



Automotive Plastics NEWS

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SPE® Automotive Division Honors the Most Recent and Innovative Uses of Plastics in Automotive at the 47th-Annual Automotive Innovation Awards Competition

The 47th-annual SPE Automotive Innovation Awards Competition and Gala is now behind us. This year's event drew 58 nominations and 820 gala registrations making it the largest attendance in recent memory, eclipsing last year's mark of 780. It is always very difficult for the First Round and Blue Ribbon Judges to narrow down the list of quality submissions we receive each year to pick finalists and then category and the Grand Award winners. Many times the difference between being a finalist and winning a category is the difference of a vote or two. I think this shows how competitive the Automotive Innovation Awards Program is each year and should give satisfaction to all the nominees for a job well done with respect to commercializing innovative solutions in this industry. This year we also had record support from our student volunteers with approximately 45 students and faculty from Ferris State, Lawrence Tech, Michigan State and Oakland Universities. These students are representative of the future of plastics engineering and will likely be much better prepared to handle the needs of automotive companies as pressure for cost and mass reduction escalate on new model programs.



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AUTOMOTIVE DIVISION MEETING SCHEDULE & SPECIAL EVENTS CALENDAR



ANTEC Paper Deadline	January 12, 2018
TPO Shanghai Abstract Deadline	January 12, 2018
SPE Auto. Div. Design Scholarship Program	January TBD, 2018
AutoEPCON Abstract Deadline	February 9, 2018
SPE Auto. Div. Board Meeting American Chemistry Council - Auto. Ctr. New King Street, Troy, MI, USA	5:30 - 7:30 p.m. February 12, 2018
TPO Shanghai Paper/Presentation Deadline	February 28, 2018
ACCE Abstract Deadline	March 15, 2018
3rd Annual TPO Shanghai Engineered Polyolefins Conference	ALL DAY March 27-29, 2018
AutoEPCON Presentation Deadline	April 8, 2018
SPE Auto. Div. Board Meeting American Chemistry Council - Auto. Ctr. New King Street, Troy, MI, USA	5:30 - 7:30 p.m. April 9, 2018
13th Annual AutoEpcon New King Street, Troy, MI, USA	ALL DAY May 1, 2018
ANTEC 2018 Orange County Convention Ctr., Orlando, FL	ALL DAY May 7-10, 2018
SPE Auto. Div. Board Meeting American Chemistry Council - Auto. Ctr. New King Street, Troy, MI, USA	5:30 - 7:30 p.m. June 11, 2018
ACCE Paper Deadline	June 15, 2018

Automotive Division Board of Directors meetings are open to all SPE members. All events are listed on our website at <http://speautomotive.com>

Email Matt Carroll at auto-div-chair@speautomotive.com for more information.

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Reba McEntire says, "I have a lot to be thankful for. I am **healthy, happy** and I am **loved**," And while that's all good, in the Automotive Industry, we are additionally grateful for healthy light weight vehicle sales! As seen in the chart below from FRED (Federal Reserve Economic Data), the party is not over as the Seasonally Adjusted Annual Sales rates are still averaging around 17 million units, despite a bit of a summertime dip. **Healthy** sales making **happy** engineers — what's not to **love**?

Closer to home, the SPE Automotive Division is thankful for the many excellent events over the last few months. Going back to August 23rd, Louay Chamra, the Dean of the Oakland University School of Engineering and Computer Science, along with Mark Richardson, Special Consultant to the Dean, of Series One, LLC, hosted a kick-off for the Advanced Plastics Manufacturing Initiative (APMI) at Meadowbrook Hall on the campus of Oakland U. As Louay says, "Education Leads To Innovation," and to quote from Louay and Mark's position statement:



- The US has a \$427 billion plastics industry with over 1 million workers. A significant concentration of these jobs are in Michigan, which supports a variety of plastics sectors. The plastics industry is the third largest manufacturing sector in the U.S. and has a trade surplus. However, it also has a serious shortage in technical workforce that is aging out, with a scarcity of young talent to fill the pipeline.
- The APMI will focus on serving students and industry partners. The program is being structured to provide a hands-on learning environment to develop engineers who are capable in plastics manufacturing. The goal is to train the plastics STEM workforce through certificate programs, associate degrees, 2+2 programs in engineering and technology, engineering bachelors and eventually masters programs.

What a great initiative!

The next night, Thursday August 24th, Plastics News organized "THE FUTURE IS PLASTICS" night at the GEM Theater in Detroit. Sponsors were the SPE Detroit Section, International Automotive Components (IAC) and the IQMS. This event celebrated the old and the new. For 75 years, the Society of Plastics Engineers has led the industry's continuous development and improvement so the SPE was saluted on its 75th anniversary. Patrick Farrey, the SPE CEO, gave the welcoming address and Mark Denson of the Detroit Economic Growth Corp. welcomed attendees to Detroit. Talks from Christina Keller of Cascade Engineering and Saber Haidous and Rae Howard of General Motors followed with a culmination in the honoring of Plastic News's Rising Stars of 2017 in the Plastics Industry — 26 high achievers aged 35 and under. No shortage of inspiration with that crowd!

In September, SPE Automotive Division really hit high gear. Tuesday, September 5th was our annual golf outing organized by Fred Deans and Teri Chouinard. The weather cooperated (if not my driver, wedge or putter) and the company was magnificent, making for a fine walk that was hardly spoiled at all. Not to mention a good finishing meal at the Fieldstone Golf Club in Auburn Hills, MI.

Welcome



Then, on September 6th-8th, SPE Automotive Division in cooperation with SPE Composites Division, hosted our 17th Annual Automotive Composites Conference and Exhibition at the Novi Suburban Collection Showplace. Kudos in particular go to Conference Chair - Rani Richardson of Dassault Systemes, our "behind the scenes Master Mind" - Dale Brosius, Program Administrator and Treasurer - Bonnie Bennyhoff, Student leaders - David Jack, Alper Kiziltas, Uday Vaidya, Editor and Sponsor Chair Teri Chouinard, Webmaster Marc Bahm and the many other volunteer Session Leaders and Registrars. Thanks to all on a very successful and educational three days.

This was followed on October 1st-4th by the SPE Detroit Section's 19th Annual SPE TPO Conference in Troy, Michigan, co-chaired by Dr. Sassan Tarahomi of Mitsubishi Chemical Performance Polymers, Inc. and David Okonski of General Motors. Close to 1000 guests attended from around the world and the technical program was the largest ever with 81 presentations in ten technical tracks. The team's hard work in the preceding 11 months was very apparent at this excellent conference.

Finally, on November 8th, the Plastics Community all came together at our 47th annual Innovation Awards Competition & Gala in Livonia, Michigan, billed as the oldest and largest recognition event in the automotive and plastics industry. Dr. Jeffrey Helms of Celanese did his usual fine job leading the team as Program Chair and special thanks go to our student usher organizers Teri Chouinard, Crystal VanHouten and Dave Reed, just to name a few of our hardworking teammates. Every year at this event, I am overwhelmed with the ingenious parts on display and the latest ideas from top engineers and plastics professionals throughout the industry, and it is hard to believe that, once again, a fantastic program was produced. I know it is cliché but in this case it is really true that there are no losers in this event; only the better and the best

During this winter Holiday season, there is always a lot to be grateful for. Thank you fellow SPE members for making all our events so successful this Fall.

1. From BrainyQuote.com

Changing gears, the SPE Automotive Division Newsletter team is also very thankful for its many newsletter sponsors. As a tribute, the ½ page sponsors are described briefly below, again, with our sincere thanks.



Plasmatreat, established in 1995 by Christian Buske, an engineering graduate from Leipzig University, provides customized surface treatments using atmospheric plasma and low-pressure plasma. The original start-up has evolved into a medium-sized company headquartered in Steinhagen, Germany and operating in 35 countries and with 15 subsidiaries in 11 countries. Plasmatreat North America was first established in Ontario in 2000 and is now in Ancaster, Ontario.
www.plasmatreat.com



Founded in 2003, **e-Xstream**, developer of Digimat, is a software and engineering services company 100% focused on the multi-scale modelling of composite materials and structures. e-Xstream was acquired in 2012 by the MSC Software Company, which in turn was acquired in April 2017 by Hexagon (Nasdaq Stockholm: HEXA B), a firm with 3.1bn EUR revenue.
www.e-xstream.com



ENTEC provides an expansive selection of engineered and commodity thermoplastics to the North American automotive market. ENTEC, first established in 1961 with a foundation in recycling, and now a member of the Ravago group (Arendonk, Belgium), began serving the engineering resins community in 1985. In the Americas, operations include distribution, and numerous compounding and recycling facilities for both commodity and engineering thermoplastics.
www.entecpolymers.com



SABIC is a global leader in diversified chemicals operating in more than 50 countries with more than 35,000 employees and is headquartered in Riyadh, Saudi Arabia. Most notable in local automotive circles, SABIC acquired GE Plastics in 2007 which is now its Specialties Strategic Business Unit. In the Detroit area, Sabic Innovative Plastics is located in Wixom, MI. www.sabic.com

On January 1, 2003, Mitsui Chemicals established **Advanced Composites, Inc.** (known as ACP) by merging two major Automotive TPO Compounders: C&C Tech in Sidney, Ohio, and ATC Inc. in Nashville, Tennessee. Advanced Composites is a leading supplier of TPO's (Thermoplastic Olefins) and Polypropylene Compounds to the North American Automotive Industry. Customers include all of the domestic and transplant OEM's, as well as their major T1 and T2 suppliers. www.advcmp.com



Asahi Kasei Plastics North America, located locally in Fowlerville, Michigan, manufactures plastic compounds, including the four resin families of polyamide 66 (PA66), polyacetal (POM), modified polyphenylene ether (m-PPE), and the styrenics acrylonitrile-butadiene-styrene (ABS) and styrene-acrylonitrile (SAN), for OEMs and tier suppliers around the globe. Asahi Kasei originated in 1922 and now has a head office in Tokyo Japan and 33,720 employees. www.asahikaseiplastics.com

The **ELIX Polymers** plant in Tarragona, Spain started their operations 40 years ago. Over the years, ELIX Polymers has become a leading manufacturer of ABS resins and derivatives in Europe and has now moved to become a new automotive ABS manufacturer in the U.S. ELIX Polymers's shareholder is an affiliate of Sun European Partners, LLP, part of a global private equity firm. www.elix-polymers.com

Attention SPE Innovation Award Winners



We have a new logo to promote your pride in winning an award for your innovative technology in automotive plastics. All category award winning OEMs and suppliers are encouraged to include this logo in their marketing communications. Together, we are educating the industry to the benefits of plastics in automotive applications

Congratulations!

Please contact Teri@intuitgroup.com for artwork.

From across the 9 category winners, this year's Grand Award went to the Body Exterior category winner, the Structural AGS with Integrated Loose Layer Construction on the 2018 Ford Motor Company Expedition luxury SUV. We also recognized the 2018 Chevrolet Traverse SUV with the Vehicle Engineering Team Award for its use of innovations in engineering plastics. And, we awarded this year's Lifetime Achievement Award to Dr. Suresh Shah, a long time contributor to innovations in automotive design and use of engineering plastics as well as a long time contributor to the SPE Automotive Division and Detroit Section. Congratulations to Suresh on a well-deserved recognition of his 40 years of contributions to the automotive and plastics industries.

Category Winner: Lifetime Achievement



Dr. Suresh Shah, retired, Senior Technical Fellow at Delphi Corporation, formerly General Motors – ACG

Dr. Suresh Shah, retired, Senior Technical Fellow at Delphi Corporation, formerly General Motors – ACG (Automotive Components Group) was honored as the 2017 Lifetime Achievement Award winner. Shah is a technical specialist, with over 30 years of experience and more than 45 Intellectual Properties including patents and trade secrets – more than 40% of these are in production, which is far more than the 4% industrial average. Shah advanced plastic processes including gas-assist injection molding, co-injection molding, microcellular molding, hybrid plastic/metal molding, direct (inline-compounded (ILC) long-fiber thermoplastic (D-LFT) composites and thin wall molding. He also advanced material developments involving natural fiber composites, nanocomposites, thermoplastic polyolefins (TPOs) and thermoplastic elastomers (TPEs). This expertise lead to several game changing innovations including the single piece, all plastic door hardware module known as SuperPlug®, and TPO thermoformable skin for instrument panels. He also developed many other innovative applications for exterior, interior and under-the-hood components. His rare combination of expertise in materials, processes, part design and analysis; has earned him a reputation as one of the best problem solvers in the industry. Shah has won more than 20 prestigious awards internationally. He is respected as an industry expert and a key opinion leader and has been interviewed over 30 times by industry trade journals, presented as a keynote speaker more than 15 times and has presented more than 80 technical papers worldwide.



We will now turn to planning for next year's event, expanding our blue ribbon judging panel and recapping what went well and what could be done better for the 2018 program. If you attended our Awards Gala on November 8th and have suggestions on what we can do better, please don't hesitate to let us know. Email your comments to: feedback@speautomotive.com.

Jeff Helms

2017 SPE Automotive Innovation Awards Chair

See this year's SPE Automotive Innovation Awards Competition winners at <http://speautomotive.com/inno>.

Attn. Editors: Photos of all the parts nominated for this year's SPE Automotive Innovation Awards Competition (including these Category and Grand Award winners) are available via Teri@intuitgroup.com.

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2017 SPE Automotive Division GRAND AWARD & CATEGORY WINNER: Body Exterior



Structural Active Grille Shutter (AGS) w/ Integrated Loose Layer Construction 2018 Ford Motor Company, Ford Expedition

- System Supplier: Magna Plastcoat
- Material Processor: Magna Plastcoat
- Material Supplier: Celanese
- Material / Process: Celstran 40-20 PP / injection molding
- Tooling Supplier: Integrity Tool

In the Body Exterior category, the Winner and Grand Award Winner was the **Structural Active Grill Shutter (AGS) with Integrated Loose Layer Construction** on the 2018 Ford Expedition luxury sport-utility vehicle (SUV) from Ford Motor Co. Tier supplier and processor Magna Plastcoat, material supplier Celanese and tool maker Integrity Tool also were named on the award. The material used for this application was Celstran 40-20 PP GF. This, possibly the largest 2-shot AGS in production today, was designed with an integrated locating and attaching system for consistent fit between the grille and headlamps, eliminating the need for FEM assembly, dunnage and shipping. In addition to reducing variable and piece costs by an estimated \$5 with an entirely thermoplastic solution, the enhanced design achieved \$16 internal assembly cost reduction per vehicle and eliminated around \$45 auxiliary costs by negating the need for a FEM. As a result, Ford avoided an estimated \$2 million in dunnage, assembly plant line and handling costs. Improved parts consolidation also phased out the need for four separate fasteners and associated labor. Using LFRT technology to develop a structure with polypropylene offset an estimated 3 lbs. of weight over alternative metal and nylon hybrid designs considered. An equivalent steel structure would weigh 18 lbs. more than the LFRT design, which delivers the required durability.



Category Winner: Aftermarket



Integrated Floor Bedliner Divider 2017 General Motors Co. Chevrolet Silverado

- System Supplier: Penda Corp.
- Material Processor: Penda/Durakon
- Material Supplier: A. Schulman
- Material / Process: Polytrope TPP1026EU TPO / twin sheet thermoforming
- Tooling Supplier: Penda Corp.

In the Aftermarket category, the winner was the **Integrated Floor Bedliner Divider** on the 2017 Chevrolet Silverado pickup from General Motors Co. Tier supplier and tool maker Penda, processor Penda/Durakon, and material supplier A.Schulman, also were named on the award. The material used for this application was A. Schulman Polytrope TPP1026EU TPO. This first time twin sheet thermoformed bedliner divider is integrated into the bedliner as one piece. A \$275 cost avoidance resulted by not having to manufacture a separate floor divider part. The divider incorporates a molded in locking feature to secure the divider into the truck wall when it is raised. It eliminates the need for a cargo net or separate divider allowing the customer to put smaller items in the bed without having the items move and slide around while the vehicle is in motion. Dual textures are achieved on both sides of the part and the design can be applied to different vehicle models and brands via an insert for different logos.



Category Winner: Body Interior



Instrument Panel Carrier 2017 BMW Countryman

- System Supplier: International Automotive Components (IAC)
- Material Processor: International Automotive Components (IAC)
- Material Supplier: SABIC
- Material / Process: Stamax PP LGF / injection molding
- Tooling Supplier: Siebenwurst

In the Body Interior category, the winner was the **Instrument Panel Carrier** on the 2017 Mini Countryman subcompact crossover utility vehicle (CUV) from BMW AG. Tier supplier and processor International Automotive Components (IAC), material supplier SABIC and toolmaker Siebenwurst also were named on the award. The material used for this application was Stamax PP LGF. Long glass fiber PP injection molding via structural chemical foaming with core-back process enabled the production of this part with very low VOC emissions, meeting VDA 278 specification. Extensive CAE work predicting warpage of the foamed part provided valuable insights, allowing for the modification of tooling in advance. Use of foaming means means less material is required resulting in a 15% weight savings, fewer emissions and less cost.



Category Winner: Chassis & Hardware

Category Winner: Environmental



Powertrain Mounting Clevis Bracket 2017 General Motors Co. Cadillac XT5

System Supplier:	Hutchinson
Material Processor:	Not available
Material Supplier:	BASF Corporation
Material / Process:	Ultramid A3WG10 CR BK00564 PA66+50%GF / injection molding
Tooling Supplier:	Not available

In the Chassis/Hardware category, the winner was the **Powertrain Mounting Clevis Bracket** on the 2017 Cadillac XT5 crossover sport utility vehicle (SUV) from General Motors Co. . Tier supplier and processor Hutchinson and material supplier BASF Corporation also were named on the award. The material used for this application was Ultramid A3WG10 CR BK00564 PA66+50%GF. This engine clevis bracket is the first composite mount designed for a 6 cylinder engine, and passing peak loads of 25 Kilo-newtons of force. The injection molded part replaces metallic solutions (stamping, welding and die-casting) used previously resulting in a 45% weight save. NVH was also improved (reduction in cabin noise) due to the damping characteristics of the polyamide compared to aluminum. Corrosion resistance is improved and the part can be recycled at end of life. Seven clevis brackets were developed for different powertrain combinations and there are no warranty claims after 1.5 years of production.

Next Generation Sustainable Content Bio Foam 2018 Ford Motor Co. Ford Fusion

System Supplier:	International Automotive Components (IAC)
Material Processor:	International Automotive Components (IAC)
Material Supplier:	BASF Corporation
Material / Process:	Elastoflex 3496/102 Resin, 113/4 Iso PU / foam in place
Tooling Supplier:	Not available

In the Environmental category, the winner was the **Next Generation Sustainable Content Bio Foam** on the 2018 Ford Fusion sedan from Ford Motor Co. Tier supplier and processor International Automotive Components (IAC) and material supplier BASF Corporation also were named on the award. The material used for this application was Elastoflex 3496/102 Resin, 113/4 Iso PU. This application provides a sustainable alternative to conventional petroleum based foams - at a lower weight and cost with more design flexibility. Caster based foam provides for a lower molded density and ability to be foamed in as little as 4 mm cross sections, and superior bond strength to mating materials. Foam in place tooling, where a cast PVC, TPE, or TPU skin is placed in the mold with a hard plastic retainer and the foam is injected between these two components, is used for processing. A weight savings of 20 - 40% (depending on foam thickness) and a cost savings of \$2 per average foamed in place instrument panel is achieved.



Category Winner: Materials



Low Friction Polymer for Chain Tensioner Arms 2017 Ford Motor Co. Ford F150 / Mustang

System Supplier: Borg Warner
 Material Processor: Not available
 Material Supplier: DSM Engineering
 Material / Process: Stanyl HGR2 PA46(+PTFE) / injection molding
 Tooling Supplier: Not available

In the Materials category, the winner was the **Low Friction Polymer For Chain Tensioner Arms** on the 2017 Ford F-150 pickup and Ford Mustang sports car from Ford Motor Co. Tier supplier Borg Warner and material supplier DSM also were named on the award. The material used for this application was Stanyl HGR2 PA46(+PTFE). This usage of a modified PA46 resin to enhance stiffness, on vehicles powered by a 5.0L V8 engine, was a drop-in replacement for PA66, for enhanced wear and friction performance. The resultant fuel economy savings (0.4%), from rotational torque reduction in the cam-shaft (0.5Nm), was equivalent to a 40lb weight reduction, and at 1/10th the cost. Annual environmental benefits include reductions in gas consumption by 12,000 Barrels and green-house gas emissions by 5,000 Tons. This innovation is highly translatable, to provide affordable fuel economy improvement, and will be utilized on more Ford vehicles, beginning in 2018. The total potential environmental impact of translations, at Ford, may be multiple times the values noted for the Mustang and F-150.

Category Winner: Powertrain



Turbo Charger Outlet T-Joint 2018 Hyundai Motor Co. Genesis G80, Kia Stinger

System Supplier: Hwaseung R&A Co., Ltd.
 Material Processor: SEJI Solotech, Inc.
 Material Supplier: DuPont Korea Inc.
 Material / Process: PA66 / injection molding
 Tooling Supplier: Not available

In the Powertrain category, the winner was the **Turbo Charger Outlet T-Joint** on the 2018 Genesis G80 and Kia Stinger sedans from Hyundai Motor Co. Tier supplier Hwaseung R&A Co., Processor Songwoo Industrial and Seji Solotech, Inc., and material supplier DuPont Korea Inc. also were named on the award. The material used for this application was PA66. A 42% weight and 35% cost reduction, and improved airflow reducing the pressure drop (-8kPa) to increase fuel economy and improve NVH performance was achieved by designing and molding this part with plastic compared to the previous aluminum die cast part. Air flow noise was also reduced and long term durability increased via the rib pattern design. Special 3-gate positioning tooling was designed to minimize stress in weld-line area for strength and durability and for processing optimization. A new 35% glass fiber reinforced, heat stabilized polyamide 66 resin was developed for good retention of properties over time at temperatures up to 220 degrees C.



Category Winner: Process / Assembly / Enabling Technologies



Category Winner: Safety



Two Shot Interior Decoration Bezel 2018 Ford Motor Co. Ford Fiesta

- System Supplier: Faurecia Interior Systems
- Material Processor: Faurecia Interior Systems
- Material Supplier: Lotte Advanced Materials
- Material / Process: INFINO LT120 PC & Starex LX0760 / 2-shot injection molding
- Tooling Supplier: JP Grosfilley SAS

In the Process/Assembly/Enabling Technologies category, the winner was the **Two Shot Interior Decoration Bezel** on the 2018 Ford Fiesta subcompact from Ford Motor Co. Tier supplier and processor Faurecia Interior Systems, material supplier Lotte Advanced Materials and tool supplier JP Grosfilley SAS also were named on the award. The material used for this application was INFINO LT120 PC and Starex LX0760. This unique 3-D decorative effect was achieved with 2K 'reverse' injection molding (1st shot tinted PC) with overmolding of grained surface with 2nd shot (self colored pigmented ABS). This is the first time this process was used to achieve the 3-D visual effect (color and texture) for a part of this size and geometry. A 30% cost save was achieved vs IMD/IML/high gloss painting and there was a 20% scrap reduction vs conventional 2-layer high gloss piano black appearance.

Gen-3 4-Way Head Restraint 2018 Ford Motor Co. Ford F150

- System Supplier: Windsor Machine and Stamping
- Material Processor: Windsor Machine and Stamping
- Material Supplier: Ravago
- Material / Process: Hylon N1000STHL PA / injection molding
- Tooling Supplier: Integrity Tool & Mold

In the Safety, the winner was the **Gen-3 4-Way Head Restraint** on the 2018 Ford F-150 pickup from Ford Motor Co. Tier supplier and processor Windsor Machine and Stamping, material supplier Ravago and tool supplier Integrity Tool & Mold also were named on the award. The material used for this application was Hylon N1000STHL PA. This low cost, low mass, head restraint provides exceptional rigidity for whiplash protection. Its flexible design allows the front surface of the head restraint to be translated closer to or further from the occupant by 60 mm without incurred costs (allowing for the precise balancing of comfort and safety). Using plastic, in place of steel, as the primary load bearing component is new to front row head restraints. The part design eliminates manufacturing complexity making use of intelligent geometries so that readily available materials could be used. A \$10.73 Million savings (\$2.80/vehicle) is projected by the end of MY2020.



Category Winner: Hall of Fame

Category Winner: Vehicle Engineering Team Award



Thermoplastic Polyolefin Skin Instrument Panel 2000 General Motors Co. Pontiac Bonneville

- System Supplier: Inteva Products LLC (Delphi Interior Systems)
 Material Processor: Inteva Products LLC (Delphi Interior Systems)
 Material Supplier: Mytex Polymers (formerly Exxon Mobil Chem. & Mitsubishi Chem. Corp. joint venture)
 Material / Process: TPO / injection molding
 Tooling Supplier: Mytex Polymers (formerly Exxon Mobil Chem. & Mitsubishi Chem. Corp. joint venture)

The use of TPO skin on IPs was recognized in the industry in 1999, when GM won the SPE® Most Innovative Use of Plastics Award in the Body Interior category. It improved safety by enabling air bag deployments, and reduced windshield fogging with the reduction of VOCs and odors without plasticizers and toxic stabilizers. The environmentally friendly all polyolefin system also enabled closed loop recycling and the replacement of PVC while reducing mass 10%. The TPO skin also improved interior quality by preventing brittle cracking, color fading (UV protection is improved by 4 times) and warping. Overall esthetics were improved by the dry haptic leather-like feel inherent in TPO skin.

General Motors Co.

for Significant Use of Innovative Plastic Content on the 2018 MY Chevrolet Traverse

The team:

- Introduced a first surface appearance, thin wall, structural, long glass fiber polypropylene on the floor console carrier saving the program 30% mass or 2.2 lbs. This eliminated the need for metal reinforcements to take \$1.50/assembly out of the part as well.
- Launched the first serial production polyamide clevis bracket reducing the part weight by 45% relative to the previous aluminum design while increasing damping by a factor of 10.
- Developed a new LED headlamp system that includes nine tailored elements – nine individual lenses on top of nine 1x1 LEDs producing approximately 720 lumens. These lenses include three large lenses (2 low beam / 1 high beam) coupled with six smaller ones (4 low / 2 high beam) and enabled lamp performance that is balanced with the customer requirements.
- And extended the use of low density (0.96 g/cc) TPO on the front and rear fascias, wheel opening moldings, claddings and rocker moldings.

The use of plastics and composites contributed to enhanced performance (8% power gain with the 3.6L V6), weight savings (7% lower than the previous program), improved fuel economy (17% increase) with best in class cargo space and up to 14 available advanced safety features.



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ANTEC 2018 REPORT

By Dr. Norm Kakarala



The SPE ANTEC 2018 will be collocated with the NPE at the Orange County Convention Center in Orlando, Florida from May 7-10, 2018. Norm Kakarala is serving as the Technical Program Committee (TPC) Chair for the Automotive Division for the ANTEC 2018. Any questions on paper submissions, please direct them to Sriman.kakarala@gmail.com for support and navigation.

In addition to the traditional highly technical program, ANTEC® 2018 will feature a new Technical Marketing track. This new track will be organized into sessions focused on specific topical areas and is intended to be a forum where new products, processes, and services can be effectively shared with attendees in a timely manner. Candidates for these sessions should represent new offerings with market entry having occurred in the last two years or in an advanced stage of development with commercialization planned in the near future. Older products and processes will be considered as long as they bring value to those attending.

Presentations are to be directed at a technical audience and are expected to tell a story that includes the problem the new technology is solving, the economic benefit, and the ease of implementation. Data and analysis that support the claims

and benefits for the new technologies being presented must be included.

Here are few Highlights of requirements the presenters at the ANTEC 2018 need to follow:

- No abstracts are required. Written Papers or Presentation Files (PowerPoint) without written papers are acceptable.
- All papers and submitted presentation files need to be approved by the Review Committee for inclusion on the Program.
- All Papers or Presentations need to be submitted through the e-touches system (Details provided on the SPE Call for Papers Announcement for ANTEC 2018)
- The [due date for the Papers or Presentations](#) for Committee Review is by [December 15th](#).
- We plan to have a good Automotive Sessions at the ANTEC with thought provoking presentations. When papers or presentations are submitted please ensure to select the Automotive Session for your participation.



ANTEC® ORLANDO

The Plastics Technology Conference



May 7-10, 2018 • Orange County Convention Center • Orlando, FL

CALL for Papers & Technical Marketing Presentations

Submission Deadline: December 15, 2017

Questions?
Scott Marko
Event Manager
smarko@4spe.org

4spe.org/antec18

The image shows the rear of a dark-colored SUV with its trunk open. Two Great Danes are sitting upright in the back seat. The dog on the left is black with a white chest and wears a red collar. The dog on the right is grey with a white chest and wears a blue collar. The background shows a blurred outdoor setting with greenery.

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SPE Design Outreach Program

by Chuck Jarrett and Steve Van Loozen

The SPE Automotive Chapter kicked off an Auto Design outreach program with the faculty and students at Lawrence Technologies University's (LTU) Transportation Design and Industrial Design program, which is one of the premier Auto Design schools directed by Keith Nagara. The intent from the SPE Auto Section is to educate the up and coming students from the design program on the capabilities of today's thermoplastics related to Design, and to fund \$5,000.00 in scholarships.

The project was launched with the students on the SPE design brief to leverage the innovative use of plastics as a Design enabler versus traditional materials such as steel, aluminum or thermosets. The LTU design students have been collaborating with several other corporate-related design tracks this semester and our design brief is to dovetail into their current body of work which includes: FCA, Wards Automotive and Calsonic.

Since the introduction of the project, we have met with the students multiple times. We've hosted thermoplastics training in reviewing the capabilities for various applications and manufacturing feasibility scenarios. Additionally, we spent time one on one discussing the students' plastics influences on their individual projects, how using plastics opened the door to a new solution set, and how it enhanced their capability to deliver their design intent.

We have been very fortunate to have two of Detroit's iconic Automotive Design leaders as judges for our student design competition. We have Gordon Platto, Design Director from Ford Motor Company along with Mark Trostle, Head of Dodge and SRT Design at FCA. Both judges have been involved with the students and supporting the SPE Auto Chapter Design outreach scholarship program. We appreciate their guidance and participation in support of the students at LTU's Transportation Design, Industrial Design program and SPE.

The judging for the scholarship program will occur prior to the end of the fall semester. The announcement for the winners will occur at a very notable venue in line with the commencement of the North American International Auto Show (NAIAS) in January at the "MAIN Event20". The MAIN Event (Motor City Auto Industry Night) will be held at the famed Max M. Fischer Music Center - Detroit Orchestra Hall on the Sunday night prior to Media days at NAIAS. The event recognizes the industry's global leaders in Auto Design and industry thought leaders such as Bob Lutz and Elon Musk. The event is MC'd by Detroit's own Huel Perkins who will recognize the scholarship winners during the awards segment of the event.



Participating LTU students in the SPE design competition with Professor Keith Nagara.



Senior Transportation Design student Josh Desouza



Senior Transportation Design student Dillon Kane

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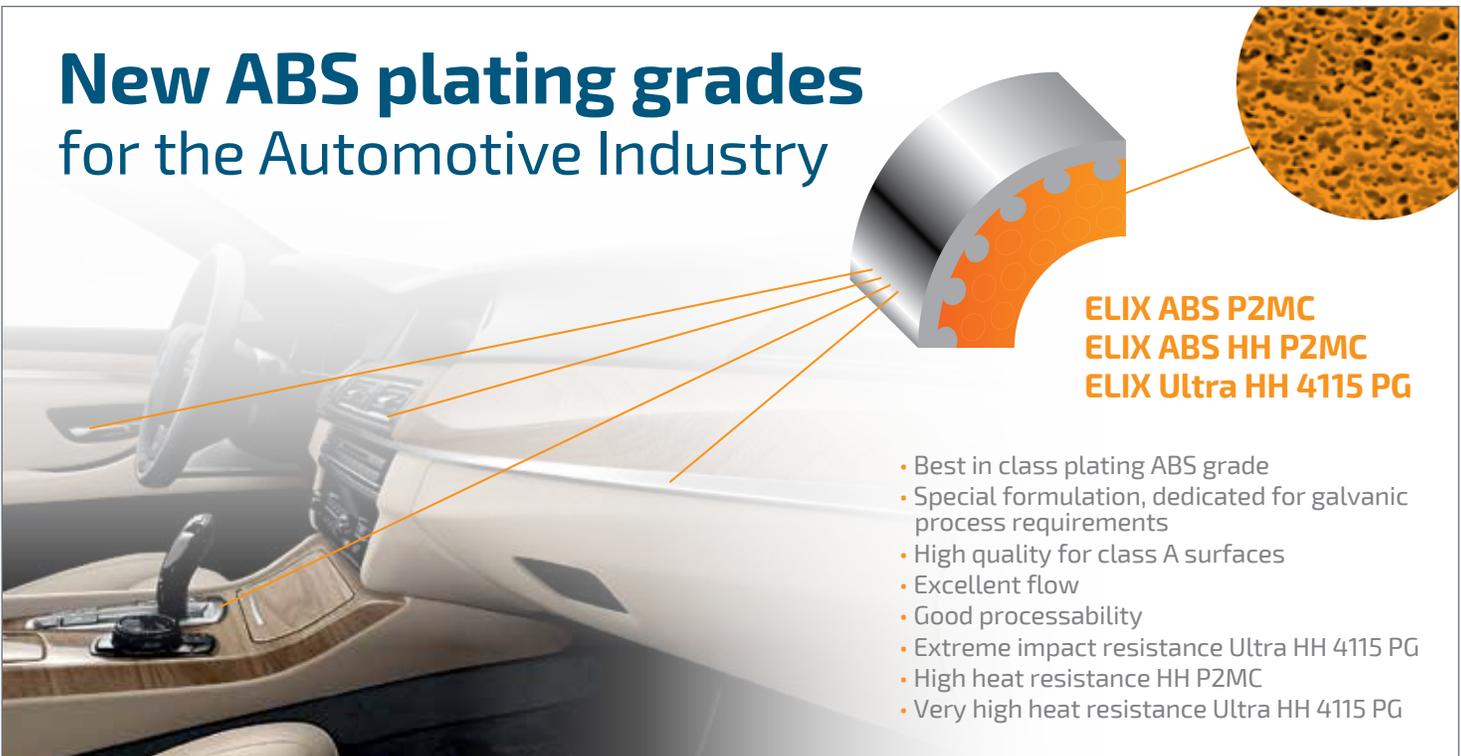
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ACCE 2017 Recap

by Teri Chouinard,
SPE Automotive Div. Communications Chair



SPE® ACCE – Automotive Composites Conference & Expo Grows with More Scholarships, Sponsorships and OEM Support

Strong Attendance, Technical Sessions and Part Competition Enhance the Program

The SPE ACCE – “The World’s Leading Automotive Composites Forum”, is awarding more scholarships with increasing sponsorships and OEM support; while providing a robust technical program, part competition, exhibit floor and enjoyable networking opportunities. The Automotive and Composites Division of the Society of Plastics Engineers (SPE®) jointly produce the ACCE to educate the automotive industry about the benefits of composites in automotive applications. The goal is to grow the industry via education and providing scholarships to students pursuing careers in the composites industry furthers that objective. This year’s ACCE annual scholarships were made possible with support from the Michigan Economic Development Corp. (MEDC), Dr. Jackie Rehkopf endowed fund, and Asahi Kasei Plastics.

The ACCE had great sponsorship support with 115 companies featured as sponsors of exhibit and non-exhibit promotional packages. All exhibit spaces were sold out with a total of 85 companies exhibiting. Exhibits highlighted advances in materials, processes, equipment and supporting technologies in both thermoset and thermoplastic composites in a wide variety of transportation applications. All 16 non-exhibit sponsorship packages were also sold out including scholarships packages (2) and advertising opportunities (3) and networking breakfasts (3), lunches (3), coffee breaks (3) and cocktail receptions (2). Automotive and composites media publications and associations also participated (14).

“Thanks to our sponsors, The SPE ACCE continues to make a positive impact in the industry and in individuals benefitting from the educational opportunities the conference enables,” notes Rani Richardson, composites & additive manufacturing business experience consultant, Dassault Systemes and 2017 ACCE event chair. “Composites are essential in taking mass out of vehicles while offering structural strength and more design flexibility than any other material,” continues Richardson. “Our technical sessions, student poster presentations, and exhibitor displays continue to exemplify the advantages advanced composites technology brings to automotive applications.”

Growing OEM interest in ACCE, including 180 OEM attendee registrations in 2017 (141 OEMs registered in 2016 and 130 OEMs registered in 2015) out of an average of 900 total attendees registering each year over the last 3 years, is a testament to the increasing interest OEMs, tiers and other automotive engineering professionals have in ACCE and automotive composites technologies. The 2018 ACCE will be co-chaired by Dr. Alper Kiziltas, Lead Research Scientist, Ford Motor Company and SPE Automotive Div. Education committee chair and Matthew E. Carroll, Materials Engineering, General Motors Company and SPE Automotive Div. Chair, which is a further testament to the increased interest OEMs have in ACCE. “I am looking forward to continuing the growth of ACCE and expanding the Student Program to grow the education of our future leaders in the automotive composites industry,” noted Dr. Kiziltas. “Continued success of ACCE is essential to the industry as we have to meet challenging emissions and fuel-economy standards by eliminating mass and the ACCE provides us with technologies and options to help us achieve these goals,” noted Carroll.

This year, the MEDC increased their ACCE Scholarship Program to include \$8,000 USD for four awards for students pursuing advanced studies in a composites-related field. (last year’s program included \$6,000 USD for three awards). The three winners of the SPE ACCE graduate scholarships (\$2,000 USD each) were Mr. Benjamin Blandford of Baylor University, Mr. Jake Fallon of Virginia Polytechnic Institute and Ms. Madhura Pawar of University of Massachusetts at Amherst. A fourth ACCE scholarship (also \$2,000 USD) for a student attending a university or college in the U.S. state of Michigan was won by Mr. Christopher Hershey of Michigan State University. ACCE scholarship winners are required to present the results of their research at next year’s SPE ACCE show, September 5-7, 2018.



The Dr. Jackie Rehkopf Scholarship, created in 2016 from an endowed fund to honor the long-time SPE committee member, SPE Automotive Div. board member and automotive composites researcher, (\$5,000 USD) was won by Mr. Arya Tewatia of Rutgers University. The Rehkopf scholarship winner is required to either present the results of their research at next year's ACCE or publish them in an SPE journal.

This year's Student Poster Competition, sponsored by Asahi Kasei Plastics, was the largest ever. The committee received 49 applications from students including 34 PhD/MSc students, 12 undergraduate students and 3 high school students from 16 schools in the US, Canada and Germany. A total of \$5,000 was donated to assist with student travel expenses (including travel stipends and shared hotel room accommodations) and provide scholarships to the students with winning poster entries. Additionally, all 49 students received free student memberships in SPE.

In the PhD student category, the first-place winner of \$1,000 USD was Zhaogui Wang from Baylor University for a poster titled, "Effect of Polymer Melt Rheology on Predicted Die Swell and Fiber Orientation in Fused Filament Fabrication Nozzle Flow." Second-place winner of \$500 USD in this category was Robert Brüll from Aachen University (Germany) for his paper titled, "Mechanical Properties and Spinning behavior and of Polyamide 6/Ferrite-Compounds." Third-place winner of \$250 USD was Anmol Kothari from Clemson University for the paper titled, "Design Optimization of a Carbon Fiber Reinforced Thermoplastic Composite Vehicle Door Assembly for Weight Reduction."

In the MSc student category, the first-place winner of \$750 USD was Siegfried Werner from the University of Wisconsin Madison for his paper titled, "Effect of Initial Fiber Length on Fiber Attrition During Processing of Long Glass Fiber-Reinforced Polypropylene." Second-place winner of \$375 USD in this category was Oscar Valeria from the University of Guelph for his poster on "Hyperbranched Glycerol Polyesters as New Impact Modifiers for Sustainable Thermoplastic Blend Materials with Balanced Performance." Third-place winner of \$175 USD was Ian Walter from University of Wisconsin, Madison for his poster titled, "Investigation of Fiber-Matrix Separation in Rib Filling During Compression Using a Direct Fiber Simulation."

In the Undergraduate student category, the first-place winner of \$500 was Ian Major from the University of Guelph for his paper titled, "Miscanthus Biocarbon as a Renewable Carbon Substitute for Automotive Manufacturing Applications." The second-place winner of \$250 USD was Nathaniel Arnold from Michigan State University for his paper titled, "Design of Bio Based Flexible and Rigid Polyurethane Foam Formulations using Bio, Petroleum & Silicon Based Polyols." Third-place winner of \$125 USD was Christoff Reimer of from the University of Guelph for his paper, "Nitrogen-Doped Distiller's Dried Grains with Solubles (DDGS) Biocarbon Supercapacitors in Automotive Electrical Systems."

In the High School student category, 3 students from Ford Motor Co's High School Intern Program participated and all were awarded \$200 USD. Participants included: Robert Chen from Novi High School High School for his poster on "Sustainable Fillers as a Replacement for Mineral Fillers in Polyamide Composites," Logan Boals from South Lyon East High School for his poster on "Incorporating Rice Hull Ash Based Polyol into Flexible Polyurethane Foams," and Alp Aydin from Bloomfield High School for his poster on "Upgrading Biomass for Sustainable and Lightweight Automotive Applications."

The ACCE 2017 featured four keynote presentations and a panel discussion with industry experts. The first day of the conference included two keynotes including "Road Mapping of Structural Thermoplastics and Manufacturing Research at the University of Maine" by David Erb, Senior R & D Program Manager at the University of Maine Advanced Structures and Composites Center and "The UK National Composite Centre: Meeting the Challenges of the Automotive Industry" by Alison Starr, National Composite Centre. The second day of the conference included a keynote address, "IACMI: Fulfilling the Promise for Advanced Composites" by Dale Brosius, Chief Commercialization Officer, IACMI – The Composites Institute. Brosius also moderated a panel discussion on "International Industry-Institute Collaboration: Addressing Big Issues in Composites" later that afternoon. The fourth keynote, presented on the third day of the conference, was "Completing the transition From Metallic to Multi-Material Automotive Solutions – Challenges and Opportunities," by Dr. Patrick Blanchard, Global Technical Leader, Composites, Ford Motor Company.

The technical program included 80 paper presentations (30 min. ea.) organized into the following 13 categories: Advances in Thermoplastics Composites; Enabling Technologies; Virtual Prototyping & Testing; Bonding, Joining & Finishing; Sustainable Composites; Opportunities & Challenges with Carbon Composites; Advances in Reinforcement Technologies; Nanocomposites; Business Trends & Technology Solutions; Enabling Technologies; Additive Manufacturing & 3D Printing; Opportunities & Challenges with Carbon Composites; and Advances In Thermoset Composites.

The 2017 ACCE Best Paper Awards Winner was Mariana Desir e Reale Batista, a doctoral student in Materials Science & Engineering at Michigan State University.

Batista won the award for her paper presenting her research results with the topic "Hybrid Cellulose Composites: Lightweight Materials for Automotive Applications." She also won an ACCE scholarship in 2016 for her paper describing her proposed research in this area. Her presentation described her research study including cellulose fibers, which are attracting considerable attention within the transportation industry, as a class of reinforcing agents for polymer composites due to their low cost, low density, high mechanical properties, and considerable environmental benefits. The objective of the study was to develop hybrid composites or talc in a polypropylene (PP) matrix to optimize the overall composite properties. Adding an optimum concentration of the cellulose fiber is a promising alternative to reduce or replace the utilization of inorganic fibers. For applications in automotive under-the-hood and body interior components, the hybrid cellulose inorganic reinforcement composite approach not only leads to superior weight and cost savings, but also environmental benefits over the inorganic reinforced composites.

This year's ACCE also had more nominations in the Innovative Part Competition than ever before. A total of 7 nominations were submitted:

- Thermoplastic Re-Engineered '98 Dodge Dakota Rear-Differential Cover-Nominated by: Advanced Structures and Composites Center - University of Maine Orono
- CFRP Motorcycle License Plate Holder-Nominated by: Hennecke
- Fabrication of a Recycled Tow Carbon Fiber Overwrapped Pressure Vessel-Nominated by: Vartega Inc., Steelhead Composites and Michelman Inc.
- Structural Floor, Seat Pan and Front Bulkhead in a Prototype Vehicle-Nominated by: Huntsman
- Carbon Fiber Composite Front Perimeter Subframe Prototype-Nominated by: Magna
- Class A, Painted, Injection Molded, Thin-Wall Body Panels in Polypropylene Carbon Fiber-Nominated by: Magna (for Material Category)
- Rear Bumper Beam made with Tepex (a thermoplastic composite laminate) for Honda Clarity Fuel Cell Vehicle-Nominated by: Lanxess

A panel of 9 industry experts from the ACCE planning team selected a winner for "Most Innovative Process" and "Most Innovative Material". Magna won in both categories. Their "Class A, Painted, Injection Molded, Thin-Wall Body Panels in Polypropylene Carbon Fiber" won in the "Most Innovative Material" category. Their "Carbon Fiber Composite Front Perimeter Subframe Prototype" won the "Most Innovative Process" category. ACCE attendees selected a winner from all categories for a "People's Choice Award" and Magna won again. Both of their nominations tied to win the "People's Choice Award."

The mission of SPE is to promote scientific and engineering knowledge relating to plastics worldwide and to educate industry, academia, and the public about these advances. SPE's Automotive Division is active in educating, promoting, recognizing, and communicating technical accomplishments in all phases of plastics and plastic-based composite developments in the global transportation industry. Topic areas include applications, materials, processing, equipment, tooling, design, and development.

For more information see www.speautomotive.com. For more information on the *Society of Plastics Engineers*, see www.4spe.org.

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EDUCATION REPORT

by Alper Kiziltas,
SPE Automotive Education Chair

SPE Automotive Division and Ford Provide High School Students Opportunity to Engineer Next Generation Vehicles



Last month, **Alp Aydin**, a student at Bloomfield High School, presented his poster at the SPE ACCE Conference.

Alp worked at the Ford Research and Innovation Center, and during his time, explored upgrading biomass for sustainable and lightweight automotive. He used lobster shell powder as a filler for plastics to be used in vehicle interiors, and was able to collaborate with other high school and college interns, as well as professionals in the automotive industry. He was also responsible for working with high level machines that are widely used in the industry, which helped him learn a lot about the various components of engineering and research.

At the SPE Automotive Composites Conference and Exhibition, he had the chance to present his research to judges and other professionals in the automotive industry. He also had a chance to network with representatives from other companies, as well as presenters that had similar research.

"It was a very good opportunity to learn about the automotive industry first hand from the people that are involved in it," said Aydin. "I'm grateful to the Ford Sustainability and Emerging Materials Group, and SPE Automotive Division, as well as the ACCE committee for this opportunity."

Logan Boals, South Lyon East High School Student, presented his poster and received "Best Poster" award at the SPE ACCE Conference, September 6-8, 2017.

This summer, Boals spent six weeks working in Ford Motor Company's Sustainability and Emerging Materials Research Group as a high school intern. He was assigned to researching and incorporating rice hull ash-based polyol into flexible polyurethane foam applications. His responsibility was to review literature as well as formulate, prepare, test and analyze foam materials, and create a poster for the SPE Automotive Composites Conference and Exhibition.



Boals said he wasn't sure what to expect at the conference, as it was his first one. He was nervous about speaking in front of a group of judges, and unsure how to present his findings, but said as the day went on, he felt increasingly more comfortable.

"The judges were very kind and understanding, and seemed very knowledgeable and genuinely interested in my work," said Boals.

He also enjoyed looking at other students' projects and the displays from several other companies.

"It was so inspiring to see all the opportunities in the world of chemical engineering for young college students," he said. "I'm thankful for this extraordinary opportunity to work at Ford this summer, and the opportunity to attend the ACCE conference."

Tour of IACMI Vehicle Scale Up Facility

by Tom Pickett, SPE Automotive Board Member



On October 16, 2017, the SPE Detroit Section organized a Technical Dinner Meeting at the Institute for Advanced Composites Manufacturing Innovation (IACMI) located in Detroit, Michigan. Ray Boeman, Director for IACMI Vehicle Scale-Up Facility, delivered a presentation on the IACMI organization and objectives. IACMI is a national institute with a focus on advanced composites. IACMI provides open access to members for shared research and development in IACMI facilities that leverage existing capabilities.



THE COMPOSITES INSTITUTE

The IACMI has several facilities across the United States and each has a specific focus. The facilities include the Vehicle Scale Up Facility in Detroit; Composite Manufacturing and Education Technology (comet) Facility in Boulder, Colorado; IACMI Laboratory at the University of Dayton Research Institute in Dayton, Ohio; The Indiana Manufacturing Institute at Purdue University in West Lafayette, Indiana; The University of Tennessee Fibers and Composites Manufacturing Facility and Engineering Annex Knoxville, Tennessee; U.S. Department of Energy's Manufacturing Demonstration Facility in Knoxville, Tennessee; Oak Ridge National Laboratory's Carbon Fiber Technology Facility in Knoxville, Tennessee; Laboratory for Systems Integrity & Reliability at Vanderbilt University in Nashville, Tennessee and Carbon Spinline Laboratory at the University of Kentucky Center for Applied Research in Lexington, Kentucky.

The IACMI Vehicle Scale-Up Facility supports production scale materials development focused on vehicle light weighting in automotive. The facility has more than 50,000 square feet for proprietary and pre-competitive projects with industry, government and academia. It provides full scale capabilities to augment Michigan State University composite R&D capabilities at the main campus in East Lansing, MI.

The presentation was followed by a tour of the facility in which attendees viewed the variety of equipment available. The equipment includes the following: 4,000 ton Schuler compression molding cell; 3,000 ton Milacron injection molding machine; Litzler prepreg line; Hennecke high pressure RTM for PU and Epoxy; ROCTOOL Rapid Heat Cool System and Plasmatreat. The facility also houses the Light weight Innovations for Tomorrow – LIFT.

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COUNCILOR'S REPORT

August 25, 2017 Council Meeting Minutes Detroit, MI

by Suresh Shah, SPE Automotive Div. Councilor

SPE Financial Update

- CEO Pat Farrey provided details on SPE's current financial position and offered his perspective from the world of association management. SPE members and leaders should not underappreciate our successes: Farrey pointed out that many associations would love to have our 2017 ANTEC numbers of 1400 attendees and \$200k in revenue.
- SPE has a strong cash position, the strongest for many years. Operational expenses are tracking on-budget. Corporate sales and membership dues are down leading to revenues that will be below budget by \$377k, excluding the 1-time payment from Wiley for the journal publishing contract. Expenses are greater than revenues by \$123k. Investment income of \$220k helps to offset revenue losses though it cannot be relied upon for guaranteed future income.
- Preliminary results show that ANTEC was profitable again in 2017. Costs were higher than budget and proportionally higher than historical numbers but in-line with expectations.
- Membership dues have fallen to \$70k/mo for the past two months, though overall membership totals are up, primarily driven by e-members.
- It will be difficult to achieve corporate sales goals in 2017. Corporate sales are up 30% over 2016.

CEO Report

CEO Farrey offered that his observations at 60 days revealed no major surprises. His single strategic objective is to improve profitability. Short term priorities include the following:

- In-depth review of IT infrastructure and systems (ref. section 4.4 of 3YOP)
- More staff support for membership / affiliate group services through the hire of a new Member Services Manager
- Need to replace Business Development position. Need better focus on increasing non-dues revenue including advertising, corporate sponsorships and exhibit sales. (This position was filled as of September 2017).

Farrey also covered some additional topics:

- Operational changes: re-integration of Managing Director role into CEO role
- Expense control: CEO review of all items including travel and capex

- Longer term priorities: NGAB, young professionals, marcomms, awards

Recognition & Awards

- The structure of the Pinnacle Awards and related criteria have been reviewed by a subcommittee of the executive board. Vice-President of Education & Technology, Brian Landes, presented his group's findings to Council. Complete details of the changes are available for members to access via The Chain where all presentations are posted. After discussion, Council decided to postpone implementation of the changes until after ANTEC 2018.
- The Awards Committee called for reflection on nominees for the prestigious International Award. Other awards include the Research Award (contributions to polymer science), the Engineering Technology Award, the Business Award and the Education Award. All forms can be found online at www.4spe.org.
- President Al-Zubi recognized SPE Managing Director (leaving SPE) Russell Broome's service to SPE and presented him with a plaque. Broome thanked everyone and encourage all members to focus on the needs of industry for SPE to remain vibrant and relevant.
- President-Elect Brian Grady announced a new opening on the Nominating Committee. Councilor Scott Steele encourage everyone to find new candidates in order to be competitive.

ANTEC 2017

- The subject of commercial papers at ANTEC has been discussed for several years. Changes will now allow for technical marketing presentations. Templates have been created by Mark Spalding of Dow Chemical. Guidelines have been published and are available to membership. The goal is to allow more commercial information. While no official paper is required, a PowerPoint presentation will be reviewed by the ANTEC Program Committee. The presentations will subsequently be published alongside papers in the proceedings. Company logos are permitted but cannot consume more than 5% of the space on a slide.
- Assigning of copyright to SPE for ANTEC papers will no longer be required. Instead the author will be required to grant SPE permission to publish, without surrendering copyright.

- The ANTEC Task Force continues its important work on what changes are required to keep our flagship conference relevant and dynamic. VP Jaime Gomez cautioned that councilors should not extrapolate too much from early findings. Another update will be provided.

Sections & Divisions News

- The VP of Divisions, Creig Bowland, resigned his position due to work and family commitments. Since then, Jason Lyons of Arkema, has been appointed.
- The Sections Committee has recently published a letter outlining their strategic projects to improve communication and member benefits. Members are encouraged to use The Chain for the latest news and information about affiliate groups and general SPE business.

NGAB (Next Generation Advisory Board) & PlastiVan

- Eve Vitale, Director of SPE Foundation, presented an overview of both the Foundation Board and PlastiVan (PV) programs. Currently, there are 4 educators and a program coordinator who are part of the PV team. Vitale reviewed scholarship programs and encouraged everyone to consider more ways to support plastics education via the PV program. All councilors had the opportunity make slime as Vitale led a demonstration of actual PV classroom education.
- The NGAB continues to grow. The current NGAB membership stands at 67. VP Gomez pointed out that 89% of student members do not renew their membership when they graduate and NGAB can act as a bridge to transition members from student status to young professional status. The Executive Board continues to commit essential resources for NGAB success. Councilor Jon Ratzlaff challenged councilors to bring this NGAB news to their respective boards and encouraged them to engage NGAB.

Next Council Meeting:

- The next Council meeting will be on December 15th at 10am EST and will be conducted via conference call.



As of November 18, 2017, the division's account balances were:

Checking:	\$617,712.57
Savings:	\$27,460.92
Paypal:	\$ 60.00
Total:	\$521,339.23



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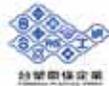
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Best Papers

SPE® Announces 2017 Automotive Composites Conference and Exhibition (ACCE) Best Paper Award Winners

The 2017 SPE ACCE *Dr. Jackie Rehkopf Best Paper Award* winners received the highest average ratings by conference peer reviewers out of a field of 92 contenders. All three winners were honored for excellence in technical writing with a commemorative plaque during SPE ACCE opening ceremonies on September 6. The conference's best paper awards honor long-time SPE ACCE committee member, session organizer, two-times technical program co-chair, and long-time automotive-composites industry researcher, Dr. Jackie Rehkopf.

First Place: **Mariana Desireé Reale Batista** is a Ph.D. candidate in Materials Science and Engineering at Michigan State University. There, she works in the Composite Materials and Structures Center where her research is focused on carbon fiber or natural fiber reinforced polymer composites, specifically modification of the fiber-polymer matrix interphase with cellulose nanocrystals. During the summer of 2016, she interned at Ford Motor Company in Dearborn, U.S., where she worked in the Sustainable Plastics and Biomaterials Research Group. In 2016, Batista won a scholarship presented by the SPE ACCE. Batista graduated summa cum laude with a B.S. degree in Mechatronics Engineering in 2011 and received an M.B.A. degree in Administration and Business Management in 2014, both from UNIFACS (Salvador, Brazil). Before coming to MSU, she worked at Ford Motor Company in Camaçari, Brazil as a product development engineer in the powertrain department. In 2014 Batista received a full-time scholarship to pursue a doctorate degree in the U.S.



HYBRID CELLULOSE-INORGANIC REINFORCEMENT POLYPROPYLENE COMPOSITES: LIGHTWEIGHT MATERIALS FOR AUTOMOTIVE APPLICATIONS

Mariana D. Reale Batista*, Lawrence T. Drzal

*Chemical Engineering and Materials Science Department, Michigan State University
Composite Materials & Structures Center, Michigan State University*

Alper Kiziltas, Deborah Mielewski

Sustainability and Emerging Materials, Ford Motor Company

Cellulose fibers are attracting considerable attention within the transportation industry as a class of reinforcing agents for polymer composites owing to their low cost, low density, high mechanical properties, and considerable environmental benefits. The objective of this study was to develop hybrid composites combining cellulose fiber with long glass fiber, short glass fiber or talc in a polypropylene (PP) matrix to optimize the overall composite properties. Tensile, flexural and notched Izod impact tests revealed that in general the mechanical properties decreased with increasing cellulose content, however, adding an optimum concentration of the cellulose fiber is a promising alternative to reduce or replace the utilization of inorganic fibers. For applications in automotive 'under-the-hood' and body interior components, the hybrid cellulose-inorganic reinforcement composite approach not only leads to superior weight and cost savings, but also environment benefits over the inorganic reinforced composites.

Second Place: **Douglas J. Gardner** is Professor and Program Leader of Forest Operations, Bioproducts & Bioenergy in the School of Forest Resources at the University of Maine. He is also member of the Advanced Structures and Composites Center and Forest Bioproducts Research Institute. Gardner's research, teaching, and service activities focus on polymer and interfacial science aspects of wood-polymer composite materials. He is also involved in research in the areas of adhesion and surface science, cellulose nanocomposites, extruded wood plastic composites, and additive manufacturing. He has co-authored over 200 technical publications and 135 research presentations, and 5 patents.



MECHANICAL PROPERTIES OF HYBRID BASALT-CARBON FIBER-FILLED RECYCLED POLYPROPYLENE AND POLYAMIDE 6 COMPOSITES

Douglas J. Gardner*, Yousoo Han, *University of Maine, Advanced Structures and Composites Center*
Alper Kiziltas, Debbie Mielewski, *Ford Motor Company*

This paper presents results of a study examining novel hybrid recycled polypropylene and polyamide 6 composites using a combination of basalt fibers (BF) and carbon fibers (CF) for potential use in automobile applications. The composites were compounded using a laboratory scale co-rotating extrusion system, and test samples were prepared by injection molding tensile, flexure and impact test specimens. The tensile and flexural properties of the hybrid composites were determined using an Instron testing machine and the Izod impact strength was determined on Ceast Impact tester. Density measurements were made on the resulting composites. The thermoplastic composites made using basalt fibers and carbon fibers were evaluated for their material properties and compared to the properties of composite samples reinforced by glass fibers. Both of the two fibers (CF and BF) significantly increased mechanical properties and the blends of two fibers showed similar trends increasing mechanical fibers. Carbon fiber appears to be superior to BF in enhancing material property improvements which were found to be greater in the PA6 than in PP samples.

Third Place: **Nathan Sharp** graduated with a BS in Mechanical Engineering from Brigham Young University. He received an MS and Ph.D. in Mechanical Engineering from Purdue University. Since graduating he has worked at the Composites Manufacturing and Simulation Center in West Lafayette, Indiana as a Validation Engineer focusing on modeling and measuring phenomena associated with the manufacturing of composite materials. Nathan is currently working on developing integrated manufacturing process models to allow a designer to quickly understand how a change in materials or process conditions will affect the manufacturing and performance of composite parts.

END TO END PROCESS SIMULATION OF THE HIGH PRESSURE RESIN TRANSFER MOLDING PROCESS

Nathan Sharp*, Johnathan Goodsell, Byron Pipes
Composites Manufacturing and Simulation Center, Purdue University

An end-to-end process simulation has been created to predict the high pressure resin transfer molding (HP-RTM) process. Material properties such as fiber orientations and resin properties are mapped throughout the process so that a performance model can be run on a part as it is actually manufactured, not just as it is designed. A B-Pillar geometry was used as a demonstration part and showed a difference in residual deformation of almost 20% when the as-manufactured material properties were considered.





SECRETARY'S REPORT

SPE Automotive Division Board
October 9th, 2017 Meeting Minutes



ATTENDEES

Crystal VanHouten,
Matt Carroll,
Tom Pickett,
Dhanendra Nagwanshi,
Alper Kiziltas,

Dave Helmer,
Suresh Shah,
Cynthia Flanigan,
Teri Chouinard,
Mark Lapain,

Fred Deans,
Steve Van Loozen,
Ron Price,
Jeff Helms,
Chuck Jarrett,

Rick Hamilton,
Marc Bahm,
Gary Kogowski,
Norm Kakarala,
Ed Luibrand,

Kevin Pageau,
Keith Siopes,
Nippani Rao,
Ph: Bonnie Bennyhoff

Meeting was held at the ACC (American Chemistry Council – New Location) in Troy, 5:33pm – 7:12pm

OPENING – Matt Carroll

Review of Agenda for Meeting.

FINANCIAL – Bonnie Bennyhoff

Balance sheet reviewed. Everything is on track and we are in good financial position.

Account Balances as of October 9th – Checking \$491,816.25
Savings \$27,459.98, Undeposited fund of \$2,000.00 for a Total of \$521,339.23

ACCE REPORT – Steve Van Loozen, Teri Chouinard

Wrap up meeting to be held October 13th, 2017. Alper Kiziltas and Matt Carroll to co-chair ACCE is 2018. No complaints or negative feedback on increased registrations fees this year. Main concern was waiting for badges.

DESIGN IN PLASTICS - Steve Van Loozen, Chuck Jarrett

CCS and SPE AD could not attain a collaborative corporate partner and we were late in the process. Bob Grace (Plastics News) is the coordinator of the event.

SPEAD can still do a design outreach program. LTU has existing company sponsored programs. SPEAD would provide project brief and student guidance/education. This design program would lead into The Main Event which is held in January and kicks off the NAIAS.

Motion raised to propose \$15,000 for The Main Event, with \$10,000 contribution towards sponsoring the event and \$5,000 for student scholarships. Motion passed.

Another motion raised for sponsorship only to the Design in Plastics conference. Motion voted down. 6 in favor; 12 nay.

EDUCATION – Alper Kiziltas

In 2015 & 2016 there were 18 supported PlastiVan events. SPE Automotive Division was 16% of the support to PlastiVan and last year, PlastiVan served 2769 students and the goal for this year is 3000 students. We would like to make 20 visits for 2017. We were offered a 10% discount to book all the visits. Concentration would be on Middle and High Schools in areas that have not experienced the PlastiVan. Payment would be due for each school visit.

49 Students attend the ACCE this year.

Best way to get involved with SPE Student Chapters is to support their programs. Would like to support 13 schools at \$2,000 each, for the year. Proposal to be made during the next Education committee meeting.

NEWSLETTER – Dave Helmer

Planned to print 1100 newsletters (prior 1300). 1100 would still be about 100 extra. Article submission deadline for the next Newsletter is 11/17/2017. Open space available for Technical content articles. This is the largest newsletter to be printed as it contains the IAG write-up.

WEBSITE – Mark Bahm

SPE Automotive Website is the #1 hit item for searches.

We had 3000 hits for the ACCE.

Marc to be copied on Newsletter so it can be put onto the Website.

CHAIR REPORT – Matt Carroll

Schedule of Events, Awards, the 2016/2017 SPE Automotive Executive Committee, Committee Chairs, and Board of Directors was updated.

Schedule of Events

December 4th, 2017 Auto Board Meeting – location TBD

Minutes



Awards – Gary Kogowski

Applications and Submission are coming up for the following Awards: HSM, Fellowship, ANTEC, Schwab International.

Executive / Committee Chairs / Board of Directors

Andy Stecher from Plasma Treat is moving to a different industry. He suggested Tim Smith be a replacement. Matt to reach out to Tim.

ANTEC – Norm Kakarala

ANTEC 2018 will be held in Orlando on May 7-10, 2018. Focus is on more industry talks.

MEMBERSHIP – Steve Van Loozen

Automotive has 916 active members as of October 2017. In August 2017, we had 923 active. We need to increase and promote membership.

IAG – Jeff Helms

IAG is on track. There is a conflict with an SAE event this year. Chuck Jarrett will help with vehicles. Crystal VanHouten will help with the Student Volunteers. Expecting another strong year this year. Oakland University would like to sponsor a table this year.

INTERSOCIETY REPORT – Dhanendra Nagwanshi

Attended an SAE Detroit Section vehicle event on September 7th. SAE holds a vehicle event once a month at various locations. Schedule of events to be shared between SPEAD and SAE.

COUNCILOR REPORT – Suresh Shah

Councilor's meeting held on August 25th.

- 2017 ANTEC – 1400 Attendees, \$200,000 in revenue. ANTEC 2018 would like more of an industry focus.
- Membership has fallen to \$70,000 a month for the past few months, however, E-Membership (free) has increased.
- There was an in-depth review of the IT infrastructure and systems.
- The decision was made to postpone the implementation of changes for the Pinnacle award until after ANTEC 2018.

- VP of Divisions is Jason Lyons of Arkema.
- Members are encouraged to use 'The Chain'.
- All councilors had the opportunity to review the PlastiVan content and do some of the experiments such as make slime.

COMMITTEE UPDATES – Matt Carroll
Social, Golf, Councilor, New Business

SPE AD Golf Outing had more attendees in 2017 than 2016. All proceeds to be spent on SPE Student Chapters, in coordination with the Education Team. Fred Deans accepted the honorary title: Golf Outing Chairman for Life.

Sponsorship Appreciation night in December at a local restaurant. Motion raised, motion passed with all in favor. More details to come.

Meeting adjourned.



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SPE Automotive Division Golf Outing Thanks its Sponsors and Participants



Another very successful outing was held on September 5, 2017 at the Fieldstone Golf Club in Auburn Hills, MI. The sun shone brightly over 125 participants at the annual SPE Automotive Division outing. A special thanks from the organizers of this year's event goes to:

- Our long-term sponsors: Plastic Engineering & Technical Services (PETS) (Dinner) and Celanese (Lunch)
- Hole Sponsors: Chromaflo, Plasan, BASF, Carver Non-Woven Technologies, EMS Grivory, Autodesk, PolyOne, JSP, RCO Engineering, Ashland, Entec Polymers, Finkl Steel, PolyAd Services, Toray, and Trinseo.
- Contest Sponsors: Neutrex/Purgex, ID Additives, Lotte Advanced Materials

Special thanks also goes to:

- Teri Chouinard: Sponsorship & PR (Teri actually organizes and runs the event.)
- Ron Price: Chief Photographer (see pics below)
- Bonnie Bennyhoff: Chief Bill Payer
- Fred Deans: Golf Outing Chairman For Life



1st place team: Ashland



2nd place team: Plastic Engineering & Technical Services, Inc. (PETS)



3rd place team: Trinseo

IBB	
CLOSEST TO PIN	#8 LADIES L. CAMPBELL
	#8 MEN ALEX STACHAL
LONG DRIVE	#7 LADIES KRISTE BARR
	#7 MEN KEVIN BINGHAM
LONG PUT	#10 LADIES SHAWNA BRADY
	#10 MEN STEVE PIESAK

Contest Hole Winners

Thanks to our sponsors for making our 23rd golf outing a big success!

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INTERSOCIETY REPORT

Dhanendra Nagwanshi,
SPE Automotive Division Intersociety Chair

*Where do ideas come from?
Do they come from flashes of genius? Where?*

We can't answer that question in the space I have here, but I do want to offer a thought that is relevant to my role as your Intersociety Chair – good ideas can be brought to life when people from different disciplines, teams and associations come together.

And it can happen anywhere. I attended one of SAE Detroit's Vehicle Events in September at the Ford Conference & Event Center in Dearborn. If you have not yet participated in one of these events, I highly recommend them. SAE members and guests come together for an evening and hear directly from key members of an OEM team surrounding the development of a recently launched vehicle.

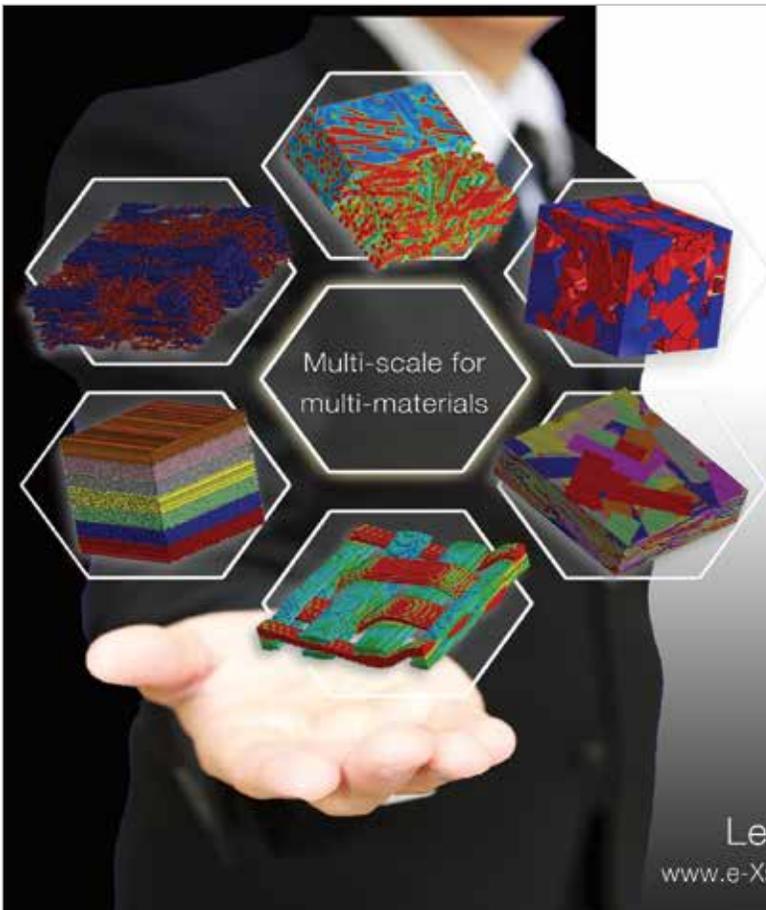
I was stuck by the Ford's use of multi-material solutions to reduce the Expedition's weight by up to 300 pounds and achieve additional improvements to the vehicle's overall performance. Other features like driver assist technologies, vehicle connectivity and an all new cargo management system (an SPE Automotive Innovation Awards finalist in the Body Interior category) were among other innovations showcased.

Hearing about the new technologies and speaking to my teammates and others about them was a bit like a creative collision. We started thinking up ideas of our own. Innovative thinking can truly be infectious.

You're in luck if you would like to attend of these events in the future. SAE Detroit has two upcoming vehicle events on the schedule, one focused on the 2018 GMC Terrain (December 6) and another on the new Nissan LEAF (March 7 next year).

By the way, I had the same experience at this year's SPE Automotive Innovation Awards Gala. Innovation was everywhere around us. You couldn't help but catch a fever for invention.

I always say that we as the SPE Automotive Division should look for new and innovative ways to work with other societies. And I am happy to have your suggestions. But I would also encourage all of our SPE Automotive members to branch out and do something different – like attend an SAE Vehicle Event. Bring colleagues, ask questions, share your thoughts. ***It might just spark your next big idea.***



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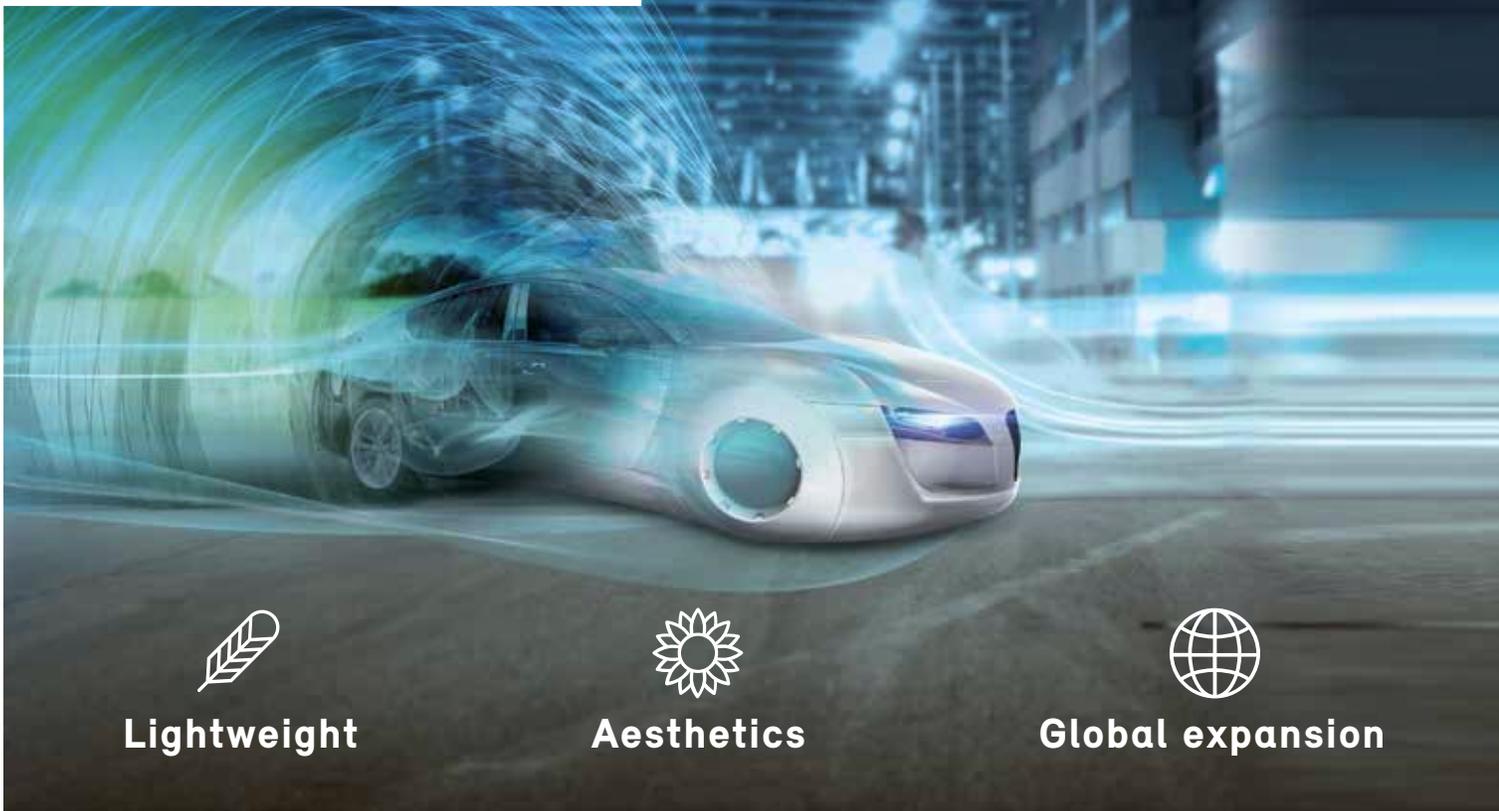
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Technical Report

METHODS TO IMPROVE MECHANICAL PERFORMANCE OF CARBON FIBER EPOXY SMC

I. Swentek*, S. Greydanus, *Hexion Canada Inc.*
C. Ball, *Hexion Inc.*

Abstract

There is an increasing uptake of composite materials in structural applications due to their high specific properties and the decreasing cost of carbon fiber. One of the most industrially-relevant manufacturing processes is sheet molding compound (SMC) due to its commonality and high-throughput. Epoxy carbon fiber SMC is a relatively new material system that has been developed to address issues with traditional SMC. Volatile organic compounds arising from the solvents present in traditional SMC are undesirable from both production and end-use perspectives; epoxy as the matrix can also best achieve the highest mechanical performance. Carbon fiber, however, poses a processing challenge since the small fiber diameter and high surface area are difficult to fully impregnate. Herein a systematic approach is taken to improve the mechanical performance of carbon fiber epoxy SMC by material selection and process-property relationships. Different fiber types, hybrids, roving sizes, processing parameters, the use of a fiber spreader, and the addition of continuous fiber prepreg are examined as methods to achieve the best mechanical performance. Using numerical simulations of the heat balance in a frequently used hot-end, a "v6" from UK 3D printer component supplier E3D, it is possible to demonstrate how much the homogeneity of the temperature distribution decreases with increasing printing speed.

Background

Sheet molding compound (SMC) has long been used with polyester and vinyl ester resin systems to achieve good overall performance and commercial acceptance in a range of applications [1]. Material systems to increase the mechanical performance, such as epoxy and polyurethane, have been recently developed with chemistries compatible to the SMC processing technique [2,3]. Epoxy, specifically, is suitable for numerous semi-structural and structural applications through low-viscosity formulation which can best wet the carbon fiber. Also, it is low in volatile organic compounds, and eliminates styrene monomer exposure [2].

Previous studies have examined some of the material format relationships of advanced carbon fiber composites, albeit with a vinyl ester matrix. Boylan found a relationship to the length of chopped fiber [4]. In her study, she found increasing fiber length did increase the mechanical properties nearly linearly, but caused an increase in cycle time as well as a reduction in the surface quality of moldings. Cabrera-Rios looked at hybrid sheet molding compound whereby the SMC laminates were fabricated with combinations of glass and carbon fiber layers after the individual material sheets had fully matured [5]. The result had quite a bit of scatter but generally suggested a linear trend in properties between the material formulations.



About Ian Swentek

Dr. Ian Swentek is an Applications Development Engineer at Hexion where he specializes in epoxy-based technology for high-volume automotive applications such as epoxy-carbon sheet molding compound, liquid compression molding, and high pressure resin transfer molding. In the short time he has been with Hexion he has helped develop structural applications such as the C7 Corvette roof frame for Plasan as-well-as newer applications in composite suspension systems. Previously, Dr. Swentek worked at the Fraunhofer Project Center in Canada as a Research Engineer specializing in High Pressure Resin Transfer Molding and Fiber Preforming where he wrote multiple papers and helped develop these technologies in the North American market. He holds a doctoral degree in Mechanical and Materials Engineering from the University of Western Ontario where his dissertation was on the fracture mechanics of long-fiber polymer composites. Additionally, Dr. Swentek is a registered Professional Engineer in Ontario, Canada and is currently serving on the Board for the Society of Plastics Engineers Composites Division as the chair elect.

Studies with an epoxy matrix have focused on molding cut prepreg (rather than processing cut fiber into SMC sheet). Feraboli noted excellent properties with epoxy SMC and looked at the orientation effects in the prepreg chips [6]. Nicoletto discussed more of the damage evolution of the cut prepreg SMC and the relatively high variability in the observed performance [7]. While using prepreg eliminates the fiber wet-out issues, it adds a layer of cost and processing complexity not easily tenable in high-volume processing.

With the advent of new epoxy systems specifically formulated for the sheet molding compounding process [2], studies are required to understand the range of performance in carbon fiber composites. Carbon fiber, however, is notoriously difficult to process, often resulting in strengths much less than a similar glass based composite [1,2,4,5]. Thus, this report documents several of the process-property relationships of epoxy / carbon fiber SMC for semi-structural and structural applications.

Experimental Setup

SMC Compounding

Epoxy sheet molding compound (EP SMC) was manufactured on the Dieffenbacher equipment located at the Fraunhofer Project Center in London, Ontario. This industrial-scale line has a throughput up to 354 kg/hr and is suitable for both standard and direct SMC processing. In this instance, the in-line maturation features of the direct process were not used so as to replicate the standard conditions with which many SMC producers are already familiar. A schematic of this equipment and the line heating features are shown in Figure 1 with some of the heating capabilities highlighted. Though room temperature processing of epoxy carbon fiber is possible, it is common to heat the paste slightly to reduce its viscosity to better wet the chopped fiber.

Since the material was often made in small batches, a Bowers stand mixer with a low-shear dispersion blade was used instead of continuous dosing equipment such as a meter-mix-dispense system or an extruder. The low viscosity SMC epoxy from Hexion, EPIKOTETM Resin TRAC 06605 and EPIKURETM Curing Agent TRAC 06608, was provided with an internal mold release, HELOXYTM Additive 06805. The resin was mixed according to the data sheet with the exception that the optionally recommended BYK A-560 degassing agent was not used. The epoxy was always mixed for 5 minutes at moderate shear rate to keep the batches consistent.

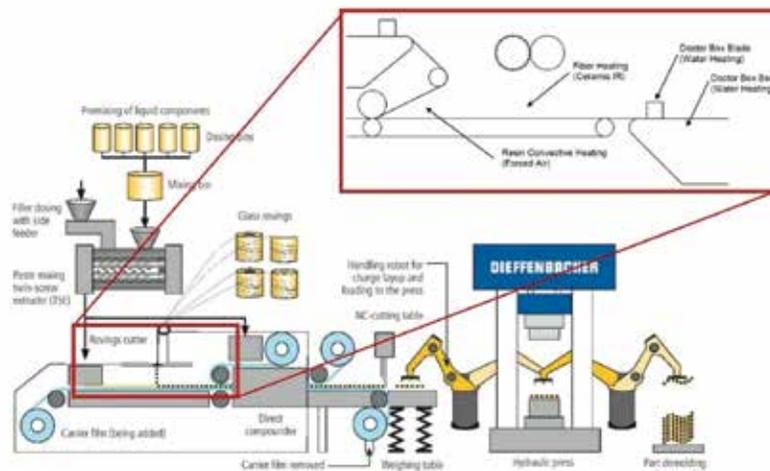


Figure 1 Schematic SMC Equipment at the Fraunhofer Project Center with heating callout

Unless otherwise stated, the carbon fiber was the Zoltek Panex 35 50K-T13. This standard modulus fiber has a low amount of epoxy compatible sizing such that the fiber spreads easily in the compounding and molding operations.

The quality of the SMC sheet is directly related to the selected processing parameters. While a full design of experiments was not conducted, from previous work, several key parameters were selected as the main optimization targets included the sheet basis weight, compaction pressure, and zone temperatures. The target fiber volume content was set to 45% for all the different materials created. The baseline parameters are documented in Table 1.



Table 1 Epoxy SMC compounding parameters Parameter Baseline setting Anecdotes

Parameter	Baseline setting	Anecdotes
Batch size	10 kg	
Fiber length	25 mm	
Sheet width	400 mm	
Resin film thickness	1.5 mm	Lower film thickness resulted in better, but less consistent sheet
Basis weight	3500 g/m ²	Lower basis weights resulted in better sheet material
Line speed	1.5 m/min	The line speed was capped at 1.5 m/min for operator safety
Fiber volume fraction	45%	
Line heating	Off	Line heat at 40°C resulted in improved fiber wet-out
Compaction 'pressure'	75 mm	Compaction set by roller offset with no simple way to measure the direct SMC sheet pressure (calculations estimate 0.25 bar)

Hybrid epoxy with glass and carbon fibers was also fabricated by layering glass and carbon SMC sheet prior to molding. Symmetric charges were composed of 0%, 33%, 66%, and 100% volume fraction glass SMC. The glass SMC was produced at the same fiber content level with the same epoxy from Hexion and with ME1510 glass fiber from Owens Corning.

Panels made from carbon fiber with different filament counts were also fabricated as previously described: 3K, 12K, 15K, and 50K. While the fibers were of different manufacturing origin, they were all epoxy sized at similar concentrations.

Tailored (also called co-cured) epoxy SMC with epoxy prepreg was created in a sandwich-panel style SMC charge such that both materials were simultaneously cured when molded together. Here, the carbon fiber was identical in both the SMC and prepreg materials and the respective resin contents similar. Though the prepreg did use a different epoxy resin system from Hexion, this system was selected with similar chemistry to ensure a miscible, uniform cure kinetic profile in the tailored panel. This prevents residual stress arising from differential curing in the mold which can cause micro cracking and delamination at the SMC/prepreg interface. The prepreg was added as unidirectional material aligned with the SMC machine direction. Several weight fractions of prepreg were selected to examine the trend of properties between pure SMC and pure prepreg materials. Charges were also fabricated with a variety of prepreg orientations and charge laminations including unidirectional, orthogonal, outer sandwich, inner sandwich, to name a few. This report discusses the agglomerate results, while future publications may describe the orientation effects of different co-cure arrangements.

A fiber spreading device was installed in the SMC line to better open the fiber bundles prior to compaction. The approach to spreading the fiber is proprietary to Dieffenbacher, but is designed specifically for high-tow carbon fiber. Panels were made using the same 50K carbon fiber as described, but with the added spreading processing equipment.

Finally, split-tow fiber is a fiber architecture technique to segment a large tow fiber into multiple smaller tows and is different to spreading; a technique to open the fiber bundles at the point of sheet compounding. This is not the same as an assembled roving whereby small tow creels are assembled and wound together to form a larger collective tow. Zoltek processed their Panex 50K in such a way as to effect a multi-ended roving; marketed under the moniker Kassen. Unfortunately, the results of this material were not available at the publication time, but the anticipated result based on trends with vinyl ester material is included for the purposes of expected directional trends and overall discussion.

SMC Maturation & Compression Molding

The epoxy SMC was matured according to the recommended guidelines at room temperature for at least a week prior to molding. Panels, 457.2 mm square, were compression molded for this study using a chromed tool and were always molded with a thickness in the range of 2-3 mm, depending on the sheet basis weight. For reference and context, this overall process is depicted in Figure 4: compounding > maturation > molding > testing.



Figure 2 Epoxy / Carbon SMC fabrication process: a) sheet compounding b) roll maturation c) compression molding d) panel testing

The SMC molding parameters were generally held constant; small changes were made trial-to-trial to improve the quality of the panels. The major settings are captured in Table 2 below. One of the critical parameters was found to be the mold filling speed (controlled by the press close speed), whereby a slower speed during the final few millimeters prevented several observed molding defects. Also, an external mold release, Henkel LOCTITETM FREKOTE 770NC, was applied at the start of each molding day.

Table 2 Epoxy SMC molding parameters Parameter Setting Notes

Parameter	Setting	Notes
Core Temperature	145 °C	
Cavity Temperature1	135 °C	
Vacuum	On	Until resin gel point (~40s)
Load profile	75 bar	Constant
Speed profile (fast)	80 mm/s	Slow close only when tool contacts SMC charge
Speed profile (slow)	1 mm/s	
Mold coverage	50%	Center placed
Cure time	3 min	~60s/m

SMC is known to have a ‘machine direction’ whereby some percentage of fibers align parallel to the compounding direction due to shear stress in the compaction zone of the line. This can help improve properties in this aligned direction, but reduce the transverse properties. To maintain this characteristic, all SMC charges were stacked with the individual cut blanks aligned; this was done to understand the processing effects and mechanical property variation.

Three exemplar panels are presented as-molded in Figure 3 from the baseline formulation, the spread tow, and one of the co-cure sandwich panels. These panels generally exhibited a clean, blister-free surface, but were not of class-A quality (a class-A surface was not the focus of this study series).



Figure 3 Sample SMC panels a) baseline b) spread tow c) co-cure sandwich



Composite Characterization

The molded panels were sectioned into testing specimens following European standards. The test coupon pattern is shown in Figure 4, with the tensile samples following ISO 527-4 and the flexure samples following ISO 14125. For reference, the disks and tensile gauges (post-test) were subjected to ignition loss testing following ISO 7822 to map out the panel fiber volume content and variability. Some dynamic mechanical analysis samples were also taken from each sample panel for separate study.

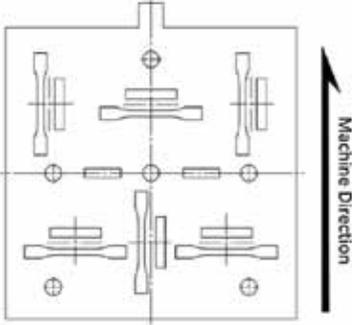


Figure 4 Flat panel geometry and test coupon pattern

Results and Discussion

The tensile results are presented for two selected carbon fiber and one glass fiber formulation in Table 3. These raw results are presented as averages for all the tested coupons in both the machine direction and counter machine direction.

Table 3 Selected epoxy SMC properties Baseline Improved II Glass/epoxy SMC

	Baseline	Improved II	Glass/epoxy SMC
Density [g/cm ³]	1.44 ±0.04	1.47 ±0.04	1.94 ±0.05
Volume Fraction [%]	44.6 ±5.3	49.0 ±3.6	53.5 ±3.2
Tensile Modulus [GPa]	21.8 ±3.3	32.0 ±2.5	20.9 ±1.6
Tensile Strength [MPa]	87.0 ±17.9	142.6 ±15.7	304.8 ±18.3
Failure Strain [%]	0.44 ± 0.09	0.50 ±0.06	2.46 ±0.32

The glass epoxy SMC has excellent properties with high modulus and strength values for a chopped-fiber product, coming only with a penalty to the material density. The baseline carbon epoxy SMC represents a first effort with a new SMC matrix and exhibited sub-optimal fiber wetting and low properties. The primary issue is due to being able to fully wet all the fibers within a fiber bundle and the ability for that fiber bundle to open and separate during compaction and molding. The improved II epoxy/carbon SMC takes advantage of a lower basis weight, using line heating to lower the paste viscosity further, and slightly higher compaction pressure. These improvements helped to increase the carbon fiber wet out as well as reduce variability in the SMC sheet and subsequent molded panel.

To best compare all the results, the properties are normalized with respect to a given fiber volume fraction. The linear normalization is generally accepted as accurate for small volume fraction differences of <5% and follows Equation 1. The normalized property is the result of the ratio of the target fiber volume content to the measured fiber volume content multiplied by the measured property. This equation is also used to scale the measured standard deviation.

$$X^* = \frac{v_f^*}{v_f} X \quad (1)$$

The normalized results for the 50K carbon/epoxy SMC are shown together in Figure 5. Small improvements are observed by adjusting the compounding settings. Major improvements are seen by employing either spread- or split-tow material. The best properties were achieved by co-curing the epoxy SMC with 20%wt of epoxy prepreg in a sandwich type material.

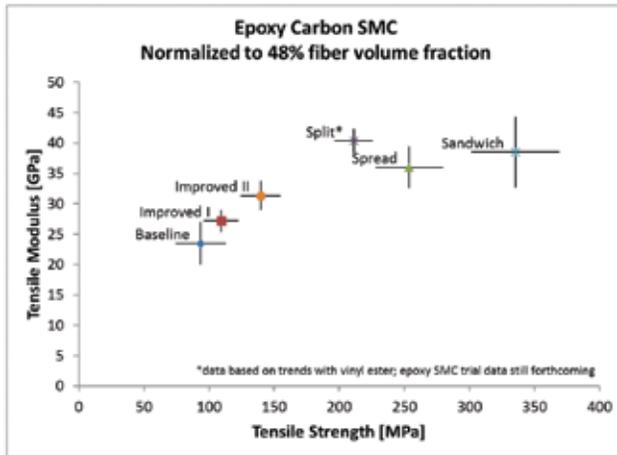


Figure 5 Tensile properties of various epoxy/carbon SMC products and production settings

Plotting the different co-cure materials (Figure 6) with respect to the baseline SMC material reveals a linear trend between the pure SMC and pure prepreg panel properties. This observation is especially important since it implies that epoxy SMC, a lower value product, can displace prepreg, a high value product, in some current designs without impacting weight. For example, a panel primarily in flexure could maintain its bending stiffness by using a sandwich panel with epoxy SMC as the core material rather than a pure prepreg alternative. Thus a simple relationship can be established between the desired material properties and the amount of continuous fiber reinforcement required in a given design.

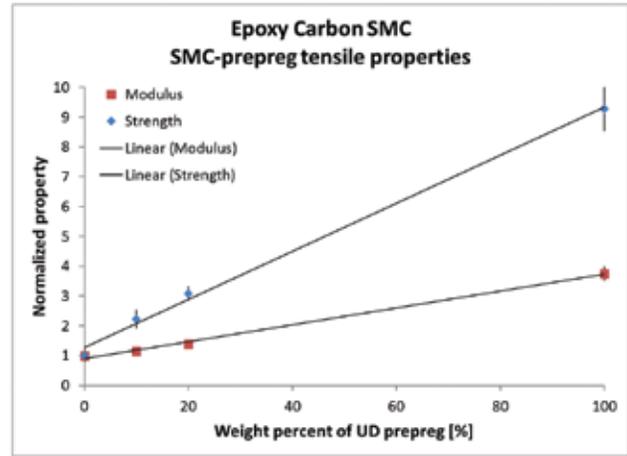


Figure 6 Tensile property trends of co-cured prepreg with epoxy/carbon SMC

The glass and carbon SMC hybrid materials resulted in similar linear property trends based on the component constituents, Figure 7, with respect to the carbon baseline material. Though the glass does offer excellent performance on its own, adding carbon is a viable method to reduce weight without the full cost implication of an all carbon fiber material. These property curves can act as a framework for a design engineer to best select the best material to balance the component cost, mass, and performance.

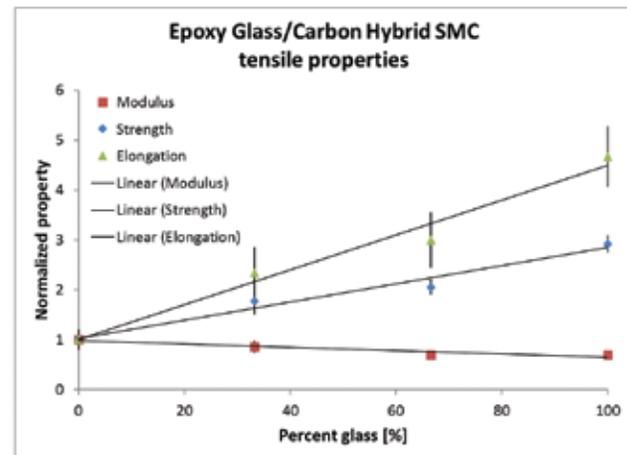


Figure 7 Glass/carbon hybrid epoxy SMC tensile performance trends

Finally, the different carbon fiber tow SMC materials are compared in Figure 8. As the tow size is decreased, both the stiffness and strength of the resulting epoxy SMC increase. At first glance it might have been expected that only the strength would increase since the volume fraction and fiber modulus are constant. However, smaller fiber



bundles are more easily wetted during compounding and more easily dispersed during molding resulting in more complete load transfer between fibers and fiber bundles affecting the composite modulus and strength alike. The standard deviations are also observed to decrease with lower filament counts, resulting in molded SMC material with less variability. Thus a 50K spread-tow material performs at a similar level as a 12K standard-tow, but without any of the material cost premium.

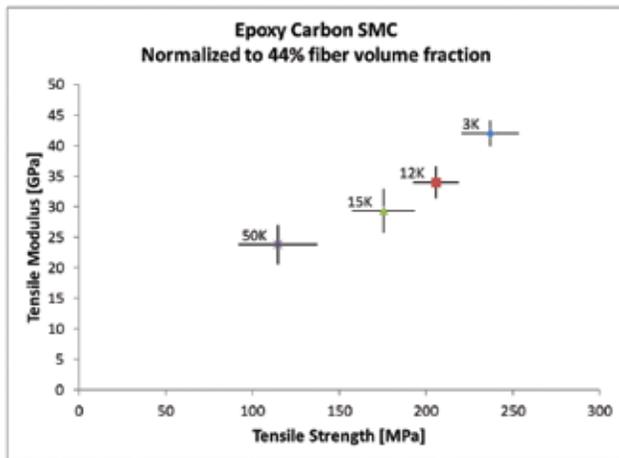


Figure 8 Epoxy/carbon SMC performance based on fiber tow size

Summary and Next Steps

A wide range of carbon fiber epoxy SMC panels were fabricated and tested in a series of industrial scale trials. These materials are suitable for high-volume production such as needed for the automotive industry. Several approaches were taken to improve the performance of epoxy/carbon SMC including process settings, carbon fiber type, and hybrid materials with glass or prepreg. Individually, each of the different approaches offer some level of possible improvement to the material properties. The combination of these approaches is expected to yield the best material solution. Thus future developments should focus on process optimization with fiber spreading technology and the combination of continuous fibers to produce high value, lightweight structural materials suitable for high-volume composite applications. On the chemistry side, future improvements are focused around reducing the system cure time and improving the system T_g without impact to any of the other processing characteristics.

While some optimization is possible with a given material combination and format, the extent of improvement is dwarfed by the performance gains made possible through a slightly different starting material reinforcing the importance of proper material selection in design. The next steps with this work is to analyze a full cost model for the different approaches and document a business case around these semi-structural and structural material systems.

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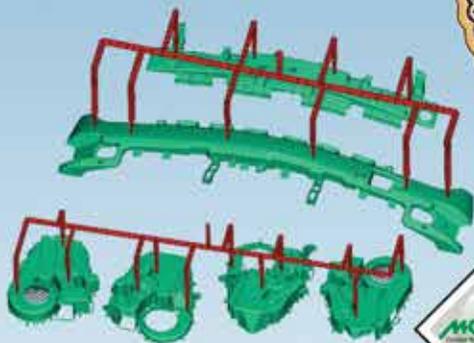
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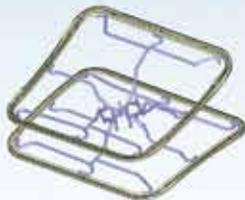
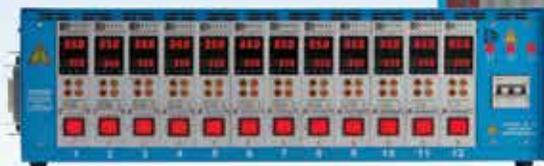
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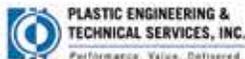
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