ENABLING TECHNOLOGIES PART 1: NEW THERMOPLASTIC PROCESSING INNOVATIONS

Differential Pressure Molding Process

Jack Van Ert, Vantage Technologies

Differential pressure molding (DPM), is a new patented process that was developed to meet the auto industry's need to produce interior-trim products at remote sites. The process was developed to incorporate low-cost tooling, minimum support equipment, and simple energy-efficient work cells. The process uses low-pressure compression molding to shape thermoplastic and some thermoset materials. It makes use of thinshell composite molds and applies pressure across the entire tool surface – either by placing a vacuum inside the tool or placing the mold in a pressure chamber – which saves on capital equipment and the energy required to run a hydraulic press and cooling system.

Progressive Forming of Thermoplastic Composites

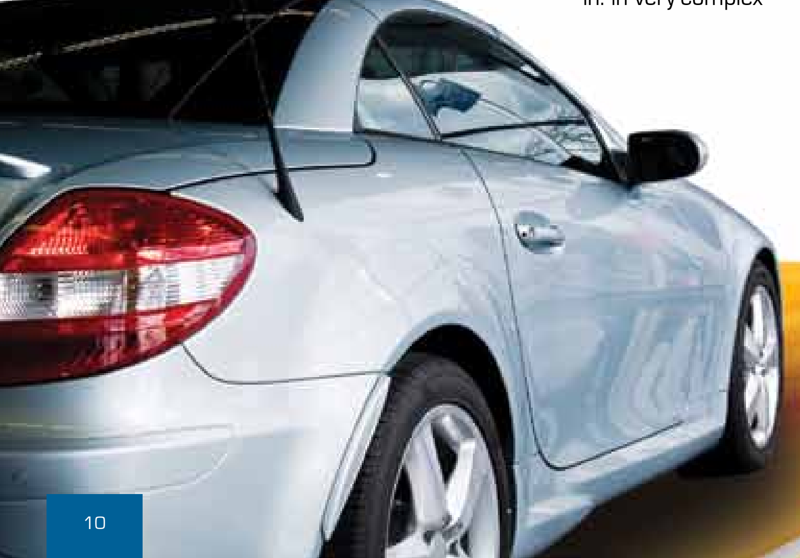
Uday Vaidya, University of Alabama-Birmingham

Thermoplastic composite laminates can be post-manufactured by progressively thermoforming them to generate contoured parts from prior flat panels. This process is attractive for expanding the potential usage of composite materials in next generation transportation, infrastructure, marine, and military sectors for part replacement and structural applications. Thermoforming has proven to be an efficient means for creating parts of complex geometries. Accurately predicting material properties and temperatures prior to forming is of utmost importance to minimize waste and reduce cost for mass-production applications. This paper presents a finite-element modeling approach to establish the manufacturing parameters for locally formed, thermoplastic composite plates.

New Molding Process Offers Unique Levels of Design Complexity, Mechanical Strength, Cost Reduction for Long-Fiber Thermoplastic Composites

Werner du Toit, LOMOLD Group

A new technology has emerged that offers significant advantages vs. traditional molding processes through rapid cycles, excellent surface finish and 3D design possibilities in a closed molding process similar to injection molding while producing parts with material properties similar to compression molding by keeping post-mold fibers longer – typically 10 mm / 0.4 in. in very-complex designs, and up to 50 mm / 2 in. in simpler structures. This paper summarizes the research and results of a comprehensive, 10-year study on the effects and benefits demonstrated by this new molding process through an analysis of its design flexibility, material formulation, cycle-time reduction, strength improvement, aesthetic enhancement and weight-saving capabilities.



Production of Class-8 Truck Trailer Bed Using cPBT Thermoplastic Prepreg & Vacuum Bag Processing

James Mihalich, Cyclics Corp.

An ambitious, multi-year program was recently undertaken in Europe to improve the sustainability of composites used in transportation – particularly with respect to the ability to develop thick parts with large surface areas economically. The program worked with a novel, highly reinforced thermoplastic composite based on cyclic oligomers of polybutylene terephthalate (cPBT), which were used to produce thermoplastic prepregs that were then evaluated in vacuum bag processes, while liquid cPBT / fiberglass systems were assessed in vacuum infusion and vacuum-assisted resin-transfer molding – all forming processes traditionally used for composites with thermoset (not thermoplastic) matrices. Once the best material / process combination for the program was determined, and small-scale testing confirmed the finished composite provided sufficient mechanical performance, the prepreg / vacuum bag process was selected to mold one of the largest thermoplastic parts ever produced: a 3-piece structural floor for a flat-bed trailer for a Class 8 truck, which is the focus of this paper.

ENABLING TECHNOLOGIES PART 2: NEW THERMOSET PROCESSING INNOVATIONS

High Pressure Resin Transfer Molding – Process Advancements

Matthias Graf, Dieffenbacher GmbH & Co. KG

The resin transfer moulding (RTM) process is well established for low-volume manufacturing and has recently gained interest for manufacturing higher volumes, particularly in automotive to produce lightweight composite structures. However, the process is currently limited by the low-volume production capacity of the preforming processes, long impregnation times, and lack of robust processing equipment, all of which limit RTM's use for continuous manufacturing of components. This presentation addresses recent developments in the RTM process and R&D strategies of a trilateral collaboration working to address these issues.

Heatpipe / Thermosyphon Augmented Mandrels to Improve Cure Quality & to Reduce Cure Time in the Thermoset Pipe & Tube Filament Winding Process

Joseph Ouellette, Acrolab Ltd.

Filament winding as a composite process for fabricating high-strength, reinforced thermoset hollow structures is well documented. Traditionally, cure was accomplished in a convection oven and this cure sequence was the most time consuming portion of the overall process as well as the least predictably controlled. This paper will define and detail a new method for curing filament-wound composites. Here, a closed-loop controlled, heatpipe thermally enhanced mandrel heated by induction heating replaces a cure oven, allowing for very-rapid cure and permitting the escape of volatiles and water vapour that normally are trapped interstitially.

High-Volume Automotive Structural Composites: Novel Thoughts on Key Enabling Materials & Manufacturing Technologies

Don Lasell, Retired

Fiberglass-reinforced epoxy (FG/epoxy) and carbon fiber-reinforced epoxy (CF/epoxy) composite components are known to be produced in high volumes using the compression-molding process. This same molding technology can reasonably be expected to produce high volumes of CF/epoxy automotive body structure and chassis components. The author discusses unique epoxy chemistry, forming and molding processes possible due to the thermoplastic stage-of-cure referred to as the epoxy "B-stage." B-staged epoxies are discussed and then compared to what is commonly referred to as a B-staged sheet molding compound (SMC). A progression-molding assembly line concept similar in configuration to existing automotive sheet-metal forming lines is discussed. This conceptual molding operation would be capable of producing complex CF/epoxy structural composite components at a rate of at least 120 / hour.

Eco-Friendly Automotive Plastic Seat Design

Dev Barpanda, The Dow Chemical Co.

This paper deals with plastic front and rear seat designs that provide more than 20% weight reduction for improved fuel efficiency and lower CO_2 emissions. The materials of construction include recyclable plastics and "green" polyurethane foam, making this design eco-friendly. Low cycle time, reduced part count and assembly time, optimized contours for passenger comfort, and reduced material consumption lead to cost-competitive design.

ADVANCES IN THERMOSET COMPOSITES PART 1: SMC & BMC

Light Weight Class "A" SMC Body Panels-TCA Lite®

Mike Siwajek, Continental Structural Plastics

Currently, the automotive industry is making a major push toward vehicle weight reduction. While traditional SMC provides several advantages over other materials for use on Class "A" body panels, weight reduction is not necessarily one of them. The invention of a lower density Class "A" SMC allows the material to maintain its traditional advantages while also competing with other lightweight alternatives. Unreinforced panels (e.g. fenders, roof panels, etc.) molded with the material can reduce weight by up to 20%. Closure panels (e.g. hoods, decklids, etc.), when bonded to low-density inner panels, can provide up to 30% weight savings over a traditional SMC assembly. This paper will summarize the development of the material as well as present manufacturing trial and part performance data. Initial evaluations at OEM facilities will also be discussed.

A Case Study-SMC Consistency: A Data-Based Technique to Quality Improvement

Probir Guha, Continental Structural Plastics

A method to identify root causes of manufacturing quality defects has been developed that allows for the implementation of process and material improvements via a databased analysis system known as "The SMC Consistency Method." In 2006, a statistical method that ties SMC molding parameters to process and raw material parameters was introduced. The following year, an SMC viscosity improvement effort using this method was announced. The current paper presents additional examples that have identified root causes of material and process variations that have resulted in sporadic defects in the molded product. The case study will show how defect data from the molding plant was successfully used to identify key molding, compounding and raw material factors. The SMC consistency method utilizes actual production data as opposed to the use of data generated by conducting special DOEs.

Direct Compounding – Insight & Results of the First Full-Scale Pilot Plant

2008 SPE ACCE Scholarship Award Winner

Tobias Potyra, Fraunhofer Institute of Chemical Technology

The innovative Direct SMC process has reached a point where it can be introduced into industrial applications. This presentation gives an overview of the state of development of the process and will give an insight in the processing technology. Furthermore, the full industrial scale process line will be shown as it is installed at the facilities of Fraunhofer ICT, Germany.

"Near-Perfect" New Centrifugal Pump Wear Rings and Bushings

Randy Lewis, P.R. Lewis Consulting, LLC

Pump bushing or shaft wear is readily indicated by a dramatic loss of pump performance that required down time for maintenance. With all previous bushing materials in difficult applications, Carver pumps were scheduled to last no more than 90 days without maintenance down time for bushings replacement, and some exceptional applications required bushing replacement every week. However, a new molding compound has been developed for the manufacture of pump wear bushings. Since switching, no measurable wear has been detected during pre-production testing or during 2 years in the field. Furthermore, no shaft wear has been found either, indicating the wear problem has been solved.

ADVANCES IN THERMOSET COMPOSITES PART 2: URETHANE, COPOLYESTER, & EPOXY

Novel Isocyanate-Based Resin Systems with Tunable Reaction Times

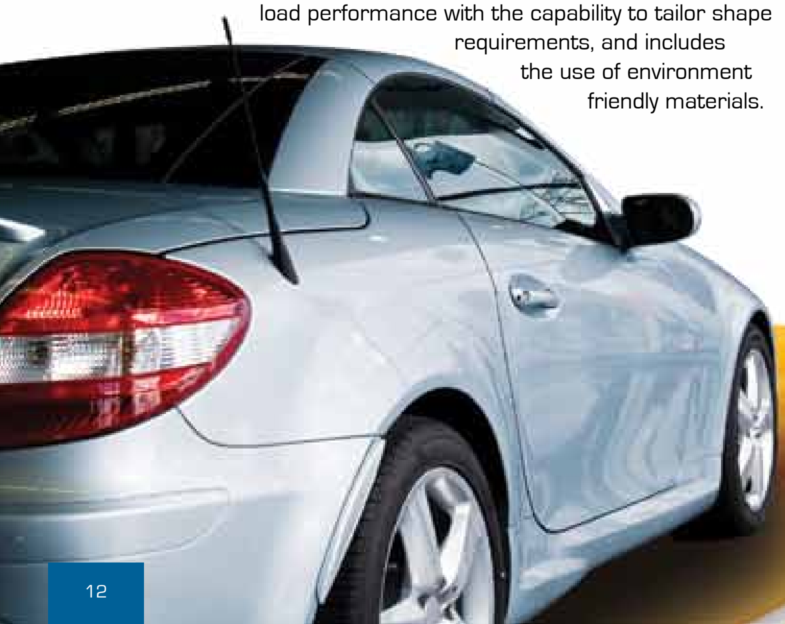
Daniel Heberer, Huntsman Polyurethanes

Newly developed isocyanate-based resin systems offer a combination of high thermal stability and toughness in a resin system that is easy to process and cure. This novel chemistry can be adapted to achieve low initial viscosity, long open times, and snap-cure profiles at elevated temperatures. The benefits of these resins lead to applications in a number of composite manufacturing processes.

Polyurethane Environment Friendly Sandwich Structure Load Floor

Allan James, The Dow Chemical Co.

Dow Automotive and Magna International have developed a polyurethane-based system to enable a novel sandwich structure that includes extensive use of environment friendly materials. This system addresses two significant challenges in the automotive industry: weight reduction and incorporation of renewable materials. An ideal application for this technology is the load floor, an interior component located in the rear of the vehicle immediately above the floor pan. This paper will review the performance requirements for a load floor, the alternative materials, and the development of a novel sandwich structure solution, which gives the best mass to load performance with the capability to tailor shape requirements, and includes the use of environment friendly materials.



Orientational Order Induced by Carbon Fiber in Aromatic Thermosetting Copolyester Matrix

2009 SPE ACCE Scholarship Award Winner

Zeba Parkar, University of Illinois-Urbana / Champagne

This presentation describes a new class of resin, aromatic thermosetting copolyester (ATSP), which shows high temperature stability, flame resistance, and adhesive properties. Carbon fiber helps in stabilizing the nemetic phase in the liquid crystalline melt. The morphology of novel aromatic thermosetting copolyester in the presence of carbon fibers will be described and the presence of crystallinity, which helps in improving the fracture toughness of these structures, will be discussed.

Light, Strong and Economical – Epoxy Fiber-Reinforced Structures for Automotive Mass Production

Heinz-Gunter Reichwein, Hexion Specialty Chemicals, Inc.

A family of new epoxy resin systems will be introduced that meet the requirements of automotive production and performance. Also, an outlook will be given about what one can expect from a dedicated development partner and supplier.

VIRTUAL PROTOTYPING & TESTING OF COMPOSITES – PART 1

Improvement in Orientation Measurement for Short & Long Fiber Injection Molded Composites

2009 SPE ACCE Scholarship Award Winner

Gregorio Vélez-García, Virginia Tech

Short-fiber-reinforced thermoplastics are a feasible alternative to develop lightweight materials for semi-structural applications. These materials present a layered structure showing a complex fiber orientation distribution along the molding. The details of fiber orientation in a center-gated disk with diameters of 1.38 and 2.05 mm were obtained in several regions including the gate and advancing front. Several modifications were introduced in the method of ellipses to obtain unambiguous orientation measured over small sampling area. Two fiber suspensions (30 % short glass-fiber PBT and PP) with different rheological characteristics were used in these experiments. The results showed an asymmetric distribution of fiber orientation that gradually washs out as the flow progress. In addition, the initial orientation measured at the gate presented a fiber distribution different from the random orientation that is assumed in literature for a center-gated disk.

Predicting the Tensile Strength of Short Glass Fiber Reinforced Injection Molded Plastics

Michael Wyzgoski, American Chemistry Council

The tensile strength of a composite is dependent on the properties of the fiber, the properties of the matrix resin, the fiber content, the geometry and orientation of the fibers, and the interfacial strength between the fiber and the matrix. We have found we can successfully model the strength with knowledge of the fiber length distribution, the average through-thickness fiber orientation, and the stress / strain curve for the unfilled resin. Surprisingly accurate strength predictions (within 10%) have been validated for both flow and cross-flow directions, which can greatly simplify analysis and allows for a quick estimate of the strength values of any reinforced plastic using material data that is generally available.

Improvement in the Simulation of Injection Molded Short Glass Thermoplastic Composites

Syed Mazahir, Virginia Tech

This paper presents simulation results for prediction of fiber orientation in a center-gated disk using Folgar Tucker model with Newtonian flow and experimentally measured orientation at the gate as an initial condition. A steady moving front with circular shape was included to capture the effects of the frontal flow on fiber orientation. Quadratic and invariant-based optimal fitting closures are also assessed in shear and planar extensional flows and compared with experimental evolution of fiber orientation.

Effect of the Adhesive Joint Cross-Section Parameters on the Bond-Line Read-Through Severity in Composite Automotive Body Panels Bonded at Elevated Temperature

Hannes Fuchs, Multimatic

The Automotive Composites Consortium (ACC) is conducting a multi-year project to develop a better understanding of the root causes of the visual surface distortion effect known as bond-line read-through (BLRT). Initial studies using a finite-element analysis (FEA) based approach showed good agreement with experimental observations and highlighted the importance of accounting for viscoelastic adhesive material properties. A parametric FEA-based study of a small laboratory scale coupon was conducted to examine the effect of the adhesive joint cross-section geometry and adhesive type on the predicted peak curvature resulting from an elevated temperature adhesive cure. The parameters evaluated in this study were uniform and non-uniform adhesive thickness, SMC substrate thickness, adhesive bead width, and adhesive type.

VIRTUAL PROTOTYPING & TESTING OF COMPOSITES – PART 2

The Influence of Bond Dam Design & Hard Hits on Bond-Line Read-Through Severity

Kedzie Fernholz, Ford Motor Co.

An experiment to investigate the root causes of adhesive-induced distortion in Class “A” panels was completed. This experiment showed that features in the inner panel that change the thickness of the adhesive across the bead width are responsible for the visible distortions in the outer panel surface. In addition, a visible distortion occurs in the surface only when there is adhesive between the inner and outer panels.

Multi-Scale Modeling of Creep of Reinforced Plastics Parts with DIGIMAT

Laurent Adam, e-Xstream Engineering

This paper deals with the prediction of the overall behavior of polymer matrix composites and structures based on mean-field homogenization. We present the basis of the mean-field homogenization formulation and illustrate the method through the analysis of the creep properties of fiber-reinforced structures. The present formulation is part of the DIGIMAT software, and its interface to FEA packages, enabling multi-scale FE analysis of these composite structures.

Scaling Down Methodology for Composite Cab Front Prototype Using Resin Transfer Moulding Process

Swati Neogi, India Institute of Technology

Most industrial composite parts that are large and complex in geometry are manufactured by the hand layup method. The resin transfer moulding (RTM) process is a better substitute, but is not used readily due to the lack of proper manufacturing technology. Development of a proper RTM manufacturing process for a specific application requires a proper mould design. In addition, the difficulty in the tooling design and mould fabrication cost increases with size and complexity of the component. The scale down strategy of full scale product avoids bigger size mould requirements, prototype production for product testing and quality check at the starting phase of product development. Moreover, the scale down strategy can be used to validate the process and the product with less capital input. In this work, we propose a methodology to develop a scaled down prototype for a large and complex composite structures based on virtual simulation technique keeping the mold fill time and mold fill pattern unchanged. The methodology has been demonstrated taking a composite cab front that is currently used by the hand layup technique as case study. From the simulations and actual experiments, it was found that the injection pressure at the full scale model has to be reduced to the times of reciprocal of square of geometrical mould scale down factor to meet the same mould fill time and mould fill pattern, keeping the injection strategy the same.

Constituitive Property Estimation of Stitched Composites for Engineering Applications — A Hybrid Approach

Siddharth Ram Athreya, The Dow Chemical Co.

Fiber-reinforced polymer composites are finding new applications in aerospace, high-performance as well as medium build-volume alternate powertrain automobiles, civil infrastructure, sports equipment, and emerging alternate energy industries due to their high stiffness-to-weight ratio. Laminated structures are among the most common forms of structural fiber-reinforced polymer composites. Fiber orientation in each lamina and the stacking sequence of the laminated structures can be chosen to tune the desired strength and stiffness. For enhancing the predictive modeling capability of composite structural performance, an accurate computation of the effective material properties of composite materials is of special interest to engineers. This paper discusses the prediction of the effective mechanical properties of glass fiber-reinforced epoxy composites (fabricated using an infusion process), utilizing both classical laminate theory as well as a finite element-based micromechanics approach and compares the results against experimental findings. The results from the physical tests exhibit good correlation with the predicted mechanical properties.

DESIGN & DEVELOPMENT OF A STRUCTURAL COMPOSITE UNDERBODY – PART 1

Design and Fabrication of a Structural Composite Automotive Underbody

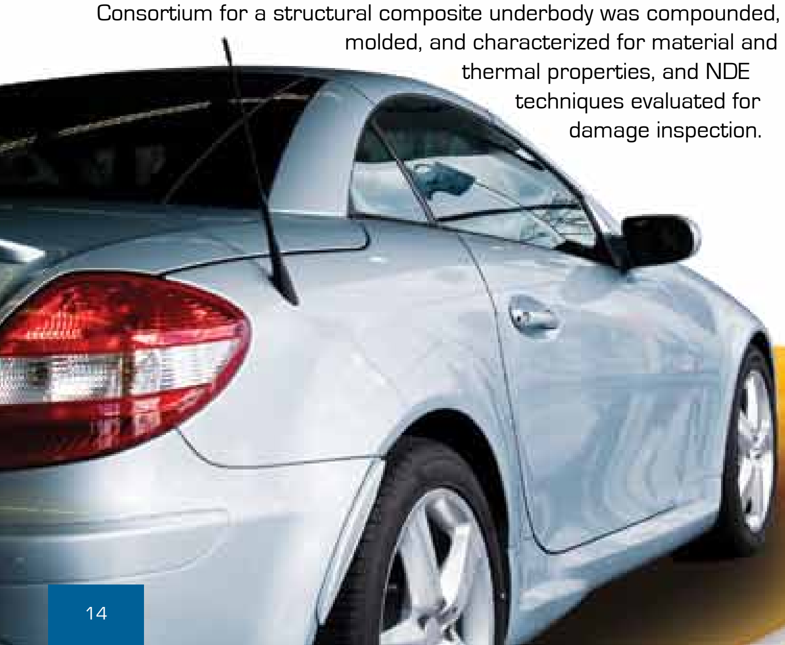
Libby Berger, General Motors Co. / USCAR

This paper describes the design and fabrication of a structural composite underbody by the Automotive Composites Consortium. This includes material and process development, joint methodology and design, design of the component manufacture and design scenario, and initial fabrication of the underbody.

Properties and Molding of a Fabric SMC for a Structural Composite Automotive Underbody

Libby Berger, General Motors Co. / USCAR

The glass fabric SMC developed by the Automotive Composites Consortium for a structural composite underbody was compounded, molded, and characterized for material and thermal properties, and NDE techniques evaluated for damage inspection.



Double Dome Structural Test—Analysis Correlation Studies

Hannes Fuchs, Multimatic / USCAR

Computer-aided engineering-based design methodologies have been utilized throughout the Automotive Composites Consortium Focal Project 4 to assess the vehicle level structural stiffness and impact performance of the composite underbody design proposals, and to estimate the potential mass reduction for several candidate material scenarios. To increase confidence in the vehicle-level model predictions, and to better understand the effect of fabric draping on fiberglass fabric Sheet Molding Compound composite material properties, several quasi-static structural "double dome" component tests were simulated for the purpose of test-analysis correlation and modeling methodology development.

Super Lap Shear Joint Structural Test—Analysis Correlation Studies

Hannes Fuchs, Multimatic / USCAR

Computer-aided engineering-based design methodologies have been utilized throughout the Automotive Composites Consortium Focal Project 4 to assess the vehicle level structural stiffness and impact performance of the composite underbody design proposals, and to estimate the potential mass reduction for several candidate material scenarios. To increase confidence in the vehicle-level model predictions, and to better understand the effect of temperature on hybrid composite-to-metal joint performance, quasi-static structural joint coupon tests were simulated for the purpose of test analysis correlation and modeling methodology development.

DESIGN & DEVELOPMENT OF A STRUCTURAL COMPOSITE UNDERBODY – PART 2

Shear Deformation Properties of Glass-Fabric Sheet Molding Compound

Caroline Dove, Ford Motor Co. / USCAR

In the current phase of the Automotive Composites Consortium structural composite underbody project, a draping analysis of a full underbody made of woven glass-fabric sheet molding compound (SMC) was used to identify changes in local mechanical properties due to fabric shearing during compression molding. As a laboratory-scale effort, woven glass-fabric SMC was compression molded into double-dome shapes and flat plaque configurations of three separate 4-ply layups. Double domes underwent static crush, impact, and mechanical testing; mechanical properties were further compared to corresponding flat plaque properties. All data was used to broaden the material property database and validate model predictions of strand orientations in a molded part.

Structural Performance Evaluation of Composite-to-Steel Weld Bonded Joint

Bhavesh Shah, General Motors Co. / USCAR

One of the critical challenges for the structural underbody program was finding a way to attach the composite part to the steel structure in a high-volume automotive manufacturing environment and meet the complex requirements for crash. Weld bonding, a combination of adhesive bonding and spot welding, was selected as the primary joining method. A novel concept of bonding doubler steel strips to the composite enabled spot welding to the steel structure, ensuring the compatibility with the OEM assembly processes. The structural performance of the joint, including durability, was assessed via analytical and physical testing under various quasi-static and dynamic loading conditions. This paper discusses the results of the experiments designed to generate key modeling parameters for finite-element analysis of the joint, and presents the correlation between experimental and analytical results.

COMPOSITES – BUSINESS TRENDS & TECHNOLOGIES

Technology Development for Automotive Composite Part Production — New Materials & Processes

Frank Henning, Fraunhofer Institute of Chemical Technology

The presentation will introduce a large network and cluster forming in Germany to provide a strong initiative that increases the use of composites in the automotive industry. Also discussed will be an overview of the technologies that have been selected by industry to be further developed to meet the requirements of the automotive industry.

Leveraging Government Money to Drive Innovation in Materials

Susan Ward, ITECS

With an uncertain economy, creativity is necessary to uncover new, stable R&D growth opportunities. One possibility may be to explore opportunities with the federal government. In 2009, the U.S. government increased the research and development spend 16%, resulting in an unprecedented $171B budget. More than 60% of this funding is through contracts with business, universities and non-profits. Whether the initiatives are with medical devices, drug delivery, alternative energy, smart infrastructure applications, improved transportation solutions, or defense applications, materials development is the backbone for maintaining the U.S. technical leadership position. By leveraging some of this funding, a company can help mitigate risk in developing new technology products and markets.

Plastics/Composites in Automotive Applications — Defending the Product Performance in Insurance Claim and Litigation Situations

Jackie Rehkopf, Exponent, Inc.

More and more automotive structural applications are being developed with plastics / composites. Is the industry prepared for claims from our litigious and insurance-fraud fraught society - false or not - that a vehicle or component may have performed better in a crash situation if it had not been made of plastic / composite materials?

BIO- & NATURAL FIBER COMPOSITES

More Sustainable Non-Woven Fabric Composites for Automotive Using Coir (Coconut) Fibers

Walter Bradley, Baylor University

More environmentally friendly composite materials for automotive manufacturing and building construction have been made by substituting coir fibers for the widely used polyester fibers to make non-woven fabric composites of coir fibers and recycled polypropylene fibers that can be compression molded into a wide range of parts or rolled into flat panels. This more environmentally friendly composite has a greater bending stiffness, is more resistant to fire, less expensive, and without the odor problems that accompany many natural fibers.

Compression Molded, Bio-Fiber Reinforced, High Performance Thermoset Composites for Structural and Semi-Structural Applications

Leonard Fifield, Pacific Northwest National Laboratory

Plant-based bio-fibers can reduce the weight of automotive composites if technical hurdles such as the rampant moisture uptake and loss of composite mechanical properties with exposure to moisture can be controlled. Pacific Northwest National Laboratory is developing chemical additives for thermoset resins that enable dramatic reduction in bio-fiber composite moisture uptake and loss of mechanical properties following exposure.

Eco-Friendly Acrylic Copolymers Offering Clean Manufacturing, Reduced VOC Emissions, Excellent Performance

Gero Nordmann, BASF Corp.

A new (to North America) family of cross-linkable acrylic-copolymer binder resins is providing unique new opportunities for the production of durable, eco-friendly composites with comparable or improved performance vs. common thermoplastic and thermoset offerings in a variety of industries. Already used in Europe for automotive interior components, cork flooring, and various nonwoven fabrics, the technology is thermoplastic in its "B-stage," and of very-low viscosity, allowing for easy impregnation of a wide variety of fibrous and particulate reinforcements. This, in turn, may be used to produce either nonwoven fabrics, or thermoplastic prepregs or semi-finished goods, which subsequently are cured to form very-durable thermoset composites with excellent thermomechanical and physical properties. Unlike most thermosets, these polymers neither contain any hydrocarbon solvents or other volatile-organic compounds (VOCs), nor produce toxic emissions during cross-linking, so no special air-handling equipment is required during processing. In fact, the only reaction by-product is water. This presentation will provide an overview of the technology and how it is typically used.

Lightweight Sustainable Substrate Materials for Automotive Interiors

Matt Barr, Faurecia

This presentation provides a global overview of natural fiber composite materials and processes, highlighting current research as well as the next generation of lightweight automotive interior substrates. It discusses both pros and cons of various lightweight sustainable substrate materials (including the wide family of resin-matrixed composites with an assortment of fibrous additives ranging from wood to flax), taking into account material suitability for automotive interior substrate applications. The goal of this talk is to encourage discussion of uses and benefits of natural wood composites to reduce weight and increase product sustainability.

ENABLING TECHNOLOGIES PART 3: MACHINING COMPOSITES

Precision Waterjet Cutting in the Composites Industry Utilizing Robots for High Quality Accurate Machining

Duane Snider, Flow International Corp.

This paper discusses the coupling of 5-axis Gantry robots and 6-axis articulated-arm robots to abrasive waterjets for a range of cutting applications, primarily in the composites market. The use of ultra-high pressure waterjets and their technical advantages over conventional mechanical cutting tools are covered as well as the succesful adaptation of advanced software packages typically used in the aerospace industry. A few case studies are also presented that address composite trimming for wing skins used in aircraft and wind turbines, small airframe composite parts, glass trimming for high efficiency solar panels, and three-dimensional machining of relatively small parts used in jet engines.

Machining Composite: A Collaborative Approach to Application Specific Solutions

Andrew Gilpin, AMAMCO Tool

This presentation discusses the difficulties that Lockheed Aerospace experienced routing composites for the F-35 fighter and how they overcame those challenges through a collaborative effort.

ENABLING TECHNOLOGIES PART 4: OTHER PROCESS ENHANCEMENTS

Recycling of Landfill-Bound Automotive Headliners into Useful Composite Panels

Jean-Jacques (J.J.) Katz, TrimaBond, LLC

This paper describes the recycling of automotive headliner post-industrial waste into useful composite panels. The process relies on granulating the waste, blending it with a 100% solids, VOC-free MDI isocyanate adhesive and thermally molding the mixture under pressure, using atmospheric moisture as the curing agent.

Methods of Making 3-Dimensional Shaped Composite Structures

Parvinder Walia, The Dow Chemical Co.

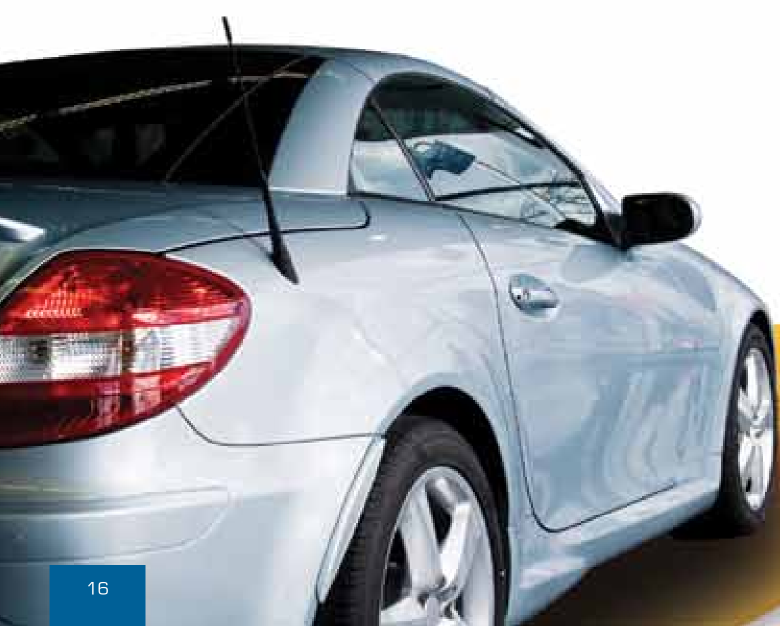
Shaped composite structures (specifically sandwich panels) are made by the combination of cold forming of thermoplastic foam core and thermoset processing of skins. This combination is ideally suited since the thermoset processing conditions are in a range that keeps the foamed core intact while simultaneously allowing the cold forming to be achieved. This technology affords a unique avenue to create sandwich and other composite structures that have curvilinear shape and 3-dimensionality via a single processing step that uses existing processing technology. Various process embodiments are described in this paper. This work discusses shaped foam composites and methods for manufacturing such composites.

Crashworthiness of GF/PET and GF/PA6 Tubes Produced in a Novel Rapid Tape Placement Process

2010 SPE ACCE Scholarship Award Winner

Benjamin Hangs, Fraunhofer Institute of Chemical Technology

GF/PET and GF/PA6 tubes were tested at high speeds of 4 m/s to investigate energy absorption capabilities of adhesively bonded tubes made from unidirectional prepreg tape and produced in a novel and rapid tape laying process. The study's focus was on the influence of fiber orientation within the specimens to determine guidelines for optimized laminate configurations. Subsequently, results were compared to similar test setups.



ADVANCES IN THERMOPLASTIC COMPOSITES PART 1: LFT VS. D-LFT, & OLEFIN COMPOSITES

Unpainted, Visible-Surface LFT Parts for Auto Interiors

Hansel Ramathal, Ticona Engineering Polymers

Recently LFRT materials have been used in the automotive interior to incorporate structural requirements while delivering a first-surface appearance, thereby eliminating secondary operations such as painting, plating or fastening. The key technical requirements in many of these applications is impact strength, surface abrasion resistance and color uniformity. Added benefits of using LFRT materials are superior dimensional stability, even in thin-wall parts. With proper tool design, warpage can be significantly reduced while reaping the weight reduction benefits of lower specific gravity LFRT PP materials.

Morphological & Mechanical Comparison of Injection & Compression Moulding In-Line Compounding of Direct Long Fibre Thermoplastics

Martin McLeod, National Research Council Canada

Long fibre thermoplastics (LFT) based on polypropylene / glass fibre (PP/GF) composites has become one of the most widely used plastics in semi-structural and structural automotive applications in both aesthetic and non-aesthetic parts. LFTs are commercially available in pre-compounded pellets for injection moulding and are developed with specific properties for targeted functions. In a rationalizing effort to reduce costs, heat histories, and create in-house flexibility of material blending, in-line compounding (ILC) of base materials including resin, additives (heat stabilizers, colors, coupling agents, etc.), and glass roving reinforcements for direct moulding of LFT parts (D-LFT) has been developed in the last 10 years. Two major versions of D-LFT technology currently exist on the market, both relying on twin-screw extrusion for ILC – one utilizing compression moulding and the other injection moulding. These two technologies have their specific features related to fibre length, orientation and resulting properties. The objective of this paper is to address some of them.

Decreasing VOC Emissions at the Source with New Additive Technologies for Olefin Composites

Louis Martin, Addcomp North America Inc.

New pressures and regulations in the transportation and commercial and residential construction industries intended to improve “interior” air quality are spurring new research in additive technologies to reduce emission of volatile organic compounds (VOCs), odors, and fogging for polymeric materials. Much work has already been done to help reduce VOCs, odors, and fogging by addressing coupling-agent purity. Unfortunately, there are many pathways for the release of VOC emissions, and in cases where they cannot be eliminated at the source in components of the masterbatch, a third strategy is needed. One such approach, described in this presentation, has studied the use of adsorbents and stripping agents during extrusion compounding of the masterbatch to capture and flashoff (in the case of stripping agents) or permanently bind up (in the case of adsorbents) VOCs and fogging or odor causing emissions.

Tensile and Fatigue Performance of a Self-Reinforced Polypropylene

P.K. Mallick, University of Michigan-Dearborn

Self-reinforced thermoplastics are single polymer composites in which the reinforcing fibers and the polymer matrix are of the same thermoplastic type. The principal advantages of such materials are that they are completely recyclable and the interfacial bond between the fibers and the matrix is very strong, which helps them achieve high tensile strength. Polypropylene fiber-reinforced polypropylene is the most common self-reinforced thermoplastic available today. It not only possesses high tensile strength, but also high impact strength, and for these reasons, it is being considered for a variety of automotive applications. In some of these applications, fatigue properties of the material may be of greater significance than the tensile or impact properties. In this study, both tensile and fatigue tests were conducted on a self-reinforced polypropylene fabric. Fatigue performance was evaluated in terms of number of cycles endured and changes in cyclic properties occurring during fatigue cycling.

ADVANCES IN THERMOPLASTIC COMPOSITES PART 2: NYLON APPLICATIONS

Design and Part Performance Testing for Thermoplastic Automotive Oil Pans — NA Market

Marianne Morgan, BASF Corp.

Thermoplastic oil pans are an up and coming metal-to-plastic application. With the need for light-weighting vehicles for improved fuel economy and reduced emissions, thermoplastic oil pans and oil pan modules that incorporate the windage tray and oil pickup tube are under investigation at a majority of the global OEMs. At present, there are 7 serial product thermoplastic oil pans most of which have just launched in the past 18 months. This presentation will provide a brief overview of OEM concerns by global region and outline the component design challenges. The focus will highlight the CAE analysis methodology used on current productions plastic pans and provide a comparison of plastic pan performance relative to aluminum or stamped steel.

High Duty, Lightweight Polyamide Engine Mounts

Hans-Juergen Karkosch, ContiTech Vibration Control &
Holger Klink, BASF SE

Engine mount components are the key link between the engine transmission unit and the body or the chassis, and are designed to secure the power unit in the engine compartment and suspend it so that, by damping impacts due to road irregularities and isolating engine vibrations, the power unit does not come into contact with the body. Such load-bearing structural components are primarily made from steel or aluminum. but their high weight not only affects vehicle mass, and thus fuel consumption, but also axle load distribution. This paper will discuss the development of heavy-duty fiberglass-reinforced polyamide structural components for motor vehicle engine mounts, which yielded weight savings of up to 50%.

NANOCOMPOSITES

Nano Graphene Platelets (NGPs) and NGP Nanocomposites: A Review

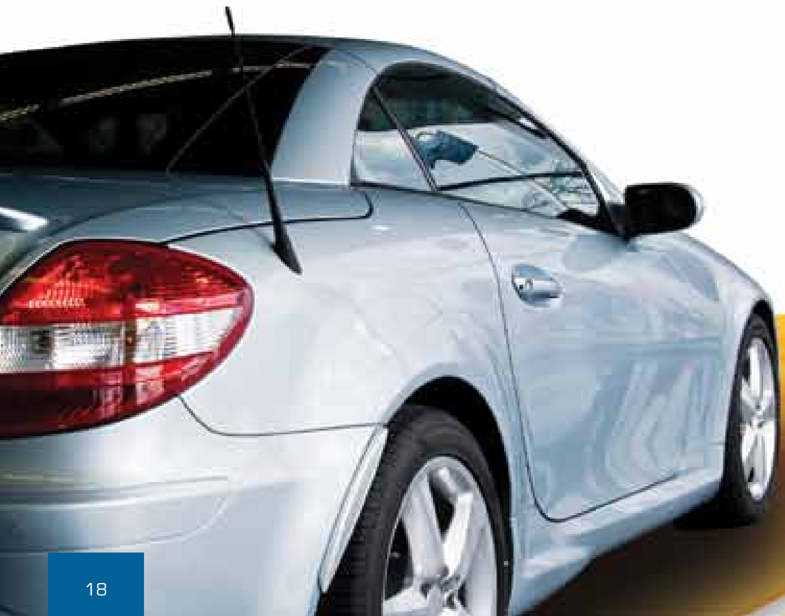
Bor Zang, Wright State University

The nanoscale graphene platelet (NGP) or graphene nano-sheet is an emerging class of nano materials and can be a low-cost alternative to CNTs and carbon nano-fibers (CNFs). Graphene's applications as a nano filler in a composite material and as a functional ingredient in an energy system (supercapacitor, battery, and fuel cell) are imminent. However, the availability of processable graphene sheets in large quantities is essential to the success in exploiting composite and other applications for graphene. This presentation begins by a review of the current processes for producing NGPs and their composites and is followed by a discussion on the new advances in materials, processes, and applications related to NGPs and their nanocomposites.

Graphene Nanoplatelet Additives for Multifunctional Composite Materials

Lawrence Drzal, Michigan State University

With the emphasis on alternative energy vehicles, the need for materials that are not only structural but possess other desirable properties such as electrical conductivity, thermal conductivity, and barrier properties is increasingly important. Nanocomposites are opening up "windows of opportunity" to not only increase structural properties but also the non-structural surface, electrical, thermal and barrier properties. Graphite (graphene) nanoplatelets are a new, cost-effective nanomaterial that can be used as an additive to polymers and composites to impart multifunctionality without the need for developing new or alternative processing and manufacturing methods. Examples in thermoset and thermoplastic systems – with and without macro reinforcing fibers – will be used to illustrate the potential of this nanomaterial.



Mesoporous Silicate Particles (MSP) for Improving Performance & Productivity in Various Composite & Polymer Formulation

Mike Brooks, InPore Technologies

This presentation focuses on a new silicate mesoporous nanoparticle technology, which will bring significant productivity and performance benefits to both thermoset and thermoplastic moldings by increasing mechanical properties of neat resins, imparting greater flame retardance, and reducing processing cycle times. The particles' intrinsic porous structure allows polymer chains to link the particles into a 3D network, improving both strength and modulus at very-low particle loadings (typically 5.0 to 7.5 wt %). The technology does not require organic surface modification to achieve dispersion in the polymer matrix, nor does it require retrofitting of processing equipment or modification in processing methods.

PANEL DISCUSSION:

Taking Structural Composites from Niche to Mainstream: Can it be Done?

Moderator: Dale Brosius

Now that we are emerging from the global financial crisis, attention once again is returning to engineering and building the next generation of automobiles. Clearly, new mandates on fuel economy, paired with a reshaped automotive industry, create opportunities for innovation, including electric and hybrid powered vehicles, new styling potentials, and significant changes in materials and processes. The historical use of composites in mainstream vehicles has been in closures and other body panels, and not in the core structure of the vehicle. Advanced composites have been and are continuing to be employed in the main structural components of high performance, low volume vehicles such as supercars and racing platforms. They have proven to be safe and to deliver considerable improvements in fuel economy without sacrificing speed, acceleration, or comfort. However, the leap to higher volume implementation of these innovative materials is proving to be quite a challenge. Is this aspiration-achievable or is it simply a fantasy? What barriers stand in the way? What can and must be done to make structural composites viable for medium and higher volume cars and trucks? A premier panel of executives from U.S. and European OEMs, suppliers and industry experts will tackle these and other provocative questions. Audience participation is strongly encouraged through an active Q&A session.

KEYNOTE SPEAKERS

Dynamics of Recovery & Competitiveness: The North American Outlook in A Global Context

Mike Jackson, IHS Automotive

This outlook will examine current settings in the context of market fundamentals that impact light vehicle demand and production planning forecasts. Remarks will highlight market trends resulting from the changing production landscape of manufacturers and developing product portfolios through the forecast horizon. A review of platform strategies will highlight market leaders and emphasize different approaches to achieve profitable growth.

Carbon Fiber Composites Research & Development at Automobili Lamborghini

Paolo Feraboli , Univ. of Washington
Luciano DeOto, Automobili Lamborghini S.p.A.

Speakers will provide an overview of technologies Lamborghini is currently focused on in the area of liquid resin infusion and pre-forming technologies. A second area of focus is evaluation of the crashworthiness of carbon composites, which perform extremely well in crash scenarios and dissipate more energy per unit mass than aluminum or steel. However, this is obtained only through a complex and careful design effort – a process that traditionally involved experiments and crash-testing of full-scale vehicles, which is both costly and time-consuming. Borrowing from the aerospace industry, Lamborghini has adopted Boeing's Building Block Approach where margin-of-safety calculations are based on a complex mix of testing and analysis at various levels of structural complexity, often beginning with small coupons and progressing through sub-components up to full-scale components. The presentation will review this approach and discuss how Lamborghini is using it to design new structural concepts, which are subsequently being evaluated as technology demonstrators.

Birth of the T35 Sports Car: Releasing the Familiar & Secure to Embrace the New

Antony Dodworth, Bentley Motors Ltd.

Bentley has used a steel monocoque body shell for all its vehicles since the T-series debuted in 1965. However, in 2005 the company established a research group to investigate and recommend alternative materials and design concepts, which will be used for the first time on the new T35 vehicle that will launch in 2016. This presentation will highlight key technologies being investigated for that program.

McLaren MP4-12C Carbon Fibre "MonoCell"

Claudio Santoni, McLaren Automotive Ltd.

McLaren is gearing up for the 2011 launch of its new street-legal, two-passenger, mid-engine MP4-12C supercar. A unique feature of this aluminum- and composites-intensive vehicle – and the subject of this keynote – is its single-piece, 176-pound / 80-kg carbon composite moncoque / safety cell, which the company calls a "MonoCell." The MonoCell not only holds and protects passengers, but also responds to loads from front and rear aluminum subassemblies. Not only is the first time a carbon-composite chassis has been offered on a performance vehicle in the target price range of £125,000 to £175,000, but the vehicle will set new standards for fuel economy and CO_2 emissions thanks to Formula 1 technology and processes.

Predictive Modeling of "Composite" Materials & Structures: State-of-the-Art Solutions & Future Challenges

Roger A. Assaker, CEO, e-Xstream Engineering

Computer-aided engineering (CAE) has been used for many years to reduce the time and cost of vehicle design and manufacturing. The majority of the CAE processes, tools and even engineering mindset have been optimized and mainly targeted toward homogeneous and anisotropic materials like steel. This presentation will discuss the opportunities and challenges of using emerging multi-scale modeling technology, tools, and processes with state-of-the-art CAE tools to better understand and optimize usage of high-performance, light-weight materials for greener and more-efficient vehicles.

Flying Off The line: How Aerospace Knowledge Can Accelerate the Use of Composites in Mass Produced Autos

Rani Richardson, Dessault Systèmes

The use of composites by the automotive industry is nothing new, but technical issues like material characterization, manufacturing and joining prevented large-scale adoption. Composites have been slowly introduced where it made sense, and the time is quickly approaching where performance, safety and fuel economy standards dictate the need for their use in mass production. This session will leverage technology and knowledge from the aerospace industry – where a major shift in commercial jetliner design has accelerated the research, development and usage of composites tools – and apply "lessons learned" to the automotive industry. The benefits of using composites in mass production will be discussed, along with the important factors needed for composites to succeed in the automotive industry.

Achieving a 10-Min Cycle Time in Advanced Composites

Gary Lownsdale, Plasan Carbon Composites

Historically, carbon composites' growth has been slow to reach into the mainstream applications in the auto industry due to long manufacturing times that prevent these composites from being considered for high production volumes; costly raw materials that cannot be recycled; high capital investment costs; and incomplete engineering analytical tools. To address these concerns, a technology strategy has been developed to evaluate new and faster processing methods; develop automation and low-cost materials that reduce direct labor and materials base costs; create analysis code and a design guide that better assist customers in designing carbon composite parts; and diversify the base of applications through strategic partnerships. This has led to modeling of a 10-minute cure cycle and the development of material specifications that are moving the organization toward a 10-minute (or faster) cycle time for advanced composites.