AUTOMOTIVE PLASTICS NEWS
A PUBLICATION OF THE AUTOMOTIVE DIVISION OF THE SOCIETY OF PLASTICS ENGINEERS

March 2011 - Volume 40, Issue 3

AUTOEPCON Explores Role of Engineering Plastics in Vehicle Lightweighting, Cost Reduction, & Design

A report out January 10 by Global Industry Analysts, Inc. predicts that worldwide use of engineering plastics will exceed 20-million metric tons by the year 2015, due in large part to their potential to reduce automotive component weight and cost in the range of 40 percent. Against this resurgence of double-digit growth, SPE® announces its sixth-annual ***Automotive Engineering Plastics Conference & Exhibition*** ("***AutoEPCON***" 2011), a one day event that will be held Tuesday, April 26 at the Management Education Center in Troy, Mich.

Organized by the Detroit Section and Automotive Division of the Society of Plastics Engineers (SPE), ***AutoEPCON*** features technical presentations, keynote addresses, exhibits, and a networking reception to highlight the latest advances in materials, design, processing, and automotive use of engineering plastics, plus the challenges and opportunities still on the horizon for this versatile class of polymers. The event annually draws 200-250 attendees from North America and Europe, with close to half reporting they work for automakers or tier suppliers.

The conference focuses on the most pressing auto industry needs for lighter weight, more cost efficient and higher performing material applications for vehicle electrification, turbocharging and a host of other technologies that will be required to meet fuel economy and vehicle performance standards worldwide.

AUTO EPCON
Tuesday, April 26, 2011
SOCIETY OF PLASTICS ENGINEERS
Detroit Section and Automotive Division

Nippani Rao, 2010 & 2011 ***AutoEPCON*** event chair, president of Rao & Assoc., and retired Materials Engineering supervisor at then Chrysler LLC said, "You'd be hard-pressed to find a more effective event to dialogue about transportation uses of engineering plastics than ***AutoEPCON***. It's an outstanding opportunity to network with and learn beside the most influential engineers and scientists developing, specifying, and recommending engineering plastics - the auto industry's workhorse materials for lightweight drivetrain, vehicle electrification, safety-

Continued Page 4

Treasurers Report

Yvonne Bankowski

The SPE Automotive Division bank account balance is in good standing with $90K in checking and $27.4K in savings for a total of $117.4K.

In January, $500 Scholarships were paid out to 3 students from the 2010 ACCE Student Poster Competition. The 2010 ACCE income and expenses were finalized with a positive cash flow of $13.4K which was split with SPE National and the Composites Division.

www.speautomotive.com

Automotive Division Meeting Schedule and Special-Events Calendar

Automotive Division BOD Meeting—All invited ! American Chemistry Council, Troy, MI	April 28, 2011 5:30 pm
6th-annual AutoEPCON Engineering Plastics Conference Troy, MI	April 26, 2011
SPE Annual Technical Conference (ANTEC) Boston, MA	May 1-4, 2011
11th-annual SPE Automotive Composites Conference & Exhibition Troy, MI	September 13-15, 2011
13th-annual SPE Automotive TPO Global Conference Troy, MI	October 2-5, 2011
41st-Annual SPE Automotive Innovation Awards Program Burton Manor, Livonia, MI	November 9, 2011

Automotive Division Board of Directors meetings are open to all SPE members. All our events are listed on our website at **http://speautomotive.com/ec**
Call Jeff Helms at (248) 337-6895 for more information.

ANTEC 2011

The 2011 Society of Plastics Engineering Annual Technical Conference (ANTEC) will take place in Boston, Massachusetts at the Hynes Convention Center and Boston Marriott Copley Center Hotel, May 1 – 5, 2011. ANTEC is the world's largest international gathering of engineers, scientists, and business professionals in plastics.

Learn about the latest technology in plastics automotive at the ANTEC Automotive Session on Tuesday, May 3. On May 3 the Automotive Session T1 will have five talks focused on the latest developments in automotive materials. The afternoon session T19 will have seven papers related to plastic processing and testing of automotive applications. The Automotive Division business meeting is scheduled after the last talk on May 3 at 5:00PM.

The Chair of the 2011 ANTEC Automotive Division Session is **Tom Pickett**. Helping Tom with the ANTEC Automotive Session are **Norm Kakarala**, **Jay Raisoni**, **Suresh Shah** and **Mike Tolinski**.

For more information about ANTEC, visit the website: www.antec.ws, or Contact: Lesley Kyle, CMP, SPE International Senior Event Manager, lskyle@4spe.org, phone: 1-203-740-5452 or Tom Pickett, Chair of SPE ANTEC Automotive Session, tomjpickett@yahoo.com, phone 1-248-431-9724.

Chair's Message

Jeff Helms

This newsletter comes at the beginning of Spring when many of us are looking forward to warmer and sunnier weather. The Automotive Division Board and our volunteers have been hard at work during the Winter preparing for this year's Technical Meetings and activities. The 6th-Annual Automotive Engineering Plastics Conference (AutoEPCON) is right around the corner and will occur on April 26th at the MSU Management Education Center in Troy. The theme of this year's event is the role of engineering thermoplastics in vehicle lightweighting, cost reduction and design.

We are all challenged to meet vehicle weight targets that will enable the automotive industry to meet aggressive fuel efficiency improvements in the 2014-2017 timeframe. Whether the vehicle is a conventional gasoline or diesel powered vehicle, or an extended range or full electric powertrain, the automotive OEMs and supply base will need to reduce vehicle mass to extend fuel economy or range. Cost reduction and design are just as important to produce vehicles that customers can afford and want. I hope that many of you can join us at this one day event.

Quickly after AutoEPCON, the SPE ANTEC meeting will occur on May 1-4 at Hynes Convention Center and Boston Marriott Copley Center Hotel in Boston, Massachusetts. This meeting is a broad-based plastics technical meeting with a variety of topics over the course of 4 days. The Automotive Division will conduct two technical sessions on Tuesday, May 3, followed by the Division business meeting at the end of the second session. If you are planning to attend ANTEC, please join us at our business meeting to meet some of the Division Board and provide us with any input that you might have related to the Division. We would encourage any of our members to become active in Division operations, either in person or remotely.

Planning is already beginning for several other meetings and events later this year.

- The 11th-Annual Automotive Composites Conference and Exhibition is scheduled for September 13-15 at the MSU Management Education Center. This year's event theme is "Composites: Driving Design." This event has historically been well attended with a blend of technical and industry trend presentations, and exhibits showing off the latest technologies in automotive plastics. Please be sure to mark your calendars for this event. And, as in years past, Fred Deans will be busy putting together the SPE Golf Outing so that you can enjoy a day on the course with colleagues or customers or both. This is a great networking event and we are always looking for sponsors for events on the course as well as awards after the golf ends.

- The Automotive TPO Global Conference is also in the planning phase. This conference is the world's leading, and longest running, automotive olefins forum. The conference runs from October 2-5 at the Troy Marriott. The theme of this year's event is "Learn How to Design Lighter, Less Costly Automotive Components."

- And then on November 9th, we hold the 41st SPE Automotive Division Innovation Award Gala at Burton Manor in Livonia, Michigan. Last year we had approximately 600 attendees at this event. Again, the Division volunteers are already working on the details around this event. We are anticipating an even larger turnout this year and a new round of exciting technologies that have made the production leap.

I would encourage each of you to take a look at our website for more details on the SPE and Automotive Division events at **www.speautomotive.com**. I look forward to seeing and meeting many of you at the upcoming meetings. The Automotive Division is committed to educating, promoting, recognizing, and communicating technical accomplishments for all phases of new automotive plastics and plastics-based composite developments in the automotive industry. We can only do this well if you are involved in the planning and/or content of these events.

AutoEPCON

Continued from Page 1

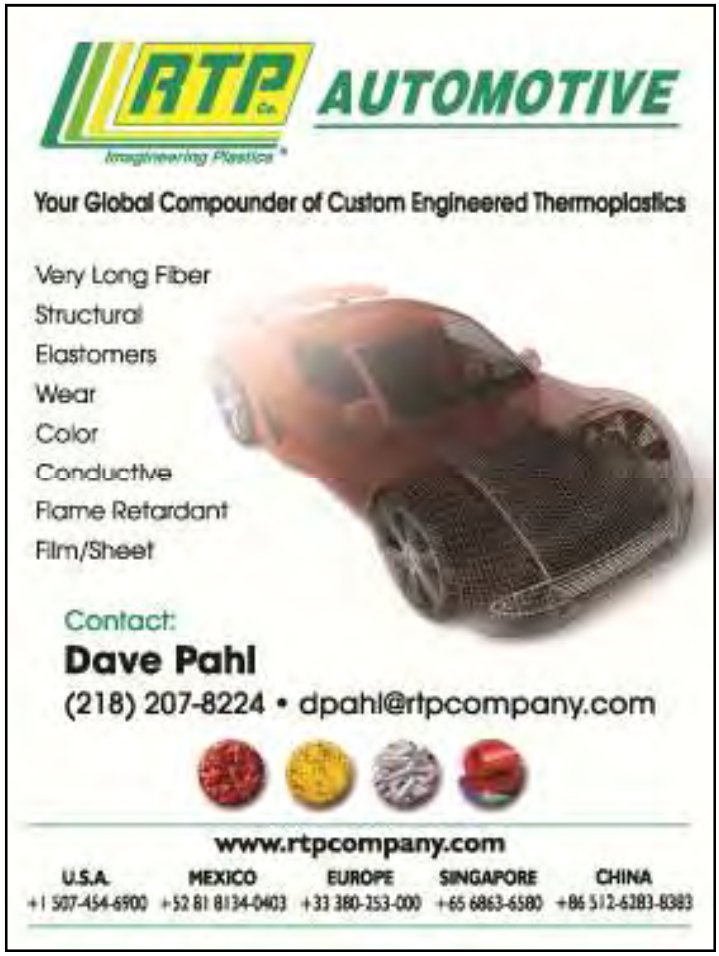
enhancing body and chassis components, and high-value ergonomic design."

First held in 2006, ***AutoEPCON*** features several keynotes from industry leaders, plus 16 or more presentations in multiple technical tracks on the newest advances in materials technology, predictive engineering, process enhancements, and application developments for thermoplastic and thermoset engineering plastics for the automotive industry.

Exhibits are also on display throughout the event. Registration fees of $100 USD for SPE members and $125 USD for non-SPE members include the conference program book, which contains abstracts of presentations, as well as lunch, refreshments, and an evening reception to further networking opportunities for all who attend.

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 Detroit Section and Automotive Divisions, which co-organize the ***AutoEPCON*** show each year, are active in educating, promoting, recognizing, and communicating technical accomplishments for all phases of plastics and plastic based-composite developments – particularly in the automotive industry. Topic areas include applications, materials, processing, equipment, tooling, design, and development.

For more information about the ***SPE Automotive Engineering Plastics Conference***, to view the conference's program, or to register for the event, please visit **http://speautomotive.com/emc**, or contact the group at +1.248.244.8993, or write SPE, 1800 Crooks Road, Suite A, Troy, MI 48084, USA.



SPE Announces Details for Eleventh Automotive Composites Conference and Exhibition

Conference Organizers Issue Call for Papers for September Event

Abstracts Due March 26, Papers / Presentations Due May 28, 2011

Troy (Detroit), Mich. – The organizing committee for the SPE Automotive Composites Conference & Exhibition (ACCE) today announced the dates, theme, and location for this year's show and issued its annual Call for Papers. Now in its eleventh year, the ACCE has become the world's leading forum for automotive composites and draws exhibitors, speakers, and attendees from Europe, the Middle East, Africa, and Asia / Pacific as well as North America. This year's event, whose theme is Composites: Driving Design, returns September 13-15, 2011 at the MSU Management Education Center in Troy, Mich., U.S.A.

Creig Bowland, senior research associate at PPG Industries, and the 2011 SPE ACCE conference chair said, "The auto industry is showing signs of recovery, and the focus with OEMs is clearly on quality, safety, energy efficiency, and attention to detail – both inside and outside the vehicle. But to sustain real growth, our industry needs to work together to develop and execute new technologies that meet customer targets for attractive styling, functional design, increased safety, less environmental impact, and affordability. We at SPE believe that composites are an enabling technology for the automotive industry to meet those goals, and each September for the last decade we've gathered to discuss the latest breakthroughs and most successful applications in ground transportation at the ACCE. We look forward to hosting this year's event."

Those interested in speaking at this year's event should submit abstracts by March 26, 2011 to the review committee via **ACCEpapers@speautomotive.com**. Full papers or presentations are due May 28, 2011. Authors who submit papers (not presentations) in the proper format by the due date will automatically be eligible for consideration for the conference's Best Paper Awards, which will be presented during the event's opening ceremony.

The ACCE typically draws over 400 speakers, exhibitors, sponsors, and attendees from 14 countries on four continents with fully one-third indicating they work for a transportation OEM. Interestingly, over the past few years, the types of OEMs represented at the show have continued to broaden beyond traditional automotive and light truck, to include agriculture, truck & bus, heavy truck, and aviation. This trend may indicate greater interest in technology sharing among transportation OEMs and suppliers.

Held annually in suburban Detroit, the ACCE provides an environment dedicated solely to discussion and networking about advances in the transportation composites. Its global appeal is evident in the diversity of exhibitors, speakers, and attendees who come to the conference from Europe, the Middle East, Africa, and Asia / Pacific as well as North America and who represent transportation OEMs and tier suppliers; composite materials, processing equipment, additives, and reinforcement suppliers; trade associations, consultants, university and government labs; media; and investment bankers. The show is sponsored jointly by the SPE Automotive and Composites Divisions.

The mission of SPE is to promote scientific and engineering knowledge relating to plastics. SPE's Automotive and Composites Divisions work to advance plastics and plastic-based composites technologies worldwide and to educate industry, academia, and the public about these advances. Both divisions are dedicated to educating, promoting, recognizing, and communicating technical accomplishments for all phases of plastics and plastic-based composite developments, including materials, processing, equipment, tooling, design and testing, and application development.

For more information about the SPE Automotive Composites Conference, visit the Automotive Division's website at **http://speautomotive.com/comp.htm**, or the Composites' Division website at **http://compositeshelp.com**, or contact the group at +1.248.244.8993, or write SPE Automotive Division, 1800 Crooks Road, Suite A, Troy, MI 48084, USA.

11TH ANNUAL AUTOMOTIVE COMPOSITES CONFERENCE & EXHIBITION

World's Leading Automotive Composites Forum

SOCIETY OF PLASTICS ENGINEERS
AUTOMOTIVE & COMPOSITES DIVISIONS

COMPOSITES: DRIVING DESIGN

SEPTEMBER 13-15, 2011

CALL FOR PAPERS

EXHIBIT & SPONSORSHIP OPPORTUNITIES

ATTEND THE WORLD'S LEADING AUTOMOTIVE COMPOSITES FORUM

The Automotive and Composites Divisions of the Society of Plastics Engineers (SPE) International invite you to attend the 11th annual **SPE Automotive Composites Conference and Exhibition** (ACCE), **September 13-15, 2011.** The show – which has become the world's leading automotive composites forum – will feature technical paper sessions, panel discussions, keynote speakers, networking receptions, & exhibits highlighting advances in materials, processes, and applications technologies for both thermoset and thermoplastic composites in a wide variety of ground-transportation applications.

PRESENT BEFORE AN ENGAGED, GLOBAL AUDIENCE

The **SPE ACCE** typically draws over 400 attendees from 14 countries on 4 continents who are interested in learning about the latest composites technologies. Fully a third of attendees work for an automotive, heavy truck, agricultural / off-road equipment, or aerospace OEM, and roughly a fifth work for a tier integrator. Few conferences of any size can put you before such an engaged, global audience vitally interested in hearing the latest composites advances. Interested in presenting your latest research? **Abstracts** are due no later than **March 26, 2011** and **Papers** no later than **May 28, 2011** to allow time for peer review. E-mail abstracts or papers to **ACCEpapers@speautomotive.com.** Approved papers will be distributed on a CD to conference attendees and posted on our website after the event.

SHOWCASE YOUR PRODUCTS & SERVICES WITH EXHIBIT & SPONSORSHIP OPPORTUNITIES

A variety of sponsorship packages – including displays, conference giveaways, advertising and publicity, signage, tickets, and networking receptions – are available. Companies interested in showcasing their products and/or services at the **SPE ACCE** should contact Teri Chouinard of Intuit Group at **teri@intuitgroup.com**.

FOR MORE INFORMATION

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Education Report

Monica Prokopyshen & Peggy Malnati

College for Creative Studies (CCS) Plastics in Automotive Design Project
(Photos courtesy of American Chemistry Council – Plastics Division)

In the last issue of this newsletter we showcased some of the ideas which inspired this year's College for Creative Studies (CCS) Plastics in Automotive student projects for the topic: **Sustainable Transportation for "New Detroit".**

This issue features some of the excellent quarter scale models presented at the December 13th final project review. Photos of all the models can be found at the American Chemistry Council – Plastics Division office in Troy, Michigan. Shown are: Urban Professional (Florin Blebea), Recreational City Car (Brian Malczewski), Lusty Green (Christopher Persons), Delivery Vehicle (TaeYeong Kim), Community Recreation (Sean Sangsoo Hahn), and Slows Bar-B-Q (Alexander McGowen).


Urban Professional (Florin Blebea)

Slows Bar-B-Q (Alexander McGowen)


Recreational City Car (Brian Malczewski)


Lusty Green (Christopher Persons)


Community Recreation (Sean Sangsoo Hahn)


Delivery Vehicle (TaeYeong Kim

SPE® AUTO TPO Conference Organizers Announce 2011 Event Dates, Issue Call for Papers & Presentations.

The thirteenth-annual SPE® Automotive TPO Global Conference, the world's leading automotive olefins forum sponsored by the Detroit Section of SPE will be held October 2-5, 2011. Since 1998, SPE volunteers have organized the conference to update attendees on the latest developments in rigid and elastomeric thermoplastic olefins (TPOs). The show typically features 40+ technical presentations, panel discussions, keynote speakers, networking receptions, and exhibits that highlight advances in olefin materials, processes, and applications technologies as well as a growing range of thermoplastic elastomers (TPEs) and thermoplastic vulcanizates (TPVs).

The polyolefin supply chain has experienced major changes in recent years that are providing both challenges and opportunities for OEMs and the entire supply community. To help attendees better follow these trends, traditional technical sessions on Materials Development, Polypropylene Compounds, Applications Development, Surface Enhancements, and TPO / TPE Interfaces are planned for this year's program, as well as a new session on Polyolefin Foam & Processes. Those interested in presenting this year should submit both abstracts and papers / presentations to TPOpapers@auto-TPO.com. Abstracts are due April 29, 2011 and non-commercial papers or presentations are due September 9, 2011.

For the first time in the event's history, this year's conference will be held at a new venue: the Troy-Marriott. A variety of sponsorship packages are available for companies interested in showcasing their products and / or services.

About the TPO Conference

Since 1998, the SPE Automotive TPO Global Conference has highlighted the importance of rigid and flexible polyolefins throughout the automobile – in applications ranging from semi-structural composite underbody shields and front-end modules to soft-touch interior skins and bumper fascia. Polyolefins have been the fastest-growing segment of the global plastics industry for more than a decade owing to their excellent cost / performance ratio. The show typically draws over 400 attendees from 20 countries on four continents who are interested in learning about the latest in rigid and elastomeric TPO as well as TPE and TPV technologies. Fully a third of conference attendees say they work for a transportation OEM,

and roughly 20% work for a tier integrator / molder, with the balance from materials or reinforcement suppliers, equipment OEMs, industry consultants, and members of academia.

SPE's Detroit Section is active in educating, promoting, recognizing, and communicating technical accomplishments for all phases of plastics and plastic based-composite developments – particularly in the automotive industry. Topic areas include applications, materials, processing, equipment, tooling, design, and development.

For more information about the SPE Automotive TPO Global Conference, to view the conference's evolving technical program, or to register to attend the event, please visit **http://auto-tpo.com** or **www.speautomotive.com/tpo.htm**, or contact the group at +1.248.244.8993.

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Call for Papers

Exhibit & Sponsorship Opportunities

Attend the World's Leading Automotive Olefins Forum

Since 1998, the Detroit Section of the Society of Plastics Engineers (SPE®) International has organized the *SPE Automotive TPO Global Conference* to update attendees on the latest developments in thermoplastic olefins (TPOs). Now in its 13th year, the show is the world's leading automotive olefins forum featuring 40+ technical presentations, panel discussions, keynote speakers, networking receptions, & exhibits that highlight advances in olefin materials, processes, and applications technologies as well as a growing range of thermoplastic elastomers (TPEs) and thermoplastic vulcanizates (TPVs). This year's show will be held **October 2-5, 2011** at the Troy-Marriott and will feature sessions on *Material Development, PP Compounds, Application Development, Surface Enhancements, TPO/TPE Innovations*, and a new session on *Polyolefin Foam & Processes*.

Present Before an Engaged, Global Audience

The *SPE Automotive TPO Global Conference* typically draws over 400 attendees from 30 countries on 4 continents who are vitally interested in learning about the latest in rigid and elastomeric TPO as well as TPE and TPV technologies. Fully a third of conference attendees work for a transportation OEM, and roughly 20% work for a tier integrator. Few conferences of any size can provide this type of networking opportunity or can put you before such an engaged, global audience vitally interested in hearing the latest olefin advances. Interested in presenting your latest research? **Abstracts** are due **April 29, 2011** and **Papers/Presentations** on **Sept. 23, 2011**. E-mail abstracts/papers to TPOpapers@auto-TPO.com

Showcase Your Products & Services with Exhibit & Sponsorship Opportunities

A variety of sponsorship packages are available. Companies interested in showcasing their products and/or services at the **SPE Auto TPO** should contact Filippani Rao or Dave Okonski at TPOsponsor@auto-tpo.com

For More Information

www.auto-tpo.com or www.speautomotive.com/tpo
Ph: +1 248.244.8993 or email: g.jayne@yahoo.com
SPE Detroit Section, 1800 Crooks Road, Suite A, Troy, MI 48084, USA

The Washington Update

Medium and Heavy-Duty Truck Regulations Proposed

By Suzanne Cole, CEO, Miller-Cole LLC,
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Phone: 202.241.3022

About the Author

Suzanne Cole is past Chairperson of the SPE Automotive and Environment Divisions and has served as Chair of the SPE International Automotive Awards Program, several global automotive safety conferences and the 1992 ANTEC Supersession on Global Environmental Management. Suzanne has been engaged in legislative and regulatory affairs for over 20 years.

Overview

In May, President Obama called on DOT/NHTSA and EPA to include work trucks, medium and heavy- duty vehicles under the fuel economy and emissions reduction umbrella that already includes passenger cars and light-duty trucks.

The Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA) have jointly proposed the first-ever fuel economy and greenhouse gas standards for medium - and heavy-duty trucks, which if adopted would raise fuel efficiency requirements ranging from 7 to 20 percent depending on the vehicle category. EPA claims the proposed standards have the potential to reduce greenhouse gas emissions by nearly 250 million metric tons and save approximately 500 million barrels of oil over the life of vehicles sold during 2014 to 2018.

The program has received positive reactions from both the American Trucking Association and environmentalists, as well as qualified support from truck and engine manufacturing associations.

Background

Mobile sources emitted 29 percent of all U.S. GHG emissions in 2007 and have been the fastest-growing source of U.S. GHG emissions since 1990. In May 2009, the Obama administration addressed these emissions in part by finalizing tighter standards for fuel efficiency and setting limits on GHG emissions for cars and light trucks. Those rules will begin to take effect with MY 2012, assuming they survive pending legal challenges. Now, EPA and NHTSA are focusing on the heavy-duty sector, which accounted for nearly six percent of all U.S. GHG emissions and 20 percent of mobile GHG emissions in 2007.

Proposed Heavy-Duty Sector Standards

Fuel-economy targets for passenger vehicles have been in place for decades, but the new proposal would for the first time cover vehicles that weigh more than 8,500 pounds. That broad category includes over-the-road tractor trailers, some large sport-utility vehicles and heavy-duty pickup trucks used to tow boats, campers and horse trailers.
Depending on the type of vehicle, truck manufacturers would be required to cut greenhouse-gas emissions and fuel consumption of their fleet by a range of 7% to 20% by 2018.

EPA is proposing emissions standards for CO2 and NHTSA is proposing fuel consumption standards under each agency's respective authorities covering model years 2014-2018. For purposes of these proposed rules, the heavy-duty fleet includes all on-road vehicles rated at a gross vehicle weight at or above 8,500 pounds, and the engines that power them, excluding sport utility vehicles, vans with less than a 13-person capacity, and half-ton pickups. EPA's rule also proposes to include RVs and motor homes, while NHTSA's proposed rule does not.

The new proposed standards are tailored to three vehicle categories: (1) combination tractors; (2) heavy-duty pickup trucks and vans; and (3) vocational vehicles. EPA is additionally proposing standards for air conditioning-related emissions of HFC from pickups, vans and tractors; as well as N2O and CH4 standards applicable to all heavy-duty engines, pickups and vans.

Instead of miles per gallon, heavy-duty trucks will be measured in terms of gallons per ton-mile and emissions will be measured in terms of grams of carbon dioxide per ton-mile. EPA and NHTSA adopted this approach in order to account for the work the truck is doing, rather than just the fuel efficiency of the engine.

Heavy-duty pickup trucks are very profitable for Ford, General Motors and Chrysler. Many large Class 8 tractor-trailers and medium-duty commercial trucks are made by a different group of companies that includes units of Daimler AG, Navistar, Paccar, and AB Volvo, as well as engine makers such as Cummins Inc. and Daimler unit Detroit Diesel Corp. Multiple suppliers including Eaton, Federal Mogul and Borg Warner will be involved in the production and supply of truck components including drivetrain and hybrid powertrain systems for fuel economy, safety and performance to help manufacturers meet the more stringent fuel economy and emissions reduction regulations, in the event they are finalized.

The standards are expected to cost the industry $7.7 billion. Regulators maintain that buyers could recover any costs within the first year through fuel savings. The proposal would provide $41 billion in "net benefits," chiefly through fuel savings, over the lifetime of vehicles produced between 2014 and 2018, and the operator of a semi-truck would save as much as $74,000 over the truck's life under the proposal, according to the Obama administration.

Combination Tractors

Heavy-duty combination tractors are the semi trucks that typically pull trailers. The agencies are proposing differentiated standards for nine subcategories of combination tractors based on three attributes: weight class, cab type and roof height. The standards would phase in to 2017 levels set by the agencies, and would result in a seven to 20 percent reductions in emissions and fuel consumption from affected tractors over the 2010 baselines.

Heavy Duty Pickup Trucks and Vans

These standards are similar to the approach taken for light-duty vehicles. Each manufacturer's standard for a model year would depend on its sales mix, with higher capacity vehicles (payload and towing) being subject to less numerically stringent target levels, and with an added adjustment for 4-wheel drive vehicles.

To address GHG emissions, EPA's proposed standards set target standard curves based on a vehicle's payload, towing capabilities, and whether or not it has 4-wheel drive. These standards would phase in from 2014-2018, with the 2018 standards (including a separate standard to control air conditioning system leakage – see below) representing an average per-vehicle reduction in GHG emissions of 17 percent for diesel vehicles and 12 percent for gasoline vehicles compared to a common baseline.

The corporate average standards for fuel consumption proposed by NHTSA, which are equivalent to EPA's proposal, represent an average per-vehicle reduction in fuel consumption of 15 percent for diesel vehicles and 10 percent for gasoline vehicles, compared to a common baseline. Both agencies are offering alternative phase-in approaches: one beginning at 15 percent in 2014 and reaching 100 percent by 2018, and another that also begins at 15 percent but phases the final standards to reach 100 percent in 2019.

Vocational Vehicles

Vocational vehicles include delivery, refuse, utility, dump, and cement trucks as well as transit, shuttle, and school buses and emergency vehicles, motor homes, tow trucks and others. Because the build process for these vehicles varies widely, the agencies propose to regulate chassis manufacturers for this segment of the heavy-duty sector, divided into three subcategories – Light Heavy, Medium

Continued Page 14

The Washington Update

Continued from Page 13

Heavy, and Heavy Heavy. This is consistent with the engine classification.

Air Conditioning Standards and N2O, CH4

While current gasoline and diesel engines emit relatively low levels of N2O and CH4, EPA's proposed standards would cap emissions to ensure that future engines do not increase these GHGs significantly above the currently controlled low levels. As for air conditioning systems, which contribute GHGs though refrigerant leakage and extra load on vehicles' engines to power the system, EPA is proposing a standard of 1.5 percent refrigerant leakage per year for pickup trucks, vans, and tractors.

Compliance with Proposed Standards

Engine and vehicle manufacturers have a number of options in complying with the proposed standards. Among many options, trucks can reduce idling, make aerodynamic improvements, reduce weight, and draw on direct-injection technology or advanced transmission designs. The agencies have also proposed an averaging, banking, and trading (ABT) program, which would allow for emission and/or fuel consumption credits to be averaged, banked and traded within each of the regulatory subcategories. Additionally, EPA is proposing to allow engine manufacturers to use CO2 credits to offset CH4 or NO2 emissions that exceed emission standards.

Manufacturers also have credit options to assist in achieving compliance. First, those manufacturers who demonstrate improvements in excess of a proposed standard prior to the model year it becomes effective will receive a specific number of credits. Second, those manufacturers implementing advanced technologies, for example hybrid powertrains, Rankine cycle engines, and electric or fuel cell vehicles can receive additional credits. The last credit option would apply to new technologies that reduce vehicle CO2 emissions and fuel consumption, but for which benefits are not captured over the test procedure used to determine compliance with the standards.

The EPA, NHTSA jointly proposed first-ever fuel economy and greenhouse gas standards for medium - and heavy-duty trucks clearly envisions clean diesel power as the centerpiece of freight transportation in the clean energy economy of tomorrow.

For more information on the federal medium and heavy-duty proposed standards or to be updated on recent legislative and regulatory issues impacting the automotive, transportation, chemicals or energy sectors please contact Miller Cole LLC at:
Michigan office: (810) 750-3863;
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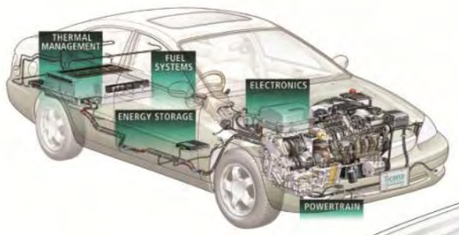

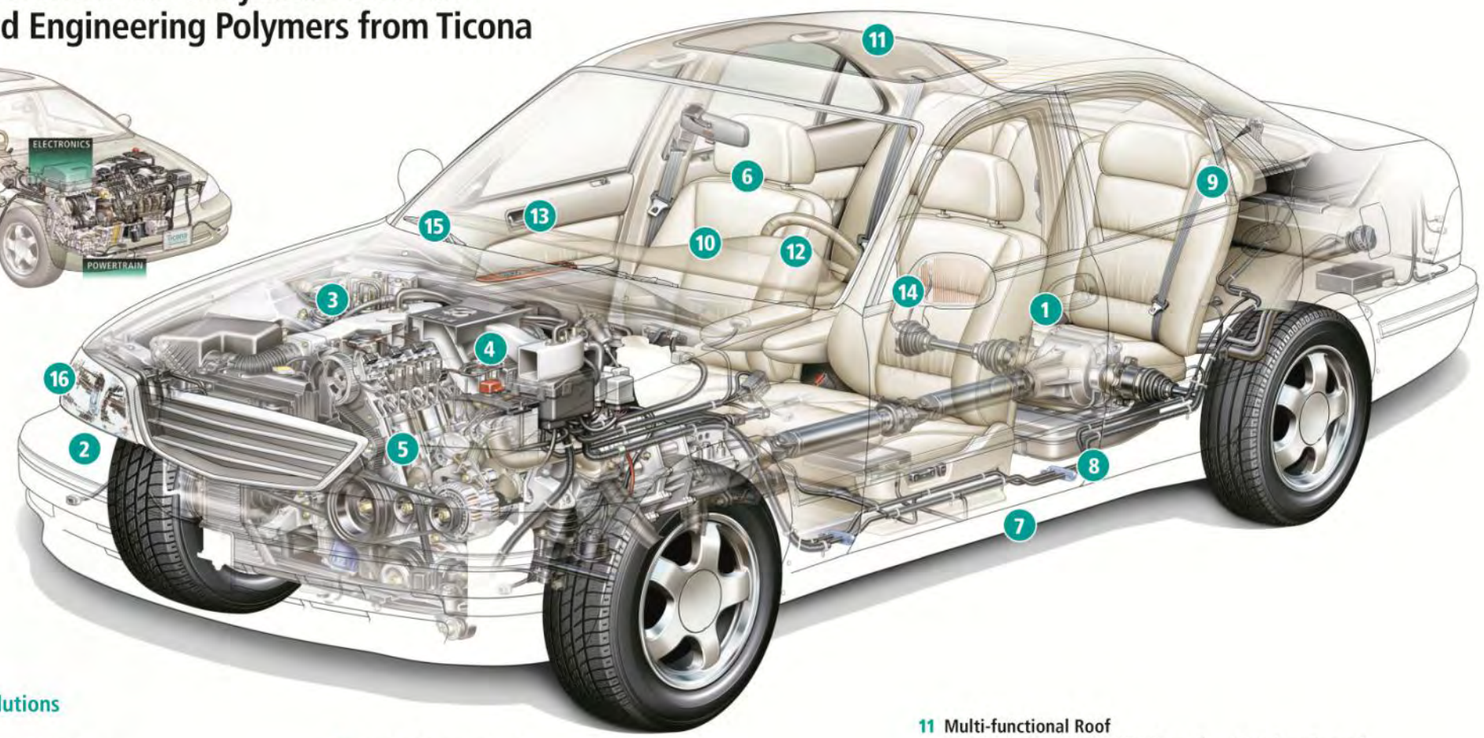

Integrated System Solutions

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2 Front End Modules
Celstran®/Factor® LFRT, Celanex® PBT, Impet® PET

3 Electrical/Ignition
Celanex® PBT, Fortron® PPS, Vectra®/Zenite® LCP, Hostaform®/Celcon® acetal copolymer, Thermx® PCT

4 Power Distribution
Celstran®/Factor® LFRT, Celanex® PBT, Vectra®/Zenite® LCP, Fortron® PPS

5 Powertrain
Fortron® PPS, Celstran®/Factor® LFRT, Vectra®/Zenite® LCP, Hostaform®/Celcon® acetal copolymer, Thermx® PCT

6 Cockpit Environment
Hostaform®/Celcon® acetal copolymer, Celanex® PBT, Vandar® PBT, Riteflex® TPC-ET

7 Underbody Skid Plates
Celstran®/Factor® LFRT, Celanex® PBT

8 Advanced Fuel Delivery
Hostaform®/Celcon® acetal copolymer, Fortron® PPS, Celanex® PBT, Riteflex® TPC-ET

9 Seating and Restraint
Hostaform®/Celcon® acetal copolymer, Celstran®/Factor® LFRT, Riteflex® TPC-ET, Celanex® PBT, Vandar® PBT

10 Safety Systems
Celanex® PBT, Vectra®/Zenite® LCP, Fortron® PPS, Hostaform®/Celcon® acetal copolymer, Celstran®/Factor® LFRT

11 Multi-functional Roof
Celstran®/Factor® LFRT, Hostaform®/Celcon® acetal copolymer, Celanex® PBT, Fortron® PPS

12 Instrument Panels
Celstran®/Factor® LFRT

13 Speaker Grilles, Knobs, Handles and Levers
Hostaform®/Celcon® acetal copolymer, Celstran®/Factor® LFRT, Celanex® PBT, Riteflex® TPC-ET

14 Mirror Housings
Hostaform®/Celcon® acetal copolymer, Celanex® PBT, Celstran®/Factor® LFRT

15 Wiper Plenums
Hostaform®/Celcon® acetal copolymer, Celanex® PBT, Celstran®/Factor® LFRT

16 Lighting Housings
Celanex® PBT, Vectra®/Zenite® LCP, Fortron® PPS, Thermx® PCT

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Councilor's Report

Tom Pickett

SPE Automotive Division Councilor
February 11, 2011—Virtual Council Meeting

The following summarizes the highlights of the Virtual Council meeting on February 11, 2011. Details of the reports and presentations are available on the SPE website.

SPE President Ken Braney called the meeting to order. All electronic participants (with the exception of guests) were officially allowed to be seated, vote and fully participate in the meeting. Ninety-three Councilors, Proxies, guests and staff participated electronically.

The following minutes were reviewed:

Executive Committee Mtg., September 23, 2010
Executive Committee Mtg., October 15, 2010
Executive Committee Teleconference Mtg., November 12, 2010
Executive Committee Teleconference Mtg., December 10, 2010
Executive Committee Teleconference Mtg., January, 14, 2011

The Council Minutes of September 25, 2010 were approved.

The following motions were made and approved for SPE Bylaws and Policies:

Motion: Gregory Campbell moved that Bylaw 4.4.4, "Multiple Section Affiliation and Fees" be approved as distributed. The motion was seconded. The motion carried.

This Bylaw amendment will allow SPE members to affiliate with multiple Sections in the same way that is currently allowed for multiple Division membership. There was discussion about whether people will use this change to be proxies or Councilors without being active member of Section.

Motion: Bill O'Connell moved that Council approve the pricing of multiple Sections to be the same as for Divisions. The motion was seconded. The motion carried.

Motion: Gregory Campbell moved that Bylaw 6.2.5 be taken up from table. This proposed bylaw change affects councilor proxy tenure requirements. The motion was seconded. The motion carried.

Motion: Gregory Campbell moved that Bylaw 6.2.5 "Council, Proxy Tenure Requirements," be approved as published and distributed. The motion was seconded. The motion carried.

With this change, any Councilor shall be entitled to give written proxy to another SPE member from the same Section or Division for the purpose of representing the Section or Division, with full rights of a Councilor on any question before Council. The change to this motion is the elimination of the following sentence: "Sections or Divisions outside the United States and Canada are excluded from the requirement that their proxy be a member of that Section." There was considerable discussion around exactly how this would be implemented, and it was noted that policy needs to be further developed to guide Council on the use of proxies.

Motion: Gregory Campbell moved that Bylaw 6.2.2, "Council Meeting Times and Places," be approved as published and distributed. The motion was seconded. The motion carried.

This amendment divides the Bylaw into two parts – Regular Meetings and Special Meetings, clears up any confusion about which President designates meeting times and places, and adds a clause defining the amount of notification required to hold a Regular Meeting. The notification clause was included in the portion of the Bylaw about Special Meetings, but did not exist in the portion about Regular Meetings.

Motion: Gregory Campbell moved that Bylaw 7.6, "Vacancies and successions," be approved as published and distributed. The motion was seconded. The motion carried.

In reviewing Bylaw 7.6 regarding succession of elected Society officers, the Bylaws & Policies Committee determined that it was confusing and needed to be more clearly defined. The proposed amendments now spell out the procedure for filling vacancies and provide a time span for doing so. One part of these amendments states that vacancies in elected offices should be filled at a regular or special Council meeting held within 30 days of the occurrence of the vacancy. This could require that a Special Meeting of Council be convened. However, if a vacancy occurs at an election meeting – i.e. is caused by the election of an existing Vice President to a higher office – the vacancy could be filled at that election meeting.

Other Motions:

Motion: Brian Grady moved that Mark Spalding be approved as 2012 and 2013 Technical Program Chair for ANTEC. The motion was seconded. The motion carried.

Reports were delivered as follows:

PAOM Update/Strategic Planning Committee

A discussion of the work of the committee ensued. The presentation is available on-line. Lance Neward gave a brief introduction, Scott Owens went into a significant amount of detail regarding the overall process, Jim Griffing and Brent Strong talked about the Structures subcommittee and Financial Factors subcommittee, respectively, and Mr. Neward gave a very brief concluding statement. The floor was open for questions.

Financial Update

SPE Treasurer Scott Owens gave a financial update. It was noted that this, and all presentations made as part of the meeting are available online to Councilors, who are free to use these materials with their respective boards.

Mr. Owens reported that all 2010 results were not yet audited, but the results on file at the time of the meeting were:

Gross Operating Incomes, including the Foundation, of $3,416,000
Gross Operating Expenses, including the Foundation, of $3,296,000

Operating Net:	$ 120,000
Budgeted Net:	$ 119,325

Mr. Owens specifically noted that approximately half of SPE's net incomes were proceeds from the SPE Foundation, and thus restricted funding. He further related that the Finance Committee had discussed whether or not additional funds should be distributed for rebates given the surplus, but that the Finance Committee had decided that the financial position of SPE was still too tenuous to further distribute these funds. Mr. Owens said that the Finance Committee would look at supplemental distribution of rebates in 2011 should SPE make its budgeted net revenues.

Mr. Owens then reviewed SPE's investment account funds for the SPE Foundation, the SPE Section/Division Investment Program, and the SPE Building Fund (proceeds from the sale of the building in 2009, now invested). He concluded his remarks with a brief report on ANTEC incomes to date, and noted that no material changes to the 2011 budget were being contemplated at this time.

Staff Update

Executive Director Susan Oderwald delivered a staff update. She specifically noted that a full written brief is available online. Her report included an update on staffing and technology changes. She then invited other senior staff members to report on their areas.

Membership

Tom Conklin gave the update about membership results for 2010 and the 2011 plan. He likewise reported on major findings in 2010, as well as new initiatives for 2011.

Foundation

Gail Bristol delivered a report about the SPE Foundation, Corporate Outreach and SPE's Annual Awards. It is noted there that the SPE Foundation performed in 2010 as follows:

Financial Summary – end of December 2010
Surplus - $60,000
Investment Balance - $1,700,000 (excludes Chicago Fund)
Scholarship Program
31 Students = $107,500

Grants Program
$15,190
Thermoforming equipment grant to Yale School of Architecture
General grant to Rochester Institute of Technology
Matching funds grant from the Plastics Pioneers Association for PlastiVan visits

Ms. Bristol also reported this year's Fellows and Honored Service recipients. They include:

2011 Honored Service Members
Earl W. Balthazar III – nominated by the Color & Appearance Division
Ken J. Braney – nominated by the European Thermoforming Division
Dr. Gregory A. Campbell – nominated by the Extrusion Division
Joseph J. Duska – nominated by the Palisades/New Jersey Section
Irvin E. Poston – nominated by the Detroit Section

2011 Fellows of the Society
Dr. Richard C. Bopp – NatureWorks LLC
Dr. Furong Gao – Hong Kong University of Science and Technology
Dr. David O. Kazmer – University of Massachusetts, Lowell
Dr. Andrew J. Peacock – Tredegar Film Products
Dr. Kalyan Sehanobish – The Dow Chemical Company

Ms. Bristol also reported on this year's Annual Awards recipients. They include:

International Award
Dr. Musa R. Kamal – McGill University

Research/Engineering Technology Award
Dr. Rajendra Krishnaswamy – Metabolix/Telles LLC

Education Award
Dr. Walter L. Bradley – Texas A&M University

All awards will be presented at the SPE Celebrates Banquet at ANTEC in Boston on May 1, 2011.

Conference Update

Lesley Kyle discussed the three major events: ASIATEC, ANTEC and EUROTEC.

Student Activities at ANTEC Committee

Steve McCarthy discussed an expanded poster session Monday and Tuesday afternoon at ANTEC. He also noted that the committee has a Plant tour planed, and that lunch on Wednesday is open to all members at a cost of $25, in advance. The luncheon will have 4 people talking about being CEOs of medical device companies. Mr. McCarthy expressed the committee's thanks to those Sections/Divisions who have contributed to student programming at ANTEC.

Council Continuous Improvement

Dick Cameron reported that the committee is discussing tenure policy changes for Councilors and Proxies. Bill O'Connell said he would welcome suggestions for changes by email.

The next Council meeting is scheduled for May 1, 2011, in Boston, MA, USA.

Membership Report

Bill Pippine

SPE Automotive – Membership Update

As the automotive industry recovers over the last few months, the SPE organization is looking to grow membership back to the levels prior to the past downturn. In the coming months several of the board members will be meeting with executives in the automotive industry. The purpose of these meetings will be to rebroadcast the purpose of the SPE organization and the benefits to their employees in active membership.

The automotive industry has gone through a large turnover during the last few years and much of the knowledge and experience that was once within an organization is no longer there. The new engineers, designers, account managers, and program managers are eager to learn and SPE has many opportunities for sharing of knowledge. This can be seen from the formal conferences to the less formal social events and even the board meetings. The SPE Automotive Division has a great wealth of knowledge and looks forward to share it with its current and new members.

Keep an eye out for updates on our membership and social activities.

Social Chair Report

Ben Soltisz

Over the past year, we have held several social gatherings around the metro Detroit area to aid in the growth and awareness of SPE in the automotive industry. These events were intended to be informal and provide an opportunity for new members, current members, past members, friends of members and individuals possibly interested in becoming members to socialize with board members of the SPE Automotive Division. These events have grown in popularity.

Our September 2010 SPE social / networking event at Bailey's Sports Grille in Dearborn was a lot of fun.

Yvonne Bankowski of Ford Motor Co. was our door-prize winner for the September event. She took home a new Weber grill featuring bulk-molding compound components donated by BMCI.

BMC Composites for Automotive Metal Replacement, As federal fuel economy and emissions regulations continue to become more stringent the trend is toward smaller, lighter, more efficient engines with highly complex control systems, higher temperatures and longer duty cycles. BMCI offers a lighter weight lower cost substitute for metal in a variety of automotive powertrain applications. To find out more about BMCI, please feel free to contact Jim Cederstrom, Business Development Manager, at phone number: (248)766-7111 or his e-mail address: jim_c@bulkmolding.com. You can also visit their website at http://www.bulkmolding.com/.

The October 2010 Social / Networking Event took place at Grizzly Peak Brewing Company in Ann Arbor, Michigan. It was a success. Three lucky attendees won three donated door prizes at the event.

Brian Rhudy won four tickets to the University of Michigan vs. University of Illinois football game and Conrad Zumhagen won a box of golf balls generously donated by Ticona Engineering Polymers.

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Engineering Polymers, please feel free to contact Jeffrey H. Helms, Global Automotive Director, at phone number: (248)377-6895 or his e-mail address: jeffrey.helms@ticona.com. You can also visit their website at www.ticona.com.

Mike Brooks won a golf bag generously donated by DIC International (USA) LLC.

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We had four door-prize winners at our January 2011 networking event at Kuehnhenn Brewing Co. in Warren, Michigan.

Jim Cederstrom (*above, right*) won 4 tickets to the Detroit Pistons vs.Houston Rockets basketball game generously donated by Ticona Engineering Polymers. Hank Bonutti (*above, left*) won 4 tickets to the Detroit Red Wings vs. Boston Bruins hockey game also generously donated by Ticona Engineering Polymers. And both Kevin Pageau (*below*) and Greg Poterala both won a box of golf balls and a hat generously donated by **Styron LLC**.

Styron is a global materials company and producer of plastics, rubber and latex. We sell a broad plastics portfolio of injection molding and extrusion grade resins to industries that include automotive, medical, consumer electronics, home appliances and electrical & lighting. Committed to helping customers solve complex material challenges with innovative and sustainable solutions, Styron helps OEMs and molders differentiate themselves, reduce costs, improve performance and ensure end-user satisfaction. For more information about Styron Automotive Plastics, contact Jim Otis, NA / LAA Sales Director at 248-370-7163 or jotis@styron.com or visit **www.styron.com**.

Continued on Page 23

Social Chair Report

Continued from Page 21

Our February 2011 networking event included a tour of Century Tool & Gage (www2.centurytool.com), a leading producer of compression molding tools, widely used to form SMC, BMC, GMT, and D-LFT materials in the automotive industry.

The tour included a part trial.

Immediately following the plant tour and part trial, a mixer was held down the road at **Fenton Winery & Brewery.** Bill Bowser (*below, left*) won 4 tickets to the Detroit Pistons vs. Washington Wizards basketball game generously donated by Ticona Engineering Polymers. Hank Bonutti (*below, right*) won 4 tickets to the Detroit Red Wings vs. Toronto Maple Leafs hockey game also generously donated by Ticona Engineering Polymers.

Additional events will follow. Stay updated by visiting **www.speautomotive.com** and look for emails about future events. Please contact the Social Chair at **social-chair@speautomotive.com**, if you have an idea for future events.

Automotive Division Board Meeting Minutes

December 6, 2010

Monica Prokopyshen—Secretary

ATTENDEES

Yvonne Bankowski, Teri Chouinard, Anthony Gasbarro, Ed Garnham, Jeff Helms, Peggy Malnati, Kevin Pageau, Tom Pickett, Bill Pippine, Monica Prokopyshen, Jay Raisoni, Nippani Rao, David Reed, Ben Soltisz, Ron Price, Suzanne Cole

Meeting held at ACC in Troy, 5:30 p.m. – 8:00 p.m., October 11 minutes approved.

The TPO conference is scheduled for October 2-5, 2011 at the Troy, Marriott. The next planning meeting is Dec. 9th, 2010.

Education (Monica Prokopyshen) The final CCS review session is scheduled for December 13, 2010 at the A. Alfred Taubman Center for Design Education in Detroit.

Membership (Bill Pippine) From January 2010 through November 2010 there has been a net loss of 10 members in the Detroit Section and Automotive Divisions. The SPE AD membership form will be forwarded to Bill Pippine, Ben Soltisz and Anthony Gasbarro to have the forms available at future networking events.

SPE Social Programs (Ben Soltisz) To accelerate the increase in attendance of engineers at networking events, Ben proposed scheduling plant visits. Five potential locations for a February tour were suggested for follow-up.

Treasurer's Report (Yvonne Bankowski)

Read the treasurer's report for full details. The account balance is as follows: checking $83.6 K, savings $27.4 K and total $111 K. 2010 taxes were filed November 13, with a copy to SPE International.

Income summary for period 10/11/2010 : 6/12/2010:

Income	$97.5 K
Expenses	$139.4 K
Net Income	($41.9 K)

(predominantly IAG expenses)

Councilor's Report (Tom Pickett)

Please provide suggestions for the 2011 ANTEC (Boston May 1-5) automotive session keynote speakers to Tom Pickett before January 3, 2011.

Inter-society (Jackie Rehkopf)

No report.

MARCOM (Peggy Malnati)

1. The awards modules were approved for posting on the web.
2. The 2010 ACCE conference was the strongest program to date and attendance was about 130 persons higher than last year. The CD contents will be available January 1 on the SPE AD website. Next year's ACCE, "Driving Design," is Sept. 13-15 at the Management Education Center in Troy. Online registration through SPE International will again be available.
3. IAG duplicate plaque sales underway. The finalists and winners press releases were distributed the night of the event to 600 media around the world.
4. Website. A new high was reached for November web traffic at 24,969 unique hits. The SPE AD Twitter feed is being "followed" by 62 OEMs, magazines, engineering societies, racing teams and individuals.
5. The option of offering an RSS feed for website customers was discussed.

IAG Recap

1. The board brainstormed lessons learned from this year's event (TGR/TGW).
2. The table layout maps and student assistance reduced the seating chaos. Suggestions were made to reduce the time for guests to be seated and dinner service to begin.
3. The photographic service RFQ and contract will be updated to reflect new social media uses of photos.
4. The afterglow event had good attendance.
5. The entrance to the seating area needs to be closed during the ceremony to minimize distracting noise.
6. Additional improvement ideas were captured for review and action, including additional detail in the project timeline to assist new volunteers as well as volunteers handling new tasks.

Newsletter

Newsletter submissions due December 10, 2010. (Kevin Pageau)

Newsletter sponsorship stands currently at $34,700. (Terri Chouinard)

New Business

The Pinnacle and Communication awards submission deadlines are approaching. SPE International usually sends a notice in December with a deadline by month end. The board voted to apply for both awards and provide timely assistance to Anthony Gasbarro who is coordinating the Pinnacle award submission. Peggy Malnati is coordinating the Communication award nomination.

Next BOD Meeting

5:30 – 8:00 pm Monday, February 7 (ACC, Troy)

Orientational Order Induced by Carbon Fiber in Aromatic Thermosetting Copolyester Matrix

Zeba Parkar, James Economy
Department of Materials Science and Engineering, University of Illinois, Urbana-Champaign

Abstract
The paper describes a new class of resin, aromatic thermosetting copolyester (ATSP), which shows high temperature stability, flame resistance, and adhesive properties. Carbon fiber helps in stabilizing the nemetic phase in the liquid crystalline melt. This paper describes the morphology of ATSP in the presence of carbon fibers.

Background
The automotive industry is moving towards lightweight materials to reduce vehicle weight, increase fuel efficiency and decrease emissions. Although polymer resins are finding use in automobiles in the form of composites, there is still need for truly high temperature stable systems that can replace metals in "under the hood" applications. For example, epoxies are stable only up to 150 °C. Thermoplastics like high-temperature stable PEEK show higher fracture toughness and damage resistance compared to epoxies but are difficult to process and have problems wetting reinforcing fibers when used for composite applications.

Our research group at the University of Illinois has developed an aromatic thermosetting resin (ATSP) which provides a unique blend of properties. ATSP show the following properties:

- Being fully-aromatic, it shows high thermal stability—it is stable in air up to 350 °C and in nitrogen to 450 °C, with glass transitions ranging from 240 - 285 °C.
- ATSP is easily processable on standard equipment. The ester crosslinks enable the polymer to react with itself even after curing through interchain transesterification reactions (ITR). ITR permits further densification, high temperature repair, healing, and adhesive bonding to itself and other polymers and various metals – Al, Steel, Titanium, and Cu.[1,2]
- ATSP/Carbon fiber (CF) composites show thermal fatigue resistance, i.e. lower microcracking than epoxy/CF composites when cycled from -196 °C to 80 °C[3]
- Outstanding flame resistance, LOI of 0.4 for ATSP and 0.85 for ATSP/CF composite compared to less than 0.25 for most other systems like epoxy, PEEK; additionally, an excellent ablative.
- Oligomers can be synthesized to have liquid crystalline character. This can help reduce interfacial stresses when used as a matrix for carbon fiber composites. This is facilitated because of the matching of the coefficient of thermal expansion (CTE) between the matrix and the reinforcing fibers.

In this paper we focus on understanding the liquid crystalline character of ATSP and its morphology in presence of carbon fibers, when in the form of composite. Frich et al.[4] showed that some oligomer compositions show liquid crystallinity in melt and on curing in bulk. The various oligomer compositions that show liquid crystallinity are marked in Table 1.

ATSP is an excellent candidate for use as a matrix for high temperature stable composites for structural applications where conventional epoxies cannot be used because of low Tg. Liquid crystallinity in the matrix would impart properties like fracture toughness which is typically low for thermosetting resins.

Rigid-rod thermosets have been studied earlier due to their advantages of better reinforcement and fracture toughness. Tailoring the structure to give stable mesophases at the curing temperature or using curing agents is important.[5] Literature contains a number of reports on the orientational effect of carbon fibers on liquid crystalline melts.[6 7 8] Microgrooves on the surface of the

Oligomer	TMA¶	TAB¶	ABA¶	IPA¶	HQDA¶	Mwavg (g/mol)	Function-ality
C-1	2		6	3	4	1934	4
C-2*	1		6	4	4	1890	3
C-3	2		4	2	3	1454	4
C-4	2		5	1	2	1334	4
C-5*	1		5	2	2	1290	3
A-1	2		2	2	7	1750	4
A-2*	1		5	2	5	1692	3
A-3*	1		5	1	4	1452	3
A-4		2	4	2	1	1270	4
A-5		2	2	2	1	1030	4

¶TMA -Trimesic acid , TAB- Triacetoxy benzene, ABA- Acetoxybenzoic acid, IPA- Isophthalic acid, HQDA- Hydroquinone diacetate

*Table 1. Molar ratio of monomers for synthesizing oligomers. Cx denotes carboxylic acid end-group oligomer whereas Ax denotes acetoxy end-group oligomers. Oligomers marked with *exhibit liquid crystallinity in melt.*

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Detroit Section and Automotive Division

Technical Paper

Continued from Page 26

carbon fiber can help in this orientation 9 and carbon fiber surface anchoring [10]

In this paper, we describe orientational effect of carbon fiber on the ATSP matrix.

Materials and Methods

Materials

4-Acetoxybenzoic acid, trimesic acid, hydroquinone, isophthalic acid and N-methyl-2-pyrollidinone (NMP) were obtained from Sigma-Aldrich. Carbon fibers (Sikawrap Hex -103) were obtained from Hexcel, Co. Synthesis of carboxylic acid end group (C1, C2) and acetoxy end group (A1, A2) was closely followed from Reference 1.

Optical Microscopy with cross-polarizers of thin films

50 wt.% solution of C1-A1 (1.1:1 by weight) in NMP spread on a glass slide was casted using a glass rod wrapped with one turn of Kapton tape. Few carbon fibers were placed on the slide. This glass slide was then cured using the cycle outlined in Figure 1 to obtain crosslinked ATSP (ATSP1). Samples with C2-A2 oligomer were also prepared using the same procedure. These slides were observed under an optical microscope with cross-polarizers.

X-Ray Diffraction Studies

Thin film samples of ATSP1 and ATSP2 were solution casted on aluminum foil. After curing, the coated foil was dipped in concentrated HCl for a few seconds to dissolve the aluminum and get thin film of ATSP1. This film was washed with DI water, and dried in the oven overnight.

Composites of ATSP carbon fiber were made by first wetting the fibers with an ATSP solution and using the cure cycle as Figure 1. Pressure of 100 psi was applied start of the last step (330 °C).

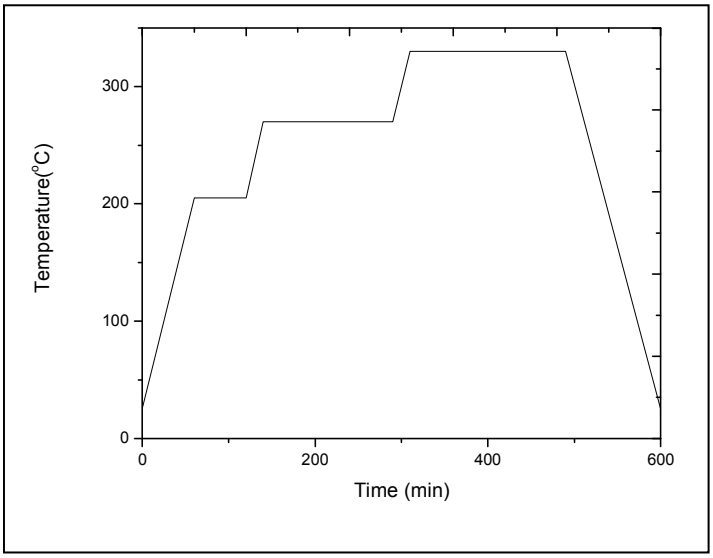

Figure 1. Cure cycle of ATSP oligomer

XRD data was collected on a Bruker General Area Detector Diffraction System (GADDS). The frame was collected for 1800 seconds. The peaks were fitted to a Lorentz function and peak maximum were analyzed using origin.

Measurement of crystal size

Crystal size was measured using Sherrer equation. Topaz software was used to fit data and background subtraction was employed to get a better fit. A PVII fit was employed for both the curves.

Results

Optical Microscopy with cross-polarizers of thin films

Thin films samples were made to better understand the morphologies obtained in cured composite samples. Thickness of the films was measured to be around 20 µm for both ATSP1 and ATSP2. For ATSP1 (Figure 2(a)), birefringence is observed at the surface of the carbon fiber when viewed under cross-polarizers. This suggests orientational ordering at the surface. Isotropic behavior was observed in the regions away from the fibers proving the need for carbon fibers for orientation of the matrix. Nemetic phase can be stabilized at the surface of the carbon fibers. Crystallinity is induced in the matrix because of freezing of these oriented molecules due to crosslinking.

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Technical Paper

Continued from Page 29

For ATSP2 (Figure 2(b)), birefringence is observed throughout the matrix, even away from the carbon fiber surface suggesting a more stable liquid crystalline phase. This observation is consistent with Frich et al.

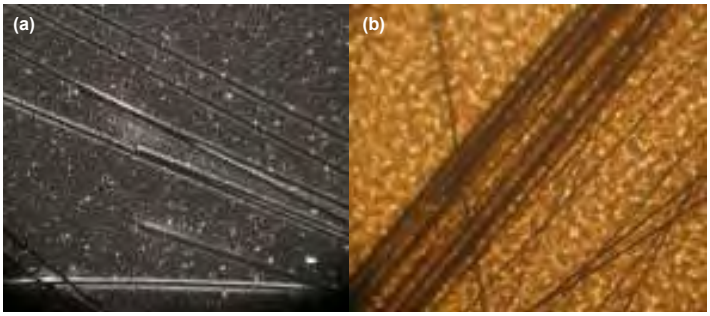

Figure 2. Thin films of ATSP in presence of carbon fiber when observed under a transmission microscope with cross-polarizers. (a) ATSP1 (b) ATSP2

X-Ray Diffraction Studies

The XRD pictures of ATSP1/C and ATSP2/C composites are summarized in Figure 3 and Figure 4 respectively.

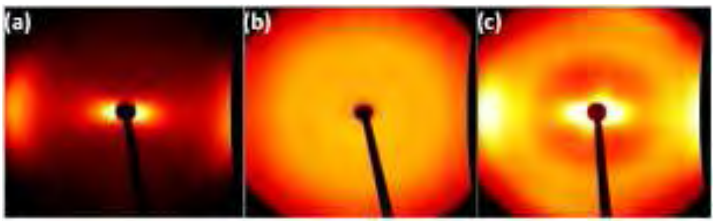

Figure 3. X-Ray Diffraction pattern of (a) carbon fibers (b) ATSP1 thin film (c) ATSP1/ carbon fiber composites

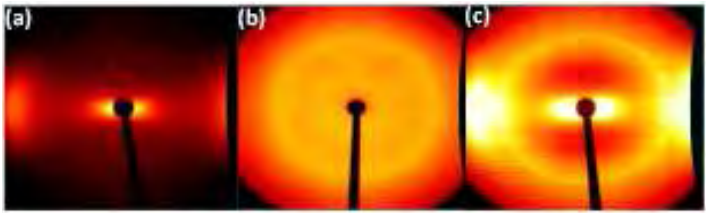

Figure 4. X-Ray Diffraction pattern of (a) carbon fibers (b) ATSP2 thin film (c) ATSP2/ carbon fiber composites

Thin films of ATSP (no carbon fiber) show a broad amorphous peak characteristic of amorphous polymer. ATSP2/C composite shows crystalline peak at 2-theta of 20.1 degrees, a d-spacing of 45 Å whereas the peak is much broader in case of ATSP1/C. Emergence of crystallinity in the cured composite samples as opposed to samples without fibers again reiterates that carbon fibers help in orienting the liquid crystals. Also, the nature of the oligomers decides the degree in crystallinity as seen from the disparity of graphs of ATSP1 and ATSP2.

Measurement of crystal size

The size of the crystals was estimated using Scherrer equation.

The Scherrer value of C1-A1 composite peak at 2-theta 19.84° was estimated to be 1.147±0.079 nm. C2-A2 composite showed a crystallite size of 5.605±0.229 at a 2-theta value of 20.12°. Note, these calculations were not intending to estimate the absolute crystallite sizes but to compare the crystallization of different ATSP matrices. C2-A2 matrix show 4 times higher particle size than C1-A1 matrix indicating higher degree of crystallinity.

Summary and Next Steps

In summary, ATSP1 matrix does not show liquid crystallinity in melt but exhibits orientational ordering on the surface of carbon fibers on curing. ATSP2 matrix on the other hand shows anisotropy on the surface as well as in bulk. Thus, carbon fiber helps in orientation of these oligomers during curing.

XRD studies suggest that ATSP2 shows higher orientation ordering than ATSP1. The presence of liquid crystalline character in the matrix imparts fracture toughness. This will help in design of thermal fatigue resistant and damage resistant structures for structural applications. This liquid crystalline polymer can match the CTE of the carbon fiber minimizing the residual stresses.

ATSP shows a great combination of thermal, mechanical and flammability properties which will open new opportunities for light weight structures in the automotive composites.

We intend to characterize the fracture toughness and damage resistance of these composites.

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