

Other design improvements:

- Modern industrial design and lower height provide greater operator comfort and make the instrument easier to use.
- Back-lit LCD counter and timer digitally display number of strokes and/or time to specimen failure, ensuring accuracy.

- Digital counter counts up to 9,999 cycles and can be preset for automatic shutoff without specimen failure.
- Digital timer precisely times down from up to 99:59 minutes:seconds with a 1-second resolution and +/- .01% accuracy.
- The reciprocating table stops in the same position each time to assure repeatable specimen approach angle.
- Improved low-noise air-injection system provides uniform pressure to the inflated diaphragm for more repeatable and reproducible tests.

While some of the improvements can be retrofitted to older instruments in use, a laboratory that purchases the newly designed UWT Universal Wear Tester will receive superior value, proven testing, and improved testing quality.

For more information regarding the new Atlas UWT, please contact your local Atlas representative or visit us on the web at **www.atlas-mts.com**. ■

In the News…

QuickDry™ Plus Boosts Productivity

The new QuickDry™ Plus by Raitech, Inc., Partner of Atlas Textile Test Products, has improved productivity at a leading U.S. textile furnishings company.

Testing for shrinkage and color consistency of cubicle fabrics and other textile-based office furnishings is a critical part of the manufacturing and quality control process at Intek of Aberdeen, North Carolina. Jeff Harmon, Intek's Technical Services Manager, said that the QuickDry Plus has been a valuable addition to their laboratory. He explained that the old oven they were using for drying had temperature control problems and that they have been extremely pleased with the operation and simplicity of the new QuickDry.

"Our dyeing team leaders make production decisions based on the sample testing," Harmon said. "They're valuable people who do not need to spend their time waiting for samples to dry." Faster drying with the QuickDry Plus, Harmon reported, translates to improved productivity at the company.

QuickDry Plus is suitable for use in any company doing lab dips and uses a spinning cycle followed by a tumbling action with warm air circulation that reduces specimen drying time to 5–6 minutes. Dried specimens have a smooth appearance with no distortion—a frequent problem in centrifuge/oven drying.

The QuickDry Plus works even faster.

The complex relationship between the drying method and time established by Raitech ensures that specimens retain an element of natural regain, avoiding time-consuming conditioning before color measurement. Multiple chambers keep colors separate so specimens are not subject to color cross-contamination associated with conventional dryer technologies.

For more information on the QuickDry Plus and Raitech's full line of specialty instruments, contact your local Atlas sales representative or Raitech directly at (704) 329-0930. ■

AtlasSpeaks

2002

Sueddeutsches Kunststoffzentrum
October 10–11
Wuerzburg, Germany

Dr. Dieter Kockott, Atlas Material Testing Technology GmbH, will present a "summary of natural climate parameters affecting the quality of products and their simulation in artificial weathering devices."

Technische Akademie Wuppertal
October 10
Wuppertal, Germany

Dr. Jörg Boxhammer, Atlas Material Testing Technology GmbH, will present a paper on temperature measuring at the exposed sample level when running accelerated light- and weatherfastness tests.

5th International Symposium on Weatherability
October 24–25
Kogakuin University, Tokyo, Japan

Andreas Riedl, Atlas Material Testing Technology GmbH, will give a presentation entitled "Weathering Test Methods: The Current Status and the Future Prospects."

Fred Lee, Atlas Material Testing Technology LLC, will present a paper on "Optical Imaging and Image Analysis Systems for the Evaluation of Surface Defects/Appearance."

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

AtlasShows

2002

CITME 2002
October 15–19
China International Exhibition Centre
Hall 8, Booth 8F196
Beijing, China

Fakuma
October 15–19
Friedrichschafen, Germany

Asia Coat
October 16–18
Shanghai Mart
Booth C247
Shanghai, China

FSCT ICE 2002
October 30–November 1
New Orleans, Louisiana

Pack Expo
November 3–7
McCormick Place
Chicago, Illinois

HET Instrument
November 4–8
Utrecht, Netherlands

TexTech
November 14–17
Chandigarh, India

Expoquimia
November 26–30
Barcelona, Spain

2003

International Hosiery Expo
May 3–6
Charlotte, North Carolina

Parachute Industry Association
January 27–30
Echo Expo
Booth 1003
Orlando, Florida

SAE 2003
March 4–7
Cobo Hall
Detroit, Michigan

European Coatings Show
April 8–10
Nuremberg

Quality Expo
April 15–17
Donald E. Stevens Convention Center
Rosemont, Illinois

Achema
May 19–24
Frankfurt, Germany

NPE 2003
June 23–27
McCormick Place
Chicago, Illinois

ITMA 2003
October 22–29
NEC
Birmingham, England

Copolyester Sheeting, from page 1

extremely low and the sample failure mode had changed from ductile to brittle (Figure 2) in the 3 mo. exposure interval as well. This implied at best no more than 1 yr. usage in locations such as Japan or Europe, insufficient for marketing as a weatherable product. Please note that these figures also show the comparison to general-purpose polycarbonate and impact-modified PMMA, which were present as controls for the exposure. Testing in the dry desert climate of Arizona and Florida showed any role of water in the results was not particularly striking. This aside, the overall conclusion was obvious: that without some sort of strong protection from UV irradiation, the copolyester would not be useful outdoors at all.

Having determined that the unprotected Spectar copolymer sheeting was by itself unsuitable for any outdoor exposure, we next examined the literature of polyester degradation for insights into how to protect the copolymer from weathering damage. There are a number of reports of the degradation of poly(ethylene terephthalate) (PET) in the literature (1–9) that existed prior to this work, and there is a later one specifically about Spectar copolymer film (10) that was research sponsored recently by Eastman Chemical Company.

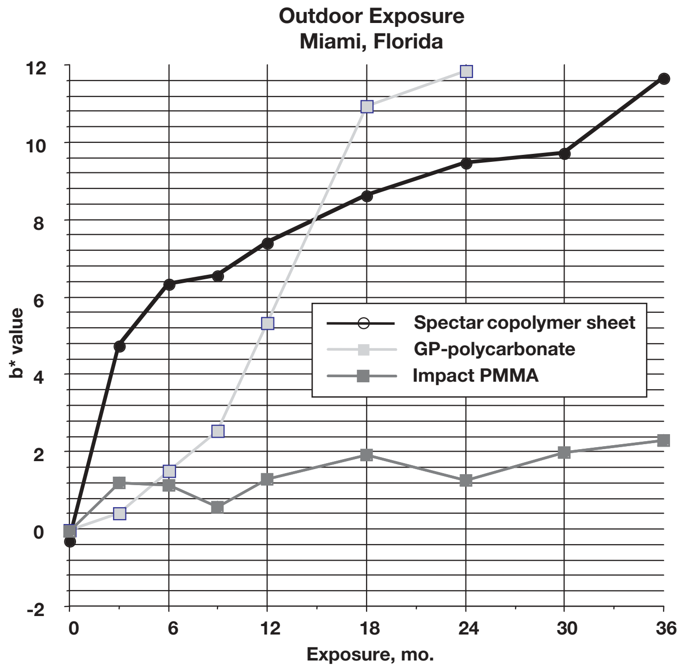
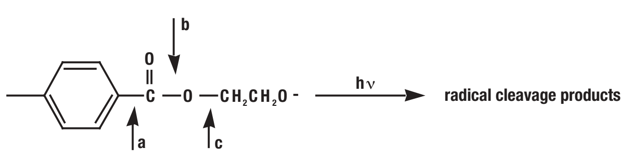


Figure 1

Many of the reactions that are postulated to occur in the PET literature arise from the interaction of UV light with the main chain of the polymer giving cleavage at 3 points:



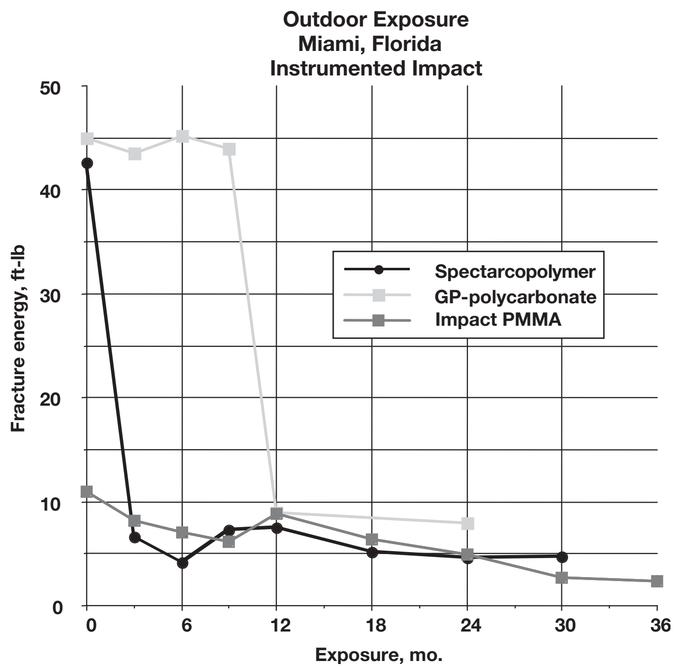


Figure 2

Hindered amine light stabilizers (HALS) were found to be incompatible with this application. Therefore, an approach to consider was attentuation or complete removal of the UV light causing the problem in the first place. The best way to do this would be to use a strong UV absorber contained in an inert matrix that is transparent to visible light. The first solution that came to mind was an acrylic polymer. Well known to be transparent to all wavelengths of UV and visible light, acrylics also do not show coloration upon exposure, at least those that are not modified with impact materials.

Turning to the literature tool once again, there is a patent (11) that discloses the use of an acrylic film laminated onto a copolyester substrate. The acrylic film contained a strong UV absorber and was adhered to the copolyester via heat lamination. The combination produced had excellent color retention when exposed to the xenon arc of a Weather-Ometer®. One severe problem resulted, however. The impact of the laminate was adversely

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affected by the presence of the acrylic layer. Its brittleness allowed cracks to start at low energies in the impact event. These cracks rapidly propagated through the whole laminate, resulting in a brittle sheet.

Before detailing some of the experiments with strong UV absorbers, we need to address one of the overarching problems that everyone faces in the area of weathering: time. The only way to verify that a product can withstand a five-year exposure under harsh conditions like Miami, Florida, is through five full years of exposure (as a minimum). There is currently no reliable way to speed this up for all materials. Fortunately, rack space to do these outdoor exposures is relatively inexpensive. It is inexpensive enough, in fact, that it makes good sense to put specimens out as soon as possible in the development cycle of a product even if one suspects that the optimum chemistry has not yet been discovered.

In our experience, one formulation's samples were left to complete their exposure even when it became apparent that the next iteration was indeed a better one. The additional information gathered on that original formulation has been an invaluable aid to further improvement ideas.

Exposure at outdoor sites requires another caution. This one is based on the intuitively obvious fact that any given year in any location such as Florida will not reproduce the well-known averages for that location. Additionally, it will not reproduce the previous year nor will it reproduce the year to come. This inherent variability from year to year anywhere one chooses to expose samples necessitates the use of control samples, which offer more reliable data. One then measures outdoor performance in reference to these samples, rather than in an absolute sense, to take climatic variations into account.

As far as a product development cycle goes, one cannot use outdoor weathering as the sole tool. The amount of time consumed in outdoor exposure and also the variability from year to year or season to season inspired development of the many artificial exposure devices that are on the market today. Therefore, we need to briefly examine artificial device exposure in context of the copolyester sheeting problem and see what was learned with each set of experiments.

One of the early tools for accelerated UV exposure was a fluorescent UV exposure device. For some materials, this has given good results; for others it does not correlate well with real outdoor results. Although polycarbonate has a very different shaped development of color vs. time than what we really see outdoors, the shape of the color development vs. time curve for the copolyester was not very different from what one actually sees in outdoor data. For this reason, we actually were able to use this device with UVB-313 bulbs as a quick screening device on things that might work. Having done so, however, we needed to constantly remind ourselves that such data was only a very quick screen, not a definitive answer.

Many other researchers report that use of a UVA-340 bulb gives much better results relative to outdoor exposure than the 313B bulb. In our experience with Spectar copolyester sheeting, however, that was not the case at all. Color development was actually much faster with the 340A bulb than the 313B bulb and could not be correlated as well with actual outdoor data.

A xenon arc Weather-Ometer proved to be a much better artificial exposure tool. Use of a xenon arc device equipped with appropriate filters (borosilicate-borosilicate) to remove the very short wavelengths of radiation gave far more realistic results for our materials. Testing of the copolyester itself and comparison to other materials showed results that agreed reasonably well with those obtained from outdoor exposure.

The prior PET literature had suggested the use of a strong UV absorber (UVA) to act as a competitive absorber vs. the terephthalate ester chain itself. Experiments focused on use of a specific, strong absorber that would dissolve in the copolyester and not cause coloration problems. The results at 0.5 and 1.0 wt% of the UVA showed some promise in the control of color. The impact results indicated that considerable progress was made but that the solution was not yet in hand even at the higher level of UVA.

The conclusion was that more UV absorber was needed. But much higher percentages would be economically impractical, thus, the need for a different approach. The only feasible way seemed to be concentrating the strong UV absorber at much higher percentages into a layer that would then be placed on top of the unmodified Spectar copolyester sheeting. It was decided that this layered construction would be made via coextrusion since that was a well-known practice more than a decade before we started this work.

Indeed coextrusion proved to be rather straightforward and yielded sheeting every bit as tough and every bit as clear as Spectar copolyester sheeting itself. All the desirable machining and thermoforming characteristics were likewise the same.

Coextruded sheeting was tested in a Weather-Ometer® and shown to have a very low increase in the amount of color (Figure 3), as measured by b* vs. energy of exposure, and also to have good impact retention, as measured by flatwise impact with the coex samples retaining 100% ductile behavior (i.e., no break was recorded) even at 4,000 kJ of exposure.

The experimental design using the level of UV absorber in the coex sheeting and the kJ of exposure from the Weather-Ometer testing was adapted for outdoor testing. Limits were inferred from Weather-Ometer testing data but also included samples judged to be too low or too high in UVA by that testing to ensure the entire range was covered adequately. Samples from this designed experiment were placed in Florida and Arizona to begin exposure. The results up to 9 mo. were excellent—all that had been expected from the xenon arc results. The 12 mo. exposure data showed color was still under control, but the impact was suddenly brittle for many of these samples. This was nonsensical after outdoor testing of the mono-layer samples with 1.0 wt% UVA only went brittle after 12 mo. of exposure. An examination of what could have possibly gone wrong turned up a surprise in a variable that should have been considered but was not: the presence of sunlight on the back side of the samples in the

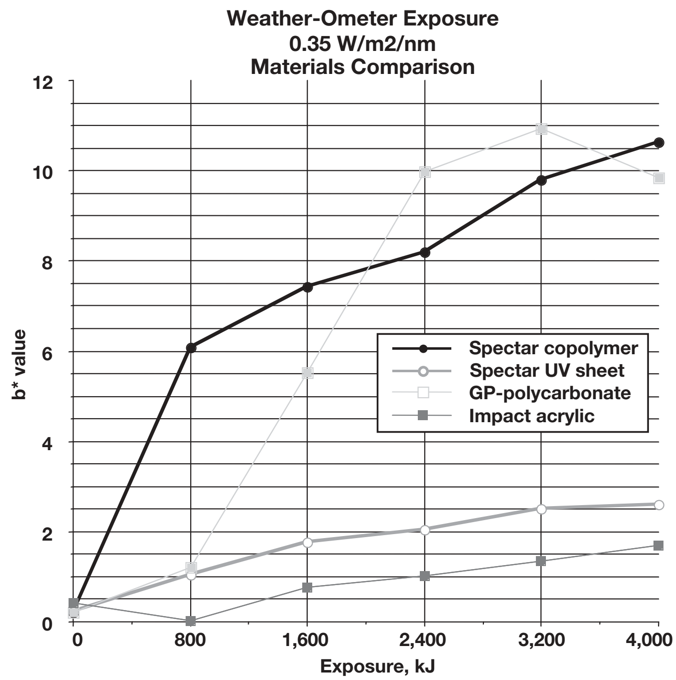

Figure 3

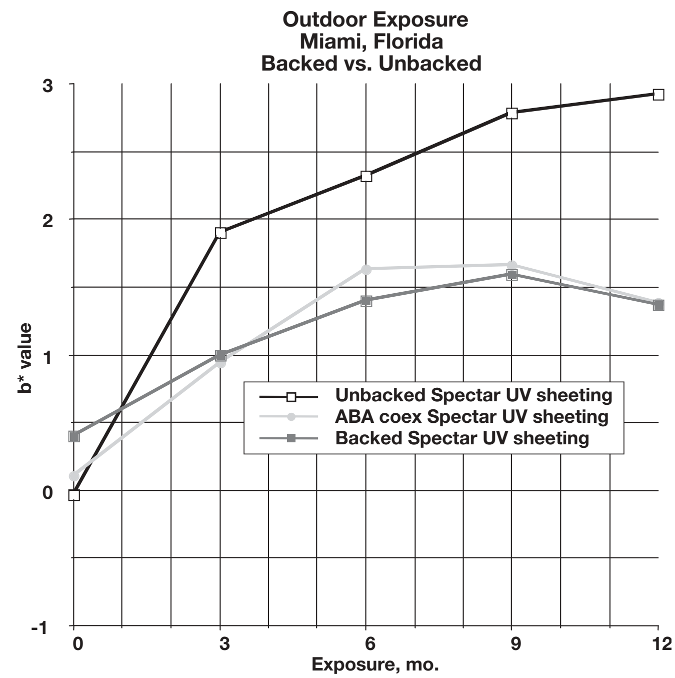

Figure 4

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Copolyester Sheeting, from previous page

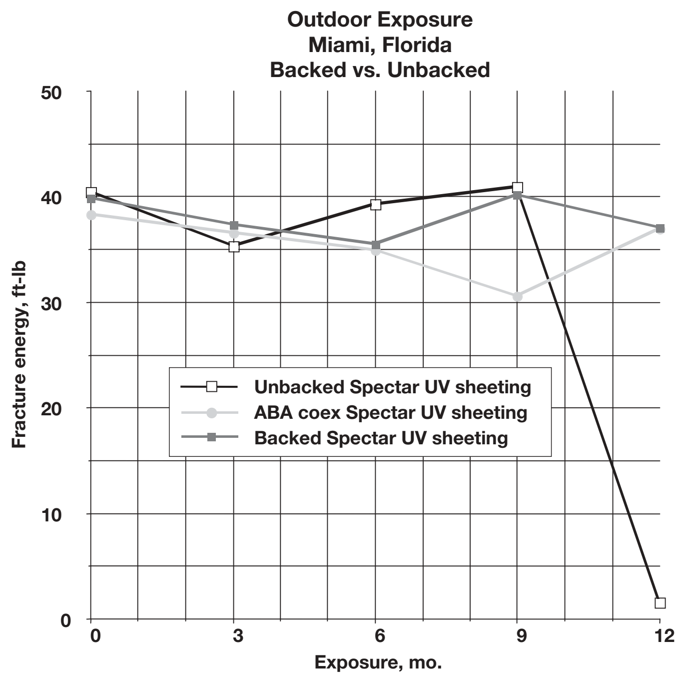

Figure 5

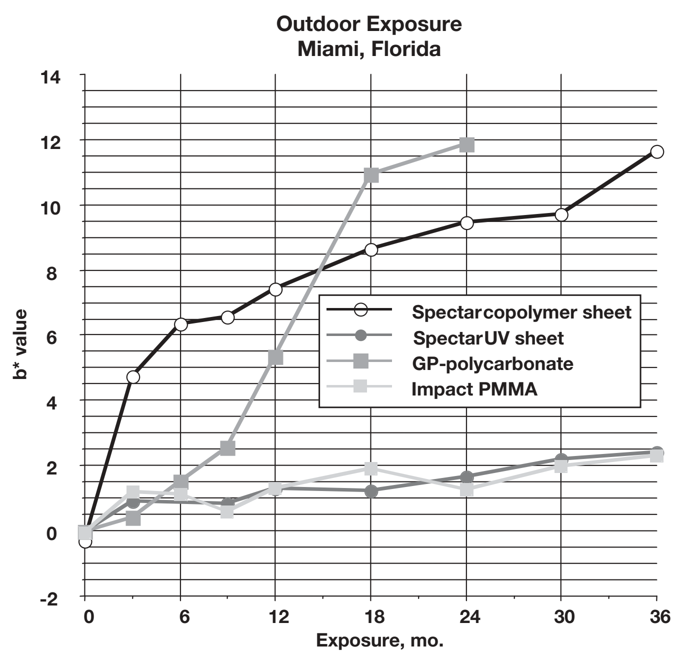

Figure 6

morning and evening on days between the spring equinox and fall equinox (the exact effects can be seen from Bennett sun angle charts for any chosen exposure latitude). Thus, our outdoor weathering tool needed to be modified somewhat.

Normal procedure for many samples to remove the effect of backside solar radiation and its apparent attendant damage would be to expose the samples "backed." The ASTM standard for this requires the use of a plywood backing material and results in raising the temperature of the specimens on exposure. With a copolyester sheeting having a Tg of 80°C, this was not particularly desirable, in particular because reciprocity testing had shown problems attributed to the raising of the sheet temperature below the surface of the exposed samples. Therefore, samples were exposed using a backing sheet made of essentially the same coextruded sheeting as was being exposed with the sheeting having an air gap of several centimeters or more. This did not raise the temperature of the exposed panels significantly.

The results for these backed samples vs. the previously exposed unbacked samples was particularly dramatic. The b* values vs. exposure time (Figure 4) were significantly lower for the backed samples, lending support to the hypothesis of damage via irradiation of the backside of the specimens. In addition, the results on instrumented impact (Figure 5) were now those expected of the material based on the xenon arc testing and the previous outdoor weathering of monolayer sheeting. An ABA coex sheeting was placed on exposure without backing sheeting in order to verify in another way that protection of the back side of the sheeting would eliminate the low instrumented impact results noted for unprotected backside exposure.

Data has been collected over a period of several years now, and the color control (Figure 6) and impact retention (Figure 7) seem to be very good for the coextruded product. Additional data has been obtained beyond the three-year exposure data shown here and continues to be positive.

In order to enable a subsequent generation product beyond the now commercially available sheeting product, experiments were undertaken early in the process to determine more about the actual mechanism of the photodegradation.

Several additional tools were employed at this point. The Spectar copolymer sheeting without and with the protective UV layer were examined by the process of milling of the exposed sheeting. The milling was done in several steps to nominal depths of 50, 125, 250, 500 microns and more down from the plaque surface. If this milling is done carefully with very sharp cutters, no lubricant, and a low material feed rate into the end-mill, the resultant steps are as they were in the original exposed specimen. These step-milled specimens were then used to determine color, IR spectra, and molecular weight information via gel permeation chromatography (GPC). The GPC data is collected by careful scraping of the step surface with a sharp sampling device, as only a few milligrams are needed for such a test.

Color data vs. depth vs. time of exposure (Figure 8) (12, 13) showed two very different color-forming processes at work, one with quite a short wavelength dependence and the other with a much longer wavelength dependence.

IR analysis of the milled specimens indicated that not much change occurred after the first 50 microns depth into the plaque. This is not at odds with the color data, as coloration usually owes itself to very low concentrations of very strongly absorbing compounds. Often one estimates that such compounds would be present in levels of only tens of parts per million. At such low levels, one would not expect to ever see these compounds in IR spectra.

GPC examination of milled specimens showed that damage indeed went deeper than what the IR spectra were showing. Some damage was occurring in relatively substantial amounts, even 250 microns (10 mils) into the exposed material. There is even indication of a small amount of damage at the back side of the plaque when one uses this measure. The conclusions from this data are much the same as from the color data, in that some rather long wavelengths are apparently involved in the photodegradation. This emphasizes the need for UV protection into longer wavelengths than one might otherwise think.

A final tool application was chemical analysis to determine the level of hydroperoxides being formed in the exposure process and also something about the identity of the acids being formed. Research on this specific copolyester was recently reported (10) and sheds more light on photoreactions. The hydroperoxide content was found to increase quite dramatically with exposure, especially in comparison to that of the parent PET homopolymer. In addition, derivitization of the samples was carried out using the very reactive SF_4. This process converts carboxylic acids, under mild reaction conditions, to acyl fluorides. The analysis showed that for the copolyester, the carboxylic acids being produced were more heavily weighted toward the aliphatic acid products than observed for the almost exclusively aromatic ones produced with PET (10).

Because the system as constructed works on competitive absorbtion, it is obvious that there will always be significant surface degradation of these samples over long exposure time. This is not

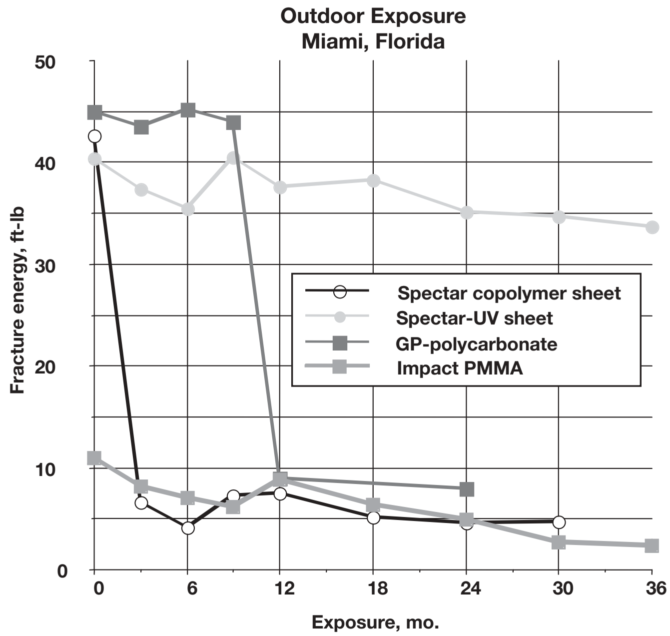

Figure 7

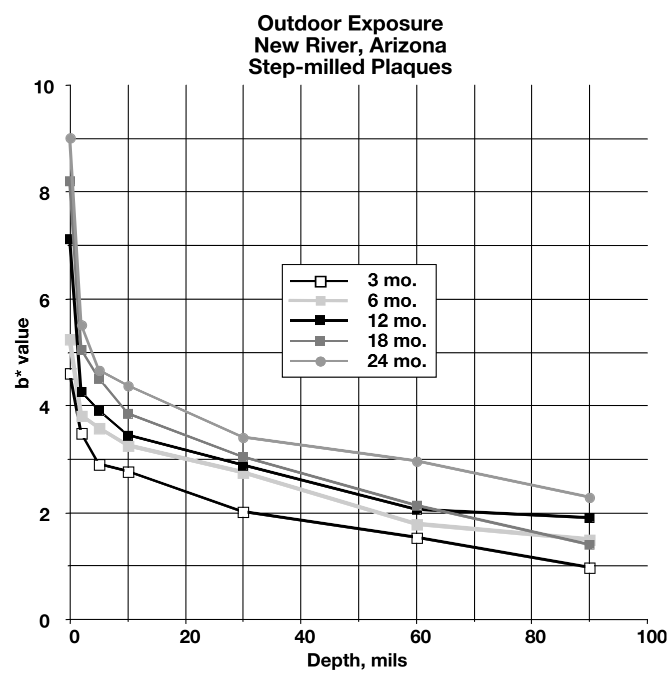

Figure 8

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Copolyester, from previous page

surprising given that such systems rely upon Beer's law to work, and where the path length is zero, there can be no absorbtion. One alternative would be to somehow change the chemistry that is occurring at the surface to avoid some of the adverse effects of the radiation absorbed.

With the information developed from the chemical, GPC, and hydrolytic analyses, it was proposed that the radicals produced came from the triplet excited state of the polymer chromophores. We, therefore, decided to employ compounds that would quench the triplet state so as to reduce the amount of radicals being generated to begin with—i.e., we would change the chemistry and make it less destructive to the polymer chains. Copolyesters were then prepared and screened with a fluorescent UV device exposure. The results were both satisfying and surprising.

In summary, by application (in designed experiments where possible) of the series of tools discussed here—literature reports, artificial device exposure, outdoor exposure, controls during exposures, step milling, color data, impact data, IR spectra of surfaces, gel permeation chromatography, and chemical analyses, especially in combination—one is very likely to be able to solve even very daunting weathering problems. ■

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KHS' Liquid Lighting System Means Better Safety Testing

As crash tests become more and more important for human safety, analyzing the vehicle's interior during crash tests also gains significance. Actions in the leg room portion of the vehicle have to be watched as well as the seat guide rails.

The main disadvantages, especially for inaccessible areas, are the size and the relatively lavish mounting. Therefore a small and more flexible source of illumination is needed. In 1992 K.H. Steuernagel developed, designed, and installed a fiber optic lighting system for testing aircraft models within the European Transonic Windtunnel project. Based on this technology, a lighting system for on-board crash tests has now been developed: the **HIGH-S-LIGHT 250 LL Liquid Light System.**

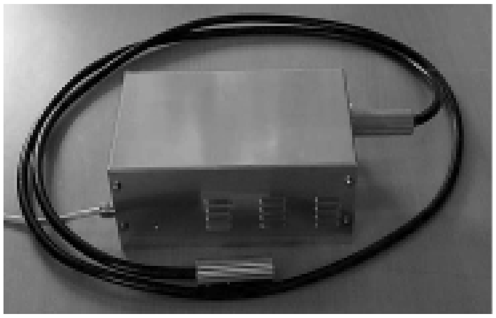
To illuminate details, liquid light guides have been more efficient than other light sources that were researched.

HIGH-S-LIGHT 250W Performance

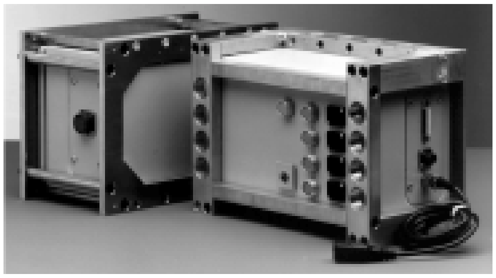
- Small size and flexibility gives access to nearly any spot of interest.
- The optical quality of the light guide guarantees that the daylight character of the light source is kept to perfectly match other HIGH-S-LIGHT sources within the illumination of the test.
- Lenses and adapters are available for a variety of applications.
- One source has up to four lights.

The HIGH-S-LIGHT 250 LL Liquid Light system is a well integrated member of the on-board light family. The system can be operated with the electronic power supplies, EPS-Modules 250 whether mains or battery driven, of the HIGH-S-LIGHT 250G series, for separate or combined use.

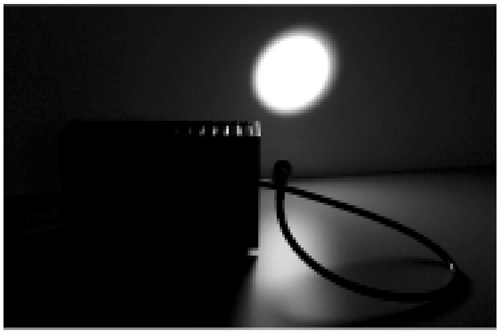
For more information regarding the HIGH-S-LIGHT 250 LL, please contact K.H. Steuernagel at **www.khslight.com.**



KHS' HIGH-S-LIGHT 250W Liquid Light



KHS' Choke EPS 250W



The HIGH-S-LIGHT 250W Liquid Light in action

Temperature Normalized Radiation is Here!

On August 1, 2002, AWSG initiated the use of TNR (Temperature Normalized Radiation) in determining the duration of outdoor exposure tests conducted in accordance with General Motors test methods, such as GMW3417 (December 2001), GM2617M (April 2002), and the soon-to-be-revised GM9538P.

The TNR method will replace SASR (Seasonally Adjusted Solar Radiation) for all GM natural weathering tests of interior automotive materials that require exposure in high temperature limited test fixtures. AWSG refers to these fixtures as "IP/DP Boxes."

Temperature Normalized Radiation (expressed in TNR Langleys) is recorded on an hourly basis and calculated with instantaneous temperature (as measured with the test fixture's reference black panel) and irradiance (as measured at the test angle under the same test glazing), with data collected at five-minute intervals.

Due to the nature of the test fixtures, and the various colors of the test specimens, it is highly unlikely that a test started in two or more IP/DP Boxes will complete on the same date when timed on a TNR Langley basis. Therefore, a test program that requires more than one IP/DP Box will have a separate AWSG order number assigned to each box in order to provide the most accurate data for that particular set of samples or components.

For additional information on the testing of interior automotive materials, please contact a client services representative at +1-800-255-3738 or info@atlaswsg.com. ■

Atlas Upholds Commitment to Quality and Customers

As the first member of the weathering industry to adopt the ISO/IEC 17025 laboratory standard in 2001, Atlas made a firm commitment to ensure accurate and repeatable test results for its customers. ISO/IEC 17025 places strong emphasis on management requirements, stresses laboratories' obligation to identify client needs, and ensures that the test methods chosen meet those needs. Atlas' recent reaccreditation of this standard in 2002 further demonstrates our dedication to providing the most efficient and effective solutions the weathering testing industry has to offer.

Prior to the adoption of this standard, various countries and regions used laboratory quality standards such as ISO/IEC Guide 25 in the United States and EN45001 in Europe. While these standards were similar, they were not completely uniform. Atlas understands the importance of this standard to its international client base; the adoption of ISO/IEC 17025 reassures that Atlas standards will be applicable to customers around the world.

For more information on Atlas Weathering Services Group's ISO/IEC 17025 accreditation, please contact an AWSG client service representative at +1-800-255-3738 or info@atlaswsg.com. ■

AWSG Partners with Testing Organization in China

Atlas Weathering Services Group (AWSG) is pleased to announce an exclusive partnership with Guangzhou Electric Apparatus Research Institute Weathering Testing Center (GWTC) and Intertek Testing Services HK Ltd., Equipment Services Division (ITS-EQT) to provide outdoor weathering testing and laboratory accelerated testing services in China.

As today's companies begin to think globally and China continues to expand its role within the world economy, materials durability testing and service life prediction will become even more important. AWSG looks to fill the role as technical leader for outdoor weathering in China by partnering with two established market leaders. GWTC is an ISO and China National Accredited laboratory testing center for materials testing. ITS is the exclusive representative in China for Atlas Material Testing Technology.

GWTC operates two atmospheric exposures site in southern China: a subtropical site in Guangzhou and a tropical site in Hainan. In addition to these sites, GWTC has affiliations with other test sites throughout China. These sites will further enhance the AWSG Worldwide Exposure Network offering our clients more choices for worldwide exposures.

AWSG has trained and authorized GWTC to perform AWSG-recognized tests for outdoor weathering, laboratory accelerated weathering using xenon and fluorescent devices, and evaluation services as specified in ASTM, ISO, and SAE standards. AWSG has put into place strict quality control guidelines for GWTC to follow in accordance with AWSG standard procedures as part of our continuing effort to provide superior material durability solutions for our global clients.

In addition, GWTC can now offer the complete array of services offered by AWSG sites around the world. With a broad scope of test methods and equipment, AWSG delivers the technology and service you need to achieve a quality product, a competitive edge, and a faster time to market.

For more information regarding testing in China, please contact your local Atlas representative or call AWSG directly at +1-623-465-7356. ■

Test Our New French Lab

We proudly announce the opening of the new Atlas test laboratory in Moussy Le Neuf, near Paris, France. This is the third laboratory Atlas has opened in Europe to better serve our customers. Others are in Lochem, Netherlands and Duisburg, Germany.

The new laboratory is equipped with several Ci Series Weather-Ometer® models to run tests according to the most common test standards and manufacturers' specifications. The French laboratory closely cooperates with the two other European laboratories to meet all your testing needs.

For more information or to submit a test, please contact Mme. Ginette Noury at 0033-1-60549400 or g-noury@atlas-mtt.fr. ■

AtlasCommitment to Education

In Review…

ATCAE Automotive Conference a Hit

Similar in format and content to the ASNAW Automotive in Phoenix, Arizona, the Atlas Technical Conference for Accelerated Ageing and Evaluation—held June 12–13 in Bad Orb, Germany—focused on new test and evaluation methods relating to automotive interior and exterior materials. It was the first ATCAE conference in Europe for the automotive industries and their suppliers. Presented in German with simultaneous translation in English, the program included a tour of a well-known testing laboratory, the EDAG Company in Fulda, featuring R&D facilities for the automotive industry.

Part I (first day) was dedicated to automotive interior materials and covered such topics as new test methods relating to standards. Solar simulation and K.H. Steuernagel Systems were also covered.

Part II (second day) dealt with automotive exterior applications and the state of test and evaluation methods for polymers and coatings. New analytical applications with the ATLAS VIEEW® system were also detailed.

Speakers were all experts from well-known automobile manufacturers and suppliers. The following list outlines the papers presented during the conference:

June 12, 2002:

- Dr. Jörg Boxhammer and Dr. Dieter Kockott, ATLAS, Linsengericht, Germany: "The Aging Test of Organic Materials in Automotive Manufacturing in the Past, Present and Future: Introduction into the Program"
- Mrs. Eveline Weber, Adam Opel AG, Rüsselsheim, Germany: "Light Resistance of Dyes of Automotive Upholstery"
- Dr. Peter Schwarzer, Volkswagen AG, Wolfsburg, Germany: "Experiences with PV1303 as Compared to Outdoor Weathering"
- Mr. Jeffrey Helms, Ford, Detroit, USA: "Redefining Vehicle Interior Weathering Requirements"
- Mr. Michael Begert-Wild, Edag, Fulda, Germany: "Comparison of the Test Methods Hot Light Exposure DIN 75202 and Solar Simulation DIN 75220 with Respect to Surface Changes"
- Dr. Wilfried Herter, Ciba, Basel, Switzerland: "Hot Light Exposure at High Irradiance"
- Mr. Burkhard Severon, KHS, Mörfelden, Germany: "System and Methods Optimize the Correlation of Tests in Solar Simulation Plants with the Exposure Conditions in Outdoor Weathering"
- Dr. Matthias Kriegel-Gemmecke, Pilkington Automotive, Witten, Germany: "Aging Tests of Automotive Glazing – Technical Features and Principles"
- Mr. Heinz Stahl and Mr. Norbert Koschmieder, Audi AG, Ingolstadt, Germany: "Solar Simulation Plants for the Performance of Aging Tests"

June 13, 2002:

- Mr. Andreas Scheibe, Fraunhofer Institute, Stuttgart, Germany: "Digital Image Analysis of Different Surface Defects"

- Mr. Thomas Raabe, BASF, Ludwigshafen, Germany: "Quality Assurance in Accelerated Weathering"
- Mr. Cees van Teylingen, ATLAS, Lochem, Netherlands: "Measuring and Classification of Corrosion Using VIEEW™"
- Mr. Xavier Duteurtre, Renault, France: "Predicted Weathering Behavior of Plastic Parts: Requirements and Progress in Understanding"
- Mr. Michael Boes, Karl Wörwag, Stuttgart, Germany: "Coated Plastic Components for the Automotive Industry, Comparison of Exposed Paint"

Due to overwhelming interest from non-ATCAE participants, we have made conference documentation available. A copy may be ordered from your local Atlas sales representative. The information will be also communicated on our web site, **www.atlas-mts.com**. The conference package will be available for €100 (about US$100), which includes the handout and a CD-ROM in PDF format. ■

Client Education Expands in Europe

The well-known workshops for Atlas weathering equipment and Fundamentals of Weathering (FOW) seminars are now taking place on a regular basis in Germany. Since March 2002, FOW courses also have been offered in other European countries, organized by Atlas representatives and business units:

Denmark
Strenometer ApS in Virum

- March 5, 2002 in Herning at the Textile Institut
- March 6, 2002 in Copenhagen at the School of Conservation

Seminar programs were supplemented by laboratory visits in both locations.

Switzerland
Atlas MTT in Härkingen

- March 12, 2002 in Kirchberg
- March 13, 2002 in Lenzburg
- March 14, 2002 in Birsfelden

France
ATLAS MTT Moussy Le Neuf-Paris

- March 28, 2002 in Paris
- March 29, 2002 in Paris (FOW II)
- June 13, 2002 in Lyon
- June 14, 2002 in Lyon (FOW II)

Italy
URAI S.P.A. Milano

- May 8, 2002 in Milano
- May 9, 2002 in Milano

Russia
Dr. Olga Anisimova in Moscow

- June 24, 2002 in Moscow (Textile Workshop)
- June 25, 2002 in Moscow FOW

India
ATLAS MTT Pvt.Ltd. in Chennai

- August 5, 2002 in New Delhi
- August 7, 2002 in Bangalore
- August 9, 2002 in Pune

See next page for workshop and seminar dates for the remainder of 2002.

AtlasCommitment to Education continued

2002

Fundamentals of Weathering

September 26
Switzerland

October
Spain & France

October 15
North Germany

October 22
Netherlands

November 7
Belgium

XENOTEST® Workshops

September 17–18 *(English language)*
Germany

November 26–27 *(German language)*
Germany

Ci4000/Ci5000 Weather-Ometer® Workshop*

October 28

Ci35/Ci65 Weather-Ometer Workshop*

October 29-30

Advanced Ci35/Ci65 Weather-Ometer Workshop*

October 31

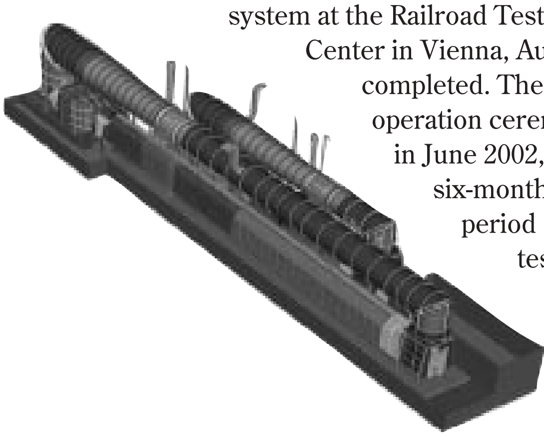
Registration information and workshop/seminar brochures are available from Bruno Bentjerodt, Client Education Europe, 0049/(0)6051-707-245 or bbentjerodt@atlasmtt.de.

* *All Weather-Ometer workshops take place in Miami, Florida at Atlas' South Florida Test Service location. Registration is available online at www.atlas-mts.com or by contacting Theresa Schultz at +1-773-327-4520.*

Vienna Rail & Test Station Update

In the Fall 2001 issue *Sun Spots,* we reported on the Rail Test Research Project in Vienna and promised to update you on the progress of this project in future issues.

After 18 months of planning, construction, prototyping, manufacturing—and testing, testing, testing—the installation of the solar simulation system at the Railroad Test and Research Center in Vienna, Austria was completed. The first official operation ceremony was held in June 2002, followed by a six-month acceptance period of the complete test facility. ■



The new Rail Test Research Project in Vienna under construction last year, and (at left) a drawing of the complete structure.

Marks & Spencer Approves XENOTEST 150 S+

The XENOTEST 150 S+ has been approved for Marks & Spencer Test Methods C9 Colour Fastness to Light and C9A Colour Fastness to Wet Light!

The Marks & Spencer test methods are two of the most important test methods in the textile industry. Until now, only Atlas' XENOTEST 150, 150 S, and Alpha (with omega-shaped lamp), and James H. Heal's Megasol were approved. Since the XENOTEST 150 and 150 S are no longer manufactured, a low-cost instrument was needed for this important textile market.

Now Marks & Spencer has officially added the XENOTEST 150 S+ to its list of approved test instruments. This approval follows the positive report of a British independent testing laboratory that conducted tests in the XENOTEST 150 S+ on behalf of Marks & Spencer to compare how results correlate with existing data and to determine the program test parameters.

The updated technical and program features of the XENOTEST 150 S+ make it stand out against its predecessors. The XENOTEST 150 S+ offers such advantages as modern design, stepless adjustment of lamp power, 10% higher sample capacity, and easy operation by microprocessor control. It is the economical solution for lightfastness testing of textiles based on the technology of the air-cooled xenon lamp. In addition to Marks & Spencer and other lightfastness tests, the XENOTEST 150 S+ meets the testing requirements of ISO 105-B02, ISO 105-B04, AATCC Test method 16H and AATCC Test Method 169, as well as various German (DIN) and British (BS) test standards.

For more information on the XENOTEST 150 S+, contact your local Atlas representative or visit **www.atlas-mts.com.**

Weathering Experimenter's Toolbox

by Henry K. Hardcastle III, Atlas Weathering Services Group

Temperature Effect on Colorimeter Measurements

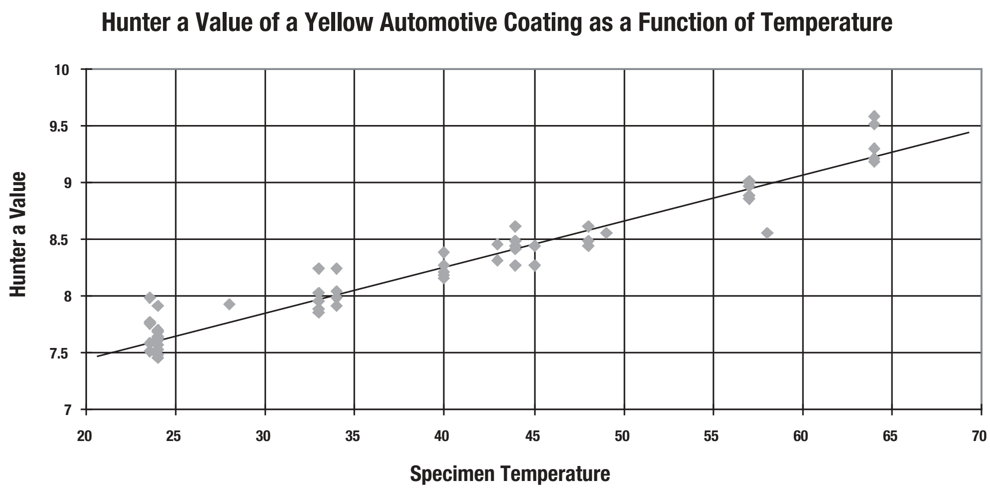
A researcher's characterization of gage behavior may be critical to successful implementation of a project. It is the weathering researcher's responsibility to qualify the measurement systems used in his/her research. Recent advances in hand-held colorimeters and spectrophotometers have led to their widespread use throughout weathering technology. These hand-held instruments provide the freedom and flexibility to measure full size operating systems in end-use environments. These instruments (as with all measurements instruments), however, also allow the chance for gross errors in weathering data.

An example of a recent study involved hand held spectrophotometer evaluations of samples on exposure in Florida. Unexplainable variations in the data prompted investigation of the instrument. Technicians walked out to backed exposure racks and measured coated panel color while panels were on exposure. Hunter a color values varied as much as 0.5 units within a week's exposure. It was noted that on some days the weather was cool and cloudy and on other days the weather was warm and sunny. These conditions seemed to co-vary with the measured a values.

An experiment was performed utilizing a commercially available yellow automotive coating on steel substrate. Thermocouples were attached to the painted surface. Initial measurements were made at room temperature. The panel was placed on a hot plate and re-measured at a variety of temperatures. The above graph was obtained.

Even though the color instrument was calibrated at the ambient air temperature of the exposed specimens, the different solar loading under clear and cloudy conditions affected the surface temperature of the specimens resulting in color measurement variation. This phenomenon represented a critical understanding and limitation to the use of this measurement method for field measurements. Characterizing limitations of measurement systems represents an important tool for weathering researchers.

Quite often measurement systems were designed for more traditional laboratory prepared specimens than the variety present in naturally or artificially weathered specimens. Effects of limited target area, surface non-homo-geneity, surface contaminants (including biologicals), equilibration issues (including dark time reactions), and other variables can result in frustrations while trying to answer specific research questions. Just as materials have adverse responses to climates, measurement systems sometimes have adverse or unexpected responses to weathered materials. Similarly, as weathering researchers perform experiments to understand weathering phenomena, researchers may also perform designed experiments on measurement systems' interaction with weathered materials. Most tools for weathering research outlined in this presentation may also be useful for characterizing measurement system behavior.



Radiant Exposure Only Tells Half the Story

The ability to compare radiant exposure between natural weathering and xenon arc exposures can be a powerful tool when developing service life prediction models. But there are other factors that must be considered as well. The spectral sensitivity of the exposed material may make these "equivalent" exposures useless. Temperature, moisture, and the secondary effects will play a role in material degradation. These factors work synergistically to degrade materials. Because of this, the study of weathering and degradation of materials has been described as "half science and half magic."

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