TUESDAY MORNING: TECHNOLOGY READINESS 1 – PART 1: European Composites Innovations

Lee Harper, Nottingham University
Advancements in Discontinuous Carbon Fibre Composites for Automotive Applications

Not Available at Press Time

Jonah Jimenez, Sigmatex High Technology Fabrics
A Novel 3D Weaving Process for Low Cost, Complex Carbon Fiber Preforms

Carbon fiber preforms enable the use of infusion fabrication processes for complex, structural components. This presentation covers recent advances in the use of a novel 3D weaving process to produce hollow and graded pre-forms to meet the requirements of complexity and cost in automotive applications. This 3D process has been used to produce an "A-pillar node" using a carbon fiber preform and a resin-infusion fabrication process. The process has also produced continuous carbon fiber fabric with varying wall thicknesses.

Speaker to be Announced
Topic to be Announced

Not Available at Press Time

Graham Barnes, Engenuity Limited
Beyond Crash Tubes: Extending Composite Impact Predictions to Adhesively Bonded Energy Absorption Structures

The author is a true believer in the potential for high-performance composites to revolutionize the safety and environmental impact of mainstream production cars. Mainstream composites are just around the corner and safety in crash is one of their biggest benefits, but until recently the hardest to predict.

TUESDAY MORNING: COMPOSITES TUTORIAL – PART 1: Introduction to Polymer Composites

Presented by the Automotive Composites Alliance & SPE Composites Division board members

Polymer composites are the key for lightweight construction and enable automakers to reduce fuel consumption and fulfill governmental requirements. Today, processes and materials are available to produce polymer composites with an excellent cost/performance ratio. The tutorial will focus on materials and processes typically used for automotive part production.

TUESDAY MORNING: VIRTUAL PROTOTYPING & TESTING OF COMPOSITES – PART 1: Best Practices & Fiber Orientation

Mike Wyzgoski, American Chemistry Council
Long Fiber Reinforced Thermoplastics Predictive Engineering Activities

Since 2006, Oak Ridge National Laboratory (ORNL) and Pacific Northwest National Laboratory (PNNL) have conducted research in Predictive Engineering (PE) of injection-molded, long-glass fiber (LGF) thermoplastic parts, funded by the U.S. Department of Energy. During this time, the American Chemistry Council's (ACC's) Plastics Division - Automotive Team has worked to identify and fund necessary critical research, collaborating with the national labs to validate modeling data. The result: a new process model to predict both fiber-orientation distribution and fiber-length distribution is now available along with mechanical property predictive tools. Now for the first time, engineers can reliably predict process modeling and design new, stronger structural components with plastics. Current ACC funded research on LGF at various universities and ORNL will also be described, setting the stage for future similar research to model injection-molded carbon fiber processes.

Dan Williams, Granta Design Ltd.
A Structure & Best Practice for the Management of Composites Data in Engineering Design & Materials Selection

This talk presents the results of a 10-year collaboration with aerospace to define a formal structure for managing composites test and design data, and discusses its application in the automotive industry. The life cycle of composites data (from materials lab to product design) will be investigated, as well as approaches to evaluate cost-benefit tradeoffs of these new materials against more traditional options.

John T. Hofmann, Virginia Polytechnic Institute & State University
******2012 SPE ACCE Scholarship Award Winner******
The Effect of Glass Fiber Length on Orientation Distribution within Center & End Gated Injection Molded Composites

The Method of Ellipses has been applied to both short- and long-fiber polymer composites in order to evaluate the effect of fiber length on experimental orientation distribution. The resulting fiber-orientation distributions for both short- and long fiber-reinforced composites have subsequently been compared at multiple percentages of mold fill for the same geometry, including near the entry region of the mold. Preliminary data suggest that an increase from short (<1 mm) to long (>1 mm) fibers results in increased transverse fiber alignment in both the center-gated disc and along the center-line of the end-gated plaque. Furthermore, preliminary results from the end-gated geometry will be compared to data obtained from the center-gated disc in order to evaluate the effect of the more complex, 3-dimensional flow field found within the end-gated system.

Cong Zhang, The Ohio State University

Discontinuous Long-Fiber Reinforced Composite Processing & Final Part Stiffness Predictions

This work employs the rod chain model of Wang et al. (2006) to study the motion of discrete flexible fibers within a polymer suspension. Model results are presented for both individual fibers and a distribution of fibers to study variations in the transient effects due to shearing flow between rigid and flexible fiber systems. The presented results demonstrate that the observed fiber motion period decreases as the fiber flexure increases, and the results provide insight into the modifications required for the equation of motion of the orientation distribution function for flexible suspensions as well as current limitations from existing short-fiber theories. A methodology for predicting the material properties of a discontinuous long wavy fiber-reinforced composite is presented using the micro-mechanical approach of Hsiao and Daniel (1996) for the underlying unidirectional stiffness tensor predictions, along with an adapted version of the rigid fiber micromechanical approach discussed by Jack and Smith (2008) for an orientationally varying distribution of fibers. The influence of the fiber waviness on the processed composite properties is shown from the simulation results, as well a discussion on possible limits of the relative fiber stiffness for industrial purposes.

Kevin Meyer, Virginia Polytechnic Institute & State University

Recent Advancements in the Simulation of Injection Molding Glass Fiber Composites

We present long glass fiber orientation predictions in center-gated disks and end-gated plaques using both a rigid and semi-flexible fiber model and compare results to experimentally obtained orientation data. The phenomenological parameters for simulation are determined through an independent rheological testing method.

TUESDAY: KEYNOTE 1

Sebastian Schelper, BMW AG

Affordable Composites for High Volume Production in the BMW i8

Not Available at Press Time

TUESDAY AFTERNOON: BIO & NATURAL FIBER COMPOSITES – PART 1:

Alper Kiziltas, University of Maine

******2012 SPE ACCE Scholarship Award Winner******

Natural Fiber Blends-Filled Engineering Thermoplastic Composites for the Automobile Industry

Engineering thermoplastic composites with varying concentrations (from 5 to 20 wt%) of natural fiber blends were prepared by injection molding and compression molding. The composites reinforced with natural fiber blends displayed enhanced tensile and flexural properties vs. neat nylon 6. Overall the addition of 20% natural fiber blends shows comparable or higher mechanical properties than the addition of 20% single-type fibers. The results indicate that use of natural fiber blends can help achieve the optimal physical and mechanical properties for particular applications in the automobile industry.

Mehdi Tajvidi, University of Waterloo

Viscoelastic Properties of Wheat Straw Fiber / Talc / Polypropylene Composites for Automotive Applications

The temperature-dependent mechanical performance of composites made of isotactic polypropylene homopolymer and impact-modified polypropylene copolymer filled with wheat-straw fiber and talc are evaluated and the effects of fiber loading, matrix type, filler type, and hybridization (combination of straw and talc) were studied using dynamic mechanical thermal analysis (DMTA). The modulus retention term (MRT) and the relative storage modulus (RSM) were used as parameters defining mechanical performance at various temperatures. The short-term creep behavior of selected composites at various stress levels will also be presented.

Alper Kiziltas, University of Maine

******2012 SPE ACCE Scholarship Award Winner******

Utilization of Carpet Waste as a Matrix in Natural Filler-Filled Engineering Thermoplastic Composites for Automotive Applications

It is possible to produce composites of microcrystalline cellulose (MCC) in high-melting engineering thermoplastics like nylon 6/6 via melt compounding followed by injection molding without compatibilizers and other additives. Tensile strength, flexural modulus, and creep resistance are improved, and thermal expansion is decreased with increasing MCC content across all temperatures, especially those in the range seen by underhood parts.

Jeffrey J. Cernohous, Interfacial Solutions, LLC

Alternative Natural Fiber Based Automotive Composites

Wood-composite-based products (WPCs) have rapidly penetrated non-structural wood applications because they offer the consumer low maintenance attributes and durability. However, the best wood composites on the market today are half the strength, twice the weight, and as much as five times the cost of pine and cedar. Additionally, these materials lack the ductility required to displace conventional plastics and composites utilized in the automotive industry. There is a need for cost-effective natural fiber composites that have improved mechanical properties. This work describes new composite materials that are based on alternative natural fibers and feedstocks that have been recently developed to address this issue.

TUESDAY AFTERNOON: ADVANCES IN THERMOSET COMPOSITES – PART 1: Epoxy & Polyurethane

Roman Hillermeier, Momentive Specialty Chemicals GmbH
Advanced Thermosetting Resin Matrix Technology for Next Generation High Volume Manufacture of Automotive Composite Structures

A new generation of epoxy resin systems has been developed that allows the rapid and economical processing of structural composites. The new thermoset formulations are unique in that they provide a long injection window for a robust impregnation of the reinforcing fiber while still enabling an extremely short cure cycle.

Tom McKay, BASF Corp.
Lightweight Composites: Epoxy-Matrix Materials for Faster RTM Processes

Epoxy systems have mainly been restricted to parts and programs with low volumes due to relatively long infusion and cure times. Solutions exist today that have dramatically reduced cycle times, making these resins a viable solution for medium- and even high-volume parts. Information on such a system will be presented, with a review of processing challenges, solutions, and part performance.

Stephen Misencik, SAERTEX USA, LLC
All-Composite Transit Bus Body

In an effort for transit bus operators in the private marketplace to achieve their goals of significantly reducing vehicle weight, lowering operating and maintenance costs, reducing carbon emissions, and realizing a longer service life, an all-composite (monocoque) transit bus body was developed. This presentation will highlight the significance of understanding thermoset resins. Chemistry and process parameters used in the design of the composite bus body will be discussed. Two different resin systems will be reviewed with regards to optimum use in development of the composite bus body shell.

Stefan Kreiling, Henkel Corp.
Polyurethane Matrix Resin Technology: Highly Durable Composites via Cost-Efficient Resin Transfer Molding (RTM) Processes

A novel polyurethane matrix resin enables fast and cost-efficient composite manufacturing processes. Due to its inherent fracture toughness properties, this polyurethane technology can offer superior fatigue resistance and damage tolerance compared to standard resin systems. The presentation outlines key processing and performance characteristics for this material.

TUESDAY AFTERNOON: VIRTUAL PROTOTYPING & TESTING OF COMPOSITES - PART 2: Laminate Behavior & Material Models

Ali Al-Sharif, Wayne State University
The Effect of Low Cycle Compression Fatigue on Composite Sandwich Beams in the Presence of Delamination

The effect of fatigue behavior on local delamination caused by low-velocity impact was investigated by using composite sandwich beams. The compression static tests were conducted for impacted and non-impacted samples, and compression-compression fatigue tests were carried out for specimens with impact delamination between the core and the face sheet. This study shows that compression static strength was significantly reduced by impact-induced delamination in the sandwich composite specimens, and that delamination growth did not occur for in-plane stress levels below 50% of ultimate stress of the impacted composites for this class of sandwich composites.

Russell Mailen, Baylor University
Laminate Stiffness & Curvature for Laminated Carbon Fiber Composites, Experimental Observation & Model Validation

Carbon fiber laminates are extensively used within the automotive and aerospace industries due to their high strength to weight ratios, although their design and fabrication pose increased engineering difficulties. During manufacturing, residual strains are introduced due to a combination of curing kinetics of the thermoset resin and induced thermal strains due to a coefficient of thermal expansion (CTE) mismatch between resin and fiber. The present work presents results for a cross-ply (un-balanced) laminate. Micromechanical theories were used to predict stiffness and CTE values of an individual lamina from the constitutive properties for the fiber and the matrix. Lamina results were coupled with a finite-element structural and thermal-structural analysis and used to predict the observed stiffness and the observed strain of a processed laminate. The finite element results were then compared with the measured results and suggestions are provided for improvements on the method for future modeling and experimental studies.

Pedro Cortes, Youngstown State University
The Fracture Properties of a Fiber Metal Laminate Based on Self-Reinforced Thermoplastic Material

The present work investigates the mechanical properties of Fiber-Metal Laminates (FMLs) based on self-reinforced composite materials. Initial results have shown that these thermoplastic multilayered structures represent a promising hybrid system for the transportation sector. It has been shown that their impact and interfacial fracture properties are considerably superior to those shown by FMLs based on thermoset materials.

Umesh Gandhi, Toyota Motor Co.
Study Effect of Unidirectional Tape on Fiber Reinforced Polymers & Development of Predictive Material Model

Effects of unidirectional (UD) tape on injection over-molded plaques for strength and stiffness is evaluated. Also, a method to develop a unified, nonlinear, predictive material model to account for both UD tape and injection-molded material is explained.

TUESDAY: KEYNOTE 2

Oliver Kuttner, Edison2

Correct Primary Decisions Leading to Positive Feedback Loops

Not Available at Press Time

WEDNESDAY MORNING: ENABLING TECHNOLOGIES – PART 1: RTM & Sandwich Panel Enhancements

Raman Chaudhari, Fraunhofer-Institut für Chemische Technologie

Characterization of High-Performance Composites Manufactured by Using High Pressure RTM Process Variants

The current work addresses new variants of the RTM process, namely high-pressure injection resin-transfer molding (HP IRTM) and high-pressure compression resin-transfer molding (HP CRTM) for the manufacturing of continuous-fiber-reinforced composites with high fiber-volume content. Influence of different process variables such as mold gap and resin injection time on the quality of the laminates and the mechanical properties is also analyzed.

Loleï Karine Khoun, National Research Council Canada

Effect of Process Variables on the Performance of Glass Fibre Reinforced Composites made by High Pressure Resin Transfer Moulding

High-throughput and cost-effective composite manufacturing processes are essential for high-performance fiber-reinforced polymer composites to penetrate the automotive market to their full potential. High-pressure resin-transfer molding (HP-RTM) is a new process combining the manufacturing of high-performance composite parts with short cure cycles, and hence is of great interest for automotive applications. In this study, the effect of HP-RTM process parameters on the mechanical performance and quality of composite plates was investigated and optimum parameters were suggested.

Jan Kuppinger, Fraunhofer-Institut für Chemische Technologie

Polyurethane Base Sandwich Structures – Face Sheet Characteristics and Part Development

The presentation addresses polyurethane-based sandwich structures manufactured with a polyurethane fiber-spraying process. The influences of different glass fiber mats in the face sheet thickness were investigated and characterization of the face sheet's thickness was carried out using X-ray computed tomography and 3D-image analysis methods for non-destructive measurements of prepared samples. Based on these results, mechanical properties of the face sheets were determined. Finally, a simplified FEM model could be applied and provided excellent agreement with the experimental data. The transfer of these results into an industrial application will be presented.

WEDNESDAY MORNING: PREFORMING TECHNOLOGIES – PART 1:

Dan Buckley, American GFM

Preforming can be Fast and Easy

This presentation will provide information on how to preform engineering fabrics to near-net shape and get net shape using 3D trimming. Emphasis will be on high-volume preforming with discussion of reinforcing materials, design, volume, and cost considerations. Conformability issues with mats and engineering fabrics will be discussed with pictures that demonstrate the conformability issues using structural engineering fabrics and other materials. Selective curing, energetic stitching, sub-assembly preforms, true net-shape preforms, and the inclusion of inserts and core materials will be explained with applications and pictures.

Christoph Greb, Institut für Textiltechnik of RWTH Aachen University

******2012 SPE ACCE Best Paper Award Winner******

Economic Potential of Single- & Multi-Step Preforming for Large-Scale Production of Automotive Composite Structures

The economic potential of single-step and multi-step preforming processes was evaluated. Three different process chains for an automotive composite structure were designed and evaluated regarding cycle times and costs per unit. The validation was carried out successfully using a modified multi-axial weft insertion machine and the ITA-Preformcenter. In the described case study, costs per piece could be reduced by 11% and cycle time was decreased by 77% vs. conventional processing of standard reinforcement textiles.

Matthias Graf, Dieffenbacher GmbH

Advancements in the Fully Automated Preform Process for Complex Parts

A key for low-cost, large-scale production of carbon fiber-reinforced plastic (CFRP) parts is a process-reliable, fully automated preform technology that fulfills the needs of industry. Just such a device has been developed for the mass production of dry carbon fiber preforms. The focus was on technologies to achieve a fully automated process with high repeatability. The presentation will introduce the concept of the preform center and the rationale for the technology approach taken. Various results that have been achieved together with automobile customers and the advancements that have been made towards higher productivity and material waste reduction will also be discussed.

WEDNESDAY MORNING: VIRTUAL PROTOTYPING & TESTING OF COMPOSITES – PART 2: Modeling, Simulation & Validation

Suof Omran Abdalslam, Wayne State University
Modeling Impact Behavior of Sandwich Composite with Balsa Core

This work presents an experimental and numerical investigation of damage analysis of sandwich composite plates comprising E-glass/epoxy composite laminate face sheets and end-gain balsa wood cores under low-velocity impact. The impact test was conducted using a drop-weight impact tower to evaluate the impact response of the sandwich structure. The primary damage modes observed were fiber fractures at upper skin, and delamination between adjacent glass–epoxy layer and core at both faces. After initial visual inspection of the top and bottom face-sheets, damage mechanisms at the interior layers and cores were ascertained through destructive analysis, i.e. sectioning of samples. Impact simulation was done using LS-DYNA® software in terms of load-deflection response. Results of finite-element modeling were compared with experimental data and good agreement was obtained.

Vasant Pednekar, LANXESS Corp.
Simulating Structural Composite Hybrid Parts Made from Continuous Fiber Reinforced Plastics

Composites have become one of the fastest growing industries in the world by increasingly replacing metals. To utilize the full potential of hybrid composite parts for structural applications, it is imperative to be able to accurately simulate not only the mechanical behavior of the part during loading, but also forming of composite sheet becomes equally important to determine orientation of glass fiber. A new method to simulate the material model for composite sheets has been developed and implemented into a HiAnt® simulation code. This presentation provides further information about the simulation technique and the correlation with tested parts.

Rani Richardson, Dassault Systèmes & Jason Curtis, Inceptra LLC
Automotive Innovation Takes Flight – Literally

There are only a few events that have single-handedly enabled a giant leap forward in automotive innovation, and the mass adoption of composites is one of them. The barriers to using composites on a large scale are being lowered every day and, as a result, things that were once dreams – like flying cars – are becoming a reality. This presentation describes how composites played a critical role in helping Terrafugia design, develop, and begin selling the first practical, street-legal aircraft. The Transition® Roadable Aircraft is automotive innovation defined – it can cruise up to 450 miles at 115+ mph in the air, take off and land at local airports, drive at highway speeds on any road with fuel economy upwards of 30 miles per gallon, and fit in a normal suburban garage space with wings that fold as easily as the top on a convertible.

WEDNESDAY MORNING: ENABLING TECHNOLOGIES – PART 2: Injection Molding & Fastening Developments

Joe Gobernatz, ATF Inc.
New Lightweight Fastening Solution for Thermoplastic Composites Applications

In the push for lightweight materials for today's vehicles, a new screw has been developed especially for plastic and composite applications. Using an aluminum alloy (7075) from the aviation industry and the innovative thread geometry of the DELTA PT screw, the new fastener, DELTA PT ALU is a viable alternative to common steel screws while lowering fastener weight by 2/3 and helping achieve a better/safer fastening joint.

Joachim Kragl, Engel Machinery, Inc.
Organomelt & In-Situ Polymerization Provide New Opportunities for Injection Molding of Composite Structures

The presentation describes the organomelt process, which combines the molding-cell integrated forming of continuous-fiber-reinforced sheets or plaques with the injection-molding process. The process allows the high-volume production of composite parts in a very cost-effective way with a faster cycle time than with other composite manufacturing methods. Parts can be trimmed directly at the machine after the molding process to leave the manufacturing cell as a net shape, ready to be assembled.

Scott Powers, Trexel Inc.
Foam Injection Molding: Unique Process Solutions for Light Weighting Automotive Plastic Parts

This presentation will provide insight about the latest developments in foaming plastic components to provide lower part weight for decreased fuel consumption, reduced production costs, and increased design freedom. The basis of physical and chemical foaming technologies will be discussed as well as design guidelines for maximizing weight-reduction strategies. Also reviewed will be unique applications such as microcellular foaming in combination with core back or reverse coining – which results in greater than 30% weight savings while increasing stiffness exponentially – foaming in blow molding applications, as well as the combination of microcellular foaming and hot/cold molding to attain Class A surface finishes. Last, the latest examples of successfully implemented microcellular-molded plastic parts by global automotive OEMs as well as implementation strategies will be reviewed.

WEDNESDAY MORNING: PREFORMING TECHNOLOGIES – PART 2:

Ulrich Mörschel, Textechno Herbert Stein GmbH & Co. KG
Characterization of the Drapability of Reinforcement Fabrics by Means of an Automated Tester

The behavior of standard and non-crimp fabrics in forming and draping is of importance in any production process of non-flat, fabric-reinforced composite parts. A new automatic drapeability tester allows one to automatically characterize drapeability and the formation of defects during draping and forming. The tester combines the measurement of the force, which is required for forming, with an optical analysis of small-scale defects, such as gaps and loops by means of image analysis. An optional triangulation sensor can determine large-scale defects such as wrinkles.

Nathan Nanlin Han, 3D Nanocomposites Inc.
Low Cost Hook & Loop 3D Composites Enable Automatic Laying-Up Fabrics for Mass Production Preforming

Now that fast-curing resin systems have been developed, the slow hand-layup fabric process is the last major barrier for applying composites in mass production to make vehicle chassis. New hook-and-loop 3D fabrics provide a breakthrough to enable automatic performing. With these materials, a vehicle chassis could be made automatically within 3 minutes by the resin-transfer molding process.

Tommy Fristedt, LayStitch LLC
Novel Fiber Placement Technologies for Composite Applications

Recent development in design tools and machine technology allows automated tailored-fiber placement (TFP) to be used to improve fiber-reinforced composites. By laying out fiber tow/roving selectively and only where needed, preform material costs may be reduced considerably vs. using woven or knitted multi-axial materials. Various application examples and design techniques will be presented along with their resulting benefits when used in simple as well as fairly complex preforms.

WEDNESDAY MORNING: VIRTUAL PROTOTYPING & TESTING OF COMPOSITES – PART 3: Modeling, Simulation & Validation (cont'd)

Sejin Han, AutoDesk
The Numerical Analysis & Validation of Compression Molding Process

In this work, simulation results from a program developed for the three-dimensional analysis of compression molding of thermoset composites were compared to experimental results of an actual molded thermoset sample. The program predicts flow pattern, fiber orientation, fiber length distribution, curing of the resin, and mechanical properties. Comparison between simulation and experiment includes short shots and fiber orientation. Actual fiber orientation images were obtained using CT scanning. The comparison shows reasonable agreement between simulation and experiment.

Roger Assaker, e-Xstream engineering
******2012 SPE ACCE Best Paper Award Winner******
Stiffness, Failure & Fatigue of Fiber Reinforced Plastics

The presentation provides an overview of recent micromechanical approaches to predict stiffness, failure, and fatigue for short-, long-, and continuous-fiber reinforced polymer composites more accurately. Each type of composite provides its own challenge and needs individual treatment to predict performance. This is made all the more complex owing to the influence of reinforcements on composites as it causes anisotropic and locally different material behavior depending on processing conditions, strain rates, temperature, static or dynamic loading, and other end-use conditions. The goal is to provide material models in an efficient manner so they can be used in an industrial simulation environment.

Richard Schaake, SKF Engineering & Research Centre
Estimation of Anisotropic Stiffening Feature Properties in Early Design Phase

To evaluate the performance of a design, the properties of thermoplastic composites need to be known. Datasheet properties may not be available for the relevant conditions and for new polymer/fiber combinations the available data may not be of sufficient quality to allow a good estimate of the performance that may be expected. We demonstrate a method to derive the matrix properties of a thermoplastic composite from a shear compliance master-curve to estimate the performance of both short and continuous fiber composite parts that have been geometrically stiffened.

WEDNESDAY: KEYNOTE 3

Gary Lownsdale, Plasan Carbon Composites & Calvin Bamford, Globe Machine Manufacturing Co.
Cutting Cycle Time for Prepregged Carbon Fiber Composites

New out-of-autoclave technology that has been developed for prepregged carbon fiber composites reduces cycle time by 75% vs. autoclave processing. The technology permits Plasan Carbon Composites to achieve a balanced 17 minute part-to-part cycle time. The new process is applicable to Class A and structural parts, producing better part surface quality than autoclave processing. Additionally, fewer consumables and significantly less energy are expended. Development of this new technology – from concept to production-representative in 12 months – will be presented.

WEDNESDAY AFTERNOON: ENABLING TECHNOLOGIES – PART 3: Combining Discontinuous & Continuous Reinforcements

Manfred Reif, Fraunhofer-Institut für Chemische Technologie

Multi-Material Design – Lightweight Design for Electric Vehicles

The simple substitution of materials is not sufficient to meet the demands placed on components. Instead, it is necessary to combine the advantages of different materials and to tailor them for component-specific requirements. Multi-material design is the key to developing resource-efficient and (modular) lightweight solutions, especially for electric vehicles. In order to develop material combinations for structural applications, a feasibility study on the multi-material design of a battery tray for an electric vehicle was carried out in the funded project "Systemforschung Elektromobilität (System Research into Electromobility)."

Jan-Anders Månson, EELCEE AB

QEE-TECH™ - Thermoplastic Composites for High Volume Structural Applications

QEE-TECH™ is an integrated processing technique that enables the production of structural, lightweight thermoplastic composite parts in high series. The tailored preforms allow a "shorter and faster" path from fiber and polymer via preforms to finished parts vs. most other composite-forming techniques. The technology enables step changes in both design and performance as well as the freedom to place fibers according to the load requirements, which gives maximal use of the more expensive composite. Furthermore, the possibility of "looping" the preform tow around mounting points provides an excellent load introduction and load transfer to adjacent elements. Complex-shaped parts with high functional integration with tailored structural properties can be manufactured. The technology integrates the advantages of conventional molding along with those of continuous-fiber reinforcements and can be implemented with traditional injection or compression molding production units with limited additional investments.

Benjamin Hangs, Fraunhofer-Institut für Chemische Technologie

******2010 SPE ACCE Scholarship Award Winner******
Co-Compression Molding of Tailored Continuous-Fiber Inserts and Inline-Compounded Long-Fiber-Thermoplastics

Thermoplastic parts made from discontinuous-fiber materials like direct long-fiber thermoplastic (D-LFT) are well established in the industry for non- or semi-structural applications. Adding continuous-fiber reinforcements can lead to innovations that help realize the high potential of structural thermoplastic composite applications. Due to the limited drapeability and flowability of such continuous-fiber-reinforced (CFR) materials, however, the forming of highly complex structures such as ribs is not feasible. One way to overcome this barrier in design freedom of parts incorporating CFR sections is the combination of those process technologies for continuous- and discontinuous fiber-reinforced materials. In the presented case study, an extensive investigation was performed to identify challenges that must be considered for co-compression molding of tailored inserts made from unidirectional tape (UD tape) with directly compounded long-fiber-reinforced thermoplastics (D-LFT). This presentation first covers a flow study based on a plaque tool and, secondly, transfer of results to realize a full-scale underbody-shield demonstrator.

WEDNESDAY AFTERNOON: ADVANCES IN THERMOPLASTIC COMPOSITES – PART 1: Polyamides

Manoranjan Prusty, BASF SE

New PA with Advanced Stabilization & Higher Glass Loading Improves Mechanicals at Elevated Temperatures

A new high-heat polyamide with advanced stabilization and higher glass loadings offers new opportunities for thermoplastic composites to be used in the challenging underhood environment. The new materials are characterized by outstanding heat aging, long-term service temperature performance, good processability, and excellent weldline strength. The products are ideal for use on all parts in the charge-air duct, including intercooler end caps, resonator, charge air lines and throttle valves, or intake manifolds with water-cooled intercoolers, offering automakers new opportunities to replace metal in key underhood application.

Jonathan Spiegel, Polystrand

Development of Continuous Fiber Reinforced Nylon Composites for Structural Applications

While the use of thermoplastics, both unfilled and as-reinforced composites, is now common automotive practice, applications of these materials has generally been limited to components that experience low to moderate structural loads. While development of long-fiber-reinforced thermoplastic (LFRT) nylon technology has yielded improved properties and allowed higher load profiles, the development of CFRT (continuous-fiber-reinforced thermoplastic) nylon composites will now allow us to approach applications previously only possible with either metal or thermoset composite construction.

WEDNESDAY AFTERNOON: ADVANCES IN COMPOSITE REINFORCEMENT TECHNOLOGIES – PART 1: New Options for Improving Mechanicals

Andy Rich, Element 6 Consulting

The Effect of Changing Process, Resin, & Fiber Architecture on Composite Properties

Generally, when predicting the properties of composites, the Rule of Mixtures is the standard tool used for most applications. However, for certain combinations of materials, and certain mechanical property tests, it has been discovered that this rule does not work. When testing a wide variety of composite materials in a comprehensive battery of tests, several examples of wide discrepancies were found between predicted values and actual test data.

Juan Serrano, PPG Industries

Technological Developments in Fiber Glass Composites for Lightweight Structural Application Solutions

This presentation will focus on recent advancements in high-performance fiberglass reinforcements that are specifically designed for weight savings along with processing and fabrication flexibility for targeted structural auto parts. New developments in thermoplastic and thermoset technologies, combined with new fiber solutions, will be reviewed.

Andrew Head, A&P Technology

Braided Reinforcements Enable Nimble Automation of Composite Molding

The braiding process is an inherently automated way to create specific fiber architectures and geometries. This type of manufacturing is ideal for designers interested in a reduced layup time and a process that is repeatable. Manufacture of near-net-shape preforms can be achieved through the following braided solutions: braided sleevings conforming to complex part geometries; overbraiding; the use of braided fabrics, specifically fabrics with a quasi-isotropic (0°, ±60° degree) and an off-the-shelf ±45° orientation; and in combination with composite processes developed by industry partners. Braiding of net-shape preforms offers the same architectural features as those found in the hand layup process, while providing the economic efficiencies found with automated processes. This results in the creation of parts optimized for strength and stiffness with better impact resistance, damage tolerance, and fatigue properties.

WEDNESDAY: KEYNOTE 4

Nathan Armstrong, Motive Industries

Composites in Space

Not Available at Press Time

WEDNESDAY: KEYNOTE 5

Jan-Anders Månson, Ecole Polytechnique Federale De Lausanne (EPFL)

Opportunities & Challenges for Automotive Composites

By the potential of new manufacturing and material forms, composites in automotive have gone from being an exotic alternative to a more realistic option in high-volume applications. The last years have seen development of a large number of new technologies, all with great potential. However, there are still challenges ahead before an extensive replacement of the metallic mainstay is realistic in large-scale production. The challenges for composites go beyond mechanical performance and cost level: they also have to prove a competitive advantage in terms of environmental performance. In order to capitalize on their benefits, targeted improvement strategies must be employed that are guided by a sound understanding of environmental performance. It will be essential to provide guidance for product development; however, specific models need to be developed to assess key life cycle phases for composite materials. Such models will assist in optimizing production technology and application design. This will result in increased understanding of the merits and limitations of composites and provide clearer recommendations for suitable applications and production volumes.

THURSDAY MORNING: CARBON COMPOSITES – PART 1: Opportunities & Challenges

Cliff Eberle, Oak Ridge National Laboratory

Status of Low-Cost Carbon Fiber Developments

Technologies to drive down the cost of industrial-grade carbon fibers are needed to enable the widespread application of carbon composites in automobiles to reduce vehicle weight and fuel demand. Strategies for the development and deployment of low-cost carbon fibers include lower cost raw materials; high-rate, energy efficient processing; advanced post-treatment; and prototyping at such semi-production scale. Such strategies are being pursued in technology development at Oak Ridge National Laboratory and other research institutions. This presentation provides an overview of technology development pathways and the current status of each approach.

George Husman, Zoltek Companies, Inc.

Carbon Fiber Composites – Low Cost Materials and Manufacturing Options

The need for lightweighting of automotive structures has spurred tremendous interest in, and development of, carbon fiber composite materials and manufacturing. This presentation will first focus on the status of the carbon fiber industry and its ability to meet demands for the automotive market. A specific update will be presented on the development and commercialization of new low-cost carbon fiber based on lignin/PAN precursor technology. Then the presentation will discuss carbon fiber composite manufacturing processes, including carbon SMC, RTM, wet pressing, and thermoplastic processes. Current projects, molding demonstrations, performance data, and cost modeling also will be discussed.

Glade Gunther, UMECO

Dform: Enabling the Use of High Performance Materials in High Volume Applications

DForm demonstrates cost reduction, rapid throughput, and high performance in a single material format, allowing the use of prepreg carbon fiber in mid- to high-volume automotive applications by combining novel technologies with automation and preforming. Design-specific customization of material formats maximizes material performance and utilization while minimizing labor and consumables, and allows for the use of a variety of high-performance fibers and resins, and truly optimized structural design. This presentation will demonstrate the ongoing development of automation, cost reduction, rapid throughput, as well as maturing recycling technologies that can be incorporated in the overall process.

THURSDAY MORNING: ADVANCES IN THERMOPLASTIC COMPOSITES – PART 2: Polyolefins

Kunal Kumar, Hanwha Azdel, Inc.

Development of a New Light Weight Reinforced Thermoplastic for Automotive Interiors

Automotive customers are demanding substrates that are lighter weight and lower cost for interior applications. In addition, there are the technical challenges of achieving the same or higher acoustical and mechanical performance. This presentation briefly discusses a unique product that achieves these goals and reviews the acoustical and mechanical performance of this new composite in comparison to the original composite.

Duane Emerson, Ticona Engineering Polymers

******2012 SPE ACCE Best Paper Award Winner******

Using Unidirectional Glass Tapes to Improve Impact Performance of Thermoplastic Composites in Automotive Applications

The presentation describes a study conducted by organizations in Europe and North America that looked at methods to increase stiffness/strength and impact resistance of thermoplastic composites by using continuous-strand, unidirectional-glass (UD) tapes to produce woven fabrics as well as tailored blank laminates. Combinations of the tape fabrics and the tape laminates in various layup patterns were then used in conjunction with charges produced in the direct-long-fiber thermoplastic (D-LFT) inline compounding (ILC) process to compression mold both test plaques and later an actual automotive underbody-shield part to determine the extent to which impact performance was improved and to ensure cycle times were consistent with automotive production requirements.

Jim Keeler, Albis Plastics Corp.

Higher Temperature PP-Based Composite Provides Nylon/PA-Level Performance at Lower Weight & Cost

With light vehicles becoming a highly preferred consumer product globally, governments have been addressing energy consumption and environmental impacts with increasingly stringent regulations. New plastic materials are an essential part of the solution path allowing automotive engineers to replace metal or higher cost plastics, *lightweight* parts through increased strength for lower total part cost, and switch to lower density material solutions. A new polypropylene-based compound offering nylon-like properties at lower total cost and weight has been developed. Properties of this new material will be compared to traditional automotive materials, including mechanical and thermal properties as well as hot oil and oven aging. Target applications that would benefit from this performance profile will be mentioned.

THURSDAY MORNING: NANOCOMPOSITES – PART 1: Nanotubes & Nanofibers

Carla Leer Lake, Applied Sciences Inc.

Carbon Nanofiber Composites: From Innovative R&D to Commercial Reality

Structural applications that require high strength-to-weight and stiffness-to-weight ratios introduce opportunities for advanced thermoplastic composites. Nanoparticle additives have been of particular interest in efforts to improve composite performance or to impart new composite properties, such as electrical conductivity into fiberglass composites. Composites reinforced with carbon nanomaterials have high potential to enable advances in material performance as well as manufacturing simplification and cost reduction.

David Inglefield, Virginia Polytechnic Institute & State University

******2011 SPE ACCE Scholarship Award Winner******

Functionalization of Multi-Walled Carbon Nanotubes with Hydrogen Bonding Sites for High Performance Polyurethane Nanocomposites

Hydrogen bonding functionalities were introduced onto the surface of multi-walled carbon nanotubes (MWCNTs) using acid oxidation to promote intermolecular interactions and facilitate dispersion in polyurethanes matrices. Chemical oxidation was achieved by refluxing with concentrated nitric acid, which introduced carboxylic acid groups onto the MWCNT surface. These surface-bound reactive carboxylic acid groups were further functionalized into amide-amine and amide-urea derivatives, providing an opportunity for additional hydrogen bonding on the surface of the MWCNT. Functionalized MWCNTs were dispersed in a 45 wt% hard-segment polyurethane matrix with sonication, and composite film properties were measured to investigate the influence of surface functionality on thermal and mechanical properties.

David Lashmore, Nanocomp Technologies

All CNT Lithium Based Secondary Battery

A silicon-coated carbon nanotubes (CNT) anode has demonstrated 100 charge/discharge cycles in a lithium-based anode chemistry at twice the capacity of a graphite electrode. The replacement of an aluminum cathode with CNT material allows the use of corrosive electrolytes in the electrolyte, thus improving power performance because the galvanic Al/Cu couple is removed from the system. The use of strong CNT electrodes enables the elimination of conductive binders, conductive additives, and dramatically lowers cell resistance, therefore lowers Joule heating. Together, these advantages using sulfur-based chemistry are expected to yield much high-specific capacity, specific energy, and better thermal stability than existing technologies. For the first time, the increase in capacity enables the mass production of this new kind of approach to secondary batteries. A CNT-polymeric composites is suggested to replace the standard steel case to improve damage protection and reduce weight.

THURSDAY MORNING: CARBON COMPOSITES – PART 2: Opportunities & Challenges

Felix Nguyen, Toray Composites (America), Inc.

Fast-Cycle CFRP Technologies for Automotive Applications

In response to the high demands of automotive manufacturers for the production of low-cost carbon fiber-reinforced plastic (CFRP) parts for low- to mid-end automobiles, new fast-cycle manufacturing technologies for both fabrics and unidirectional fibers have been developed. A rapid-cure resin technology combined with a resin-transfer molding (RTM) process for fabrics has achieved a 10-min cycle time. Slitting technology for unidirectional prepregs, when combined with the rapid-cure resin technology and the interphase technology to maximize strength translation, could offer a competing alternative for automotive manufacturers to process unidirectional fibers in applications where use of fabrics could be a constraint.

Koichi Akiyama, Mitsubishi Rayon Co., Ltd.

Development of Preforming Process in PCM (Prepreg Compression Molding) Technology

Recently prepreg compression molding (PCM) technology was introduced as a high-cycle carbon fiber-reinforced plastic (CFRP) molding process that is suitable for production of high-volume automotive applications. Further progress has been achieved in development of PCM technology – especially in the preforming process, which can rapidly produce near-net-shape preforms for complex shape parts produced with compression molding. The combination of high-cycle preforming and compression molding exhibits high potential to be used for high-volume automotive CFRP parts production.

Changchun Zeng, FAMU-FSU College of Engineering

Recycling of Carbon Fiber Reinforced Composites by Using Supercritical Water

Supercritical fluid recycling has emerged as a viable method for recycling carbon fiber-reinforced plastic (CFRP), since it possesses several advantages over other recycling technologies. This work presents investigation of the recycling of CFRP and reuse of reclaimed materials using supercritical water and an aerospace-qualified composite system. Both single- and multiple-layer composites were fabricated for the study. The effects of recycling conditions on resin elimination were systematically investigated. Extremely high efficiency was achieved, with as much 99% of resin being removed from multiple-layer composites samples. The recovered fibers, which retained their original woven architecture and showed no surface damage, demonstrated excellent retention of properties. The reclaimed degradation product (RDP) was also combined with fresh resin and cured. The properties of the reclaimed-fiber composites and cured RDP/resin mixtures were measured and these revealed possible scenarios for the utilization of these materials. A preliminary investigation on the economic viability of the process was also conducted by using process simulation.

THURSDAY MORNING: ADVANCES IN THERMOPLASTIC COMPOSITES – PART 3: Polyesters

Victor Bravo, National Research Council Canada

DLFT Experiments with Cyclic Butylene Terephthalate

Cyclic oligomers have low molecular weights and therefore exhibit very-low viscosities prior to polymerization. This characteristic is very appealing for the production of composites, as reinforcing fibres can be thoroughly wetted by the oligomer before starting the polymerization process. An exploratory project has been initiated for evaluating these oligomers in the direct-long-fiber thermoplastic (D-LFT) process. This presentation gives a description of the experiments conducted to date and the results obtained.

Jim Mihalich, Cyclics Corp.

In-Situ Polymerization of Reinforced Thermoplastics

Most reinforced thermoplastics are produced from fully polymerized resins that are then combined with reinforcements in a compounding extruder or an extruder that coats and forms tapes of various sizes. By introducing reinforcement into resin prior to polymerization, the high viscosity of the thermoplastic resin does not inhibit full incorporation and wetting out of the reinforcement. The tradeoff becomes the polymerization step, which still must take place prior to having a serviceable composite. Four processes – reactive extrusion of nano-clay-reinforced polybutylene terephthalate (PBT); direct long-fiber compounding with compression molding; reactive extrusion coating of continuous-fiber cloths to produce high-volume-fraction sheets; and molding of continuous-fiber-reinforced parts – will be discussed.

THURSDAY MORNING: NANOCOMPOSITES – PART 1: Graphene Nanoplatelets

Jon Myers, Graphene Technologies LLC

Enabling the Future through Bottom-Up Synthetic Bulk Graphene

A novel method has been developed for atom-by-atom synthesis of bulk graphene. This method is efficient, scalable, and produces a uniquely small aspect and few-layer material. This material may be useful in a number of automotive applications.

Lawrence Drzal, XG Sciences, Inc.

Graphene Nanoplatelets: A Multi-Functional Nanomaterial Additive for Polymers and Composites

Graphene-based nanoparticles appear to have a number of desirable intrinsic properties that make them particularly attractive as additives to polymers and composites as well as for energy-storage applications. The graphene structure of carbon is largely responsible for the unprecedented high level of intrinsic mechanical, electrical, and thermal properties obtained in carbon nanotubes (CNTs). While the tubular graphene structure in the CNT is synthesized from a 'bottom-up' approach, graphene itself can be inexpensively and efficiently extracted in nanoplatelet morphology by a 'top-down' approach using common chemicals starting with mineralogical graphite with properties competitive to CNTs. Nanocomposites for electrical shielding, and energy storage, generation, and thermal management require these nanomaterials to not only be dispersed but also to be structured in 2D and 3D nanostructures in order to achieve high-performance macro devices and applications. This presentation will described graphene nanoplatelets and the use of nanostructuring to generate 2D and 3D microstructures for graphene nanoplatelets either by themselves or with thermoset and thermoplastic matrices. Examples of such methods to create 2D and 3D nanostructured morphologies for composite structural and energy storage and generation applications will be discussed.

THURSDAY AFTERNOON: BUSINESS TRENDS & TECHNOLOGY SOLUTIONS – PART 1:

Paul Dugsin, Chetna Consulting

Shifting into High Gear: Open and Holistic Research Models as an Accelerator for Innovation in the North American Composites Industry

Know-how is a key ingredient in the creation of value and the continual development of know-how is a critical competitive advantage. How is this best achieved? Organizational R&D strategies and models need to reflect the environment to which they are designed to respond. While we still refer to the value chain, solving technology problems today is often best served through a more holistic approach that sees the market as a value ecosystem. Using the new Fraunhofer Project Centre for Composite Materials Research at Western University in London, Ontario as a context, the author will discuss how applied, collaborative, and open-platform research approaches are proving to be effective and efficient for the acceleration of innovation and technology adoption within the North American composites industry.

Jacqueline Stagner, University of Windsor

Polymeric Composites & End-of-Life Vehicles: Recycling & Sustainability Issues

As the efficiency of vehicle manufacturing and operation improves, the end-of-life impacts become more significant. This paper provides an overview of the end-of-life phase for automobiles, with particular focus on the dismantling and shredding processes and the recovery of materials. It then examines composite material recovery from end-of-life vehicles and concludes that there are no simple solutions. Instead, it will likely involve a combination of targeted unit operations such as dismantling of components from vehicles and/or pretreatment prior to shredding, along with design-for-environment principles to enable the efficient recovery of materials at the end-of-life phase.

Tom Lobkovich, General Motors Co.

Development & Engineering of Composite-Intensive Coach for EN-V Demonstration Vehicle Fleet

This presentation describes the design and development of coaches (bodies) for an EN-V demonstration vehicle fleet of 9 non-production vehicles (3 each of 3 models) that featured extensive use of composite materials to successfully meet the integration challenges of a unique propulsion system as well as achieve compelling, innovative aesthetic design. Carbon fiber composites were used as the primary material for interior, exterior, and structural members. These materials were selected for their combination of high stiffness, low mass, and ability to leverage low-cost, rapid-turnaround tooling. Polycarbonate was used for all glazing in order to reduce weight and achieve complex shapes. Lastly, sintered plastic parts were used for secondary reinforcements and were fabricated via additive manufacturing techniques to reduce tooling time and cost. Ultimately, the use of the composites, coupled with appropriate use of metals at high-load interfaces, provided a highly effective solution to vehicle program requirements.

THURSDAY AFTERNOON: ADVANCES IN THERMOPLASTIC COMPOSITES – PART 4: Additives & Mixed-Resin Systems

Chandrashekar Raman, Momentive Performance Materials

Thermally Conductive but Electrically Insulating Plastics for Thermal Management Applications

Boron nitride (BN) is a synthetic ceramic material that exhibits both excellent thermal conductivity and dielectric properties. Loading BN into thermoplastic resins therefore enables unique composite materials that are thermally conductive but electrically insulating. However compounding BN powders into plastics presents various challenges and the resultant composites exhibit anisotropic behavior due to the platelet structure of BN crystals. Optimal processing methods and ways to maximize thermal conductivity of BN/plastic composites in the desired directions are reported in this presentation. Predictions from the Lewis Nielsen model with one fit parameter ("A") are compared to the thermal conductivity data, and the model is extended further to composites with multiple fillers.

Louis Martin, Addcomp North America, Inc.

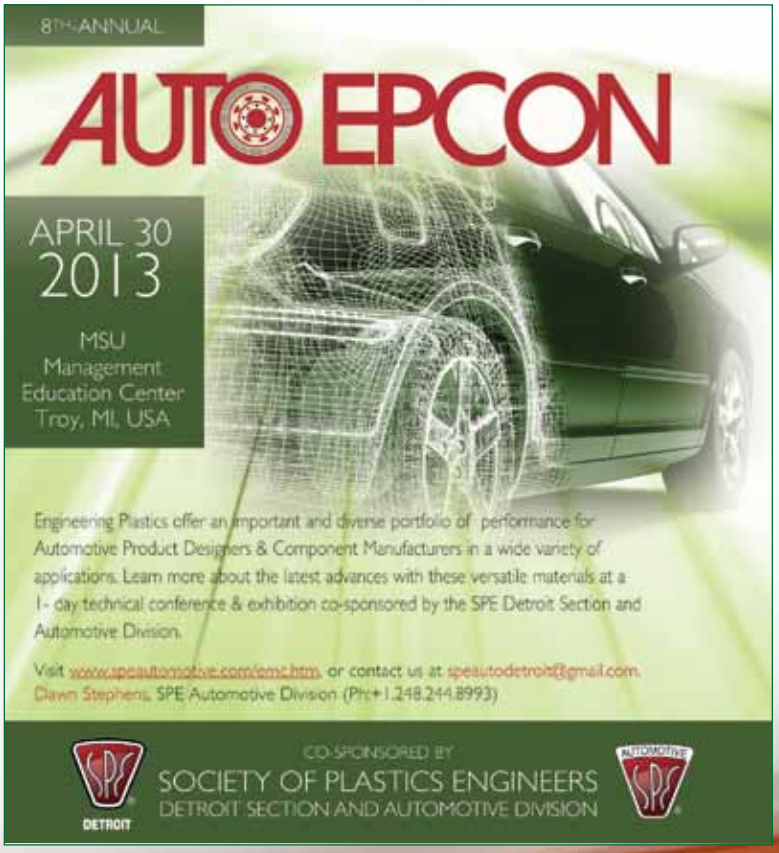
Overview of Maleic-Anhydride-Grafted Polyolefin Coupling Agents: Uses & Benefits

Maleic-anhydride-grafted polyolefins can be used as coupling agents or compatibilizers between olefins and inorganic materials or other polymers. They provide the most cost-effective solution in many applications such as polypropylene/fiberglass coupling and inter-laminar adhesion. However, there are many misunderstandings in the industry about when their use is beneficial, and when it is unnecessary and potentially counterproductive. This presentation will provide an overview of the category of products, their qualities, current and potential future uses, and development directions.

Uday Vaidya, University of Alabama at Birmingham

Thermoplastic Sandwich Composites from Recycled Sources for Impact Damage Tolerance & Crashworthiness

A range of scrap materials from edge trims and power plants were converted into thermoplastic sandwich-composite constructions applicable to automotive, mass-transit, and truck applications. The core and face sheets of the sandwich panels were made from entirely recycled sources and provide value-add as a replacement for plywood and sheet metal. Crashworthiness of this material was evaluated with a series of low-velocity and high-speed blunt object impacts to explore their failure mechanisms and energy absorption behavior.



THURSDAY AFTERNOON: ADVANCES IN THERMOSET COMPOSITES – PART 2: SMC & BMC

Cheryl Ludwig, Chromaflo Technologies Corp.

The Art and Technology of Controlling Alkaline Earth Oxide Thickeners in SMC

As SMC applications become more challenging, as regulations become more restrictive, and as customers' expectations for tighter tolerances and more consistent product increase, formulators and processors need to become more creative. To support the changing chemistries and demanding requirements in SMC compounding and molding processes, understanding of the thickening response and advanced testing capabilities allow for expanded design of appropriate thickeners to meet the industry's needs.

Randy Lewis, P.R. Lewis Consulting, LLC

BMC with Unprecedented Adhesion to Fillers, High Glass Transition Temperature and Chemical Resistance

A new bulk-molding compound (BMC) manufactured from a new thermoset resin and using a proprietary mixing process offers unprecedented adhesion to fillers and reinforcements that standard BMC grades cannot achieve – particularly with reinforcements like aramid fibers. Parts are currently being molded with this aramid-reinforced BMC and machined to a surface similar to glass-filled standard BMC. However, these non-standard fillers and the unique 250°C^{+} glass-transition temperature of the resin allow this composite to work in more demanding applications. Examples include machined wear bushings that have unprecedented use life along with extreme high temperature, chemical resistance, and variable specific gravity – properties long sought by the automotive industry.