Wednesday Morning: In Granite/Gold/Copper Room

Opportunities & Challenges with Carbon Composites – Part 1:

Patric Winterhalter
Schuler SMG GmbH & Co. KG

Application of Vacuum-Assisted High-Pressure RTM-Process for the Series Production of CFRP Components for Car Bodies

Lightweight design with CFRP is not just a catch phrase. A South German car maker has installed a total of ten lines for the large-scale series production of CFRP-parts used in a passenger cell for e-cars made of CFRP. On these lines, the vacuum-assisted high pressure RTM-method is applied on parallelism-controlled 36,000 kN presses equipped with twin-shuttle moving bolsters. This presentation begins by exploring the motivation for CFRP lightweight design, continues with an explanation of the applied vacuum-assisted high-pressure RTM method, including both press and automation technology that complies with the special requirements of the RTM process and the logistics of both preformed and final parts. The presentation ends with a systems overview of the complete RTM process chain, leading from the production of preform parts via automation to the final pressed CFRP part, and the introduction of a new development in press technology.

Leland Decker & James Truskin
Chrysler Group LLC

SRT Viper Chrysler Carbon Fiber Engine X-Brace

This presentation will discuss the design, development, and performance refinement of the 2013 SRT Viper carbon fiber-reinforced plastic (CFRP) X-brace. The single-piece all CFRP X-brace was developed from lightweight carbon fiber composite material to maximize weight reduction opportunities and meet the stringent vehicle performance targets of the all-new Viper. The design process was driven extensively by virtual engineering, which applied computer-aided engineering (CAE) analysis and results to optimize the design and improve the design efficiency. A close partnership between Chrysler Body Engineering, Chrysler Product Design Office, and tier 1 Plasan Carbon Composites lead to the completion of this part, which will be sold in the aftermarket by Chrysler's Mopar parts division.

Tim Langschwager & Matt Kaczmarczyk
Quantum Composites

The Application of Composite Design Principles for Light Weighting Structural Components using Discontinuous Carbon Fiber Materials

The primary focus of this presentation will be the use of lightweight carbon fiber-reinforced thermoset compounds (AMC® Advanced Molding Compounds) for a comprehensive approach to design and validation of structural components. Discussion will include the use of discontinuous carbon fiber sheet molding compound (CF-SMC) for light weighting structures. The presentation also will cover variations in high-flow vs. low-flow compression molding, mechanical properties, and variation in carbon fiber tow size as it relates to mechanical properties and notch sensitivity. Also covered will be applications for CF-SMC and how they compare with competitive technologies.

Takeshi Ishikawa
Mitsubishi Rayon Co., Ltd.

The Design of a Thermoplastic CF Composites for Low Pressure Molding

The design of a thermoplastic carbon fiber composite, which induces high moldability, is presented. The composite design of controlled carbon fiber length and its orientation is established by the regularly laminated prepreg sheet which has well designed with a slit pattern. Since the flowability of composite is improved by the slit pattern — not only in the in-plane direction but also in the lamination direction — the process requires relatively low pressure even if a large amount of fiber is contained. The material can be formed by compression molding and several kinds of thermoforming processes. The short cycle time of this thermoplastic composite process is an advantage for high-volume production of vehicular parts. Structural performance can also be controlled in a similar manner via flow design. This allows for tailoring and balancing of composite weight, flowability, and mechanical performance.

Jan-Anders Månson
École Polytechnique Fédérale de Lausanne

Carbon Fiber Reinforced Composite Waste: An Environmental Assessment of Recycling, Energy Recovery & Landfilling

The environmental benefits of recycling carbon fiber-reinforced plastic (CFRP) waste are assessed against other end-of-life (EOL) treatments. Recycling via pyrolysis, incineration with energy recovery, and disposal via landfilling are compared. To account for physical changes to materials from use and recycling, equivalence between recycled and virgin materials is calculated based on the ability to produce a short-fiber composite beam of equivalent stiffness. Secondary effects of using cecycled carbon fiber (RCF) in a hypothetical automotive application are also analyzed. Results underline the ecological constraints towards recycling CFRPs and demonstrate that benefits from recycling are strongly linked to the impacts of the selected recovery process, the materials replaced by RCF in a secondary application, and also to the type of secondary application in which they are used.

Abstracts of Speaker Presentations 2013

Wednesday Morning: In Emerald/Amethyst Room

Tutorials – Part 1:

Klaus Gleich & Frank Henning
Johns Manville & Fraunhofer-Institut für Chemische Technologie

Parts 1-4: Processing Technologies for the Manufacturing of Thermoplastic and Thermoset Composites Part

Polymer composites are the key for lightweight construction and enable automotive producers to reduce fuel consumption and emissions and fulfill governmental requirements. Today, processes and materials are available to produce polymer composites with an excellent balance of cost and performance. This tutorial will focus on processing technologies for the production of polymer-matrix composites. Advantages and challenges of the manufacturing of thermoplastic and thermoset composites parts will be highlighted.

James Chantler
PPG Industries

Fiberglass Reinforcement Sizing 101

An introduction and general overview of the manufacture of fiberglass reinforcements is presented. Included is a general discussion of the role and components of the chemical coating on the glass fibers known as the sizing and why these chemicals are important to the manufacture and final properties of composites. This presentation explains what sizing is, how it affects composite properties, how it is applied to glass, what classes of sizing chemicals are used, and what each component does and why it is needed. The goal is to help the fiberglass industry educate customers and debunk the myth that all fiberglass is the same.

Wednesday Morning: In Bronze/Silver Room

Virtual Prototyping & Testing of Composites – Part 1:

Tom James
FORMAX

Modelling and Optimisation of a Multiaxial Fabric

The primary aims of the project were to determine the suitability of ESI PAMFORM with regards to modelling a multiaxial fabric and to assess how a manual forming process could be simulated. Material models for multiaxial fabrics were developed through physical testing. Four different simulation methods were investigated and compared in terms of ease of set up, processing time, and results. An optimisation process was developed using batched input files in order to examine the optimum fabric property for a given component. This process is now used to assist in the selection of a fabric in the early stages of any new component design. A UK government-funded Knowledge Transfer Partnership (KTP) with Nottingham University was started in January 2013 with the aim to create a validated materials database for use with this simulation.

Roger Assaker
e-Xstream engineering

Multi-Scale Modeling of Failure of Continuous Carbon Fiber Composites Application to Coupon Tests

In the steady quest for lightweighting solutions, continuous carbon fiber composites come down to the ground, serving now not only the aerospace but also the automotive industries. This category of carbon fiber-reinforced plastics (CFRP) has recently taken a step in car body structures for its high stiffness and strength. Continuous carbon fiber composites are much more complex than metal, with respect to failure in particular. This presentation will cover the application of micro-mechanically-based progressive failure models to simple demonstrator structures such as coupons.

R. Byron Pipes
Purdue University

Lightweighting through Composites Simulations - The Composites Design and Manufacturing HUB

The primary objective of the Composites Design and Manufacturing HUB (cdmHUB) is to accelerate the development of a comprehensive simulation tool set for the composites community for use in lightweighting vehicles. The cdmHUB provides a platform for the birth, development, refinement, integration, and commercialization of the simulation tools necessary to bring composites design and manufacturing simulation to a level consistent with high-performance composites simulation tools for geometric and structural modeling such as CATIA, NASTRAN, ABACUS and ANSYS. The cdmHUB is a cloud-based cooperative platform that can host composites design and manufacturing simulation tools that may be accessed with a web browser from the Internet.

Edward Bernardon
Siemens PLM Software

Engineering Software for Designing Cost Effective Mixed Material Vehicles

This presentation discusses issues that must be addressed by engineering software tools currently used for metal structures and based primarily on geometry so that engineers can efficiently make the tradeoffs required to design mixed-material vehicles. Engineering software must help identify optimal combinations of materials, assembly methods, and joining technologies by allowing engineers to efficiently conduct tradeoffs. These tradeoffs include assembly complexity vs. part complexity, the appropriate mix of material (metals, plastics, composites), the impact of alternative joining methods, and assessment of part manufacturing and assembly alternatives, while concurrently conducting an integrated design cost and performance assessment as design features are changed.

Giuseppe Resta
Altair

CAE Simulation Catalyzes Composites Growth: Material, Modeling & Optimization

Automakers have developed successful computer simulation processes to meet the most stringent crash, noise/vibration/harshness (NVH), and aerodynamic and vehicle dynamics requirements, making computer-aided engineering (CAE) an established component in today vehicle-design process. Engineers and management are comfortable with CAE deliverables for traditional metal-based vehicle design and now require reliable simulation technologies and methods to integrate engineered plastic such as carbon fiber laminates in their standardized and automated simulation procedures. This presentation will discuss the challenges of composite material calibration, how CAE simulation can be used to aid material characterization, the unique modeling and visualization requirement for composites, and how optimization simplifies the design of laminate composite structures tailoring the material itself to the loading requirements and avoiding overdesign of part.

Wednesday Morning: In Pearl Room

Nanocomposites – Part 1:

Uday Vaidya
University of Alabama at Birmingham

Nanographene Reinforced Carbon-Carbon Composites

Carbon-carbon composites (CCC) have applications in under-the-hood and friction applications in automobiles where high heat is generated. In this study, CCC was produced by using nanographene platelets (NGP) as nanofillers. Different weight concentration (0.5 wt%, 1.5 wt%, 3 wt%, 5 wt%) NGPs were introduced by spraying the NGPs during the prepreg formation. The nanographene reinforced CCC was characterized for effect of NGP concentration on microstructure, porosity, inter laminar shear strength (ILSS) and flexural strength. It was found that flexure properties and ILSS increased whereas porosity decreased with addition of NGP.

Alper Kiziltas
University of Maine

Graphene Based Impact Modified Polypropylene Nanocomposites for Automotive Applications

2012 SPE ACCE Scholarship Award Winner

Graphene-based nanocomposites demonstrate superior electrical, mechanical, physical, and thermal properties. Because of this, they have moved swiftly from the research laboratory into the marketplace in applications in aerospace, automotive, coatings, electronics, energy storage, and paints. Based on the huge interest, enhanced properties, as well as ease of production and handling, the European Union is funding a 10 year, $1.73 billion coordination action on graphene; South Korea is spending $350 million on commercialization initiatives; and the United Kingdom is investing $76 million in a commercialization hu because many current and potential applications for carbon nanotubes may be replaced by graphene at much lower cost. The main objective of this study was to characterize the influence of exfoliated grapheme nanoplatelets (xGnP) particle diameter, filler loading, and the addition of coupling agents on the mechanical, rheological, and thermal properties of xGnP-filled impact-modified polypropylene (IMPP) composites.

Frédéric Vautard
Michigan State University

High Density Polyethylene-Exfoliated Graphene Nanoplatelet Nanocomposites for Automotive Fuel Line and Fuel Tanks Applications

The potential of exfoliated graphene nanoplatelets (GnP) to increase the barrier properties of high-density polyethylene (HDPE) to oxygen and fuel was assessed. The mechanical properties (tensile, flexural, impact resistance), thermal stability and electro-conductivity of GnP-HDPE composites were studied as well. Those properties were related to the properties of the platelets (size, aspect ratio) and the quality of their dispersion in the HDPE matrix.

Michael Claes
NANOCYL SA

Carbon Nanotubes: Applications and Benefits in the Automotive Industry

Thanks to their multi-functionality, carbon nanotubes (CNTs)/polymer composites have allowed the development of many innovative parts in the automotive industry that offer improved properties at competitive costs vs. metals and filled polymers. Since CNTs do not negatively influence warpage or shrinkage, neither molds nor dies need to be changed to obtain required part dimensions. The benefits of electrical and thermal conductivity, chemical resistance, improvements in fracture toughness and compression strength, and even better paintability are leading to new innovations that improve performance, save weight, and replace metals without need for modifying existing equipment. This presentation will discuss examples of how nanotechnology is starting to exhibit its true potential and prove that it can improve or even impart new properties to polymers, which will allow researchers and engineers to develop breakthrough materials and unprecedented new technologies.

Abstracts of Speaker Presentations 2013

Wednesday Lunch: In Diamond Ballroom Keynote Speaker 1:

Greg Rucks, Senior Consultant,
Rocky Mountain Institute (RMI)

The Autocomposites Commercialization Launchpad: Kickstarting Mainstream Adoption of Automotive CF Composites

Ultralight, ultrastrong vehicles offer dramatic improvements in fuel efficiency, safety, and performance and allow powertrains to be smaller, lighter, and more cost-effectively electrified. Such vehicles will consist of a diverse mix of materials, but advanced composites — particularly carbon fiber (CF) composites — play a central role by enabling unparalleled vehicle weight-reduction potential. Automakers and their supply chains generally recognize these benefits. What is missing is a feasible path to high-volume commercialization that can address key barriers — high cost, inadequate manufacturing scale and technology, insufficient analysis toolsets, and immature repair and recycling techniques — to ultimately unlock CF composites' transformative potential. Earlier this year, Rocky Mountain Institute (RMI) and Munro & Associates kicked off the Autocomposites Commercialization Launchpad. With partners from across the supply chain, the immediate goal of the Launchpad is to assemble a competent and competitive CF composite automotive manufacturing team to design and produce a part for a 2018 model year vehicle at the unprecedented volume of 50,000 units or greater. In the longer term, the Autocomposites Commercialization Launchpad will foster additional commercialization projects and operate as an "innovation hub" to address critical and as-yet unmet industry needs and pave the way to a transformed industry built around lighter, stronger, safer, and higher-performing composite-intensive vehicles.

Wednesday Afternoon: In Granite/Gold/Copper Room

Opportunities & Challenges with Carbon Composites – Part 1:

Allan James
Dow Automotive Systems

What's the Difference: Thermoset vs. Thermoplastic Carbon Fiber Composites?

The challenge of improved fuel economy or lower CO_2 emissions is unrelenting. The transportation industry is seeking ways to lower the mass of their vehicles realizing lower weights can result in the reduction of the size and hence mass of other components. Two classes of materials are vying for applications on the automobile: thermoset and thermoplastic carbon fiber-reinforced composites. This presentation explores the fundamental differences between thermoplastics and thermosets and evaluates the resultant effect when implemented on an application on a vehicle.

Koichi Akiyama
Mitsubishi Rayon Co., Ltd.

Development of Particle-Core Compression Molding

CFRP (Carbon Fiber Reinforced Plastic) is a proven material that can significantly reduce vehicle weight, although it has not been widely used for automotive applications due to the lack of a high-cycle production process. Recently PCM (Prepreg Compression Molding) based on rapid-cure prepreg suitable for compression molding was introduced as a high-cycle compression molding process. The PCM process can produce high quality parts like the autoclave process with equally high efficiency as compression molding, which has long been used for high volume production in automotive applications. The PCM process can also provide high mechanical properties required for automotive structural applications. Hollow sections can effectively stiffen structures without adding much mass. but it has traditionally been difficult to mold hollow sections by compression molding because of high molding pressures. This presentation discusses development of removable particle core technology, a new molding technology to produce parts with hollow sections by the PCM process, which enables molding of hollow section by high-cycle compression molding, greatly increasing the stiffness of PCM parts.

Hendrik Mainka
Volkswagen AG

Alternative Precursors for Sustainable and Cost-Effective Carbon Fibers usable within the Automotive Industry

Lightweight design is an essential part of the overall Volkswagen strategy for reducing the CO_2 emissions. Carbon fiber-reinforced polymers (CFRP) offers an enormous lightweight potential. The use of CFRP is limited in mass series applications by the costs of the conventional C-fiber precursor Poly-Acrylic-Nitrile (PAN). The investigation of novel alternative precursors enabling a significant reduction in the costs of CFRP automotive parts is essential to make carbon fibers ready for a mainstream use within the automotive industry.

Dale Brosius
Quickstep Composites LLC

Alternative Precursors for Sustainable and Cost-Effective Carbon Fibers usable within the Automotive Industry

The increasing need to reduce mass in automobiles is driving interest in newer materials like carbon fiber composites. While the use of prepregs and autoclave processing is acceptable for racing cars and high cost supercars, a need exists for processes that can deliver higher volumes in much faster cycle times and lower costs. Compression molding and high-pressure RTM are options for highest volume applications that can justify the high equipment and tooling cost. For volumes in the 2,000 to 25,000 vehicles per year segment, Resin Spray Transmission (RST) offers a balance of low material costs, low tooling costs, and cycle times under twenty minutes per part, while delivering a Class A finish straight out of the mold for thin carbon fiber body panels. This presentation will cover materials and process development associated with the novel RST solution.

Wednesday Afternoon: In Emerald/Amethyst Room

Tutorials – Part 2:

Lindsay Brooke
SAE International® / Automotive Engineering International magazine

Parts 1-2: A Short History of Automotive Composites

For 100 years, plastics and composites have been vital to making vehicles lighter, more durable, and more efficient. But how well do you know their greatest milestones — and flops? Join veteran autowriter and SAE Magazines Senior Editor Lindsay Brooke as he turns on the way-back machine for a fun and surprising historical journey.

Dan Buckley
American GFM

Parts 1-2: Dry Fiber Preforming Methods — Pros and Cons

This presentation will discuss the various dry fiber preforming methods that can be used with the many iterations of liquid composites molding processes (e.g. resin transfer molding (RTM), vacuum-assist RTM (VARTM), liquid compression molding, high-pressure injection molding, etc.). The evolution of dry fiber processing methods will be shown as will the changes in binders, the importance of binder selection, and the evolution in mechanization of preforming. Many photos will be shown of the various types of preforming equipment with discussion of each dry fiber preforming method, process options, and how they relate to the types of reinforcing materials, applications, properties, and production rates achieved. It will be shown how application, material, and production requirements drive selection of the dry fiber preforming process. The pros and cons of each dry fiber preforming process will be discussed to provide guidance for process selection based on the design requirements of an application, material selection, and production requirements. For structural applications, complex dry fiber preforming will be shown for complex laminate schedules with mixtures of reinforcing materials such as engineering fabrics, woven materials, and unidirectional fabrics in complex fiber alignments. The use of inserts and core materials with complex dry fiber preforms also will be shown and discussed. Last, the pros and cons of the need for net-shape dry fiber preforms for high volume applications and structural applications will be discussed with examples and pictures.

Wednesday Afternoon: In Bronze/Silver Room

Virtual Prototyping & Testing of Composites – Part 2:

John T. Hofmann
Virginia Polytechnic Institute and State University

Experimental Evaluation of the Orientation of Long, Semi-Flexible Glass Fibers in Complex 3-Dimensional Flow

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

The experimental orientation of long, semi-flexible glass fibers has been evaluated in complex 3-dimensional flow. Preliminary experimental values of long-fiber orientation were obtained within injection-molded end-gated plaques at multiple percentages of plaque length and width, including in the areas of complex flow near the mold side walls. Additionally, experimental values of orientation were obtained within the sprue and gate region of the injection molded parts. Modification of the experimental method for measuring fiber orientation in these regions due to the increased length and flexibility of long fibers is included.

Gregorio Manuel Vélez-García
Oak Ridge National Laboratory

Assessment of the Slowdown in Fiber Orientation Evolution in a Center-Gated Disk

****2009 SPE ACCE Scholarship Award Winner****

Recent modifications to the standard Folgar-Tucker model aim to slow down the evolution of fiber orientation and have been shown to improve orientation predictions in shear flow experiments. However, assessment of these models in injection-molded geometries, in which shear and extension are both present, is very limited. In this work, researchers have assessed the evolution of orientation using the newly developed models in a center-gated disk, which provides a good injection molding test case combining both shear and extension.

Ken (KC) Cheng
Moldex3D Northern America

Three Dimensional Prediction of Fiber Orientation for Injection Molding of Long Fiber Reinforced Thermoplastics

****2013 SPE ACCE Best Paper Award Winner****

Long fiber-reinforced thermoplastic (FRT) composites in automotive industrial fabrication are of critical requirement -- more so than short FRTs. The FRT products' mechanical properties and warpage are dominated by fiber orientation within the part. This presentation will discuss a recently proposed new fiber orientation model for improving the prior developed models with regard to interaction and diffusion of the fibers immersed in a matrix, namely, iARD-RPR (Improved Anisotropic Rotary Diffusion model combined with Retarding Principal Rate model). The iARD-RPR model has been demonstrated to describe changes in fiber orientations well, whether treating short fibers or long fibers. In this study, 40 wt% glass-fiber immersed in polypropylene

matrix was injection molded in a center gated disk and then predicted fiber orientation distribution pass the thickness was compared with measured results. Good agreement with experimental observations was achieved.

Mark Cieslinski
Virginia Polytechnic Institute and State University

Simulating Orientation of Long, Semi-Flexible Glass Fibers in Three-Dimensional Injection Molded Thermoplastic Composites

In this presentation, a comparison between rigid and semi-flexible fiber-orientation models are assessed for long, semi-flexible glass fibers in an end-gated plaque. Simulations were done under non-isothermal conditions, taking into account entry effects and the fountain-flow behavior at the advancing front. Orientation predictions are compared to experimental data measured in the gate and mold cavity both along and away from the centerline.

Wednesday Afternoon: In Pearl Room

Nanocomposites – Part 2:

Jane Spikowski
PolyOne Corp.

Effect of Fabrication and Electrical Testing on the Measured Performance of Thermoplastic CNT Composites

To fully realize the performance advantages of carbon nanotubes (CNTs) in thermoplastic composites, the development process must extend beyond the formulation and production of materials. Electrical performance is strongly influenced by the fabrication processes used to form these materials into application-specific parts. Furthermore, the measured properties are highly sensitive to the electrical testing configuration, even when common standards-based test methods are used. This study demonstrates the impact of forming and testing effects through a simple injection molding study for polycarbonate/CNT (PC/CNT) composites. Common electrical testing techniques were applied in standard and modified configurations and compared to characterize sources of variability. This testing suite was also used to track performance changes in injection molded parts as a result of an annealing process. This study addresses the resulting implications for evaluating the electrical performance of CNT composites in real-world applications and demonstrates the opportunity to adapt standardized methods as application-driven tests throughout the development process.

Brian Cromer
University of Massachusetts - Amherst

Melt-Mastication for Polyolefin Nanocomposite Dispersions

Polyolefin-exfoliated graphene nanoplatelet (xGnPTM) nanocomposites were prepared by a new process called melt mastication (MM) in which the polymer nanocomposite undergoes a mastication process that allows for enhanced breakup of larger clusters of xGnP. This presentation will present comparative results from different polyolefin-xGnP fabrication strategies, including conventional melt mixing, in-situ polymerization methods, and MM. Improved dispersion quality with MM was confirmed using differential scanning calorimetry (DSC) and visualization of sample films by optical microscopy (OM). The nanocomposites prepared by MM showed the smallest agglomerate sizes and best xGnP dispersion, followed by conventional melt mixing, and finally in-situ polymerization.

Marilyn Minus
Northeastern University

Using Nano-Carbon Templates to Control Polymer Matrix Micro-Structure Formation and Properties in the Composite

For nano-materials — in particular nano-carbons — one of the most attractive uses has been to fabricate polymer-based composites that are lightweight, but exhibit high strength and high modulus. While impressive properties for such composites have been found to date, one major drawback for commercial usage has been the high cost of nano-carbons. Some potential solutions to this issue have included improving the production methods to increase batch sizes/quality to drive down materials cost, as well as looking at alternative nano-carbons such as graphitic nano-platelets, which can be derived from cheaper carbon sources (i.e. graphite) as fillers. An alternative route to achieve nano-carbon polymer-based composites that are low cost, lightweight, high modulus, and high strength is to use the nano-fillers as templates to modify the thermoplastic micro-structures. It is well known that polymers can exhibit high modulus (>100 GPa) and high strength (>10 GPa) if the structure can be controlled. The work outlined in this presentation shows that by using low volume percents of nano-carbons (i.e. less the 1 vol%) in the polymer, the micro-structure of the matrix can be modified around the nano-carbon to influence its intrinsic properties. It has been demonstrated that the modified-polymer properties are significantly higher than the bulk-polymer component. This method provides insight into processing routes that can lead to structural control in the composite. This technology may enable the production of high-performance polymer-based composites, which utilize low volumes of nano-carbons that are low-cost and thereby attractive at the commercial scale.

Wednesday Afternoon: In Diamond Ballroom Keynote Speaker 2:

Mario Greco, Director-Ground Transportation Market Sector Team, Growth and Market Strategy,
Alcoa, Inc.

The Multimaterial Reality

This presentation will focus on study that was completed by the Aluminum Association that looked at optimization of a *Toyota Venza* CUV to meet safety and fuel efficiency targets. It discusses the multi-material advances that can be made in that structure to pass new fuel targets.

Abstracts of Speaker Presentations 2013

Wednesday Afternoon: In Diamond Ballroom Panel Discussion:

Aluminum & Composites – Compete or Collaborate?

MODERATOR: Antony Dodworth, Dodworth Design & SPE ACCE 2013 Co-Chair

PANELISTS: Mario Greco, Alcoa, Inc.; Doug Richman, Kaiser Aluminum; Jim deVries, Ford Motor Co.; Martin Starkey, Gurit Automotive Ltd.; Jai Venkatesan, The Dow Chemical Co.; & Jay Baron, Center for Automotive Research

It is becoming increasingly evident that vehicle lightweighting will be a multi-material solution, incorporating a mixture of metals and polymers, the latter both in unreinforced and reinforced (composites) formats. Decisions on which materials will be used in specific components are based on a number of factors, including cost, performance, maturity level of the technology, and compatibility with other materials and manufacturing operations involved in vehicle assembly. Aluminum and composites — particularly carbon fiber composites — are gaining traction in the race to provide the lowest mass solution to meet new emissions and fuel economy regulations. Are these 2 materials competing for the same applications on the vehicle, for example, in exterior body panels? Or are they better as synergistic partners when employed for the structural body-in-white (BIW), as exhibited in the *BMW i3*? The aerospace industry has long used both materials, with carbon fiber composites increasing in share for structural portions of the aircraft in recent wide-body models. Are automobiles headed toward a similar co-existence between the 2 materials? With steel as the common target for replacement, do the aluminum and composites communities work alone, or seek ways to work together? Are there specific portions of the vehicle that make better sense to have fabricated from one material vs. the other? Issues such as joining, galvanic corrosion, and differences in response to impact/crash must be addressed in order to realize widespread adoption of both materials. This panel will address these and other questions, exploring where the two materials compete and where there are opportunities for collaboration.

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Thursday Morning: In Granite/Gold/Copper Room

Enabling Technologies – Part 1:

Kip Petrykowski
Single Temperature Controls, Inc.

A Study of the Effects of Rapid Cycling Pressurized Water Heating / Cooling on Composite / Injection Mold Tool Temperatures

There have been several technologies used to bring mold surface temperatures above/to a polymer's glass transition temperature (T_g) in order to improve part finish, appearance, and mechanical properties. Steam, cartridge heaters, induction, and high-temperature pressurized water have all been successfully applied. Due to the inherent energy savings, high-temperature spectrum, precise temperature control, and fast ramp rates, pressurized water offers numerous advantages over these systems when applied to composite and injection molding of various materials.

David Lowe
Regloplas AG

Temperature Control in Manufacturing Self Reinforced Polymers (SRPs): A Smart Way to Keep Cool

Self Reinforced Polymer (SRP) composites use a reinforcement and matrix from the same polymer group to make lightweight, impact-resistant, and easily recyclable products. However, the processing requires very tight process control and, in some cases, an in-tool cycle of cool-hot-cool (so-called isobaric or variotherm processing). To achieve optimum cycle times when heating and cooling tools, the European Esprit project used the Regloplas dual-channel heating system, which utilizes advanced valve systems, pressurised circuits, and a novel 'energy battery' to mold SRP composite parts.

José Feigenblum
RocTool

Thin Wall and Superior Surface Quality Processing Method of Fiber Reinforced Thermoplastic for Cosmetic Applications

The induction heating capabilities allow high-heat molding of the tool to obtain a resin-rich surface of the final part and avoid forming issues or surface defects, while also keeping cycle time and energy consumption at acceptable levels. This presentation will discuss some design rules describing key points such as: steel selection, inductive integration, thermal expansion, H&C performance, and energy consumption. Finally, examples of tool design and associated cycle time will be shared along with trends for large parts in order to propose an out-of-autoclave process.

Scott Blake
Assembly Guidance Systems

Aerospace Process Control for Automotive Composites: Defect Prevention, Data Collection and Documentation

As the automotive industry makes the transition from metal parts to high-performance composite materials in critical structures, it will encounter many of the problems that the aerospace industry has already grappled with and resolved. The systems used in aerospace composites to verify and document acceptable fiber orientation, absence of FOD (Foreign Objects or Debris), accurate vacuum and debulk, out time, and material batch are described. Current development efforts to extend capabilities to automatically address wrinkles and other forms of fiber distortion are also discussed.

(Break)
Enabling Technologies – Part 2:

Jim Mihalich
Cyclics Corp.

Rapid Molding of Thermoplastic Composites

A crude bench-top setup was used to demonstrate a rapid resin transfer molding (RTM) process to make plaques roughly 25 cm wide, 40 cm long, and 0.5 cm thick from cyclic polybutylene terephthalate (cPBT). A 14 minute cycle was demonstrated. The cycle time included a 7 minute heating period used to increase the 150C de-molding temperature to the cure temperature of 230C in the forced hot air oven. The plaques demonstrated cure completion and molecular weight build consistent with commercial grades of PBT.

Frank Billotto
Dow Automotive Systems

Adhesive Technology for Automotive Multi-Material Substrate Bonding

The global trend towards improved fuel efficiency and reduced environmental impact is driving the use of new and dissimilar substrates for lightweight vehicle construction. Modern lightweight designs require new joining technologies to support the use of new materials as well as an increased use of mixed material substrates. Adhesive bonding is an enabler for lightweight and mixed substrate construction — allowing joining where traditional methods are not feasible — and takes advantage of structural bonding benefits such as improved load bearing capability, enhanced NVH performance, ride and handling, and safety. This presentation will focus on the available adhesive-bonding solutions and will give an outlook into future adhesive-development directions.

Thomas Smith
TenCate Performance Composites

Continuous Fiber Reinforced Thermoplastic (CFRT®) Inserts for Injection Over-Molding in Structural Applications

A primary goal in automotive structures is reduction of weight while maintaining or improving other desirable attributes. Composite materials offer solutions to weight reduction in comparison to metal structures and thermoplastic composite materials offer the added benefits of improved cycle times, high impact resistance, cost-effective solutions, and a path for sustainability. Developments in the area of injection over-molding of structural inserts produced from continuous-fiber-reinforced thermoplastics (CFRT®) are an example of this and combine the advantages of injection molding with CFRT properties. Typical applications are in seat structures, airbag housings, front-end modules, and crash beams that take advantage of the excellent strength and impact characteristics of the materials. A seat back application produced with injection over-molding of CFRT inserts is used as a demonstration case study.

Thursday Morning:
In Emerald/Amethyst Room

Tutorials – Part 3:

Lou Dorworth
Abaris Training Resources, Inc.

Parts 1-2: Repairs for Advanced Composite Structures

This presentation provides a short overview of current repair methodologies used to restore structural integrity in advanced composites in aerospace and how these practices might be transferred to the automotive industry.

David Sheridan
Ticona Engineering Polymers

Parts I-2: Design & Development of Precision Plastic Gear Transmissions

This presentation will provide a methodical and rational procedure for designing and developing high-precision injection-molded plastic gear transmissions that function satisfactorily across the entire range of manufacturing tolerances and operating conditions.

(Break)
Tutorials – Part 4:

Roger Assaker & Rani Richardson
eXstream engineering & Dassault Systèmes

Parts 1-2: Developing Accurate Material Models for Composites

Modeling the behavior and failure of composite materials is challenging and requires models that take into account the material anisotropy, nonlinearities, and progressive damage and failure. This behavior depends on the local material composition (matrix and fibers) and underlying microstructure (fiber length, content, orientation) as induced by the manufacturing process. This tutorial will address the modeling of short-fiber-reinforced plastics (in Part 1) and continuous-fiber composites (in Part 2) materials and structures. Part 1 also will cover tests needed to calibrate the material model that can be used in FEA analysis, taking into account the fiber orientation predicted by injection molding simulation; Part 2 also will cover the use the classical laminate theory to model the linear behavior of CFRP structures and the use of coupon test results to calibrate the nonlinear stress-strain and failure behavior of the composite.

Thursday Morning: In Bronze/Silver Room

Virtual Prototyping & Testing of Composites – Part 3:

Kurt Danielson
e-Xstream engineering

Multi-Scale Modeling of High-Cycle Fatigue of Chopped and Continuous Fiber Composites
******2013 SPE ACCE Best Paper******

Two micro-mechanically based composite fatigue models are introduced in this presentation. The focus is on the high-cycle fatigue model implemented specifically for chopped-fiber-reinforced plastics. Its application for a Toyota Motor Europe automotive oil-cooler bracket made of a nylon 6/6 material reinforced by short-glass fibers will be presented. Through this case study, the presentation aims to show how the use of proper fatigue-modeling tools, developed specifically for composites, can increase the accuracy of simulation in the field of durability and pave the way for new simulation standards towards the desired lightweight reductions.

Peter Heyes
HBM United Kingdom Ltd.

Multiaxial Assessment Method for Fatigue Calculations in Composite Components

Multiaxial assessment methods have proved to be a useful tool in the fatigue analysis of metallic components. Fatigue analysis of composites presents additional challenges due to the anisotropy and non-homogeneity of the materials. This presentation considers how multiaxial assessment methods may be extended and applied for fatigue analysis of fibre-reinforced composite materials.

Frank Abdi
Alpha STAR Corp.

Damage and Failure Mechanism Study of Composite Crushtubes during Axial Crush through Progressive Failure Dynamic Analysis

Carbon fiber-reinforced polymer (CFRP) is considered to be a good candidate for energy absorption due to its high specific energy absorption (SAE) as the ratio of energy absorbed by the tube mass. However, composite damage distribution in the components should be carefully designed to confine damage progression in the load application region and prevent any premature catastrophic failure. This presentation addresses different damage and failure modes triggered in composite crush tubes that have different ply orientation angles. The modeling strategy is validated by experimental quasi-static crush tube experiments and the study contains a comprehensive damage-mode tracking in each ply to identify the effectiveness of the candidates. The correlation between the damage propagation is compared with the overall crash response in terms of crush load vs. crush displacement.

Ram Iyer
Eicher Engineering Solutions, Inc.

A Method for Developing Composite Beam Structures that are Optimized for Energy Management using Non-Linear Topology Optimization

A methodology utilizing a non-linear topology-optimization technique was applied to develop designs of mass-efficient composite beam structures. The traditional linear optimization technique is shown as suitable to develop designs that are maximized only for part stiffness. Non-linear effects like plasticity and material failure are not taken into consideration using linear techniques, and hence the suitability of the linear-optimization technique can prove to be inadequate for applications that require energy management. Non-linear topology optimization, using the software tool LS-Tasc from LSTC, uses fully non-linear LS-Dyna simulations to arrive at the optimized design shape. Plasticity, material damage and failure, and load path variation on account of contact are taken into consideration, as is typical with non-linear LS-Dyna simulations. The optimization process tracks the contribution of each element in the finite-element model of the design space to the stated objective and performance constraints to determine the ideal load path, and hence the part shape. Development of the beam structure designs using this methodology results in design shapes that can be optimized for energy management rather than stiffness.

(Break) Virtual Prototyping & Testing of Composites – Part 4:

Camilo Perez
University of Wisconsin - Madison

Study on the Fiber Properties of a LFT Strand

A novel algorithm to measure fiber-length distribution was implemented. The fiber-orientation distribution within a long-fiber thermplastic (LFT) charge was measured using micro-computerized tomography (μ-CT). Using a 3D numerical-simulation package, Moldex3D, the influence of the initial fiber orientation within an LFT strand was evaluated.

Sarah Stair
Baylor University

Ultrasonic Characterization of Fiber Reinforced Composites
******2013 SPE ACCE Scholarship Award Winner******

Several industries, such as automotive, aerospace and sports, are incorporating fiber-reinforced composites into their products due to the high strength to weight ratio of these materials. Unfortunately, the final part's characteristics depend greatly on the manufacturing process, and a non-destructive testing procedure is required to inspect the final part. This study utilizes ultrasonic A-scan and C-scan techniques to ascertain the material properties of a carbon fiber-reinforced composite based on the orientation of each lamina.

Abstracts of Speaker Presentations 2013

David Sheridan
Ticona Engineering Polymers

Integrated Anisotropic Simulation for Components Made from Glass Fiber Reinforced Thermoplastics
2013 SPE ACCE Best Paper

Accurately analyzing and predicting the mechanical behavior of components made from fiber-reinforced thermoplastics is complex because the fibers are individually oriented during injection molding. Finite-element analysis often uses isotropic material models. Results can be improved if local fiber orientations are considered with anisotropic material properties. This analysis process and a practical application are presented.

Thursday Morning: In Pearl Room

Advances in Thermoplastics Composites – Part 1:

Chul Lee
INVISTA Engineering Polymers

Nylon 6,6 Continuous Fiber Thermoplastics Composite – Evaluation of Processing Techniques for Optimal Performance

After evaluating mechanical properties of thermoplastics composite laminates constructed from unidirectional tape of nylon 6,6 / glass fiber system, the author will present findings in preparing prepregs, including the key factors that affect laminate quality and productivity, such as resin weight, glass size, and "knottability" and "spreadability" of tow. Also discussed will be considerations in using these properties for a composite product design and pros and cons of two compression molding methods.

Victoire de Clermont-Tonnerre
SolVin

The First Generation of Vinyl Composites with Long & Continuous Fibers

To date, the only types of fibre-reinforced PVC composites were made of short fibres mixed with PVC dry blend before being extruded, but that process cuts the fibres, giving limited properties to the finished products. New technologies have been developed that allow long and continuous fibre lengths to be maintained in PVC composites via processes without shearing. The first technology consists of a rigid impregnation of the fibres by a water-based PVC dispersion, followed by drying, gelation by hot air and calendering. Reinforcement can be unidirectional (UD) fibres (e.g. fiberglass) to produce tapes or in the form of fabrics to produce prepregs, especially in flax fibres. The second technology consists of a dispersion of PVC powder into a network of fibres by an alternative electrostatic field followed by a gelation in a flat calender. The plates obtained present isotropic properties and an excellent ratio of rigidity to impact toughness. The presentation shows the outstanding properties obtained with these composites by keeping the original length of the fibres and the possibilities offered in term of applications.

Nolan Krause
RTP Co.

Parts 1-2: Light-Weighting with Engineered Thermoplastic Compounds Including Carbon Fiber Reinforced Polypropylene

The automotive industry is changing. Today less means more as engineers are challenged to reduce vehicle weight to meet CAFE and emissions regulations. This presentation will highlight several high-performance solutions for mass-reducing thermoplastic compounds / composites, including the strength-to-weight advantages and design considerations for: increasing performance with glass fiber reinforcement; "stiff and tough" very-long-fiber composites; going lighter by using carbon fiber compounds including carbon fiber polypropylene; and shedding weight with glass microspheres and blowing agents.

Thursday Lunch: In Diamond Ballroom Keynote Speaker 3:

Jai Venkatesan, Director-Material Science & Engineering,
The Dow Chemical Co.

Industrialization of Carbon Fiber Composites – Lessons Learned, Investment Priorities for the Future

As carbon fiber composites mature penetration in segments like military, aerospace, and recreation equipment, the natural extension of their benefits to higher volume sectors such as series auto, wind, civil infrastructure, oil and gas etc. has been receiving growing attention over the past decade. So, what are the barriers that inhibit continued proliferation and what can be done about them? This question has been posed in various forums and it is difficult to provide a definitive answer largely due to the breadth of impact this typically has on the incumbent supply base. This presentation will aim to provide a perspective from a chemical and materials development standpoint. What learning can be applied, if any, from similar adoption in analogous industries like aerospace and sports cars? What have we learned from the proliferation of plastics in auto, and have innovations here paid off? What is the role of companies across the value chain and allied state partnered organizations, and how has this changed from the previous material substitution attempts? These questions will be examined in light of some key success factors such as cost-performance trade-offs, scalability of material systems and processing techniques, utility of design, simulation and prototyping tools, and product life-cycle issues. This study will also step through areas that will might require disruptive innovations vs. others where more modest advances would suffice and assess the viability of these investments and their relative priorities expected in the period ahead.

Thursday Afternoon: In Granite/Gold/Copper Room

Enabling Technologies – Part 3:

Matthias Graf
Dieffenbacher GMBH Maschinen- und Anlagenbau

High-Pressure Resin Injection – Key Technology for Large-Scale Production

The presentation differentiates the high-pressure processes from the standard resin injection molding (RTM) processes and discusses the latest R&D results regarding the development of high-pressure RTM of high-performance fiber compounds. The focal point is set on the innovative production processes suitable for high volume as well as on the industrialization of the so-called RTM process within the high-pressure compression RTM (CRTM) process --from preforming to the final component. The compression process is of special focus. Various process parameters and their influence on part quality are highlighted, and a serial process run is demonstrated.

Darin Grinsteinner
CPI Binani Inc. (formerly Composite Products Inc.)

Improving DLFT Molding Productivity via Lessons Learned in Non-Automotive Applications

Applying the direct-long-fiber-thermoplastics (DLFT) process to recent composite product launches outside of automotive has given a fresh perspective on how to create more effective products and efficient launches for future DLFT applications. Recent expansions of DLFT into markets such as agricultural construction, personal watercraft, recreational vehicles, and trailers, brought unique challenges that fit the flexibility of the DLFT process. Combining common materials such as glass and polypropylene with more unique materials such as wood block and recycled polymers led to a unique over-molding solution for one high-volume molding application with aggressive material cost targets. Other lower volume applications benefited from new predictive-modeling techniques of long-fiber compression molding to ensure the proper tool design of a compression molded part that weighed 40 kg and that had a length of 2.7 m could achieve a 99.9% accuracy in its length from the first shots of the tool.

Chad Duty
Oak Ridge National Laboratory

Additive Manufacturing Research Briefing

This presentation will summarize Oak Ridge National Laboratory's (ORNL's) research activities related to additive manufacturing (AM). ORNL's Manufacturing Demonstration Facility is exploring the use and further development of a wide range of AM technologies, with basic research tasks focused on 1) new material development, 2) *in-situ* process monitoring and control, and 3) expansion of system capabilities. Use of AM across various industries will be highlighted, as well as how ORNL is developing new technology in this space.

Ben Halford
Surface Generation Ltd.

Active Thermal Management using the PtFS Process for Rapid Processing of Composite Structures

This presentation will outline the technical, commercial, and legal requirements for manufacture of high-volume fibre-reinforced structures in the context of fully automated, lights-out production environments. Fusing of discrete technical elements will be shown to deliver order of magnitude gains in cycle time, precision, energy efficiency, and quality for thermoset and thermoplastic components. With reference to prismatic and fully developed forms, the presentation: identifies methodologies for using fully integrated production solutions to achieve 95% reductions in cycle time and 50% - 95% reductions in energy consumption; outlines benefits whereby highly integrated composite structures with varying section thicknesses can be processed optimally using local thermal control; explores opportunities for in-mold residual stress correction, reductions in ply count, increased feedstock tolerance, and optimisation of part surface finish; and examines the benefits of 100% in-process quality assurance from a production and legal perspective (i.e. insurance, crash & repair).

Thursday Afternoon: In Emerald/Amethyst Room

Advances in Preforming & Reinforcement Technologies – Part 1:

Jaap Van der Woude
PPG Industries

Thermoplastic Composites in One Step: In Situ Polymerization of Caprolactam into Fiber Glass Reinforced APA6

In situ anionically polymerized fiberglass reinforced composites from lactams can provide the advantages of both thermosets and thermoplastics: long fiber retention, one step process, short cycle times, thermoformality, and re-cyclability. Due to the low viscosity of caprolactam, very-high glass contents can be realized, which in essence makes these composites unique new engineering materials. The very strong and lightweight composites can potentially replace many existing materials in a wide field of applications.

Mingfu Zhang
Johns Manville

Structural Thermoplastic Composites (STPC)

Continuous glass fiber-reinforced structural thermoplastic composites can be made with reactive resin systems using structural molding process, such as resin transfer molding. By tailoring glass sizing chemistry, composite properties can be improved significantly through maximizing the bonding between reinforcing fiber and resin matrix .

Antonio Cossolo
Cannon USA

Industrial Preformers for CFRP

Glass, carbon, aramid, and natural fibers of every type and consistency can be successfully handled and precisely placed in large or small molds and formed into a preform in dozens of different applications. In each application, the preform is then placed into a mold for the application/injection of a thermoset resin to complete a composite part. The production equipment required to ensure a fast cycle time and a high quality part is described along with important considerations for the equipment.

Tommy Fristedt
Laystitch LLC

Tailored Fiber Placement Technologies for Composite Applications

New software design tools and scaleable production technology allows automated tailored fiber placement (TFP) to be used for high-volume preform production. Tailoring the fiber orientation and fiber placement/distribution within the part enables better utilization of the fiber strength and therefore improves performance of the part. Various application examples and preform designs will be presented along with resulting benefits.

Thursday Afternoon: In Bronze/Silver Room

Bio & Natural Fiber Composites – Part 1:

Sunil Kumar Ramamoorthy
University of Borås

Biocomposites Based on Regenerated Cellulose Fiber & Bio Matrix

Wood pulp-based regenerated cellulose fibers like Lyocell and viscose, which are from natural origin, have high and even quality and can be used to develop superior composites with good properties. In this project, Lyocell and viscose fibers were used as reinforcements ina chemically modified soybean-based bio-matrix of acrylated epoxidized soybean oil (AESO) and formed by the compression-molding technique. Mechanical properties of the resulting composites were characterized by tensile, flexural, and impact tests, dynamical mechanical thermal analysis (DMTA) was used to evaluate viscoelastic performance, and scanning electron microscopy (SEM) was used to provide morphological analysis. In general, Lyocell composites had better tensile and flexural properties and better elastic and viscous response than viscose-based composites. Hybrid composites also were formed by fiber blending and these showed better impact strength. The results show the good potential of these composites to be used in automotives and construction industries.

Damien Maillard
National Research Council Canada

Compaction Behaviour and Permeability of Cellulosic Fibre for RTM Applications

With the current driving force to use more sustainable and/or recyclable materials, the automotive market is considering cellulosic fibres and biocomposites with a growing interest. However, for those fibres to be used efficiently in thermoset liquid processes such as resin transfer molding (RTM), reinforcement compaction response and permeability must be well-known as they govern resin flow, injection time, and void formation, and therefore are key to success. In this presentation, the compaction response and permeability of flax and hemp mats were investigated and compared to traditional glass fibers.

Alper Kiziltas
University of Maine

Micro- and Nanocellulose Composites for Automotive Applications

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

This review of recent work and technical developments by researchers at University of Maine discusses the opportunities, challenges, innovations, and properties of micro- and nanocellulose fiber-filled thermoplastic composites (particularly engineering thermoplastic composites with melting points above 220C) and hydrophobic (polypropylene- and polyethylene-based) polymer composites.

Henning Karbstein
BASF Corp.

Lightweight Bio-Composites with Acrodur® Resin Technology

The technical performance and sustainability value of natural fiber/thermoset acrylic composites has been demonstrated over the past few years. Recent development updates and further value-chain improvements in North America support further cost efficiency towards economical competitiveness. Local North American sources of natural fibers, disconnected from Asian sources, are now being established and offer greater reliability and affordability for the industry. New inline processing equipment to coat and dry nonwoven natural fiber or glass mat also has entered the market allowing for improved energy-efficiency and small production footprint, plus higher quality process stability as well as other opportunities. The combination of these advances enables sustainable bio-composites that offer tremendous lightweight potential at competitive costs today.

Thursday Afternoon: In Diamond Ballroom Keynote Speaker 4:

Elias Shakour, Research Scientist, Manufacturing, Engineering & Technology, Center for Automotive Research

Creating Value through Collaboration

Whether we are working in small teams or across global enterprises, achieving ambitious goals requires stakeholders to work together to create and implement a strategy. Everyone agrees that collaboration is vital to shared success, but we have likely all worked on projects where working together was a challenge or even a failure. Dr. Shakour will share his experiences in creating value through collaboration and discuss how strategic stakeholders can partner for success in the future.

Keynote Speaker 5:

Ray Boeman, Program Director-Energy Partnership, Oak Ridge National Laboratory

The National Advanced Composites Manufacturing Institute – A Consortium Approach to Automotive Composites

The National Advanced Composites Manufacturing Institute (NACMI) is being created to satisfy long-standing industry needs toward overcoming challenges associated with the commercialization of composite structures and assemblies. NACMI is a membership-based, public-private partnership that will serve as a bridge to realize the potential of material and manufacturing innovations through the development of critical technologies needed to commercialize these solutions in ground transportation applications. Bringing together industry, national laboratories, universities and community colleges, and professional organizations in the heart of the region's ground transportation cluster to reinforce the region as a global center of manufacturing excellence, the NACMI partnership is establishing highly leveraged, shared infrastructure to provide industry with affordable access to advanced physical and virtual tools to accelerate the development, demonstration, and adoption of high-volume manufacturing for advanced composite structures and thereby address a critical gap in existing U.S. composites infrastructure. The Institute will combine a focus on transformative innovations that can provide enduring competitive advantages for U.S. manufacturers with capital equipment and intellectual resources, RD&D, training, and workforce development programs for near-term employment and economic benefits for the region. NACMI aligns well with emerging government opportunities aimed at a multi-stakeholder approach to next-generation manufacturing and process technologies for composite materials.

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Friday Morning: In Granite/Gold/Copper Room

Advances in Thermoset Composites – Part 1:

Stefan Kreiling & Frank Fetscher
Henkel AG & Co. KG & Benteler SGL

Progress with Polyurethane Matrix Resin Technology: High-Speed Resin Transfer Molding Processes and Application Examples

Novel polyurethane matrix resin enables manufacturing of automotive composite parts via high-speed resin transfer molding (RTM) processes. Due to its inherent fracture toughness, the polyurethane technology can offer superior fatigue resistance. Technical insights into the mass production of an automotive composite leaf spring will be given. In addition, painting and assembly of composites via adhesive bonding are important steps along the process chain where further efficiencies can be realized.

Mike Super
Bayer MaterialScience LLC

Evolution of an Excellent Lightweighting Tool – PUR Sandwich Composites

This presentation details how polyurethane spray sandwich technology, originally developed for sunshades, has been improved for use in more demanding applications such as load floors and parcel shelves. Polyurethane sandwich construction combines the low weight of a honeycomb core with the high strength of a fiber-reinforced polyurethane skin to produce load-bearing parts with very-high flexural stiffness and excellent thermal properties, making it an attractive, lighter weight alternative to ABS, polypropylene, sheet-molding compound (SMC), and wood products. Information on the deflection performance of different constructions with different systems, including some with natural and some with glass mats, will be given to guide manufacturers on the best ways to hit specific targets such as cost, thickness or weight. Newer formulations enable productivity improvements, including longer open times and shorter demolding times, which facilitate production of larger parts and reduced scrap, as well as feature higher bio-renewable content than previous versions.

Mahmut Bingol
University of Yalova

New SMC Application for Automotive Seat

Thermoset-based sheet-molding compound (SMC) with an unsaturated polyester matrix was used to develop a new glass-fiber reinforced material. Specimens were cut from newly molded SMC plates and subjected to 3-point flexure and tensile tests. FEM models of an SMC seat-connection element have been generated and analyzed. then compared with physical testing results.

Ian Fellows
Core Molding Technologies

Continuing Evolution of Low Density SMC for the Automotive Market

This presentation will showcase some examples of the current market for low-density sheet-molding compound (SMC) and will provide a brief history of weight reduction initiatives and benefits in the automotive industry. One specific development program will be described in detail. This program focused on improving stiffness-to-weight ratio, maximizing the benefit of microsphere technologies, and creating a paint-ready surface suitable for high-appearance applications. The result was a new low-density SMC with an industry-leading density of 1.18 sp.gr. — 9% lower than the previous industry best. The discussion concludes with a peek at future opportunities for thermoset composites in this specific marketplace.

(Break)
Advances in Thermoset Composites – Part 2:

Tobias Potyra
Fraunhofer Project Centre @ Western University

Screening of Natural Lightweight Fillers for Sheet Moulding Compound in North America

******2008 SPE ACCE Scholarship Award Winner******

This presentation focuses on fillers that could be used for lightweight sheet moulding compound (SMC) applications. In particular, a focus on the density of the particles will be made, as well as the ecological factor of the use of by-products from biomass. Preliminary testing has been made on the processing of local (Ontario, Canada) derived agricultural by-products to see if biomass in different forms could potentially be a suitable substitute for glass bubbles in low-mass SMC formulations.

Cedric Ball
Momentive Specialty Chemicals, Inc.

Recent Case Studies of Engineering Thermosets for Under-the-Hood Applications (Part A: Overview)

Automotive engineers are looking for options to reduce weight and increase engine efficiency to comply with new CO_2 emission and fuel economy regulations. As a consequence, under-the-hood operating temperatures continue to increase. Engineering thermosets are an effective lightweighting alternative to heavier conventional steel and aluminum die-cast products. They combine outstanding temperature stability, long-term mechanical strength, dimensional stability, and high chemical resistance. This presentation focuses on 2 recent automotive underhood applications where phenolic-based engineering thermosets successfully replaced traditional metals. First, a thermoset water pump housing was shown to outperform cast aluminum in dimensional stability while lowering overall weight; and a thermoset vacuum pump, also originally designed in die-cast aluminum, provided high mechanical strength and improved dimensional stability at reduced cost and weight. Finally, various recycling methods for these thermoset materials are described.

Andreas Kürten
ISK GmbH

PART B: Thermal and Rheological Design of Thermoset Molds

Modeling the behavior of short-fiber reinforced thermosets during the molding process remains one of the most difficult challenges for successful thermoset part design. This presentation covers examples of thermoset molding best practices and explains how advanced simulation techniques can help predict flow behavior and overcome issues frequently encountered with short-fiber thermoset molding. Factors considered include part geometry, thermodynamics, molding pressures, and fiber orientation.

Stefan Pastine
Connora Technologies

Sustainable by Design: Introducing Recyclable Epoxy Hardener Technology

Thermosetting plastics used today are not recyclable simply because they were never designed to be in the first place. However, there is nothing inherent about the design of the plastics that precludes them from being re-designed to be recyclable/reusable materials. A general overview of recyclable epoxy technology is presented, including the underlying chemical principles that enable recyclable epoxy and recyclable carbon fiber composites.

Friday Morning:
In Emerald/Amethyst Room

Advances in Thermoplastic Composites – Part 2:

Duane Emerson
Ticona Engineering Polymers

Energy Absorption Characteristics of Automotive-Type Beam Structures in High-Speed Crush Testing

Work presented here is the result of a larger study on automotive Lightweight Materials and Low-Carbon Vehicles being conducted at the University of Warrick in the U.K. The context of this presentation examines the energy-absorption characteristics of an automotive-type U-beam structure under flexural load testing as well as high-speed crush testing. The variants evaluated in this study included a thermoplastic composite plus two (2) metallic (steel and aluminum) structures. The presentation details study parameters and test results, and discusses future work based on the outcomes of this initial study.

Timo Huber
Fraunhofer-Institut für Chemische Technologie ICT

Thermoplastic Composites in Structural Lightweight Applications – Potential of Unidirectional Fiber Reinforcement & Sandwich Structures

This work presents the investigations of process developments with injection molded components in combination with damaged and planar fiber structures. Fundamental experiments with tensile loaded structures in the first and flexural loaded structures in the second case are presented. The results lead to a better understanding of the influence of local continuous-fiber reinforcements in thermoplastic composites and their applicability in structural applications.

Calvin Nichols
BASF Corp.

Advancing Structural Capability of Injection Molded Components with Continuous Fiber Reinforcement -- Seat Pan Opel Astra OPC

This presentation provides a state-of-the-art overview on continuous fiber reinforcement laminates and tapes as overmolded inserts for enhancing structural capability of injection molded polyamide. The talk will highlight the design and manufacturing development of the world's first seat pan made from a thermoplastic laminate with continuous fiber reinforcement.

Victor Bravo
National Research Council Canada

Effect of Runner & Gate Configuration on the Performance of D-LFT Composite Parts

This presentation deals with the hypothesis that the differences in the geometry of the flow channels for 2 composite moulding approaches affect the length, dispersion, and distribution of reinforcing fibres in the polymer matrix. It has been well documented in literature that fibre length affects the mechanical properties of the composite material while dispersion and distribution affect the uniformity of these properties. A systematic analysis of composite parts produced with the 2 processing methods was carried out, results of which are reported here.

(Break)
Advances in Thermoplastic Composites – Part 3:

Creig Bowland
PPG Industries

A Formulation Study ofLong Fiber Thermoplastic Polypropylene (Part 4): The Effect of Molding Changes on Mechanical Properties of the PP LFT Parts

In Part 4 of this multiyear study, the relationship between the polypropylene long-fiber thermoplastics (PP LFT) and the processes used to mold are presented. Parts are formed by injection molding, compression molding, and plunger tool using the same formulation in the PP LFT part. The effects of glass-fiber diameter, sizing and changes in molding conditions were explored. Prior work showed significant differences between injection molding and compression molding. The use of the plunger tool has given a unique opportunity to evaluate the effects of molding conditions and fiberglass products on the final part performance.

Ke Feng
Ticona Engineering Polymers

Innovative Polyphenylene Sulfide Material Tailored for Robotic Manipulated Blow Molding

With the aid of a unique lab scale test, a new polyphenylene sulfide material has been developed to enable the first-ever 3D robotic blow molding production. Data on melt viscosity development and details in the test method will be discussed.

Marcia Kurcz
Polyscope Polymers BV

Integrated Semi-Convertible Sunroof System in Glass-Reinforced SMA/ABS Resin

This presentation discusses the first very-large thermoplastic sunroof module for a serial (production) cabrio (semi-convertible) vehicle. Industrial partners combined their efforts to reduce weight and optimize systems cost. The large innovative tool that was developed molds both sunroof and rear window frames at one time. The part uses glass-reinforced styrene maleic anhydride/acrylonitrile butadiene styrene (SMA/ABS-GR) resin and meets all the OEM's requirements for precise dimensions, weathering resistance, good aesthetics, and adhesion to other substructures. This paper will detail the development process, tooling considerations, and benefits vs. other materials (e.g. metals and thermoset polymers).

John Geldernick
Plasticomp, Inc.

Expanding Design Options for Long Fiber Thermoplastic Composites

A methodology for the rapid adoption of long-fiber thermoplastic (LFT) composites in the industry is outlined. Examples of recent metal-to-composite conversions are given to illustrate the innovation process.

(Break)
Friday Morning:
In Bronze/Silver Room

Bio & Natural Fiber Composites – Part 2:

Senat Mohanty
Indian Institute of Technology &
Inkilab Technologies Pvt. Ltd.

High Performance Moldable Bamboo Fiber-Epoxy Composite

Auto-rickshaws, or motorized tricycle passenger taxis are a common form of transportation in India. These vehicles are often used at loads beyond specifications and under difficult road conditions. Part failures negatively affect earnings of the operators, who play at the bottom of the economic pyramid. Use of bamboo fiber–epoxy composites has been

investigated in these applications. The composites typically contain 30-40 wt-% fibers, although loadings to 60 wt-% fiber can be used and fillers such as carbon black and fly ash can also be added. The composites exhibit tensile strengths of 140 MPa, flexural strengths of 160 MPa and notched Charpy Impact strengths of 60 kJ/m^2. These composites were subsequently molded into auto body parts (dashboard, doors, and panels) and are under investigation with an auto-rickshaw manufacturer. Additionally, helmets made with these composites were taken through drop tests similar to Snell Memorial Foundation Test Standards (ISO 17025 and American Association for Laboratory Accreditation A2LA). Bamboo-fiber composites positively impact the socio-economic health of the local community since bamboo is a renewable source, it need not be chemically processed, it reduces the petrochemical component of the composite, and is known to help in waste-land reclamation and for combating soil erosion.

Tri-Dung Ngo
National Research Council Canada

Fire Resistance Cellulosic Fiber-Thermoset Composites

This presentation reports an innovative and sustainable approach to fiber surface treatment that improves the fire resistance of cellulosic fiber/ epoxy composites made with flax fiber. This new approach not only retards burning of cellulosic fiber, but also produces self-extinguishing cellulosic-fiber composites. The low-cost treatment was carried out in aqueous solutions using non-toxic inorganic chemicals.

Abdul Shakoor
Loughborough University

Toughening the Polylactic Based Biocomposites with Natural Fibres and Epoxidized Natural Rubber Masterbatch

Biocomposites are recent advancements used to develop cost-effective sustainable materials for numerous applications in response to the mounting needs to find substitutes for polymers based on fossil fuels. Polylactic acid (PLA) is an aliphatic, and is the most promising in the bioplastics' family, although its use can be constrained by its poor mechanical properties, lower thermal stability, and processing difficulties. The objective of this research was to investigate and improve mechanical and thermal properties of PLA by developing PLA composites reinforced with hemp natural fibres, results of which are discussed in this presentation.

Tim Bearnes & Raymond Schenk
Laurel BioComposite, LLC

Protein Polymer with Cellulosic Filler Compatible in Various Thermoplastic and Thermoset Systems

Distillers grain, a by-product of the ethanol process, has been used to produce thermoset and thermoplastic polymers that can replace a portion of and/or enhance traditional petroleum-based resins in various plastics manufacturing processes. The process results in unique characteristics and allows inclusions into finished plastics products at rates of up to 40% final bio content. The pellets produced are consistent with the standard feedstock materials used by plastic manufacturers in thermoplastics and currently are being tested with polypropylene (PP) and polyethylene (PE), and the bio-based polyhydroxyalkanoate (PHA) and polylactic acid (PLA) resins in some applications. Trials are underway in injection molding, rotary molding, and extrusion molding. Test results have indicated improvements in some properties of finished goods with good processing characteristics when run at temperatures below 193C. Further testing in thermoset bulk-molding compound (BMC) has resulted in lower specific gravity while retaining physical properties and good surface finish.

Friday Lunch / Afternoon: In Diamond Ballroom Keynote Speaker 6:

Martin Starkey, Managing Director, Gurit Automotive Ltd.

A Class Surface Composites: from Niche Production to Advancing Materials for Higher Volume OEMs

Gurit Automotive's composite part production facility has been supplying leading sports car OEMs with carbon fiber-based Class A composite panels since 2007. Development of innovative technology is the defining strength of the organization and is enabled by the unique understanding of composite materials, structural design, and materials processing. This has resulted in its out-of-autoclave SPRINT CBS technology being the system of choice for many of Europe's leading supercars over the past 6 years. Through continued development of this CBS system, the next generation product, CBS 200, has proven highly compatible with press forming in less than a 10 minute cycle and achieving a temperature performance in excess of 200C/392F. In turn, this has allowed Gurit to develop a Class A parts technology both capable of production in volumes up to 30,000 parts per annum from a single tool set as well as full integration of the components into the body-in-white line.

Keynote Speaker 7:

Howard Coopmans, Senior Manager-Body Engineering, *SRT Viper,* Chrysler Group LLC

Composite Technology Developments on the SRT Viper

This presentation discusses the development plan, working timeline, design challenges, and fabrication end result of carbon fiber technology use on exterior body panels of the *SRT Viper.*