ENABLING TECHNOLOGIES – PART 1: New Process Options

Raman Chaudhari, Fraunhofer Institut für Chemische Technologie

High Pressure Compression RTM - A New Process for Manufacturing High Volume Continuous Fiber Reinforced Composites

The HP-CRTM process is a combination of resin transfer molding (RTM) and compression molding. The objective of the proposed study was to investigate the effect of parameters such as mold opening distance and fiber orientation on the quality of the HP-CRTM components. The influence of these process variables on the component quality and the mechanical properties were analyzed. The study proved the applicability of the HP-CRTM process for high-volume manufacturing of RTM components.

Koichi Akiyama, Mitsubishi Rayon Co., Ltd.

Development of PCM (Prepreg Compression Molding) Technology

A high-cycle CFRP manufacturing process named PCM (Prepreg Compression Molding) has been developed. Newly developed fast curing prepreg is suitable for compression molding and cures in 3 minutes. Several application development studies suggested PCM is a feasible process to be used for high-volume production.

Tobias Potyra, Fraunhofer Institut für Chemische Technologie

Process, Material & Part Characterization of the Innovative Direct SMC Process

2008 SPE ACCE Scholarship Award Winner

The direct processing technology for thermoset compression moulded composites parts offers new degrees of freedom in the manufacturing step. An insight into the correlation between process parameters and the resulting mechanical characteristics of the material is given. Based on a design of experiments (DOE) study, crucial parameters have been varied in order to identify their quantitative effect on material properties.

Paul Condeelis, Romeo RIM, Inc.

Process & Equipment Breakthroughs in Long-Fiber Injection (LFI) Technology

When designing new components, the demand for materials that provide property flexibility, durability, low weight, and low cost options continues to be high. LFI is one of the materials that more engineers are selecting for applications, because it meets these criteria. With the newest breakthroughs in process and equipment capabilities, the ability to use LFI for larger and more complex parts continues to increase while providing more options for engineers to meet demanding performance requirements.

ENABLING TECHNOLOGIES – PART 2: Process Control & Secondary Finishing

Tom Trexler, Signature Control Engineering LLC

Dielectric Sensing Technology: Key to Productivity & Product Consistency

Breakthroughs in dielectric sensor design have resulted in the development of durable in-mold sensors that can operate on the production floor and in the laboratory. Thermoset molders can now "see" changes in flow and cure inside their production tools, and in spiral-flow tools allowing automatic "real-time" adjustments for process variation and enabling significant gains in productivity and quality.

Duane Snider, Flow International Corp.

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

Six-axis, articulated-arm robots and 5-axis Gantry robots are commonly deployed with plain waterjets for many applications, especially in the automotive industry. The focus is on extending the use of these robots to abrasive waterjets and for a much wider range of applications, primarily in the composites market. This paper discusses the cutting process of the ultra-high-pressure waterjet and its technical advantages over conventional mechanical cutting tools.

Mark Handelsman, KMT Robotic Solutions

Robotic Trimming, Cutting & Sanding of Carbon Fiber Body Structures

Any automotive OEM or tier 1 supplier who is planning to either ramp up or begin higher volume production of carbon fiber body structures will need to address the unique production challenges of these materials. One of the most significant is how to handle cutting and other material-removal processes. This paper steps through the experience from the automation of carbon fiber automotive components and critical lessons learned on the best approaches to process CFRP panels and why. Next, the paper discusses how the lead companies are preparing for the production of carbon fiber body structures and shares some insights from their experience.

ADVANCES IN THERMOSET COMPOSITES – PART 1: SMC & BMC

Marcel Schutte, DSM Coating Resins

Powder In-Mould Coating as a Superior Finishing Solution for SMC in Automotive Applications

Paper Previously Presented at the European Coatings Conference

New controlled chemistry now enables automotive-grade powder in-mould coatings, providing an efficient solution for interior and exterior applications. The durable coating also has a lower ECO footprint, plus good barrier and surface properties.

Thomas Schmidt, Tiger Coatings GmbH & Co. KG

Class A Surface Finishing of Composites via Powder in-Mold Coatings

One of the limiting factors today in composites usage for large-volume manufacturing is surface coating up to Class A standards. In many cases, surface finishing of composites contributes 50-70% of total part cost. A new cost-effective solution for Class A surface coatings via powder in-mold coating will be presented. Powder in-mold coatings can be used in various composite manufacturing processes including pre-preg, autoclave, and RTM processes. New developments of highly reactive powder coatings will lead to new opportunities for highly productive large volume manufacturing. After molding, composite parts can be directly top coated without any primer or sanding operations, and in the future even top coats will be able to be applied directly by power in-mold processes.

Cedric Ball, Bulk Molding Compounds, Inc.

Bulk Molding Compound Use in Automotive Fuel Cell Applications

Bipolar plates made from conductive bulk molding compound have proven to be effective, durable, and low cost in comparison to other materials. This presentation covers properties, recent developments, and the successful commercialization of bulk molding compound for transportation fuel cell applications.

Terrence J. O'Donovan, Core Molding Technologies, Inc.

Continuing the Development of Reduced Density Composites (SMC) for Automotive Applications

With more rigorous CAFE standards and continued development of hybrid and electric vehicles, there should be a unique opportunity for composite products in the automotive market. To meet the unique challenges of this opportunity, the composites industry will need to develop materials that will meet or exceed the physical property, dimensional, and appearance standards of the materials that they will be replacing. This presentation will provide a brief history of composites development, an example of a material-development program, and some thoughts on where composites could go in the future.

ADVANCES IN THERMOSET COMPOSITES – PART 2: Adhesives

Jie Feng, The Dow Chemical Co.

Analysis of Adhesive Geometric Effect on Fracture Behavior in Applying Rubber Filled Epoxy Materials

This study investigates the geometric effect of applying rubber-toughened epoxy as an adhesive. Using a combination of experimental and predictive modeling approaches, the effect of bonding layer thickness variation is evaluated for rubber-filled epoxy.

Syed Mahdi, Dow Automotive Systems

Two-Component Polyurethane Adhesives Having Novel Properties

One-component, moisture-cure polyurethane adhesives are the preferred choice for direct-glazing and semi-structural modular assembly for automotive parts. However, one disadvantage of moisture-cure adhesives is longer curing time to achieve full adhesive properties, especially at low temperature and humidity. New requirements and trends in the transportation industry, such as lighter weight vehicles using dissimilar substrates, which have different coefficient of linear thermal expansion (CLTE), require adhesives that cure rapidly with high modulus and high elongation. This creates a need for two-component polyurethane adhesives, because conventional polyurethane adhesives are unable to meet the above requirements.

BIO & NATURAL FIBER COMPOSITES

Andre Bendo, BASF Corp.

Material Characterization of Natural Fiber – Acrylic Thermoset Composites

The pressures facing many industries to move to lighter weight parts and more environmentally friendly materials of construction and processing methods has risen considerably over the last decade. Meeting those goals without sacrificing performance or durability remains a significant challenge and limits the adoption of many technologies. This presentation will discuss a new enabling technology capable of producing natural fiber composites with acrylic-based thermosets that deliver high mechanical performance and address drivers for mass reduction and environmental issues.

Victor Bravo, National Research Council Canada

Direct Long Biofibre Thermoplastic Composites for Automotive, Aerospace & Transportation Industries

This paper deals with the challenges of using biofibres as reinforcing materials for thermoplastic resins. The research work involved the use of short flax fibres in a continuous-compounding process and flax fibre rovings in a direct-long fibre thermoplastic (D-LFT) process. Experiments using commercial flax rovings (continuous fibres) on an industrial large-scale D-LFT line showed the viability of the processing technique.

Robert Joyce, Innovative Plastics & Molding
Fluid Assist Injected Molded Parts with FibreTuff – a Natural Fiber Composite
This presentation discusses the advantages of fluid-assist technology with a new biopolymer compound, "FibreTuff," as well as the applications where this new biopolymer technology helps increase performance and functionality while lowering costs to produce a molded part.

Rick Bell, DuPont Automotive
Commercial Applications of Bio-Based Polymers in Automotive
Recent new product developments have expanded the functional performance of bio-based polymers, allowing their use in some of the most demanding automotive applications for high temperature, chemical resistance, and structural properties. Commercial applications include glass-reinforced polyester and nylon for structural and underhood components. While these polymers provide significant environmental benefits, their unique properties have also provided cost savings. This presentation will provide an overview of DuPont's bio-based technology platform, polymer properties, and applications in the automotive sector.

VIRTUAL PROTOTYPING & TESTING OF COMPOSITES – PART 1: Fiber Orientation

Tim Latimer, University of Tulsa
A Method for Characterizing Fiber Length Distribution in Random Fiber Composites
It is well known that retained fiber length in random-fiber composite materials relates directly to resultant mechanical properties. However, a rapid and robust quantitative fiber-length characterization method seems to have eluded the industry to date. Based upon these limitations and needs, a method to rapidly characterize the fiber-length distribution in random-fiber composites was investigated. The experimental procedure is discussed and the results to date are presented.

Kevin Meyer, Virginia Tech
Progress on Simulating Orientation of Long Glass Fibers in Composites Molding
This presentation offers a novel method of predicting fiber orientation in simple and complex flow fields based entirely on rheological methods. Fiber-orientation predictions are made with the classical Folgar-Tucker model along with a flexible fiber model and compared to experimental measurements.

Francesco DeLeo, University of Washington
Crashworthiness Energy Absorption of Carbon Fiber Composites: Experiment and Simulation
2010 SPE ACCE Scholarship Award Winner
2011 SPE ACCE Best Paper Award Winner
The merits and weaknesses of a progressive-failure composite-material model, MAT54, of a commercially available explicit finite-element solver, LS-DYNA, are highlighted through single-element investigations. Then, the suitability of MAT54 to simulate the quasi-static crushing of a composite specimen is evaluated. Through extensive calibration by trial and error, the crushing behavior of a semi-circular sinusoid specimen comprised of carbon fiber / epoxy unidirectional prepreg tape is properly simulated. The study is extended to five different geometries in order to evaluate the effect of geometric features on crush behavior, both from an experimental and numerical standpoint. Finally an energy-absorbing composite sandwich structural concept, comprised of a deep honeycomb core with carbon fiber / epoxy facesheets, subject to through-thickness crushing and penetration, is considered.

Syed Mazahir, Virginia Tech
Simulation of Folgar-Tucker Orientation Model with a Semi-Circular Advancing Front Geometry
The standard method of simulating fiber orientation in injection molding flows uses Hele Shaw approximation with the Folgar-Tucker model for orientation, ignoring the important effects of fountain flow in the frontal region. In this work, the effects of the fountain-flow region were assessed by including a simplified semi-circular cap to the finite-element mesh. We also looked at combinations of inlet conditions for orientation and the model parameters to determine their compatibility with the geometrical simplification used to describe the front.

VIRTUAL PROTOTYPING & TESTING OF COMPOSITES – PART 2: Fiber Orientation

Marios Lambi, BASF Corp.
Predicting Performance of Thermoplastic Composites Taking into Account the Fiber Orientation Effects Utilizing ULTRASIM™ Technology – Part I: Methodology
A major advantage of plastic part design is the high degree of flexibility to adjust sectional properties such as wall thickness and shape, but that same flexibility also increases design complexity, making analysis predictions quite difficult. The dependency of performance to processing parameters, and thus to fiber orientation effects is highly dependent on inherent part properties such as geometry and thickness. The ULTRASIM™ methodology presented here can accurately simulate and predict part performance taking into account the fiber orientation effects for the particular plastic material under consideration.

Marios Lambi, BASF Corp.

Predicting Performance of Thermoplastic Composites Taking into Account the Fiber Orientation Effects Utilizing ULTRASIM™ Technology – Part 2: Case Studies

The ULTRASIM™ methodology, already presented in Part I, can accurately simulate and predict part performance, taking into account the fiber orientation effects for the particular plastic material under consideration. Therefore, using finite-element structural analysis while accounting for anisotropic behavior of plastic materials yields very accurate predictions where the specific failure – whether tensile or compressive in nature – of the material is also taken into account. In this paper, various case studies will be presented to showcase the accuracy and predictive capabilities of this unique technology.

Robert Sherman, RTP Company

Injection Molding Fiber Orientation, Property Predictions, and Failure Analysis

This presentation reviews the principal driving factors that determine fiber orientation in structural injection moldings and how that influences the properties that these materials exhibit in actual part designs. It also presents an approach utilizing current predictive technologies to better predict at what loads and how part designs will fail.

VIRTUAL PROTOTYPING & TESTING OF COMPOSITES – PART 3: Toward Mainstream Automotive

Rani Richardson, Dassault Systèmes

CAD: Composites Are Different - Moving Beyond Yesterday's CAD Tools to Accelerate Adoption in Mass-Produced Autos

Most existing computer-aided design (CAD) software solutions were originally intended for use with metal and plastic parts of far less complexity than today's multi-layered composites. They offer no facility for keeping track of the laminate and composites properties, forcing the engineer to track this information manually in a spreadsheet. To reap the benefits of wide-spread composites use, the industry must adapt its processes and tools accordingly. Attendees of this presentation will learn how tight collaboration between design, analysis, and manufacturing teams will enable automotive OEMs, as well as suppliers to implement a seamless process to develop high-quality composites designs and bring them to market faster and at a lower cost.

Richard Schaake, SKF Engineering & Research Centre

Understanding of Aerospace Composite Design Principles for Structural Fittings

To design composites for weight reduction in structural components, aerospace *know-how* on design principles can be used. However, automotive volumes and functional needs are different from those of the aerospace industry, and the *know-how* needs to be translated to *know-why*. Simple mechanical models were used to generate this understanding and to provide a starting point for further investigations.

James Salerno, Plasan Carbon Composites

Implementation of Advanced Composite Design Software and Practices

An evaluation of current computer modeling and simulation techniques and their integration with composite design practices in the automotive industry is underway. This presentation includes discussion of the tools available to R&D, product development, prototyping / PPAP, and manufacturing engineering, and the potential benefits that result from their use.

VIRTUAL PROTOTYPING & TESTING OF COMPOSITES – PART 4: Modeling

Roger Assaker, e-Xstream engineering

DIGIMAT for Continuous Fiber Reinforced Composites

Predictive simulations are key to the development of composite materials, as well as their application in structural design. Mirroring the full process chain in the simulation approach of designing new parts provides the means to shorten development time and to reduce cost for experimental testing. Based on DIGIMAT unique technology, the nonlinear, anisotropic, temperature- and strain-rate dependent material properties for short- and continuous-fiber reinforced plastics are accurately predicted. This paper will demonstrate the basic idea and workflow of DIGIMAT for the modeling of (thermo-) mechanical behavior, NVH, crashworthiness, or fatigue in advanced multi-scale simulation models.

Michael Parrott, e-Xstream engineering

Multi-Scale Modeling of Fatigue of Fiber Reinforced Plastics with DIGIMAT

This presentation deals with the prediction of the high-cycle fatigue behavior of polymer-matrix composites, based on mean-field homogenization. We present the basis of the mean-field homogenization formulation and illustrate the methodology through the analysis of the fatigue properties (i.e. SN curve) of fiber-reinforced materials having different microstructures. Such fatigue modeling using DIGIMAT allows analysis of the sensitivity of the fatigue properties to fiber orientation and the nature of the applied load.

Paul Deslauriers, Multimatic Engineering

Finite Element Modeling of Bond-Line Read-Through in Composite Automotive Body Panels Subject to Elevated Temperature Cure

The current paper discusses the FEA-based approach to predict bond-line read-through (BLRT), which can occur when bonding Class A SMC body-panel assemblies. A parametric joint parameter study is reviewed as background, and the results of a lab-scale coupon study are presented in which measured curvature results are compared to FEA predictions and good qualitative agreement is found. Additional analytical panel studies are presented that indicate that BLRT is a localized phenomenon so that the overall panel geometry does not influence the local BLRT severity. However, changes in local panel geometry can influence the BLRT severity.

FINALIZING THE DESIGN & DEVELOPMENT OF A STRUCTURAL COMPOSITE UNDERBODY – PART 1:

Libby Berger, General Motors Co. / USCAR

Program Summary of the ACC Automotive Composites Underbody

A structural composite underbody capable of carrying crash loads has been designed, fabricated, assembled into a structure, and tested by the Automotive Composites Consortium. The underbody is compression molded of glass fabric sheet molding compound (SMC). Design was via CAE-based methodologies, and the molded underbody was weld bonded to a steel BIW structure. The underbody structure was tested to simulate an offset deformable-barrier crash, and the results compared to design.

Charles Knakal, USCAR

Manufacturing Scenarios & Challenges with a Fabric SMC Automotive Underbody

Compression molding of fabric SMC in steel tooling is a cross between prepreg molding and regular sheet molding compound (SMC) molding. Material processing differences, such as minimal material flow, represent major manufacturing challenges requiring different approaches for production operations. This paper will present the observed challenges and potential approaches that will enable cost-effective manufacturing scenarios. Aspects of the processing include (but are not limited to) SMC compounding, charge cutting, charge placement, tool loading, edge filling of the part, wrinkles and overlaps, part trimming, modeling, and material testing. Presented will be solutions we utilized, in addition to studies and cost models used to alleviate some concerns.

Libby Berger, General Motors Co. / USCAR

Material Properties of a Fabric Sheet Molding Compound for a Structural Composite Underbody

The Automotive Composites Consortium (ACC) has selected a fabric sheet molding compound (SMC) as the main material and compression molding as the process system for a structural composite underbody. This paper describes the properties of this SMC material, including tensile, compression, and flex. Thermal properties including coefficient of linear thermal expansion and thermal transition temperatures were determined. The effect of two different fabric weights, and molding temperatures is also reported. Overlap and butt joints within the layup were compared.

FINALIZING THE DESIGN & DEVELOPMENT OF A STRUCTURAL COMPOSITE UNDERBODY – PART 2:

Justin Hunt, AET Integration Inc. / USCAR

Fatigue Performance of SMC Composite Material under Different Environmental Damage & Temperature Conditions

The fatigue performance of SMC under different environmental and impact-damaged conditions is explored. The effects of stress, loading frequency, and environmental temperature on localized heating is explained.

Hannes Fuchs, Multimatic Engineering / USCAR

Status of the Composite Underbody Component & Assembly Structural Test-Analysis Correlation

2011 SPE ACCE Best Paper Award Winner

The paper will discuss the preparation and fabrication underbody test assemblies, the structural stiffness and modal performance testing of trimmed underbody molded components and assemblies, and the destructive testing of assemblies. The predicted performance was investigated for two composite thickness assumptions to account for the additional thickness observed in the prototype components. Predictions were then compared to the measured test results to understand the status of correlation between the response of idealized components and the as-molded prototype test components. Predictions were found to be in good agreement with testing.

ADVANCES IN THERMOPLASTIC COMPOSITES – PART 1: Enhancing Polypropylene

Scott Miller, Dow Corning Corp.

Closing the Gap Between Polypropylene and Polyamide Composites with New Silane Grafting Technology from Dow Corning

A breakthrough has been made that will significantly improve the performance of polypropylene (PP) composites, thereby reducing the performance gap between PP and polyamide. Novel silane technology has been discovered allowing for the coupling of glass fibers to PP, as well as cross-linking neat PP, while minimizing polymer degradation. The presentation will show the improvements in performance, when compared to homopolymer and maleic anhydride grafted PP (MAgPP), including improvements in thermal stability, mechanical performance, aging under various conditions, and more.

Yan Jin, SINOPEC Beijing Research Institute of Chemical Industry

Analysis of Polypropylene Odor Based on Electronic Olfactory System

In this work, the undesirable odor from neat PP was evaluated using an electronic olfactory system equipped with 18 metal-oxide semi-conductor sensors. Odor of PP and the effects of heating temperature and heating time on the odor from different grades of PP resin were studied. It was found that the odor of PP resin could be detected by the electronic olfactory system quickly and accurately and significant effects of heating time and heating temperature above 50°C on the release of the odor was observed, with the odor intensity of PP resin increasing with the increase of heating temperature and heating time.

Joseph George, Quadrant Plastic Composites

Lightweight Design of Structural Parts with Thermoplastic Composites

Glass mat thermoplastic (GMT) composites have been available for many decades. Recent developments in woven-fabric reinforced GMT, as well as improved computer simulations have enabled the material to be used in new applications that previously were designed solely in steel. This presentation will focus on utilizing computer simulations and best design practices in order to specify the most appropriate GMT formulation for a given application.

ADVANCES IN THERMOPLASTIC COMPOSITES – PART 2: Enhancing Polypropylene

Creig Bowland, PPG Industries, Inc.

A Formulation Study of Long Fiber Thermoplastic Polypropylene (Part 3): Mechanical Properties of PP DLFT Composites

In part three of this multiyear study, the properties and performance of PP DLFT are explored using a Coperion-based DLFT compression-molding system. An extensive formulation DOE was initiated to determine the performance of PP DLFT and to compare and contrast this work with the prior work done on PP GLFT. The results of this ongoing research are reported.

K.B. Thattaiparthasarthy, University of Alabama at Birmingham

Colored Inorganic Pigmented Long Fiber Thermoplastics

This work establishes a comprehensive understanding of the effects of colored inorganic pigments in long fiber pellets. The ability to integrate color in LFT products in the manufacturing step eliminates the need for secondary painting. Pigment variables such as particle size, distribution, chemistry, and coatings and their influence on the strength of the final part have been investigated.

John Klein, Asahi Kasei Plastics North America

High Performance Engineered Polypropylene Compounds for High Temperature Automotive Under-the-Hood Applications

Over the years, plastic composite air-intake manifolds made of glass-filled nylon 6 and 66 have replaced their metal counterparts. While nylon has been an ideal material for these demanding underhood applications, optimized polypropylene compounds are proving that they are able to perform equally well in these high-temperature operating environments. This paper introduces a new polymer innovation: a high-temperature glass-reinforced polypropylene compound. Key performance attributes will be compared to incumbent materials and the material's suitability for underhood applications will be explored.

ADVANCES IN THERMOPLASTIC COMPOSITES – PART 3: Applications Update

C.H. Choi, Hyundai Motor Co.

Recent Thermoplastic Composites for Automotive Applications

Recently, Hyundai & Kia Motors have developed many kinds of composites based on polypropylene (PP) and have tried to apply these for the exterior, interor, chassis, and body parts. The company has achieved good results, which helped reduce part costs as well as weight.

Marcia Kurcz, Polyscope Polymers B.V.

Automotive Sunroof Systems & Frames in Xiran® SMA/ABS

Automotive sunroof systems have become popular options on many classes of vehicle owing to their ability to enhance comfort and styling. Sunroof components, particularly frames, need to meet a wide range of technical requirements, with a clear focus on dimensional stability, functional integration, safety, and cost and weight reduction. Current metal and plastic designs used for sunroof frames do not adequately meet these application needs. However, an engineering thermoplastic – glass-reinforced SMA/ABS – long used on vehicle interiors is increasingly being considered on sunroof components owing to its unique combination of precision molding capabilities, compatibility with sunroof adhesives, fast processing, lower systems cost and weight, and ability to be recycled.

Thomas Russell, Allied Composite Technologies LLC

Thermoplastic Composite Structural Strut

This presentation will describe Air-Frame™, a novel low-mass, high-strength composite strut member made in a high-productivity process. The technology is compatible with a wide variety of thermoplastics and continuous-strand reinforcements and creates a helical braided design with a very-high stiffness / weight ratio. Potential applications are various structural components as well as crash and energy-management systems.

ADVANCES IN THERMOPLASTIC COMPOSITES – PART 4: High-Temperature Matrices

Bob Newill, Ticona Engineering Polymers

Aerospace & Automotive Seat Frames from Carbon & PPS Thermoplastic Tape

In both the automotive and aerospace industries, seat frames are typically multipiece aluminum designs and can represent a significant proportion of total seat and vehicle weight. Both industries also face pressures to reduce mass (to increase fuel efficiency) and to contain or reduce production costs. New materials and process options that reduce mass and increase functionality are welcome, but must be cost-competitive with current aluminum systems. An award-winning seat frame and seat back using high-performance thermoplastic tapes of PPS resin and carbon fiber have been shown to meet aerospace performance requirements and are currently being evaluated by seat suppliers. They also show promise of meeting automotive cost and production targets.

Steve Mok, DuPont Automotive

Superior Resistance to Thermo-Oxidative & Chemical Degradation in Polyamides & Polyphthalamides

DuPont™ SHIELD technology allows polyamide and polyphthalamide (PPA) resins to be used at higher temperatures than could be previously achieved. This technology combines several innovations, including a new polymer backbone, polymer modifications, and a special set of additives to enhance performance. Resistance to thermo-oxidative damage and chemical degradation is highly superior vs. standard polyamide resins. Examples of improved performance, including resistances to hot air oven aging at 210°C, hot automotive oils, and calcium chloride cracking will be discussed.

Charlie Costello, Ticona Engineering Polymers

Thermoplastics for High-Temperature Composite Processes & Applications

The high-temperature, high-mechanical performance end of the composite materials spectrum has long been dominated by thermoset matrices with continuous-strand, unidirectional fiber or fabric reinforcements. However, that is starting to change as thermoplastic resin suppliers position their own high-temperature offsets in this segment – not just as lower cost, lower weight, faster processing replacement for thermosets, but as direct metal replacements themselves. This paper provides an overview of current market pressures supporting growth of high-performance thermoplastics, and then reviews processing options for high-performance composites with thermoplastic as well as thermoset matrices. Next, several short case histories involving conversions to thermoplastic matrices directly from metals are presented.

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

Kipp Grumm, BASF Corp & Amit Kulkarni, Faurecia

Thermoplastic Overmolded Continuous Fiber Structures

The technology of over-molding continuous fiber inserts to achieve strong, lightweight composite parts allows for the additional benefits of feature integration and parts consolidation. This technology can be used with nearly any polymer and reinforcing fiber. To illustrate the versatility of this technology, we will present a case study on a seat back produced with glass-reinforced nylon 6, including discussion of adhesion with the continuous fiber insert, CAE methods, and correlation with actual testing.

Benjamin Hangs, Fraunhofer Institut für Chemische Technologie
Integration of Features into Parts Made from Thermoplastic, Unidirectional Tape – Overview and Case Study
2010 SPE ACCE Scholarship Award Winner
The paper presents an overview of desired features that are commonly part of complex technical applications. It shows how implementation of those can be achieved with continuous-fiber-reinforced structures by combining them with short and long fiber-reinforced material. In a case study, an investigation on over-molding of unidirectional tape inserts is presented.

Timo Huber, Fraunhofer Institut für Chemische Technologie
Local Continuous Fibre-Reinforcement – Tailored Injection Moulding >> Lightweight Potential for Injection Molding Parts <<
Weight reduction of components is becoming increasingly important, for example in automotive applications where significant fuel savings and CO_2 emission reduction can be made. The limited mechanical properties, such as stiffness and impact strength, prohibit the use of injection moulded parts in higher load-bearing applications. The high potential of local continuous fibre reinforcement under static and dynamic load conditions is presented.

ADVANCES IN COMPOSITE REINFORCEMENT TECHNOLOGIES – PART 2: New Options for Improving Mechanicals

Jackie Rehkopf, Plasan Carbon Composites
Sustainability with Automotive Carbon Fibre Composites: Reclaimed Carbon Fibre – cPBT Thermoplastic Composite
During the development and deployment of more carbon fibre composites in the automotive industry, consideration is also given to sustainability aspects. Partnering with Materials Innovation Technologies and Cyclics Corp., Plasan Carbon Composites is developing a new addition to its portfolio that uses reclaimed carbon fibre in a thermoplastic matrix that emits no volatile organic compounds (VOCs) during production or in-service life. The presentation will provide details on the carbon fibre reclamation, the processing with cyclic polybutylene terephthlate (cPBT) resin for a high fibre content, and preliminary properties of the composite to guide component application targets.

Uday Vaidya, University of Alabama at Birmingham
Hybrid Thermoplastic Composites with High Strength Embedded Metal Cords - Static & Impact Behavior
Hybrid materials featuring thermoplastic polymer composites in conjunction with high-strength steel cords can be used as structural materials in commercial transport, trucks, mass transit, and military vehicles. The synergy of metal cords with thermoplastic composites in terms of mechanical and chemical treatment of the interphase, pull-out, and impact has been investigated.

Uday Vaidya, University of Alabama at Birmingham
Mechanical & Impact Response of Recycled Thermplastic & Flyash Foam Composites
The heavy transport industry has a significant amount of scrap generated in the manufacture of parts such as trailer bodies and structural components. Presently, that scrap is landfilled. This paper presents the processing and resulting properties of recycled thermoplastic composites into useful products for reuse in transportation and related applications.

NANOCOMPOSITES

Martin Bureau, National Research Council Canada
Selective Compatibilization for Stiffer, High Impact TPO/Clay Nanocomposites
Different compatibilization strategies from masterbatch mixing with a twin-screw extruder with various coupling agents were investigated to improve the stiffness of nanocomposites using a high-impact TPO. Based on impact and microstructural analysis results, it is concluded that organoclays act on the rubbery phase to increase the toughening effect in the TPO, presumably by increasing the cavitation stress of the TPO.

Xian Jiang, Michigan State University
Synthesis of Bipolar Plates for Fuel Cells Based on Exfoliated Graphene Nanoplatelets Filled Polymeric Nanocomposites
2011 SPE ACCE Best Paper Award Winner
The objective of this research was to investigate the potential of using exfoliated graphene nanoplatelets (GNP) as the conductive filler to construct highly conductive polymeric nanocomposites to substitute for conventional metallic and graphite bipolar plates in the polymer electrolyte membrane (PEM) fuel cells. It is believed that the bipolar plates made from HDPE/GNP nanocomposites will allow lighter weight PEM fuel cells to be produced with enhanced performance that is particularly suited for automotive applications.

W.H. Katie Zhong, Washington State University
Enabling Faster Resin Infusion Processing of Automotive Composites: A "Nano-Nectar" Technology Leading Epoxy to High Performance and Low Viscosity
2011 SPE ACCE Best Paper Award Winner
A "nano-nectar" technology is used to make nanofillers into liquid nano-reinforcement (LNR) acting as a "nano-nectar" for making nano-epoxy. The LNR can easily be dispersed in the base epoxy matrix and proves highly effective for reinforcing and toughening the epoxy resin. It also contributes to dramatically reducing viscosity, which is significant to FRP composites manufacturing energy efficiency (reduced power requirements for flow and part consolidation).

KEYNOTE SPEAKERS

John Schweitzer, American Composites Manufacturers Association

NTP's Cancer Assessment for Styrene – Science, Policy and Implications

Despite several authoritative weight-of-the-evidence assessments supporting a conclusion that styrene does not pose a cancer risk, in June the U.S. Department of Health & Human Services National Toxicology Program (NTP) listed styrene as a "reasonably anticipated" carcinogen in the NTP Report on Carcinogens. ACMA is concerned that the impact of this listing on composite manufacturers may include increased worker turnover, loss of community goodwill, increased costs for liability insurance, unwarranted tort claims, and problems obtaining financing or selling a business. With its industry partners, ACMA is campaigning aggressively to overturn the NTP listing. The campaign includes 2 major ongoing scientific studies, seeking an authoritative review by the National Academy of Sciences, legal action against NTP, and efforts aimed at developing support in Congress. In addition, ACMA provides tools for its members to communicate with employees and plant neighbors about styrene health risk.

C. David Warren, Oak Ridge National Laboratory

Lower Cost Carbon Fiber in High Volumes for 21st-Century Industries – The Obstacles to Getting There

There has been great excitement about the potential for using carbon fiber-reinforced composites during the last few years in high-volume applications. Currently, the largest hurdle to broad implementation in transportation, infrastructure, and consumer goods is the high cost of carbon fiber itself vs. other candidate materials. As part of the U.S. Department of Energy's (DOE's) Vehicle Technologies and Industrial Technologies Programs, significant research is being conducted to develop lower cost, high-volume capable technologies for producing and using carbon fiber. To date, new precursor materials and processing technologies have been developed that offer the potential for a future type of lower cost, moderate performance, high-volume, commodity grade of carbon fiber. This presentation will highlight ongoing research and the potential future applications of less expensive fibers, as well as cover other obstacles beyond cost and provide suggestions for approaches to overcoming those challenges.

Antony Dodworth, Dodworth Design

Stiffer is Better: Lessons Learned in Composites Design of Lightweight Automotive Structures

With all the pressure to take weight out of vehicles these days, both aluminum and carbon composites-intensive architectures have gotten a lot of attention. An alternative approach is to use a hybrid materials design that meets functional objectives of performance and cost that otherwise are not achievable with a mono-material system. By picking the best of new materials and assembly methods to meet volume and investment, novel designs can be produced that solve long-established problems. This presentation describes a clean-sheet design for a 2+2 sports car that incorporates lessons learned throughout a career working on both aluminum- and carbon-intensive vehicles for the racing and supercar segments.

Chuck Kazmierski, Program Manager, Lucintel

Growth Opportunities in Global Composites Market 2011- 2016

The composites industry is already sustainable with over 30,000 applications worldwide. There are positive signs of healthy, visible growth in the gradual rebound of the automotive, construction, electronics, and consumer-goods markets. Right now, there are numerous external forces that are reshaping the composites industry – population growth, new infrastructure projects, urbanization, increases in middle-class populations in the developing world, and the green movement. These pressures will help ensure growth stays strong for the foreseeable future, especially in the Brazil/Russia/India/China (BRIC) region.

Patrice Sinthon, JEC Group

Main Trends & Dynamics of the Worldwide Composites Industry

Over the last decade, JEC Group has become the world's largest industry organization, serving the complete value chain of the composites industry and providing a network that connects 250,000 professionals in 96 countries. The organization joins science, technology, and business through six areas of expertise: connecting opportunities (tradeshows in Europe, Asia, & the Americas), information channels (web hub, magazines, and eNewsletters), learning resources (end-users forums, conferences, workshops, and technical demonstrations), business intelligence (strategic studies), a publications library, and innovations programs (including regional and international design competitions). The American composites industry has a strong record for high-volume usage with automated processes coupled with good design and development expertise. This market looks prosperous through 2015 and beyond. Hence, JEC has joined with the Industrial Fabrics Association International (IFAI) for its newest tradeshow in Boston, November 7-9, 2012. This presentation will discuss benefits of participating in this new show, as well as provide industry forecasts drawn from JEC market research.

Nathan Armstrong, Motive Industries

Return of the Small Car Maker

Over the last decade, the pace of technology has advanced in all fields of design and manufacturing at an unparalleled pace thanks to a number of useful tools, like CAD, rapid prototyping, CNC milling, new plastics and composites technologies, and the knowledge and experience to combine all these elements into "the second industrial revolution." The impact this has had on industry is unquestionably enabling the largest shift in influence ever seen. The small guys now have the same tools as the big guys, but often with more freedom and flexibility to demonstrate applications in technology that the large companies cannot. When design freedom and access to advanced materials, such as fibre-reinforced plastics are combined, the possibility of the small automaker re-emerges.

Ashish Diwanji, Owens Corning

Winning with Composites in a World Seeking Sustainable Solutions

Oil price volatility, supply security concerns, and an ever-increasing and consuming population have created significant global issues with repercussions that are being felt today and may continue for decades to come. Faced with this situation, we must develop solutions to meet problems head-on. For the composites industry, such challenges represent opportunity for business growth in markets ranging from automotive to alternative energy to building infrastructure. As a part of this solution, use of glass composites helps deliver preferable, sustainable solutions for our world. Converting traditional materials to composites can enhance energy efficiency and productivity since composite parts consume less energy, emit fewer greenhouse gases, and offer the additional benefits of greater durability, corrosion resistance, longer term aesthetics, and added safety. With tools like Life Cycle Assessment (LCA), the industry has a methodology for calculating and communicating the relative eco-benefits of composites applications.

David Lashmore, Nanocomp Technologies, Inc.

Carbon Nanotube Composites Fabricated from Multiwall Carbon Nanotube (MWCNT) Mat

Carbon nanotubes are nearly immune to corrosion and fatigue in composites at nominal operating conditions. At the nanolevel, they are also very stiff and strong, yet incredibly lightweight, all of which makes them highly desirable as structural reinforcements for composites. However, the challenge has been to find ways to integrate nanotubes and other nanoparticles into a resin matrix successfully in order to take advantage of their unique properties. Nanocomp Technologies Inc. was formed to leverage its proprietary technology for the production of long carbon nanotubes together with a unique ability to fabricate them into physically strong, lightweight, electro-thermally conductive fibers, yarns, and felts to create a new generation of advanced structural materials and electro-energy devices. This presentation reviews the synthesis of single, dual, and multiwall CNT types into large sheets or high-strength CNT-based fibers used to produce prepreg and net-shape articles for multifunctional polymeric composites with very-high CNT loadings.

Mark Voss, General Motors Co.

GM's Lightweighting Strategy for Composites

The justification for future composite executions is evolving rapidly at GM. This presentation will review the current status of composite executions at GM and discuss what is required for future applications.

PANEL DISCUSSIONS:

The Role of Composites in Battery Cases & Trays for Fleet Electrification

Moderator: **Drew Winter**, *Editor-in-Chief, Ward's AutoWorld*

Confirmed Panelists:

Jim Dutchik, *Business Development Manager, Asahi Kasei North America;*
Frank Henning, *Deputy Director, Fraunhofer ICT;*
Kestutis Sonta, *Senior Materials Engineer, General Motors Co.;*
Joe Bodary, *Manager-Engineering & Prototype, Continental Structural Plastics*

Battery packs that power hybrid- and battery-electric vehicles (HEVs & BEVs) bring their own special challenges for vehicle designers, yet provide an excellent opportunity for composites to shine. First, batteries are heavy, making it important that trays be structural and able to support significant mass without creeping over a wide range of temperatures for the life of the vehicle. Furthermore, owing to consumer "range anxiety" and the desire to extend practical driving range on these vehicles, it is highly desirable to take weight out wherever possible. Still another challenge is that batteries are caustic, so it is important that both cases and trays be corrosion resistant and able to withstand the aggressive chemicals inside. Last, metal-oxide batteries operate at high temperatures, so materials for battery cases and trays need to also provide sufficient thermal performance. This panel discussion will evaluate the challenges and opportunities presented by fleet electrification and the materials technologies that are working and those that are not.

Measuring the Sustainability Proposition of Composites

Moderator: **Jeff Sloan**, *Editor-in-Chief, CompositesWorld.com*

Confirmed Panelists:

Shristy Bashyal, *Graduate Student, University of Missouri;*
Ashish Diwanji, *Vice-President of Innovation, Owens Corning;*
Antony Dodworth, *Managing Director, Dodworth Design;*
C. David Warren, *Program Manager-Transportation Materials & Carbon Fiber, Oak Ridge National Laboratory;*
Jaap van der Woude, *Director-Science & Technology Europe, Environmental, PPG Industries;*
Mark Voss, *Lead Composites Engineer, General Motors Co.*

The automotive industry faces numerous new *green* initiatives, including end-of-life materials recovery, significantly boosting average vehicle fuel economy, and reducing its carbon dioxide (CO_2) footprint – both during production and throughout the use life of its vehicles. This makes it increasingly important for the composites industry to be able to provide quantitative data on just how sustainable composites are as a materials technology vs. metallic alternatives. However, defining just what is *green* and how that should be measured is a significant hurdle at present. This panel discussion will evaluate some of the more useful tools currently available, such as life-cycle analysis (LCA), and consider how to accurately and fairly begin the process of quantifying the sustainability proposition of composites.