PlasticsTechnology

Close-Up On Technology: Materials

20 Years of CAMPUS
A Quiet Revolution In Materials Characterization

By Matthew H. Naitove, Editor

In December, about a dozen representatives of European chemical companies gathered in Aachen, Germany, to celebrate the 20th anniversary of a quiet revolution in plastics. Two decades ago, at the urging of the German automotive industry, the Big Four of German plastics at the time—BASF, Bayer, Hoechst, and Huls—formed a consortium to reform the somewhat chaotic state of plastics materials characterization. They launched the consortium in 1988 under the name CAMPUS (Computer Aided Material Preselection by Uniform Standards). Its goal was to standardize, to a degree never before accomplished, the way plastics materials data are gathered and reported, in order to achieve a quantum leap in the quality, usefulness, and credibility of those data. They agreed on strict protocols for specimen preparation, specimen geometry, and testing conditions, as well as a uniform datasheet format.

Since then, the consortium grew to as many as 50 licensed members worldwide, though mergers and acquisitions have helped shrink that number over time. Meanwhile, usage of CAMPUS data has spread worldwide to several hundred thousand users, and the scope of CAMPUS data has expanded steadily to meet the needs of the market.

Expansion and refinement of CAMPUS protocols continues, with several technical projects under way. However, an equally great imperative for CAMPUS is to achieve broader participation by both larger and smaller plastics producers, and also to attract the attention of materials specifiers in a broader range of end-use industries besides automotive. In a time of tight budgets and shrinking technical staffs, the latter is seen as a necessary step to ensure continued financial support for CAMPUS development from materials companies.

THE CAMPUS DIFFERENCE

There have always been standards for materials testing from organizations such as ASTM in Philadelphia and ISO (the International Standards Organization in Geneva). But, in the words of one material supplier, those standards are "broad enough to drive a truck through."

Take the example of the tensile test method specified in ISO 527. It offers a choice of five different testing speeds and three different types of specimens, the thicknesses of which can vary within wide limits. Even broader choice is offered for impact testing. Two international standards, ISO 179 and 180, allow for seven types of specimens, three different notch shapes, and three methods of striking the sample—Izod, Charpy flatwise, and Charpy edgewise. Under these conditions, a designer or processor could have little confidence in comparing datasheet figures for any two materials, especially from different producers.

The newest version (5.1) of CAMPUS added long-term heat-aging data, visible at lower right. (Source: www.campusplastics.com)

The CAMPUS group addressed this uncertainty by agreeing to use a much narrower range of options for a defined slate of test methods, all based on ISO standards. What's more, the group recognized that, in addition to specimen geometry and test conditions, the processing history of how the specimen was prepared has a big influence on test results. For instance, if you wanted to injection mold a specimen to optimize impact strength, you might use the upper end of the material's melt- and mold-temperature range, along with a slow injection speed, to minimize orientation. But if you wanted to optimize a sample for stiffness, you might choose a colder melt and mold and faster injection. According to CAMPUS representatives, it would have been not at all unusual for materials suppliers to report both optimized properties on the same datasheet, even though they came from samples that were prepared quite differently. CAMPUS protocols rule out such questionable practices in data reporting.

A 'LEVEL OF TRUST'

With plastics taking over from metals and other traditional materials in a growing range of critical structural applications, the absence of truly comparable property data had required end users to perform their own testing at considerable expense. "BMW, for example, used to do its own testing of all the materials it used, but not any longer. In the automotive industry, CAMPUS has brought a level of trust," says Dr. Erwin Baur, head of M-Base Engineering + Software GmbH, which developed the software for CAMPUS.

Not only does the automotive industry save considerable sums with CAMPUS, but so do the materials suppliers. BASF, for example, estimates that it saves 1 million Euros annually by using consistent test specimens and test methods, and not having to retest according to a myriad of national standards. That helps make up for the enormous cost of retesting that was necessary to create the initial CAMPUS database—estimated at more than 10,000 Euros to generate all standard property values for a single grade of material.

In 2001, CAMPUS added chemical-resistance data, seen here at lower left. (Source: www.campus plastics.com)

CAMPUS data on around 4300 grades of plastics is currently available at no charge from at least 20 suppliers, all based in Europe and the U.S., except for Teijin Chemicals Ltd. in Japan. All are primary resin producers, except for three that are mainly or entirely compounders—A. Schulman GmbH, Albis Plastics GmbH, and PolyOne.

Viewing CAMPUS data on the Internet has largely replaced the floppy discs formerly distributed by materials suppliers. And it's not necessary to visit each supplier's website individually. Visitors to the CAMPUS website can access two free programs—WebView, which offers a central point for viewing all suppliers' data in one place; and WebUpdate, which makes it easy for users to determine when new data from all suppliers are available and to download those updates in a single step. In addition, complete current data is available from M-Base at its Material Data Center website and, since last May, from the Plaspec Global website created by Plastics Technology in association with M-Base.

The CAMPUS website (www.campusplastics.com) is visited around 10,000 times per month by an average of 4300 different users. WebUpdate software is downloaded by 1200 to 1500 new users per month. CAMPUS materials data are downloaded 15,000 times per month, an average of 670 downloads per supplier. About half of the registered users of CAMPUS software are in four countries—Germany, Italy, France, and China, in that order. The U.S. is fifth.

The industry most reliant on CAMPUS data is automotive, which accounts for 25% of WebUpdate users. While usage of CAMPUS data is highest in Europe, acceptance elsewhere has grown along with adoption of ISO materials data. The U.S. auto industry has moved largely to using ISO data for its materials specs, though ASTM data are still common as well. Japan's auto makers reportedly have converted to ISO standards. Major OEMs in the medical and electrical/electronic industries are also adopting specs based on CAMPUS/ISO data.

CONTINUOUS EVOLUTION

The CAMPUS database has gone through at least eight software releases that added progressively to the initial library of single-point data. Over the past 20 years, those additions included multi-point data curves of rheological and thermal properties, pvT and DSC data for use by molding simulation software packages, chemical resistance data, and additional properties for TPEs and film resins. CAMPUS is now available in eight languages, including Chinese, Japanese, and Korean. The most recent version (5.1), launched in early 2007, added multi-point data on long-term heat aging.

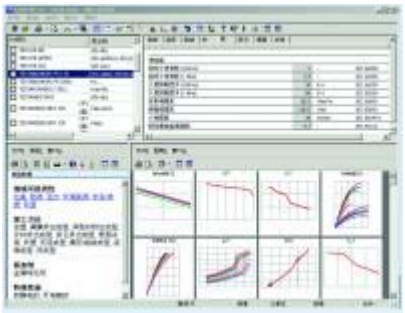
This year, a new release is expected, which will include a new subset of automotive-related materials properties requested by the German automobile industry association (VDA). These will include some new data on interior and exterior weathering, fuel and chemical resistance, FMVSS flammability, VOC emissions, and odor.

WHAT'S NEXT?

Under the guidance of its Steering Committee, CAMPUS has several technical projects in the works or under consideration. Dr. Gerhard Maurer, manager of materials testing for engineering plastics at BASF S.E., Ludwigshafen, Germany, reported at the Aachen meeting that CAMPUS members are conducting "round robin" testing to mutually calibrate their labs against each other.

A project is under way to evaluate different software algorithms used by automated testing systems for determining tensile modulus and elongation at

yield and break. According to Ralf Tullmann, senior manager of polymer testing at Evonik Degussa GmbH Performance Polymers in Marl, Germany, there is need for software that can automatically determine the type of stress/strain curve (brittle, ductile, or elastomeric) exhibited by a material so as to determine the property values intelligently (e.g., by not looking for a yield point in a brittle material). Such "smart" software would also be able to detect errors in the curve caused by a slipping specimen clamp, for example.



China is now the fourth-largest user of CAMPUS data, ahead of the U.S. CAMPUS is available in Chinese, as well as Japanese and Korean. (Source: www.campusplastics.com)

Another project under consideration is to develop a new 2-mm-thick standard test specimen that is more representative of today's thin-wall moldings than the current 4-mm specimen. But that raises new issues, cautions Dr. Ludger Czyborra, leader of processing and design for Ticona GmbH in Kelsterbach, Germany. Properties of thinner specimens, especially of crystalline materials, are more highly influenced by skin/core morphology and flow orientation. That demands even tighter control of sample molding conditions, notes Dr. Czyborra. It raises new questions like, "How closely can you control mold temperature?"

Another new sample geometry might be required to meet the growing interest in automotive crash testing. Measuring high-rate tensile properties requires a shorter specimen than is now standard.

Other projects being considered include investigation of "true stress and strain" because current measurements are compromised by necking phenomena. Some consortium members are also interested in standardizing scratch/hardness testing and gloss measurement. There is also a proposal to develop a sample preparation protocol for laser-sintered specimens in order to test properties of materials used in rapid prototyping or additive manufacturing.

CHALLENGES AHEAD

With so much technical work yet to be done, an important issue for CAMPUS is maintaining support from plastics producers for adequate financial and personnel resources during a period of global recession. Given the high cost of developing materials data, some suppliers even question why they should make it available to anyone but selected customers. As a result, some companies that have CAMPUS licenses are not currently providing data to the website or are not updating old data.

The answer, some CAMPUS members agree, is for chemical companies to recognize that a new generation of designers and engineers is accustomed to searching on their own for information via the Internet. If they don't find materials data from a supplier, they may not consider that company for a future project.

Membership is regarded as a key issue to the future of the consortium. Members want to see participation by more suppliers worldwide and by more of the "second tier" of smaller polymerization firms and compounders. While CAMPUS data now account for 90% or more of the engineering thermoplastics used in Europe, better representation by makers of TPEs and polyolefins would be particularly welcome. Although makers of materials for disposable packaging have seen a less critical need for the expense of retesting under CAMPUS protocols, it may be argued that polypropylene counts as an engineering material today, especially in automotive.

CAMPUS members also recognize the need to promote their activities beyond their core following in automotive to industries such as computers, business machines, medical, and electrical/electronic equipment. "Our goal for the next five years should be to extend to other industries what we have accomplished in automotive," said Julien Lebranchu, data management assistant in engineering polymers for Du Pont de Nemours International S.A. in Geneva, Switzerland. When more OEM manufacturers recognize the need for truly comparable materials data, they will create the "demand pull" to spur the needed interest and support from plastics suppliers.