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

SPE® AUTOMOTIVE

AUTOMOTIVE PLASTICS News

DECEMBER 2014
VOLUME 44, ISSUE 2

SPE® AUTOMOTIVE INNOVATION AWARDS COMPETITION & GALA
HONORING THE BEST IN AUTOMOTIVE PLASTICS

SPE® Automotive Division Names Winners of 44th-Annual Automotive Innovation Awards Competition

For the 44th year in a row, members of the SPE® Automotive Division's board of directors and guests from the global automotive and plastics industries gathered to honor the year's *Most Innovative Use of Plastics* in ground transportation at the SPE Automotive Innovation Awards Gala. Over 700 people attended the annual banquet on November 12, 2014, at Burton Manor in Livonia, Michigan, U.S.A. to learn which applications in this year's Automotive Innovation Awards Competition won awards in eight categories, and which category winner was also named the Grand Award winner, the most prestigious honor of the evening.

Winners survived a prequalification round as well as presentations before a panel of industry experts on October 6. Finalists from that round presented before a Blue Ribbon panel of judges on October 13, where category and Grand Award winners were selected. Details on all of this year's nominations will be found at http://speautomotive.com/awa.htm. Part and event photography can be found at http://www.flickr.com/photos/speautomotive/collections.

SPE's Automotive Innovation Awards Program is the oldest and largest competition of its kind in the world. Dozens of teams made up of OEMs, tier suppliers, and polymer producers submit nominations describing their part, system, or complete vehicle and why it merits the claim as the year's *Most Innovative Use of Plastics*. This annual event typically draws over 700 OEM engineers, automotive and plastics industry executives, and media. As is customary, funds raised from this event are used to support SPE educational efforts and technical seminars, which help educate and secure the role of plastics in the advancement of the automobile.

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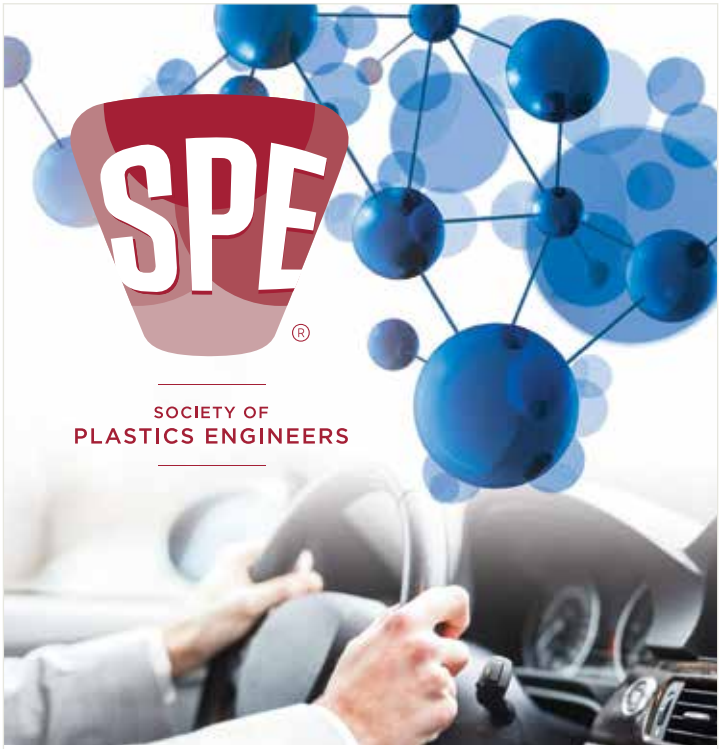

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AUTOMOTIVE DIVISION MEETING SCHEDULE & SPECIAL EVENTS CALENDAR

SPE AUTOMOTIVE

SPE Auto. Div. Board Meeting
American Chemistry Council - Auto. Ctr. — 5:30 - 7:30 pm
Troy, MI USA — Dec. 8, 2014

SPE Auto. Div. Board Meeting
American Chemistry Council - Auto. Ctr. — 5:30 - 7:30 pm
Troy, MI USA — Feb. 9, 2015

SPE Auto. Div. Board Meeting
American Chemistry Council - Auto. Ctr. — 5:30 - 7:30 pm
Troy, MI USA — April 13, 2015

9th-Annual SPE Automotive Engineering Plastics Conference (AutoEPCON)
Troy Marriott — ALL DAY
Troy, MI USA — May 5, 2015

SPE Auto. Div. Board Meeting
American Chemistry Council - Auto. Ctr. — 5:30 - 7:30 pm
Troy, MI USA — June 8, 2015

Automotive Division Board of Directors meetings are open to all SPE members. All events are listed on our website at

http: speautomotive.com/ec

EMail Steven VanLoozen at

auto-div-chair@speautomotive.com for more information.

CHAIR'S MESSAGE

by Steven VanLoozen,
2014-2015 SPE Automotive Div. Chair

Season's Greetings to all SPE members! I find it hard to believe that another year is close to being in the rearview mirror. Certainly 2014 was an eventful, exciting, and often challenging year. This year saw the loss of two huge contributors from our division and our board of directors. We will not forget Jackie Rehkopf and Ed Garnham and all their contributions to SPE. The automotive industry itself is experiencing a technological step change as the industry works feverishly to address the challenge of lightweight vehicles to meet a variety of regional and global mandates including U.S. Corporate Average Fuel Economy (CAFE) legislation.

SPE is uniquely equipped to help the industry to meet these challenges and this was again evident at the 44th-annual SPE Automotive Innovation Award Gala. This annual event showcasing the best automotive innovations utilizing plastics and composites was a great success and once more was a testament to what can be accomplished when the automotive supply chain works together to enable change. Thank you to all who participated and especially thanks to the committee that pulls this great event together every year.

As noted previously, SPE provides a wonderful venue for enhanced collaboration. If this year's awards showed us anything, it's that the more minds that work together to solve a problem, the better the solution will be. And please know that the professionals actively supporting SPE are up to any challenge.

Looking back on how fast 2014 flew by it reminds me that I am not getting any younger and one of the key roles SPE plays is in education and finding young people to foster through both scholarships and the mentoring those of us with many years in the plastics industry can provide. Youth will look at the challenges we all see in 2015 and beyond with a fresh set of eyes. They will be needed to help both the plastics and automotive industries to bring forward the innovation that will keep these segments vibrant.

Much of this message has been reflective and while it is important to remember where we have been, time waits for no one and we all need to keep driving toward the future. Consider making the resolution of bringing new ideas forward in 2015 or mentoring a young person so that when we all reflect on 2015 it can be our best year yet.

With that, I would like to extend my wish for a blessed holiday season to everyone and their families and may 2015 bring health, happiness, and enthusiasm to all.

Kind Regards,

Steven VanLoozen

Steven VanLoozen
SPE Automotive Division Membership Chair

Category Winner: Body Exterior

Panoramic Sunroof Frame

OEM Make & Model:	2015 Hyundai Motor Group Kia Sorento CUV
Tier Supplier/Processor:	Inalfa Roof Systems Korea
Material Supplier:	GS Caltex Corp.
Tooling supplier:	Hyundai Motor Group
Material / Process:	Hiprene ALC12B PA6 / injection molding

This large but very light panoramic sunroof frame utilizes carbon fiber-reinforced thermoplastic, which has been optimized for density, mechanical properties, and reasonable cost. This is the first carbon fiber-reinforced thermoplastic application in a sunroof frame. It allowed 33 steel parts to be integrated into just 4 reinforced plastic ones.

Category Winner: Body Interior

Second-Row Seat Back

OEM Make & Model:	2015 Ford Motor Co. Ford Mustang sports car
Tier Supplier/Processor:	Continental Structural Plastics Inc.
Material Supplier:	Hanwha L&C
Tooling supplier:	Century Tool & Gage
Material / Process:	GMT 45% GF uni-directional GMT / compression molding

This second-row seat back successfully meets the extremely challenging ECE luggage-retention load case through the use of unidirectional glass-reinforced GMT composite rather than typical steel. The compression-molded design, which required over 100 iterations of FEA to finalize, eliminates 5 parts from the earlier steel design and saves 3.1 kg/car in a thinner construction that also is easier to install.

Category Winner: Chassis & Hardware

Co-Extruded Thermoplastic Coolant Tube

OEM Make & Model:	2015 Renault Group Renault Twingo city car
Tier Supplier/Processor:	Tristone Flowtech
Material Supplier:	DuPont Automotive
Tooling supplier:	not available
Material / Process:	Zytel® LC6200 PA612 / co-extrusion

This co-extruded coolant tube with patented bellows design replaced aluminum tubing and rubber hose while meeting all the high-temperature and high-pressure demands of the coolant system. The co-ex tube uses functionalized high-temperature PP with hydrolysis-resistant PA 6/12 to withstand internal temperatures to 125C and external temperatures to 150C. The application delivers a 60% weight reduction and enhanced flexibility and formability vs. previous technology.

Category Winner: Environmental

Cellulose Fiber Composite Console Armrest

OEM Make & Model:	2013 Ford Motor Co. Lincoln MKX luxury CUV
Tier Supplier/Processor:	Johnson Controls, Inc. / not available
Material Supplier:	Weyerhaeuser NR Co.
Tooling supplier:	not available
Material / Process:	Thrive 20DX235 PP / injection molding

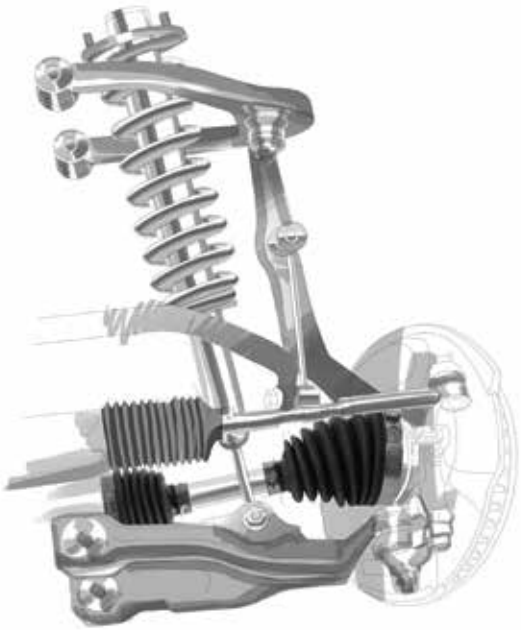
This application represents the first time glass fiber-reinforced PP has been replaced by a natural fiber-reinforced PP with equivalent performance but improved environmental impact. This armrest console uses 20% renewably sourced cellulose fiber obtained from sustainably harvested forestry by-products. The resulting part is cost neutral but 6% lighter, reduces tool abrasion, and lowers process energy 10% thanks to lower temperature and faster process cycles. From a lifecycle analysis standpoint, it reduces CO2 emissions by 11% and saves 2,500 gal of fuel over the vehicle's life.

Category Winner: **Hall of Fame**

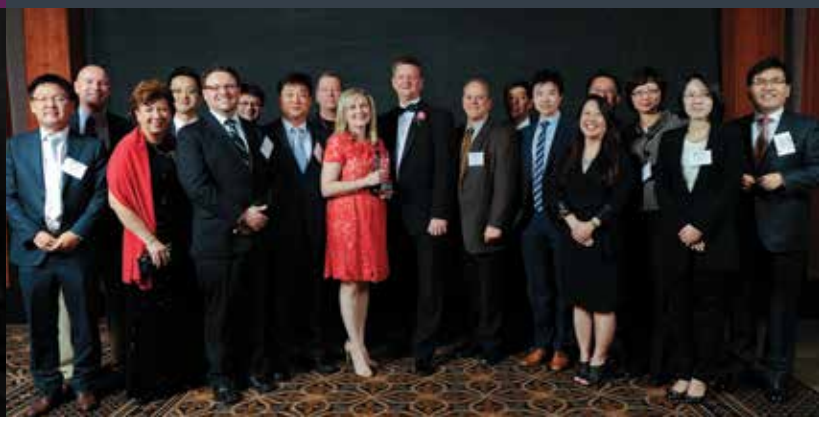
First Blow-Molded TPE CVJ Half-Shaft Drive-Axle Boot Seal

OEM Make & Model:	General Motors Co. 1984 E/K Platform
Tier Supplier/Processor:	Nexteer Automotive
Material Supplier:	DuPont Automotive
Tooling supplier:	ABC Group Inc.
Material / Process:	Hytrel TPC-EC / blow molding

The first global implementation of a blow-molded, thermoplastic elastomer (TPE) constant velocity joint (CVJ) half-shaft drive-axle boot seal used on 1984 MY E/K platform produced by then General Motors Corp. (was selected as the 2014 Hall of Fame winner. This application was a far more robust CVJ sealing solution that also was lighter, more durable, and less costly than the injection-molded rubber boots it replaced. It has been in continuous use on GM cars and trucks for 30 years, and 85% of front-axle CVJ boot seals on light-duty vehicles worldwide now use TPE in this application.



Category Winner: **Materials**



Metallic Appearance Finish Panels

OEM Make & Model:	2015 Ford Motor Co. Ford Mondeo sedan
Tier Supplier/Processor:	International Automotive Components Group (IAC) / Key Plastics Löhne GmbH
Material Supplier:	Samsung Chemical
Tooling supplier:	Michael Tool & Mold Ltd.
Material / Process:	Luminous LX-1098 PC/ABS / injection molding

This MIC metallic-look part features a weldline-free surface around holes (despite complex geometry), and sports a lush gloss surface (without grain to hide surface imperfections) and eliminates the need for paint. Additionally, special gate/runner designs and a special tool finish technique were used in combination with the eMold process (to elevate resin temperature in key areas) with continuous venting. A new high-flow material with optimum flake size and amount was developed specifically for the parts. The result is improved part appearance that also reduces warranty claims vs. previous painted parts, plus a direct $13 USD/vehicle cost savings with further indirect cost savings and environmental benefits owing to paint line avoidance.

 CONTINUED FROM PAGE 6

Category Winner:
Powertrain

Crankshaft Cover with Integrated Oil Seal

OEM Make & Model:	2014 Volkswagen AG MDB engine platform	Material Supplier:	DSM Engineering Plastics B.V.
Tier Supplier/Processor:	Kaco GmbH + Co. KG / Engel Austria GmbH	Tooling supplier:	Elmet GmbH
		Material / Process:	EcoPaxx Q-HG10 PA 4/10 50% GF / injection molding

This is the world's first sustainable crankshaft cover, which is molded in a PA 4/10 formulated from 70% renewable resources and certified to be 100% carbon neutral from cradle to grave. The design itself features a friction-optimized dynamic seal in PTFE, which replaced a wet chemistry surface treatment and is activated via a vacuum-plasma process. The entire production process is eco-driven with no net waste. The CAE-optimized design enables a plastic flange to be used as a torque support for assembly operations during vehicle manufacture. The resulting part is 40% lighter than the incumbent aluminum part it replaced.

Category Winner:
Vehicle Engineering Team Award

Ford Motor Co. 2015 Ford Mustang sports car

Category Winner:
Process / Assembly / Enabling Technologies

Single-Collimator Molded LED Lens

OEM Make & Model:	2015 Ford Motor Co. Ford F-150 pickup
Tier Supplier/Processor:	Ventra Plastics Div. of Ventra Group Inc. & Flex-N-Gate Corp. / DBM Reflex
Material Supplier:	Bayer MaterialScience
Tooling supplier:	DBM Reflex
Material / Process:	Makrolon LED 22.4.5 PC / multi-shot injection molding

This is the first application of a single- collimator, all-plastic molded lens for both low and high beam LED headlamp applications replacing glass. The efficient optical lens provides stylists with a new level of design freedom and vs. multi-lens designs save approximately $5 USD / vehicle. A special optical grade of PC material was used for optical efficiency; a multi-shot injection molding process forms the 45-mm thick lens, whose surface tolerances must be held within 40 µ. Cycle times vs. glass are significantly reduced as well.

SPE Automotive Past-Chair Award

Yvonne Bankowski Merritt, Ford Motor Co.

SPE Automotive Div. Chair 2013-2014

(presented by Steven VanLoozen, BASF & SPE Automotive Div. Chair 2014-2015)

2014 SPE Automotive Division
GRAND AWARD & CATEGORY WINNER: Safety

ACTIVE GLOVE BOX
2015 Ford Motor Co. Ford Mustang sports car

OEM Make & Model:	2015 Ford Motor Co. Ford Mustang sports car
Tier Supplier/Processor:	Faurecia
Material Supplier:	Mitsubishi Chemical Corp. & Advanced Composites, Inc.
Tooling supplier:	Extol, Inc.
Material / Process:	TP850N / ADX5028 / ADX5017 TPO / injection molding

This patented application is an industry first where an injection-molded knee airbag is integrated with the glove-box door, reducing weight 65% and space 75% vs. separate traditional knee airbags plus glove-box doors. Instead of a woven textile airbag, a special bladder is hot-plate welded to the door and then checked with a hydrostatic burst tester to ensure the strength of the resulting hermetic seal. This saves $5-10 USD/car while providing consumers with more interior space and decreasing vehicle mass for better fuel efficiency.

BATTER'S BOX

Composites will Drive Automotive Fuel Efficiency

By Herm Dillon,
Editor: AutomotiveNewsWire.net

We've been watching alternative automotive powertrain systems advance for more than 20 years. And, indeed, there have been several alternatives, especially if you include clean diesel, more fuel-efficient internal combustion engines, electrics, and hybrid-electric powertrains. But the brass ring still hangs from the pole as the search for a zero-emission passenger vehicle continues. Morgan sports cars have been powered by natural gas as far back as the 1970s in order to meet U.S. emissions standards. But you had to be a die-hard Morgan lover to cover the cost of converting the car from running on petrol to propane, and a sports car that didn't have much space to begin with became even more crowded with a metal propane tank.

In the 1990s the concept and development of fuel cells for the automotive industry began to gain momentum and by the turn of the century it became the hottest and most invested technology by many auto manufacturers. It led General Motors to abandon its first electric car technology *(EV1)* and proprietary investment, along with investment in companies like Canada's Ballard Power Systems that for a while seemed unending but never provided significant results. For the most part, the technology only inched along as automakers turned their sights to electric vehicles and hybrids. Let's face it, they had to in order to meet more stringent CAFE fuel economy and emission standards.

Perhaps one of the breakthroughs came from an unlikely company, Toyota Motor Corp. subsidiary Toyota Gosei, which announced in April 2003 that it had developed a revolutionary carbon fiber-composite fuel tank for natural gas systems that was lightweight and capable of replacing all-metal tanks of its type. It was the first carbon fiber CNG (compressed natural gas) tank capable of handling the high pressures required for onboard CNG storage, and it was 60% lighter in weight than its metal counterpart.

Toyota Gosei used a rubber alloyed PPS (polyphenylene sulfide) for the matrix resin for the tank, which at the time was reported to have non-conductive properties and excelled as a gas barrier. PPS proved to have excellent adhesive properties as well, which allowed the liner to be easily welded together.

But these tanks were large and usually produced through rotational molding, not a process that easily could keep up with the production demands of mass-produced consumer vehicles.

As is so often the case, the answer for a safe, reliable hydrogen fuel tank came from a new process technology that was being developed by machinery suppliers KraussMaffei and Engel among others. Working with leading composite material suppliers, a thermoplastic composite technology was investigated where an all-plastic hybrid composite sheet was placed in an injection mold under heat and pressure and voilà, a three-dimensional part emerged. Certainly, it wasn't that simple and later machinery suppliers began using overmolding technology, usually with nylon. Toyota Boshoku began using the technology, initially for automotive seating and other interior components and eventually for fuel-cell components.

Earlier this week (November 24, 2014), Toyota Motor Corp. announced that it would go into production with a fuel-cell vehicle under the moniker of *Mirai* by mid-December 2014. The vehicle, a sedan, will be a purely hydrogen-powered fuel cell. Honda Motor, which announced one year ago that it would introduce a similarly-powered vehicle in 2015, postponed its introduction to 2016. Nevertheless, the announcements — and there will certainly be more to come — signal a new era in automotive propulsion and environmental benefits.

Batter's Box CONTINUED FROM PAGE 11

Fuel-Cell Basics

For the uninitiated, fuel cells are relatively simple technology, although quite complicated to work in providing electricity for a vehicle's propulsion. Basically, that's all the fuel cell does – it creates electricity that in the case of automotive applications, is stored in a battery cell, usually a lithium-ion battery.

Fuel cells can run on a variety of fuels and indeed, ExxonMobil attempted to develop a fuel cell that ran on gasoline. Can you wonder why? But the auto industry's focus has been on developing hydrogen fuel cells, hydrogen being the simplest and most abundant gas in the universe. It is the lightest element on the planet, yet it has the highest energy content per unit of weight of all known fuels. Hydrogen's energy density is 52,000 Btu/lb – about three times greater than that of gasoline.

But there-in lies the problem. Hydrogen is never found just floating around out there, nor can you drill for it like crude oil. It's always combined with other elements, typically oxygen and carbon, and therefore, at least in our sense, needs to be refined. Like natural gas, it is odorless, tasteless, and colorless but unlike natural gas, it cannot be odorized. Nevertheless, it is volatile and must be handled carefully.

In the U.S., most hydrogen today is produced from steam reformation of natural gas, but it also can be produced from biomass or other compounds that don't contain carbon. What is amazing about hydrogen is that when an electric current is introduced into water, hydrogen and oxygen are separated with hydrogen forming a cathode and oxygen forming an anode, and electricity is produced. The amount of electricity is dependent on the amount of hydrogen and the ability of the cathode to produce energy and have it stored in an energy-storage system, in the case of vehicles today, a lithium-ion battery like.

In order to have sufficient hydrogen as a fuel, for say a vehicle that will have a reasonable driving range, the hydrogen has to be stored at high pressures, as much as 5,000 psi, or better still 10,000 psi, the amount of pressure used in some guns to discharge a bullet. The amount of pressure that can make you smile from ear-to-ear. Thus, there must be a reliable and safe way to store the hydrogen in the vehicle. That is where Toyota and its partners appear to have succeeded in making a fuel cell-powered vehicle practical in mass production.

Building the Toyota Fuel Cell

Toyota Motor's partner, and perhaps genius, in developing the *Mirai* fuel-cell-powered vehicle, is Japan's Toray Industries, Inc., although Toyota and its affiliates have been working on fuel-cell technology for decades.

The thermoplastic carbon fiber material used in the Toyota fuel-cell stack was developed by Toray. The tanks are lightweight, injection molded, and actually create the floor of the vehicle. Press molding time is said to be short, although neither Toyota nor Toray have said how short, and the part is molded into a shape that conforms to available space in the vehicle. Toray says it is the first time that a CFRTP has been used in the structural part of the vehicle, although we question the use of the word *structural*, and indeed, Celanese and other CF-based material suppliers have developed CFRTP materials that have been used in structural automotive components, not necessarily fuel-cell components.

Also unique in the Toyota *Mirai* is a carbon fiber paper that serves as the electrode substrate of the fuel tank stack. The carbon fiber paper is said to meet the gas diffusion properties and durability of the stack, which is the heart of the fuel-cell system.

The Toyota fuel-cell stack is believed to use a platinum catalyst, as do most fuel cells. But earlier this week, Japan's Teijin Ltd. announced it has developed a carbon alloy catalyst (CAC) that is said to eliminate the use of platinum to reduce costs for mass production. CAC is made from polyacrylonitrile (PAN) and steel via carbonization. Less expensive and more readily available than platinum (Pt), PAN enables the catalyst to be produced at reduced cost and in higher volumes.

In a 2014 paper in the *Journal of the American Chemical Society,* researchers from the Tokyo Institute of Technology noted that:

> The efficiency of PEMFC [proton exchange membrane fuel cells] is determined by oxygen reduction reaction (ORR) at the cathode, and up to now the most effective cathode catalysts for the ORR are platinum-based catalysts. However, its large scale commercial applications are hindered by high cost of Pt, and the Pt-based electrode also suffers from low selectivity, poor durability, and CO deactivation.

Batter's Box CONTINUED FROM PAGE 12

Teijin says that CAC demonstrates excellent performance using catalytic particles miniaturized by proprietary polymer chemistry and carbonization processes. It enables fuel cells to achieve electrical generation on levels equal to those of other high-quality fuel cells using a non-platinum catalyst.

Is this the end? No, not quite. History has shown that materials technology breeds process technology and they seem to move in eras of development and need. The concept of injection molding carbon fiber thermoplastic matrices is in its infancy, and we look forward to machinery companies to develop processes that will make molding these materials more productive and less expensive, opening the way for mass-produced transportation that will be more environmentally friendly and perhaps without a carbon footprint at all.

ABOUT HERM DILLON

Herm Dillon is the president of Business Intelligence Group LLC. He served in the U.S. Marine Corps from 1966 to 1968 and is a Vietnam veteran. Dillon has a B.A. in Journalism from West Chester State University and upon graduation began a 41-year career in the plastics industry. Following a seven-year stint with Dayco Corp., he joined ICI Americas where he held several managerial positions in marketing with ICI's Polyurethanes, Advanced Materials, and Electronics units. In 1987 Dillon joined Bill Communications to head up the PLASPEC electronic database business, the management of which was brought into his own company in 1991. Business Intelligence Group is an information-based company producing daily news-wire services on the plastics and automotive industries and developing market intelligence and research services for its clients. Dillon writes a daily newswire for the plastics industry and one for the automotive industry, both of which are available on the Internet. He has published a book entitled West Point: The Bicentennial Book, which chronicles 200 years of history at the United States Military Academy, and a second book entitled Military Highlife.

2014 SPE TPO Automotive Engineered Polyolefins Conference Highlights

by Bill Windscheif, 2014 Conference Co-Chair

The 16th-annual SPE TPO Automotive Engineered Polyolefins Conference was held at the Troy Marriott in Troy, Michigan in the suburbs of Detroit from October 5-8, 2014. This year's conference set another attendance record with approximately 800 registered participants. The conference theme, *TPO: Gateway to Innovations*, was highlighted in the technical program, which ran in three concurrent sessions and was outstanding with 71 technical papers and presentations. Each morning the program began with keynote presentations by leading industry executives. A total of five keynote speeches were delivered. Topics included how the industry will achieve government-mandated fuel economy standards by 2025; advantages offered to the plastics industry by shale gas; how innovative new materials are creating new application opportunities; and future growth of TPO usage in vehicle interiors.

The conference has truly become a global event, attracting attendees from 18 countries. Approximately 38% of conference delegates indicated they worked for OEMs, with the balance of the crowd from tier supplier companies. After talking with conference sponsors and exhibitors as well as attendees, it is obvious that the conference is providing great value to the automotive and plastics industry. This is because the entire TPO supply chain is represented, and the venue provides the perfect opportunity to network and conduct business. Several attendees said they were able to accomplish in three days what would normally take many months. Therefore by all measures, this year's conference was a resounding success.

Two reasons for the conference's achievements are the hard work and dedication of the TPO Committee and the fact that sponsors and exhibitors supported the event at record levels. The committee is made up of industry representatives who provide an extraordinary amount of non-profit volunteer effort each year. As a result, this event has grown into *the world's largest automotive polyolefins forum*. The latest trends and technologies were presented in eight technical sessions:

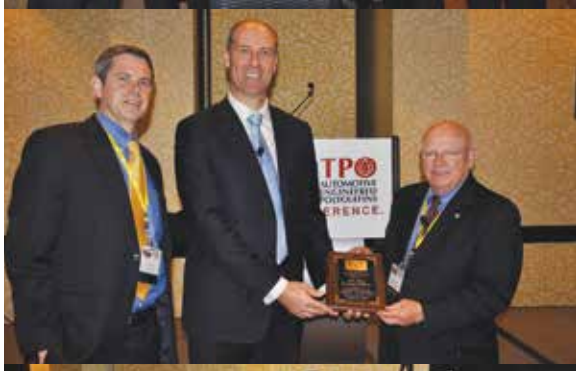
- Interior Soft Trim: Skins & Foam
- Advances in Automotive Polyolefins
- Bio-Based Materials
- Lightweighting of Polyolefin Parts
- Surface Enhancements
- Rigid Polyolefin Compounds
- Adhesives and Coating for TPOs
- Thermoforming of TPO Materials

In addition to technical sessions, the conference provided networking opportunities at two evening receptions hosted by ExxonMobil Chemical Co. and SABIC.

The conference also hosts an annual "Most Innovative Parts Award" contest. This year two prizes were presented. The winner of the *interior* category is the *Nissan Sentra* instrument panel skin using Sunvieo high MFR TPV from Asahi Kasei North America, Inc. The winner of the *exterior* category is the 2014 *Nissan Rouge* liftgate, the first all-olefinic liftgate in North America. The outer panel material is a TPO supplied by LyondellBasell and the inner panel is a long-glass polypropylene from Advanced Composites, Inc.

TPO CONTINUED FROM PAGE 14

Next year's Auto TPO conference will return to the Troy Marriott from October 4-7, 2015. For additional details, see http://auto-tpo.com or http://speautomotive.com/tpo or call +1.248.244.8993 extension 3.



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An Engineer's Life...

by Dr. Norm Kakarala

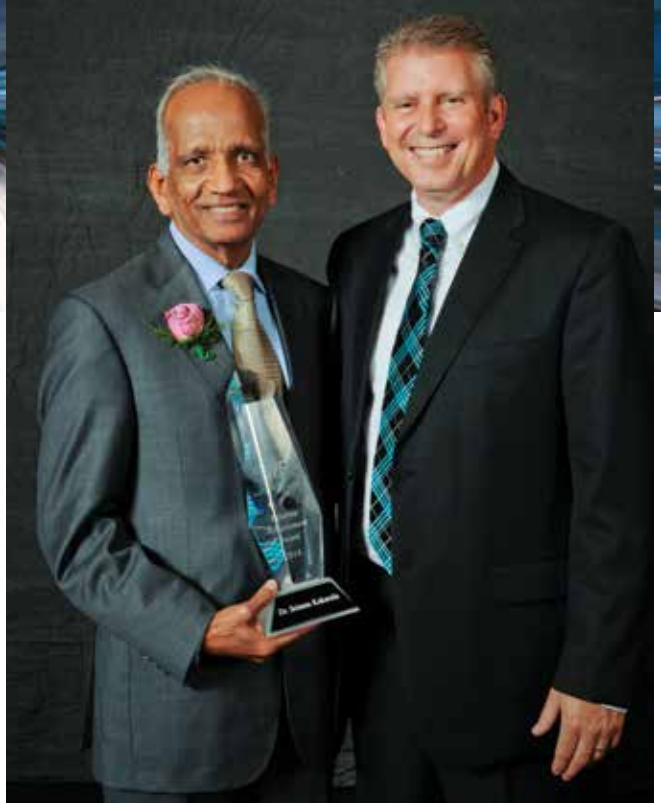
I was born and raised in the southeast region of India, in the State of Andhra. I was the fourth of eight children, with five brothers and two sisters. Being born in the middle of my family, I learned early in life to find the middle ground in order to have harmony and happiness in my relationships.

In India, education is not an "option" but rather it's a "requirement" in order to find a better life. Children are expected to pursue the highest level of education they can achieve in order to ensure career success. In general, career tracks in India are set in one direction based on aptitude and there are no viable options to cross to other career paths. For example, guidance counselors in my school offered four tracks: if you showed an aptitude for algebra, then you were guided toward a career in engineering; if were strong in the sciences, you were steered toward medicine; if you liked arithmetic, then accounting was your likely future career; and if you enjoyed the humanities, then you were directed to a career in law or a similar field. Your high school record determined your college choice, and once in college, your career track was frozen from then on.

After a year of pre-university courses at a college near my home, I enrolled as an engineering student at Andhra University, which had a good reputation in India for its Chemical Engineering program, and later for its Civil, Electrical, and Mechanical Engineering disciplines. A significant number of our professors had been educated either in the U.K. or the U.S. Deciding to pursue a degree in Chemical Engineering was made a bit easier because my older brother had already completed a degree in this field at University of Michigan-Ann Arbor. (At the advice of a family friend, he had completed a B.S. degree in Chemical Engineering, and two M.S. degrees (in Chemical Engineering and Nuclear Engineering) at that school, and later completed a Ph.D. degree in Mechanical Engineering at Akron University.) Also, I found that by majoring in Chemical Engineering, I could avoid in-depth study of either Chemistry or Engineering. I also could get away with talking "engineering" to chemists and "chemistry" to engineers.

During the junior year of my undergraduate program, I decided to focus on plastics and for my senior project I designed a plant to produce polystyrene from ethylene and benzene. I had already decided to join my brother in the Detroit area and had applied to Wayne State University for graduate work. While waiting for the logistics of getting transcripts and applications filed to attend Wayne State University sorted out, I completed one semester of a Master's degree in Chemical Engineering at the Indian Institute of Technology in Madras. Then it was off to the U.S. and Wayne State where I completed my M.S. degree in Chemical Engineering and soon started my first job as a rubber formulator for Uniroyal Tire Co. here in the Motor City. Throughout my years at Uniroyal, I took evening classes at Wayne State University and later University of Detroit's Polymer Institute. Eventually I completed my dissertation (while working full time) and received my doctorate degree in Chemical Engineering.

One of my first assignments at Uniroyal gave me the unique experience of needing to strike a balance between wear and traction characteristics in tire rubber properties. Yes, I was back to that early life lesson about finding the middle ground between conflicting



An Engineer's Life CONTINUED FROM PAGE 18

needs and desires. To do this project, I had to select the proportions of 10 different chemicals in the formulation. The concept of property optimization was well taught in school, but the understanding that this would involve tradeoffs in properties was perhaps not as strongly emphasized. When you're trying to balance friction (for vehicle handling) and wear (for durability) in tires, you improve one property at the expense of the other, so the key is to find a way to achieve an acceptable balance of both. Later in my career I would struggle with a similar set of tradeoffs when formulating composites and thermoplastic elastomers, only this time the two warring properties were stiffness and impact strength. The lessons I learned from this experience have served me well for my entire career.

Another interesting project I did at Uniroyal involved validating aircraft tires made from synthetic materials on a Canadian government contract. At the time, the Canadian government was exploring the possibility of adding small amounts of lignin, a by-product of paper production from the country's sizable forestry products industry, to polyisoprene rubber compounds. The goal was to use a waste product that otherwise would be landfilled to help improve tire performance. Lignin, in fine powder form, is difficult to disperse in thick, gummy rubber compounds and it tends to clump up in agglomerates. However, we found that by adding an amine (specifically quatrafunctional amine) and small amount of water for hydrolysis during mixing that this not only facilitated dispersion of the lignin but it also led to tires that ran cooler during dynamometer testing.

After 14 years at Uniroyal, the company closed its Detroit tire plant during a merger with B.F. Goodrich and moved its development group to Troy, Michigan. I answered an ad in the newspaper for a research engineer position working at General Motors Corp. (GM). The timing was excellent, as I'd just finished my doctorate degree at University of Detroit. I got the job and moved over to GM's Advanced Development Group. There, I was soon running a test lab to evaluate sheet-molding compound (SMC), RRIM (reinforced reaction-injection molding), SRIM (structural RIM), and unidirectional epoxy/glass composites for leaf-springs. I also worked on urethane and epoxy adhesives, which were used to bond inner and outer composite body panels to each other, and the completed assemblies to the vehicle frame. We had special equipment in this lab for high-speed impact, fatigue, creep, thermal analysis, and surface testing and we did work for most of the groups at GM. About half of our tests were run to support materials and processes that were being developed inside our company and the balance were run either to evaluate new supplier materials or to try to resolve issues with supplier materials for specific vehicle programs.

Once again I was able to put my early life lessons about compromise and my chemical engineering training about tradeoffs to good use. When you need to achieve a specific balance of properties to meet a particular application's needs, there are always things you have to give up in order to get what you want. And, unfortunately, sometimes you simply can't find an acceptable balance of properties that will fulfill the application's needs — at least not in the timeframe allowed. I learned this painful lesson with several of my early assignments at GM. For example, one of my tasks was to evaluate a nylon/RIM material from then Monsanto that was being considered for bumper fascias. We had no problems processing this material, as we had a hot melt stream RIM machine. However, what we couldn't seem to do was resolve dimensional growth caused by moisture absorption and eliminate an odor issue caused by unreacted monomer. Eventually we concluded that both issues were inherent to the material and we closed the project. Another early and unsuccessful project I was given was working on the fast (<15 sec) reaction of DCPD (dicyclopentadiene) polymer from then Hercules, also for RIM applications. The material had excellent as-molded properties and certainly processed quickly enough, but it had a highly objectionable odor. We eventually closed that project due to environmental concerns.

After 15 years at GM, my job — or at least my employer — changed when GM spun off its components business as Delphi Corp. in 1996. At Delphi, my central focus was replacing PVC (polyvinyl chloride) with soft thermoplastic polyolefin (TPO) for the skins on interior trim panels. As I worked to formulate thermoformable TPO skin materials, I used SPE as a resource to proactively promote new TPO products and to convince OEM customers of the benefits of TPO vs. vinyl skins. I did this by recruiting major TPO suppliers as partners to launch the SPE Global Automotive TPO Conference while I was president of the SPE Detroit Section in 1999. Sixteen years ago I saw tremendous lightweighting opportunities in these lower density materials (some of which practically float on water). As the Auto TPO conference has

An Engineer's Life CONTINUED FROM PAGE 19

grown, so has interest in TPOs. Given that these materials have been the fastest growing class of plastics for a decade and a half, it seems that my instincts were correct.

In 2008, my employer changed again when Delphi sold its interiors business to Inteva Products LLC. Although I really didn't change jobs in moving from GM to Delphi to Inteva, I did change the name of the company on my paycheck, a situation that a lot of engineers in Detroit can claim over the last several decades. And interestingly, a large number of my large family ended up moving to the Detroit area. My oldest brother, who arrived before me, moved to Ohio after graduating and spent 35 years working at Babcock & Wilcox Co. as a chemical engineer, although he has returned to the Detroit area upon retirement. Two of my brothers became doctors (both have lived in the Detroit area at one time or another and one still does), two became certified public accountants (one who manages community hospitals in Detroit, the other our only sibling still living in India), and both my younger sisters went into careers in medicine (one as a microbiologist at Detroit Children's Hospital and the other as an ultrasound associate at St. Joseph Mercy Oakland in nearby Pontiac, Michigan).

What advice can I offer to young engineers just starting out? First, finding the right property balance is a really important component of good materials selection. You could say that materials engineers serve two masters when trying to meet application requirements: product engineers want performance with superior properties; manufacturing engineers want fast cycles with good first-time quality. It's not always easy to serve both masters at once. To be a good materials engineer, you need to be a proactive advocate of new applications by using new material developments. My personal belief is that proactive promotion of new materials to OEM customers should be a job requirement for all materials development engineers. Who else is more qualified and more passionate at convincing their customers of the benefits of trying new product developments? And second, throughout my career I've found SPE to be a great resource and communications platform to advocate on behalf of new applications for new plastic material developments. The contacts I made at SPE enhanced my career by giving me the resources and the network I needed to resolve technical issues via consultation.

ABOUT DR. NORM KAKARALA

Dr. Norm Kakarala has had a career spanning almost five decades as a technical specialist in the area of polymers, composites, and thermoplastic polyolefin (TPO) formulations, including adhesives, coatings, and rubber. He is well known for his work in understanding structure-property relations, and the influence of forming processes like injection molding, sheet extrusion, and thermoforming on materials. He has a strong background as a technical liaison between product development and production implementation of automotive plastics. He also has designed accelerated laboratory tests (many of which have subsequently been adopted as industry standards) to predict product-service performance of automotive plastic components.

Kakarala worked with vehicle groups in the selection of materials for new programs on notable cars like the *Chevrolet Camaro*, and on plastic/composite-bodied vehicles like the *Chevrolet Corvette* and *Pontiac Fiero* sports cars, and the *Chevrolet Lumina, Oldsmobile Silhouette*, and *Pontiac Trans Sport* minivans. He also developed industry standards on adhesives and composites through his work as GM's representative on the Automotive Composites Consortium of the United States Council for Automotive Research LLC (USCAR), the precompetitive research consortium for General Motors, Ford Motor Co., and Chrysler Corp. (now Fiat Chrysler Automobiles).

Among Kakarala's significant career accomplishments, he received the Lifetime Achievement Award from the SPE Automotive Division (2014) and SPE Detroit Section (2011); he was inducted as a fellow in the Society of Plastics Engineers International (2004); he received SPE's Honored Service Member award (2003); he received the Engineering Society of Detroit's Gold Award for outstanding professional achievement (2002); and he received the 1999 Recycler of the Year award from the SPE Recycling Division (now SPE Environmental Division) for closed-loop recycling of TPO skins.

Kakarala served as president of the SPE Detroit Section (1998-1999) and chair of the SPE Automotive Division (2004-2005), and he has developed ASTM and SAE standards for testing plastics and polymer composites during his years working for General Motors. Even in retirement, he continues to be active in organizing technical sessions for the SPE Automotive Engineering Plastics Conference (AutoEPCON), an event he founded, and the SPE Automotive Engineered Polyolefins Conference.

He holds a doctorate degree from University of Detroit, an M.S. degree from Wayne State University, and a B.S. degree from Andhra University — all in Chemical Engineering.

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Service through Science

by Creig Bowland,

Colorado Legacy Group LLC

Dr. Linus Pauling once said that science is like a labyrinth. You go into the labyrinth expecting to exit in one direction and, with art of discovery, you often find yourself exiting a completely different route. This is a great summary of what my career as a scientist has been like. Comparing my career to the others who have been highlighted in this series you will find that I have changed jobs frequently. In the composites industry, this has been the norm and not the exception.

I grew up as the son of a coal miner in Colorado. When my father was hurt in the mines he decided to switch to working in construction, as he came from a long line of master carpenters. Most of the jobs were in the Denver area, so we moved from the western side of the state to Denver. I did junior high and high school there.

The junior high I attended was an inner-city school, but had a couple of great science teachers who allowed me to explore my love of science. I studied everything I could and participated in the state science fair with a geology-based project. I won a number of awards with the work and that really got me going on science. (I also made a liquid fuel rocket that someone set off in class while we were there. I really was not at fault, but everyone was quite unhappy with me that they had to be sent out into a snowstorm while the fire trucks looked over the labs.)

We moved to Littleton, Colorado, a southern suburb of Denver for my high school. At that point I was not clear which area of science I was most interested in, so I studied everything I could and ended up taking seven years' worth of science classes in high school. Ironically, given my career, my least favorite class was chemistry and that was probably because of the teacher. My grades in high school were nothing to sing about. I carried a B average. In hindsight I now know that I had a small learning problem as I am dyslexic. This made math, writing, and spelling major challenges, but it did not dampen my enthusiasm for learning.

For college I must admit that I had no idea how to pick the right college, as I was the first one in my family to ever think of attending a post-high school educational institute. I chose Baylor University to start and enjoyed a great education at that school. It was there that I fell in love with my previous nemesis, chemistry while taking an Organic Chemistry class. The logic and thought processes used in chemistry fit well with me. Unfortunately, I could not complete my education at Baylor because of the cost of the institute, so I transferred to Colorado State University (CSU) in Fort Collins, Colorado to complete my B.S. degree in Chemistry. While at CSU I was also a member of the Sigma Nu fraternity and took a lot of history classes. I almost did a minor in Ancient Near Eastern History, but because it was a B.A. degree while I was in the B.S. program, it would have taken another year to get some core courses done to qualify.

After college I took a job in technical sales for industrial chemicals while I decided on what my next step should be. It was a fascinating experience because I got to see a lot of different industries and how they use various chemicals in their processes. After a couple of years I decided I needed to continue with my education if I wanted to use my chemistry training. I chose The University of New Mexico for a graduate program because of Dr. Paine, a leading inorganic chemist of the day. I started work on various boron-based chemistries in his lab and quickly discovered that I was not well suited to the bench chemistry required to make new boron-based compounds! I was much better at instrumentation and I changed from the inorganic group to the physical chemistry group and worked for Dr. Walters. My work was on spectroscopic determination of van der Waals forces using a vacuum ultraviolet-tunable laser. While working for Dr. Walters I was introduced to the materials science group at Sandia National Laboratories and ended up working part time for Dr. Allred on the interfacial adhesion between carbon fibers and various thermoset resin systems for the aerospace industry. That work was

Service through Science CONTINUED FROM PAGE 23

so fascinating and rewarding that I decided to stop my doctorial work with a Master's in Physical Chemistry and work full time for Dr. Allred. We worked for a number of years on improving the bonding between various fibers and resin systems by fundamentally changing the surface chemistry on the fibers. I still look back on that time as the most rewarding fundamental science work I have ever done.

While working for Dr. Allred I was hired by a small company in Winona, Minnesota called PCI. The team there was working on a new process called long-fiber thermoplastics (LFT) and was having a lot of problems getting the process up to a commercial level. They wanted me to work on improving the bonding and adhesion between the fiberglass and the thermoplastic polymers they were using. The LFT process was in serious need of improvements. The equipment, materials, setup, processing steps, and formulations all needed to be enhanced. I soon was working on all aspects of the LFT process with a set goal of making a profitable and commercially viable product. Over the course of 5 years we were able to bring the process up in quality and productivity while improving the mechanical properties and performance of the products. We developed a lot of different materials and forms, but it turned out that the market mostly wanted polypropylene/glass LFT and a few grades of nylon/glass LFT. Thus the focus became getting these products to market and accepted in the automotive industry. PCI was eventually purchased by Celanese and the product was renamed Celstran and became a part of the Celanese brands. One of the great things about my time at PCI was that it strongly pushed me to get involved with SPE and the newly forming Advanced Composites Division of the society. This began a lifelong service to SPE that has served me well with the great contacts and people I have met. I have given a lot to SPE, but believe that I have received much more in return.

After my work at PCI I wanted to explore other aspects of the composites industry and went to work for Fiberite in Tempe, Arizona. I was a member of the development team for the 949 resin systems that are still in use as the primary toughened epoxy resins for military aircraft. However, with the downturn in the aerospace industry it was time for me to look back at automotive and find work there. During this period, I did a brief stay at Exxon as a development chemist for their Taffen product, a glass-mat thermoplastic (GMT) composite, and I also worked for LNP Engineering Plastics to help them with their LFT product line.

I have always had an entrepreneurial spirit and after my time with LNP I decided to go off on my own. Since I come from a long line of carpenters, I wanted to try my hand in the "family" industry. My family and I moved back to Denver and I set up a fairly successful construction business. However, it was not long before the automotive composites industry found me and called me back. I had continued to dabble in LFT technology while managing my construction company and eventually developed my own way to manufacture LFT materials. I decided to develop this into a business of licensing and selling LFT technology to companies in need of the technology. I also helped companies expand, becoming the vice-president of Arkal Automotive, an LFT molder, and setting up the company's first plant (in London, Ontario, Canada) that was outside of Israel. That became the first of many new facilities Arkal has since set up.

After a number of successful projects I was approached by PPG Industries to help them expand their business in the LFT fiberglass market. I spent 9 years working for the company, and during that time PPG became one of the leading suppliers of rovings to the LFT market. I was the global technical leader of the team responsible for this effort. It was a very satisfying and fruitful time at PPG.

This year I left PPG to go back to working for myself. My company is called Colorado Legacy Group, LLC, and I do a variety of consulting projects for the composites industry. I also have continued to license and sell LFT technology globally. There is a growing demand for my expertise in composites, especially thermoplastic composites, for the automotive industry. I can support customers in material development, provide problem solving in manufacturing and molding, as well as help with fundamental work in the adhesion of fibers to resins.

When not consulting about composites I can be found working on my ranch in North Carolina where we raise Dexter and Angus cattle. And I still get to play chemist because we also formulate and manufacture a number of food and skin-care products based on the honey our bees produce.

ABOUT CREIG BOWLAND

Creig Bowland is president of Colorado Legacy Group, LLC, a composites consulting group focused on thermoplastic composites and offering licenses for the production of long-fiber thermoplastics (LFT). He has over 26 years' experience in the design and production of composite materials for both aerospace and automotive markets. He has been involved in almost all aspects of the business, including materials design, production management, technical support, business development, and marketing. His area of expertise is the design and use of long-fiber thermoplastic (LFT) composites for structural parts. Bowland holds a B.S. degree in Chemistry from Colorado State University and an M.S. degree in Physical Chemistry from the University of New Mexico. He is the past chair of the SPE Composites Division and currently the group's councilor, and was the SPE Automotive Composites Conference & Exhibition (ACCE) chair in 2011 and 2012 and its co-chair in 2013. He also was the ACCE technical program co-chair in 2010 and technical program chair in 2014. He can be reached at cbowland@coloradolegacy.com.

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2014 SPE ACCE Recap

by Dr. Michael Connolly, 2014 SPE ACCE Event Chair

Interest in transportation composites remained strong at this year's 14th-annual SPE Automotive Composites Conference & Exhibition (ACCE), co-organized by the SPE Automotive and Composites Divisions. A record number of sponsors and exhibitors supported the 2014 show, which was held September 9-11 at the Diamond Center at the Suburban Collection Showplace in Novi, Michigan, a suburb of Detroit. Despite twice expanding the exhibit area, there still was a need to place several sponsors who signed up late in an overflow area where lunch was served, and the show's student poster and parts competitions were held. Conference organizers already have discussed moving all exhibits to that large exhibit hall next year where there will be plenty of space to expand.

The event's perennially strong technical program covered a wide variety of composite material, additive, reinforcement, and process technologies. A total of 73 presentations were given in nine tracks over three days on:

- Advances in Reinforcement Technologies,
- Advances in Thermoplastic Composites,
- Advances in Thermoset Composites,
- Business Trends & Technology Solutions,
- Enabling Technologies,
- Nanocomposites,
- Opportunities and Challenges with Carbon Composites,
- Sustainable Composites, and
- Virtual Prototyping & Testing of Composites.

For the third year in a row, the event included a Tutorials Track that any attendee could watch at no additional fees. This year's four-hour offering focused on Long-Fiber Thermoplastics and Nanocomposites. Tutorials have been video recorded and eventually will be available for members on SPE International's website, www.4spe.org.

In addition to regular technical sessions, the show featured five keynote speakers who highlighted uses of composite materials in a variety of markets and geographies:

- Dr. Jan-Anders Månson, professor and director-Laboratory of Polymer and Composite Materials (LTC), Institute of Materials, École Polytechnique Fédérale de Lausanne (EPFL, Lausanne, Switzerland) presented *Why Sport is Important for Automotive Composites.*
- Prof. Habib J. Dagher, Ph.D., P.E., director-Advanced Structures and Composites Center, University of Maine-Orono (Orono, Maine) discussed *Polymer Composite Materials in Infrastructure Applications.*
- Kestutis (Stu) Sonta, senior materials engineer, General Motors Co. (Detroit) spoke about *Novel Composite Developments on the Chevrolet Spark Battery Enclosure*, a vehicle that was on display in the conference's lobby throughout the event.
- Daniel Ageda, secretary general and chief operating officer, JEC Composites Group (Paris) described the *Overview & Dynamism of the Worldwide Composites Market.* And
- Matthew Marks, chair of the American Chemistry Council-Plastics Division's Automotive Team (Washington) explored results of the group's latest *Plastics and Polymer Composites Technology Roadmap for Automotive Markets.*

The ACCE is known for the diversity of its keynotes, which often are drawn from non-transportation industries to highlight how composites are being used to solve engineering challenges similar to those faced by automakers.

The conference also is known for its energetic panel discussions, which tackle challenging issues and permit audience members to question panel members during the last 30 minutes. This year's topic was *Lightweighting and the Multi-Material Car.* The panel was moderated by Dr. Jay Baron, president and chief executive officer, Center for Automotive Research (Ann Arbor, Mich.). This year's panelists were:

- Dr. Paul Krajewski, global manager and technical fellow-Vehicle Mass Integration and Strategy, General Motors Co.;

ACCE CONTINUED FROM PAGE 25

- Tom Pilette, vice president-Product & Process Development, Magna Exteriors (Aurora, Ontario, Canada);
- Dr. Peter Friedman, manager, Manufacturing Research, Ford Motor Co. (Dearborn, Mich.);
- Harry Singh, executive program manager, EDAG Engineering AG (Wiesbaden, Germany);
- Martin Starkey, director, Gurit Automotive Ltd. (Newport, Isle of Wight, U.K.).

Just before the event, organizers announced winners of the show's annual Dr. Jackie Rehkopf Best Paper Awards, which were given to first-place finisher, Maxime Melchior, software development engineer at e-Xstream engineering (Luxembourg), an MSC Company; as well as two authors tying for second place: Sylvain Calmels, business development manager - automotive at e-Xstream engineering and Keith Honaker, graduate student at Michigan State University (East Lansing, Mich.) and a 2013-2014 SPE ACCE graduate scholarship award winner.

Also announced before the show were winners of three graduate scholarships sponsored by Michigan Economic Development Corp. (Lansing, Mich.). Winning students whose composites-intensive projects were judged to have the greatest potential impact on ground transportation were Markus Downey of Michigan State University, Fatimat Oluwatoyin Bakare of University of Borås (Borås, Sweden), and Sebastian Goris of University of Wisconsin-Madison (Madison, Wisc.). Each student received a scholarship check and will return to present results of his or her research at next year's show.

Midway through the conference, four students won the show's annual student poster competition sponsored by INVISTA Engineering Polymer Solutions (Wichita, Kan.): Sarah Stair, Baylor University (Waco, Texas) and a 2013 SPE ACCE scholarship winner took first place in the graduate category; Siddhartha Brahma, University of Alabama-Birmingham (Birmingham, Ala.) was the second-place graduate winner; while Anup Shastry, Clemson University (Clemson, S.C.) and Avinash Akepati, University of Alabama-Tuskaloosa (Tuskaloosa, Ala.) tied for the third-place graduate poster award; and Kelly Krumm of Clemson was event's undergraduate winner.

Also announced on the last day of the show were winners of the show's annual parts competition. This year no parts were entered in the Body Interiors category, but the Body Exteriors award went to Mitsubishi Rayon Carbon Fiber & Composites, which nominated the CFRP (carbon fiber-reinforced plastic) decklid made by prepreg compression molding process featured on the *Nissan GT-R* supercar by Nissan Motor Co. Ltd., and the event's People's Choice award (chosen by conference attendees) went to Momentive Specialty Chemicals Inc. for its nomination of lightweight carbon fiber door structure with Class A appearance on the *Porsche 911 GT Cup supercar* produced by Porsche AG.

Another popular aspect of the SPE ACCE are plant tours in and around the Detroit region. This year, a free one-hour tour of Century Tool & Gage's facility in Fenton, Mich. helped about 35 ACCE attendees and other SPE members learn more about production of compression-molding tooling that is used to form parts in direct-long-fiber thermoplastics (D-LFT), sheet-molding compound (SMC), glass-mat thermoplastic (GMT), and lightweight-reinforced thermoplastic (LWRT) composites.

Planning is already underway for the 2015 SPE ACCE event, which returns to the Diamond Center from September 9-11, 2015. Organizers will issue a call for papers for the 15th-annual show in early January. Abstracts will be due March 31 and non-commercial papers will be due for peer review May 29.

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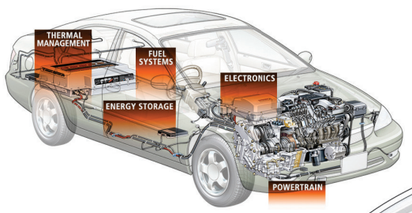

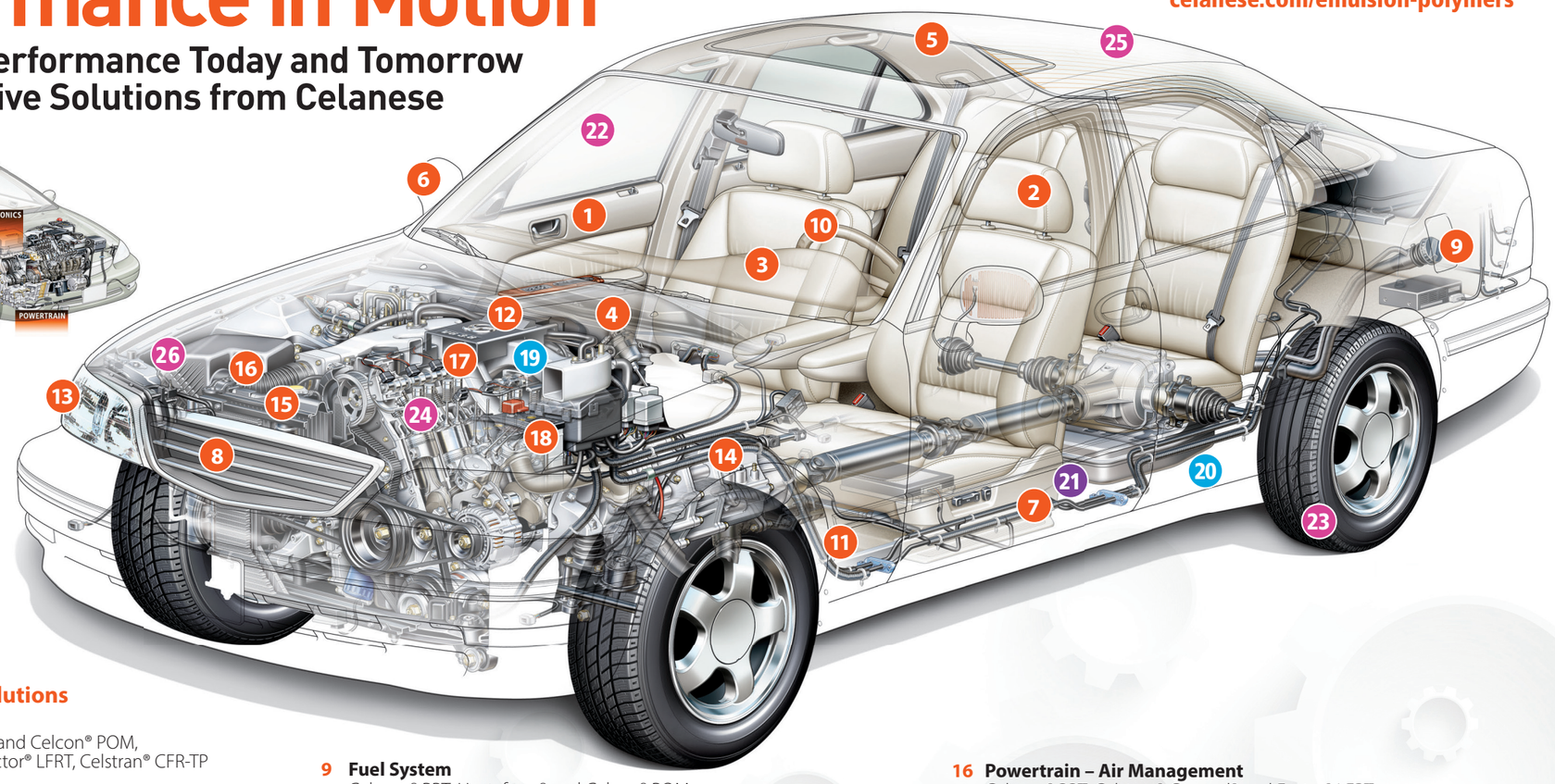

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COUNCILOR'S REPORT

September 13 & 14, 2014 - Council I & II Meeting Minutes

New Orleans, Louisiana, U.S.A.

by Tom Pickett, SPE Automotive Div. Councilor

COUNCILOR I MEETING SATURDAY, SEPTEMBER 13, 2014

1. WELCOME, ANTI-TRUST & CONFLICT OF INTEREST

2014-2015 SPE President Vijay Boolani called the meeting to order at 2:30 p.m. and reminded everyone that the meeting was operating under SPE's Antitrust and Conflict of Interest policies.

2. ROLL CALL

Determination of Attendance

Secretary Jamie Gomez conducted a formal roll call. Proxies were identified. Secretary Gomez made a motion to seat the proxies. The motion was seconded and passed.

Boolani recognized the current year executive committee (EC), past presidents, Wim De Vos, and the SPE staff in attendance.

Gomez indicated that the roll call was complete.

3. APPROVAL OF THE AGENDA

The agenda was approved as published.

4. APPROVAL OF OUTSTANDING MINUTES

Gomez asked if there were any questions on the past EC meeting minutes. There were none. Gomez requested that the April 2014 Council I meeting minutes be approved. There were errors in the April 2014 Council I & II meeting minutes. The errors will be corrected. Approval of April Council meeting minutes were tabled for approval until Sunday.

Oliver Craig was appointed EC member to complete the term that was vacated when Jimmy Masrin resigned.

5. OPENING REMARKS

Boolani remarked that we as a society are on track with plans. There were changes in staff on the executive committee. Gail Bristol, SPE managing mirector, retired as of September 1, 2014. Tom Conklin moved to part-time status. Sarah Sullinger returned part time. SPE hired Gross Recruiters to find a managing director of SPE. Russell Broome, former SPE president and longtime worker in the plastics industry, was named managing director and will start October 1. The Chain prototype is now running in beta test phase. The reception in Las Vegas was well received. Boolani asked that the Councilors *walk the talk* with him. Global conferences are in progress. Boolani asked that we keep up the good work.

6. IN MEMORY

Roger Jones, Jackie Rehkopf, Brian Edmondson.

7. RECAP OF MOVING FORWARD

De Vos presented a recap of the past and today. Twenty years ago SPE membership and the SPE staff were larger. Today we have a smaller membership, SPE staff, and budget. De Vos discussed strategies to achieve sustainability by utilizing technologies, expanding the brand, addressing generation gaps, developing and sharing resources, developing alternative revenue sources, and building partnerships.

SPE has engaged with the new technology by: Rebuilding its website, introducing smartphone apps, upgrading to a more capable and flexible AMS, creating a private networking platform, and integrating mobility across all systems. The SPE brand has expanded with a revitalized image (logo, *Plastics Engineering magazine*, website). SPE conferences have been expanded globally, marketing videos have been developed, and a private network developed for people in plastics. We are building partnerships with SPI, and *Plastics News* in Europe, and others are in progress. We have addressed the generation gaps by revitalizing the society image (logo, *Plastics Engineering magazine*, website). We have developed and shared resources. We have created a searchable technical database. SPE has a cross-functional and technically savvy staff. SPE has alternative revenue from advertisement on the website, advertisement on The Chain, and conferences are bringing in more income. Member engagement requires additional work.

Scott Owens presented an update on The Chain. The Chain is a way to communicate with members. It is a way to engage members directly. Beta testing is going on with 50 members. The soft launch is October 1, 2014 with 500 to 1,000 members. To request to participate in the soft launch, go to **https://www.surveymonkey.com/s/73TSXFS**. The launch to everyone is scheduled for January 2015.

8. TECHNOLOGY PLATFORM AND KNOWLEDGE DATA

For $5,000 USD, a division or section can purchase a microsite on the SPE website. The division and section can have control to add and edit the microsite. There is a $500 per year maintenance charge. SPE requests papers and presentations to populate its data base. The ANTEC papers from 1998 through 2014 have been loaded into the technical library.

9. FINANCE

De Vos reviewed the finance report. Year to date we are $17,702 to the budget. We are in good standing. With NPE next year, we will not expect revenue from ANTEC to be as high. The risk is selling advertisement. SPE is counting on selling advertisement and budgeted $551,500 revenue. Overall the financial situation is around break even. It is difficult to invest in the necessary technology without investment money. Thus, De Vos welcomes financial support from divisions, sections, and groups that can support SPE headquarters' (HQ) investment in technology. If a group has extra money, SPE International would appreciate financial support for investment in technology that will benefit all.

10. WORKSHOP

During the last part of the meeting, councilors divided into groups as part of a workshop on the future of SPE. The individual groups discussed the following questions: Do you get enough value for your member dues? Do you think a regular SPE member (non-leader) gets enough value for his / her membership dues? What are the top three benefits of membership for the standard member (non-leader)? Which one benefit should we improve? Which one benefit should we add (that we do not have today) and that you think will encourage lots of people to join SPE? Should we introduce an e-member type, which is free and has only limited benefits? Do you think SPE membership fee should be increased? How should we move to a 10-person governance board?

SPE AUTOMOTIVE

COUNCILOR II MEETING SUNDAY, SEPTEMBER 14, 2014

1. WELCOME, ANTI-TRUST & CONFLICT OF INTEREST

President Boolani called the Councilor II meeting to order at 8:30 a.m. A motion was made to approve the April Councilor I & II meeting minutes. The April Councilor I & II meeting minutes were approved.

2. RECAP OF WORKSHOP

The individual groups from the September 13 workshop presented their feedback on the work questions. The groups do not want to reduce the size of the governance board. Most of the groups are okay with a small increase of membership price. Knowledge and networking are the top benefits. The groups in general felt an e-membership with very limited benefits would be good. A motion was approved to allow the EC to offer an e-subscription. Motion was made and approved to allow HQ and the EC to offer e-subscriptions (not a membership) with very limited access to SPE benefits. The thought is that those people who subscribe will hopefully see enough value to join as a paying member.

3. STUDENT AND YOUNG PROFESSIONAL MEMBERSHIP CAMPAIGN

Gomez talked about the new logo's appeal to younger members. The official SPE style guide is on the web site. The red color is removed. A motion was made and approved that allows the red color logo added as an option. In an effort to keep the SPE brand identity, the logo color can be a green, grey, or red color.

4. SPI PRESENTATION

Bill Carteaux, president of the Society of the Plastics Industry (SPI®), presented a talk on the SPI Governance Evolution. The biggest challenge facing SPI was letting go of its traditional organizational structures. The SPI is in a good financial standing. The organization has been streamlined and now is able to operate quickly. NPE is the big event for SPI.

5. NEXT-GENERATION ADVISORY BOARD

Ashley from Next Generation Advisory Board (NGAB) gave an update on the strategy and activities. The purpose of the advisory board is to attract and add value to young members. NGAB plan to introduce a new event each year for next-generation members (The Race, The Next Generation Night, Mission Possible Gift Certificates, Speed Interviews, Plastics 101, and SAC Support). Mission Possible is a professional workshop that fosters open discussion and collaboration that leads to creative out-of-the-box solutions to the traditional ways SPE does things. The NGAB needs money to fund these activities. SPE Detroit Section donated $8,000 to NGAB. Gomez urges each division and section to make a donation to the NGAB.

6. DIVISION COMMITTEE UPDATE

Recommended candidates for vice president were discussed. Request for a Reaction Injection Molding Special Interest Group (SIG) was made.

7. STUDENT ACTIVITIES COMMITTEE FOR ANTEC 2015

The SPE Automotive Division was recognized for its Bronze Sponsorship for student activities at the 2014 ANTEC. A letter seeking donations for student activities at ANTEC will be sent out earlier next year.

8. BYLAWS AND POLICIES

Paul Anderson presented several bylaws. Bylaw 7.4.6 amendments were read and discussed and passed. Bylaw 14.7.10 passed. Bylaw 17 passed on how to change a bylaw, which will allow quicker response to changes. Policy 9 on logos was revised to allow EC to make changes to the logo. A number of bylaws were read for the first time. Members of the Society are encouraged to read them over and discuss them with their councilor. They will have a second reading and vote at ANTEC. Detailed copies of the motions were attached. First reading for Bylaws 4.4.1 and 4.4.2 to allow student members to vote. First reading for bylaws 7.7.3 & 7.7.4 regarding eligibility for nomination. 8.1.2 & 8.1.3 is what is a councilor for section and division. Bylaws 8.2.1 changed to allow that a councilor's term of service can be 3 consecutive terms (9 years) and then the councilor needs to wait 3 years before becoming councilor again. Members should read the proposed bylaws. Councilors should take them back to their divisions and provide feedback to Anderson.

9. OTHER OLD/NEW BUSINESS

New business: HQ was asked that a list of the value of SPE membership be created for members. There was a discussion about HQ getting the information out to the councilors earlier with the idea of the councilors having more time to review and consider the information.

10. ADJOURNMENT

Boolani requested a motion to adjourn the meeting. A motion was made, seconded, and passed. The meeting adjourned. Next council meeting will be held at ANTEC / NPE in Orlando, Florida, U.S.A.

ANTEC® REPORT

Anthony Gasbarro, Technical Program Chair
Automotive Session, ANTEC® 2015

Hello Everyone,

I'm so glad you're taking a minute to read this today.

As a reminder, SPE's Annual Technical Conference, ANTEC® 2015 will be co-located with the NPE® 2015 next year in Orlando, Florida, U.S.A. Held every three years, the National Plastics Exposition (NPE) is organized by the Society of the Plastics Industry (SPI®) and is North America's largest plastics trade show and conference. The five-day event is specifically dedicated to bringing together all sectors of the plastics supply chain to include end markets and brand owners. It will be held from March 23–27, 2015. If you haven't done so already, I'd strongly suggest you start booking your hotel arrangements now. Things start to get really expensive as we get closer to the show next March.

I'm happy to say that we have finalized our time for the Automotive Session of ANTEC 2015. It will be held on Wednesday March, 25 starting at 1:00 pm. We currently have six papers scheduled to be presented, and all are exciting and relevant to our industry. The topics include:

- Low Gloss PC/ASA Blends
- Innovative Material Concepts for Battery Supports
- Advanced Simulation for Chopped Fiber Reinforced Plastic Components
- Bio Composites and Bio Blends based on Engineering Thermoplastics for Automotive Applications
- Overview of Failure Modes in Automotive Plastic Components
- Effect of Thin Walling and Foaming on TPO Part Performance

More detailed information (such as room location) will be released as ANTEC gets closer. We will also have an Automotive Division business meeting following our session that is sure to excite everyone.

With all of this success, I could still use your help. We have a spot available for an opening presentation that could serve as a plenary speech. This could be a 30-60 minute presentation on any topic relevant to automotive plastics. We have had presentations in the past from consultants to the industry who gave really good overviews of new technologies in our area of interest. Perhaps this year is your year? And speakers attend the entire day they speak for free. If you feel so moved, please let me know and we can start to put something together. It isn't too late!

That's all for now. Please come and visit us at ANTEC 2015 as we would love to see all of you.

Thank you.

Anthony Gasbarro

Anthony Gasbarro
Business Development and Engineering Manager
Marubeni Specialty Chemicals
Phone: +1.248.721.0276
gasbarro-a@marubeni-usa.com

Meet Your SPE Staff:
Pedro Matos

For the last seven years, Pedro Matos has provided web design support, and later web content management as well as ongoing general support both to members as well as other SPE staff. He's one of the people from SPE's world headquarters in Bethel, Connecticut, U.S.A. that you're likely to reach if you call by phone, so he's the first SPE staff member we'd like to introduce you to so members will better understand what he does and how he can help them as well as leadership of SPE divisions, sections, special interest groups (SIGs), and other teams.

Originally from the Dominican Republic, Matos' family moved to Connecticut when he was in fifth grade. His father was a professor of Financial Mathematics and is an electro-mechanical engineer, so Matos grew up comfortable with technology. And while he's never taken a course in plastics, he started his work at SPE with some knowledge of plastics processing thanks to avid interest in Discovery Channel specials on television when he was a teen.

He started out wanting to design video games, and got his start in high school when a teacher taught him how to build his first web page. He considers himself largely self taught, and received a degree in Web Design from a local community college. Interestingly, about six months after graduating, he received a call from a temp agency looking to hire someone with his background for a short-term assignment at what turned out to be SPE. He was hired permanently three months after starting his job.

Since then, Matos' work has changed a good deal as staffing in Connecticut has shrunk and those remaining have picked up more responsibilities to ensure members receive proper service. "In the beginning, I made the mistake of volunteering for things," he recalls.

When he started at SPE, the website was actively managed by the eServices department, but there was a hole on the technical side that needed to be filled, which is where where Matos came in. The site has changed systems three times since he began working there. The new system — launched earlier this year and for which he wrote the scope of work — is more sophisticated, so harder to manage, but now an outside information technology (IT) vendor handles "the heavy lifting." What Matos' focus is these days is content management and graphical work developed in close collaboration with and in support of other SPE staff, including SPE graphic designer, Kim Wakuluk. He helps update individual division/section micro-sites on the main SPE website. He also designs and builds templates for newsletters and eBlasts to help divisions, sections, and SIGs communicate with their members, plus handles communications coming from headquarters to the society at large. He also researches graphics for various SPE communications, and is the go-to source for data such as membership rosters and other types of research needed by other SPE staff and SPE leadership.

He's been very busy recently not only with the new website redesign and overhaul, and providing support for www.PlasticsEngineering.org, but also with supporting work on SPE's new networking tool, The Chain, which currently is in beta testing and hopefully will be rolled out to all members at the start of the new year. Matos also acts as "technical translator" and liaison between SPE and outside vendors providing various web-based modules and other services that have to be connected to the main website, such as the new registration system, or run in parallel like the mobile event app launched in 2013. Since he's not a programmer, he acknowledges that coordinating all these systems can be tough.

When he's not assisting other staff, answering phones, helping with customer service, replacing a broken mouse, or fixing an eMail account that's not working, Matos loves to draw. He also enjoys empowering people and teaching them how to resolve computer issues. Fortunately he's known for his ample reserve of patience. As he notes, "things that flip other people out just don't bother me."

To reach Pedro Matos, SPE web administrator, eMail: pmatos@4spe.org, or call +1.203.740.5438.

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Processing Methods of High Density Polyethylene-Exfoliated Graphene Nanoplatelet Nanocomposites for Automotive Fuel Tanks Applications

K. Honaker, F. Vautard, L.T. Drzal
Composite Materials and Structures Center, Michigan State University
L. Sui
Hyundai-Kia America Technical Center, Inc.

Abstract

Melt mixing followed by injection molding was used to manufacture high density polyethylene (HDPE) – exfoliated graphene nanoplatelet (GnP) nanocomposites. In order to further enhance the composite properties (mechanical and barrier), different processing techniques were explored including microlayer coextrusion and solution mixing with sonication followed by extrusion. Multiple modifications to the nanocomposite constituents were investigated, including cryo-milling of the HDPE pellets and coating of the platelets with a wax or polyolefin elastomer before extrusion processing. In each case, mechanical properties (Izod impact and flexural) and barrier properties (permeation to oxygen) were assessed to evaluate the relationships between morphology, processing and properties.

Results showed that through simple melt mixing of HDPE and GnP, there was a clear increase in stiffness, a decrease in Izod impact resistance, and a 50% decrease to both oxygen and fuel permeation with a 5 wt. % GnP composite. Microlayer coextrusion yielded a high alignment of the nanoplatelets in the direction of the flow and resulted in improved permeation resistance at low GnP concentration, but did not result in a further improvement of barrier properties at concentrations above 5 wt. %. Cryo-milling the HDPE pellets into a powder resulted in a minor decrease in mechanical properties and a 35% decrease in oxygen permeation. A wax coating on the platelets before melt extrusion resulted in an increase in Izod impact resistance, a decrease in flexural modulus and an increase in oxygen permeation. A polyolefin elastomeric coating of the GnP resulted in retaining the flexural properties and with a slight improvement to the Izod impact resistance and the barrier properties.

Keith Honaker was lead author (along with Frédéric Vautard and Lawrence T. Drzal, all three from the Composite Materials and Structures Center at Michigan State University as well as Lang Sui of the Hyundai-Kia America Technical Center, Inc.) on a paper entitled Processing Methods of High Density Polyethylene-Exfoliated Graphene Nanoplatelet Nanocomposites for Automotive Fuel Tank Applications. Honaker was one of three Dr. Jackie Rehkopf Best Paper Award winners for excellence in technical writing from the 2014 SPE ACCE — interestingly on a paper describing research partially underwritten by his 2013-2014 SPE ACCE scholarship award sponsored by the Michigan Economic Development Corp. About his topic, Honaker explains that the paper discusses high-density polyethylene (HDPE)–exfoliated graphene nanoplatelet composites, which were synthesized and tested to measure their mechanical and barrier properties. To overcome limitations of melt extrusion, multiple processing techniques were investigated, including microlayer co-extrusion and solution mixing with sonication. Additionally, multiple modifications to the nanocomposites constituents were investigated, including cryo-milling the HDPE pellets and coating the platelets with a wax or polyolefin elastomer before extrusion processing.

Honaker earned a B.S. degree in Chemical Engineering from Kettering University. During his studies there, a co-operative work experience at Argonne National Laboratory synthesizing polymer composites for fuel-cell bipolar plates and testing materials for their use in the cathode of lithium-ion batteries got him interested in composites. After graduating, Honaker moved to Michigan State University where he is currently a third-year doctoral student. For the past two years, his work has focused on enhancing properties of a polymer matrix with graphene nanoplatelets for automotive fuel tanks. Upon graduating with his doctorate, Honaker hopes to work in industry.

 CONTINUED FROM PAGE 35

I. Introduction

Lightweight composites with enhanced barrier properties offer a potential way to reduce the weight and increase the fuel efficiency of automotive vehicles when used for the manufacture of the fuel tank and line system. Currently polymer fuel tanks are made using a layered structure with a barrier polymer such as ethylene vinyl alcohol (EVOH) sandwiched between high density polyethylene (HDPE). It is necessary to have an EVOH layer because oxygen and fuel can easily permeate through HDPE, causing fuel loss. In adding Graphene nanoPlatelets (GnP) to the HDPE matrix, a tortuous path is created due to the large aspect ratio of the platelets as depicted in Figure 1. This idea has previously been studied with nanoclays and resulted in a significant decrease in the transmission of oxygen through the composite [1].

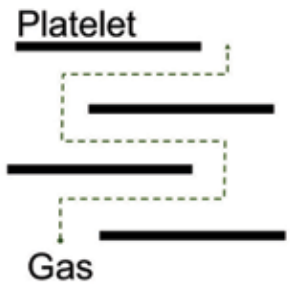

Figure 1. Tortuous path created by GnP in a polymer matrix.

Previous work has been completed on the addition of GnP to HDPE via simple melt extrusion and injection molding of composites, which resulted in a reduction in the oxygen transmission rate of up to 55% with a 7.5% wt. GnP composite, but a decrease of 50% in impact resistance [2]. In order to be viable for use in fuel tanks, the impact resistance loss needs to be recovered and the barrier properties further enhanced, leading to multiple process techniques being explored. An important factor for optimal barrier properties is the alignment of the platelets. A microlayer co-extrusion die offers a way to achieve ideal alignment in an extrusion process [3]. In this process, the die takes a stream of polymer and cuts it in half vertically, repositions the two ribbons into a vertical stack, then compresses the stack to the original thickness, creating a layered system. Each stage effectively doubles the number of layers in the system, as presented in Figure 2. Repetition of the process results in multiple layers, and should result in a high alignment of the GnP.

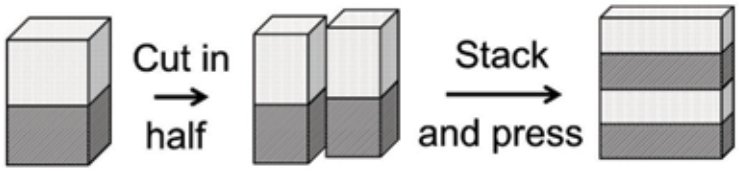

Figure 2. Microlayer co-extrusion process.

Another major factor for property enhancement is the dispersion of the platelets. It has been previously shown that coating the GnP in a low molecular weight wax improves the dispersion in a polyolefin matrix [4]. Alternatively, processing the HDPE and GnP through a solution based mixing stage could improve the dispersion. The large difference in the coefficient of thermal expansion between the GnP and HDPE could create voids during the cooling process, which may be eliminated by coating the GnP with an elastomer [5]. Coating the GnP with an elastomer could also help to recover a portion of the lost impact resistance when GnP is added to the matrix as the elastomer would help absorb energy and undergo plastic deformation.

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II. Materials and Methods

II.1 Materials

HDPE (grade K46-06-185) with a density of 0.946 $g.cm^{-3}$ was supplied by INEOS Olefins & Polymers USA in pellet form and used as received. Two grades of Graphene nanoplatelets (GnP) from XG Sciences (Lansing, MI, USA) were used – M-15 and M-25. Both grades have an average thickness of 6 nm and surface area of 120-150 $m^2.g^{-1}$, however their average diameters are 15 and 25 microns respectively. The platelets were heated at 450 ºC in air for one hour to remove any volatile compounds remaining after the manufacturing process. Two grades of wax were used to coat the platelets, a low molecular weight (500 $g.mol^{-1}$) paraffin wax provided by Sigma Aldrich and a higher molecular weight (800 $g.mol^{-1}$) wax (Sasolwax H1 by Sasol) more stable at higher temperatures. A polyolefin ethylene-octene copolymer elastomer (Engage 8200 provided by Dow Chemical) was also used as a coating.

II.2 Manufacturing Processes

Multiple manufacturing processes were used and compared. For melt extrusion a co-rotating, twin screw DSM Micro 15 cc extruder was used, with the melt temperature of the HDPE at 210 ºC. Materials were allowed to mix for 5 minutes at 6000 N of shear force (40-50 rpm) and then transferred to a micro-injector barrel with the temperature also set to 210 ºC. The melt was then injection molded into the desired mold, which was heated at a temperature of 110 ºC, with a pressure of 150 psi.

As a pre-processing step, solution mixing was investigated with the GnP dispersed in xylene via light sonication (20W) for 30 minutes, followed by the addition of HDPE pellets and heating the solution to boiling for 1 hour under reflux conditions with magnetic stirring. Upon cooling to room temperature, the composite precipitated out and then was dried under vacuum at 80 ºC overnight and then processed through the DSM. A second approach consisted of cryo-milling the HDPE pellets using liquid nitrogen and a Mikro-Bantam mill with a 0.02 inch filter. Ultrasonication of the HDPE powder and GnP was done in xylene to coat the HDPE particles with GnP, using a low power setting (20W) to avoid reduction in the platelet size.

A third pretreatment step investigated was coating the platelets. The coating material was dissolved in xylene and then GnP was dispersed using mild sonication (20W). This was repeated for the two olefin waxes and the polyolefin elastomer. The three resulting dispersions were then dried at 80 ºC overnight in a vacuum oven and then processed in the DSM microextruder at various concentrations with HDPE.

Large scale extrusion was performed using a Leistritz extruder with 25 mm co-rotating twin screws and a module multi-layer slit die provided by Premier Dies Corporation, which yields a 16 layer structure. The extruder and die were set to 200 ºC with a screw rotation speed of 20 rpm and yielding a melt pressure from 2000-2300 psi depending on the GnP concentration. Upon exiting the die, the extrudate was cooled with a 3-roll chill stack set to 100 ºC, and finally collected on a spool at a rate of 2 feet per minute.

II.3 Mechanical Testing

A UTS SFM-20 from United Calibration Corp was used to measure flexural properties according to ASTM standard D790. A 100 lb. load cell was used with a thickness to span ratio of 1/16. The crosshead speed was a constant 0.05 $inch.min^{-1}$. Izod impact resistance was measured following ASTM D256. A 1 lb. hammer was used with TMI impact equipment. Specimens were notched after injection molding and allowed to relax for 24 hours before testing.

II.4 Permeation of Oxygen

Thin films of the composite were made using a heated Carver Press. The press was heated to 210 ºC and materials were pressed between mirror-finished steel plates under vacuum with the use of a vacuum bag. For injection molded composites, two flexural samples were used to make the films. HDPE powder obtained by the cryo-milling and sonication was pressed directly. The samples obtained with the multi-layer slit die did not need to be pressed with the Carver press

as a film was directly produced. The films were tested with a Mocon OX-TRAN 2/20 ML to determine the oxygen transmission rate through the sample. The reported rate was then normalized to the thickness of the sample, which was measured with calipers before testing.

II.5 Morphology of composites with Scanning Electron Microscopy

The structure of the composites, coating of the HDPE powder and coating of the GnP were characterized by Scanning Electron Microscopy (SEM) with a Zeiss EVO LS25 microscope under high vacuum using secondary electron mode. A 3 nm layer of tungsten was deposited on the surface using a Leica EM MED020 sputter coater to eliminate sample charging.

 CONTINUED FROM PAGE 37

III. Results and Discussion

III.1 Microlayer Co-extrusion Composites

In previous work the baseline for melt extrusion mixing of HDPE and GnP was investigated [2]. While enhanced barrier properties were achieved, further improvement is necessary for the use of a HDPE-GnP composite in fuel tanks and fuel lines. Since it was previously established that the oxygen and fuel transmission rates follow a similar pattern, fuel permeation testing was omitted to save time [2]. One problem in the HDPE-GnP composites is the lack of perfect alignment of the platelets. When using a microlayer co-extrusion process, the alignment of the platelets would theoretically be ideal. Films of 0, 2, 5, 10 and 15 weight percent GnP-M-25 were produced. Figure 3 shows the comparison in morphology for a film compressed from a thicker specimen to a desired thickness compared to a microlayer co-extrusion film. In the compressed film, there is noticeable misalignment of the GnP with respect to the flow direction. In the microlayer co-extrusion film, there is a very high degree of alignment of the GnP, exactly as theorized. Figure 4 shows a comparison of the oxygen transmission rates corresponding to pressed films made with DSM specimens and the films made with microlayer co-extrusion. When using the multilayer die, an increase in the transmission rate for the neat polymer was noticed, probably because of a difference in crystallinity. However the relative improvement of the barrier properties at a weight concentration of 2% was much better. As the weight content of GnP increased, both processes led to similar values of the transmission rate. This suggests that at low concentrations, the alignment of the GnP is very important. However, the enhancement of the barrier properties at high concentrations is still limited by the quality of dispersion, which is a common problem for many carbon based nanoparticles [6].

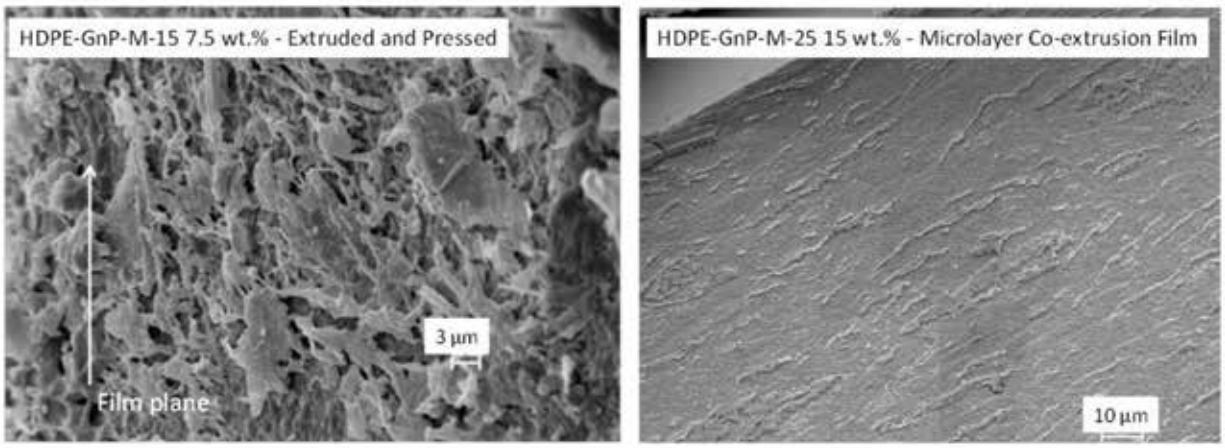

Figure 3. Comparison of the morphology between films made using microlayer co-extrusion film and a Carver press film from injection molded samples.

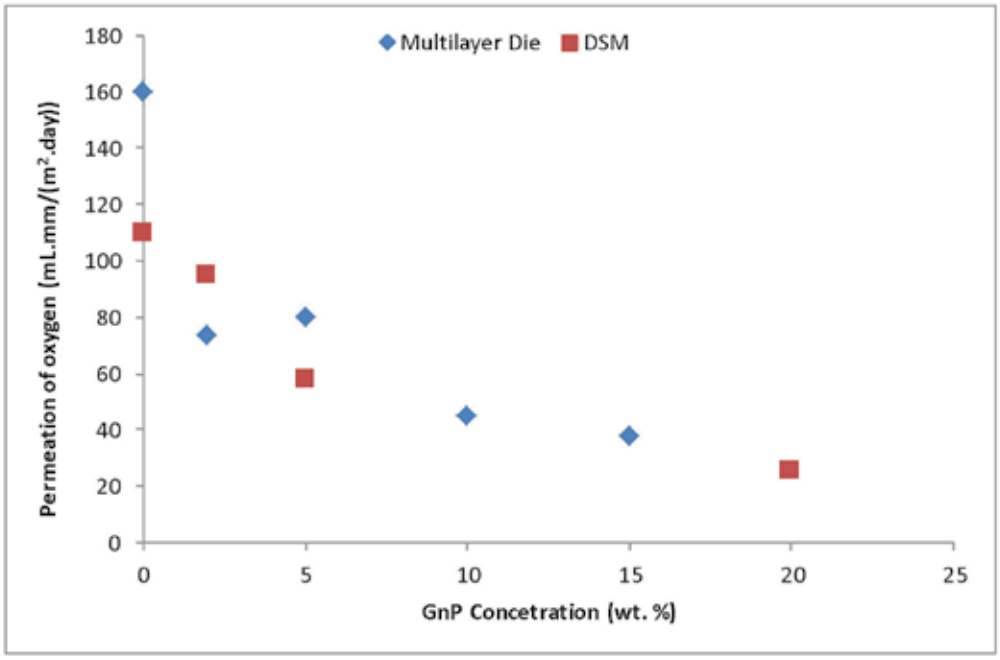

Figure 4. Comparison of the oxygen transmission rates corresponding to films made with the microlayer co-extrusion process and the DSM melt extrusion process.

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III.2 Solution dispersions of HDPE and GnP-M-15 in xylene

In order to explore better dispersion of the GnP in the HDPE, a solution dispersion approach was investigated. Since boiling xylene dissolves HDPE well, addition of the GnP to this solution may yield a better dispersion. Concentrations of 2, 5, and 10 weight percent of GnP-M-15 in HDPE were made with this method. Once the dispersion was dried to remove all of the xylene, it was processed though the DSM for the production of flexural and impact specimens. Two films were produced, one via compressing two flexural samples in the Carver press and one through compression molding of the material obtained by solution dispersion with no further processing. Figure 5 shows the mechanical properties of the solution dispersion (red) along with the previously established regular melt mixing values (blue). The flexural properties remained similar for all concentrations for both modulus and strength. At a weight content of 10% GnP, a slight improvement in the modulus was observed. There is an improvement in the impact resistance ranging from 11% to 24% depending on concentrations, suggesting that there may be a slight improvement in the overall GnP dispersion throughout the matrix. The results corresponding to oxygen transmission can be seen in Figure 6. When processed through the DSM, the solution dispersion yields similar results as the melt mixing in terms of oxygen transmission rate. However, as shown with the 7.5% wt. GnP data, if the solution dispersion is compression molded directly after drying, there is a 40% reduction in the oxygen transmission rate compared to DSM mixing. When the material is reprocessed through the DSM, the major advantages of the solution mixing are lost due to misalignment, agglomeration and size reduction of the platelets.

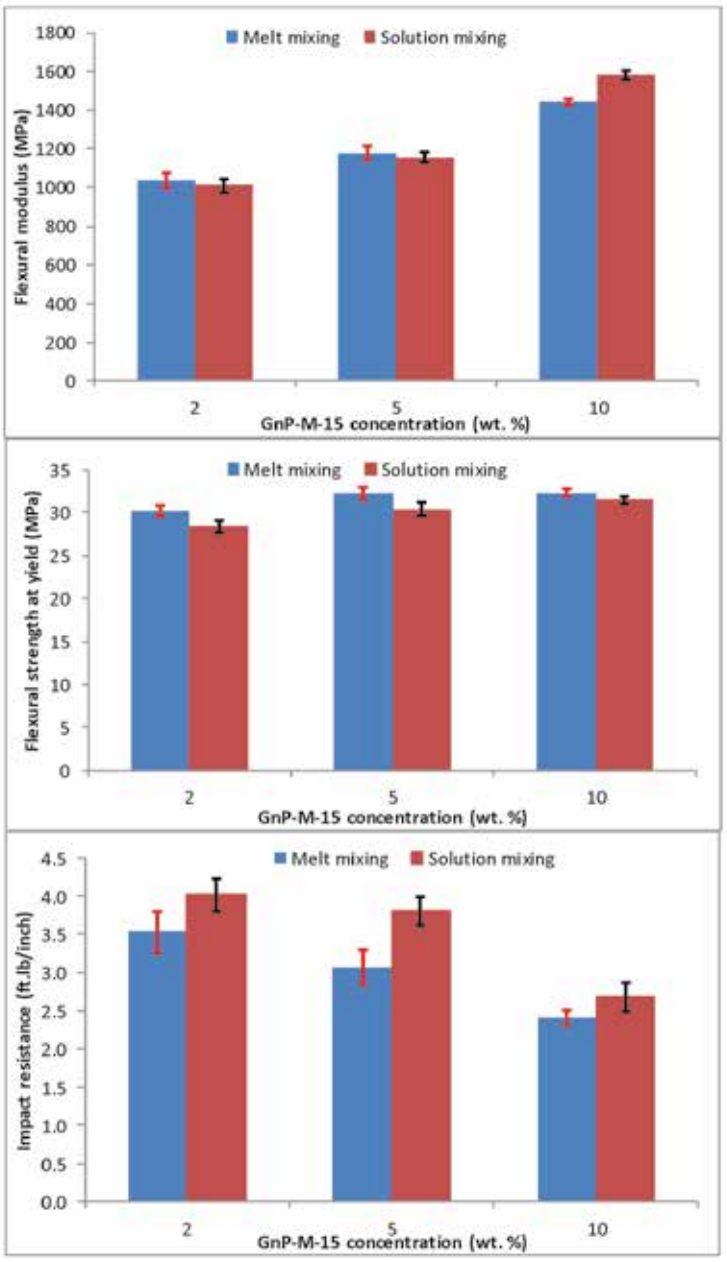

Figure 5. Mechanical properties HDPE-GnP-M-15 composites: solution dispersion versus melt mixing

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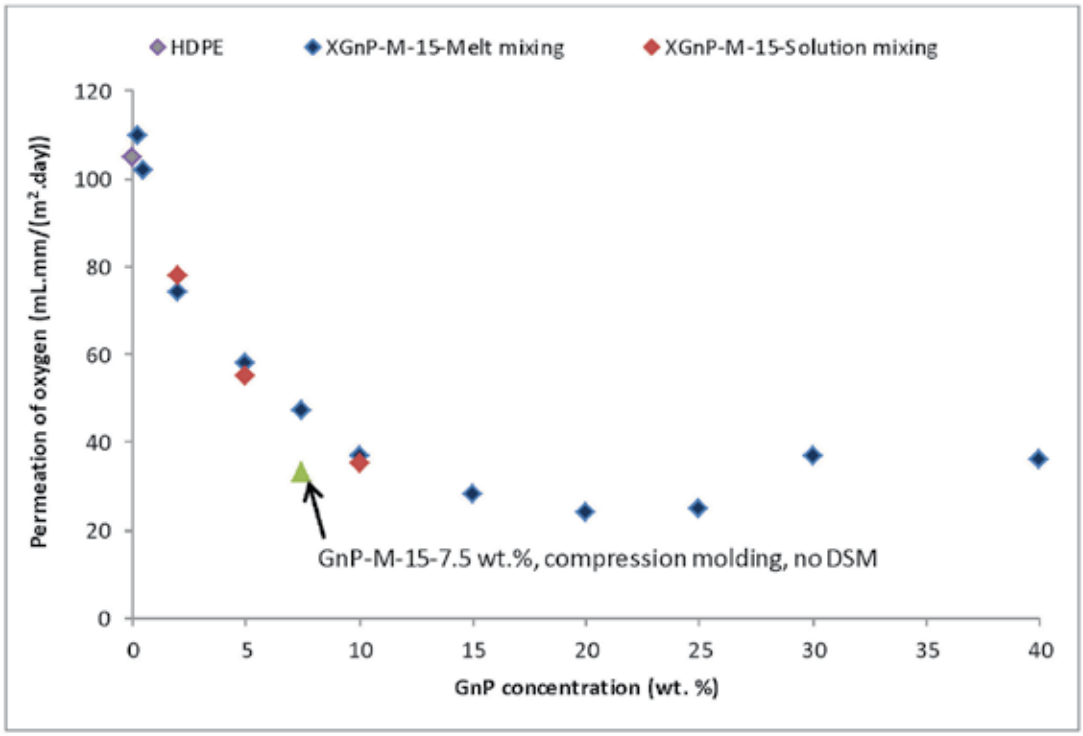

Figure 6. Oxygen transmission rates of through HDPE-GnP-M-15 composites: solution dispersion versusmelt mixing.

III.3 Cryo-milled HDPE-GnP-M-15 composites

In order to improve the platelets dispersion and consequently the barrier properties of the composite, a cryo-milled HDPE was used instead of its pellet form. Two different processing techniques were employed. Melt extrusion was done with the powder to make flexural and impact specimens, and the Carver press was used to compress a film from two flexural specimens. Additionally, sonication of the HDPE powder and GnP in xylene was investigated, and a compression molded film was made from the dried powder. The comparison of the flexural properties obtained with the melt mixing using HDPE powder (red) or pellet (green) form is displayed in Figure 7. Compared to a use of HDPE in the pellet form, there was a decrease of the flexural modulus and strength; however it was still higher than the neat pellet resin. There is a negligible difference in the IZOD impact resistance between the powder and the pellet form of HDPE. In terms of the barrier properties, sonication and compression molding of HDPE powder and GnP-M-15 yielded the same results as compressing a film from injection molded flexural samples. Both ways of processing the HDPE powder yielded a 35% reduction in the oxygen transmission rate through the composite when compared to the melt extrusion of the HDPE pellet composites, as shown in Figure 8, and a 65% reduction compared to the neat resin. Little additional improvement was found with the sonication process due to lack of uniformity in the GnP coverage on the powder particles and agglomerations of the platelets were still detected, as seen in the SEM images of Figure 9. Methods for overcoming these problems are currently being investigated.

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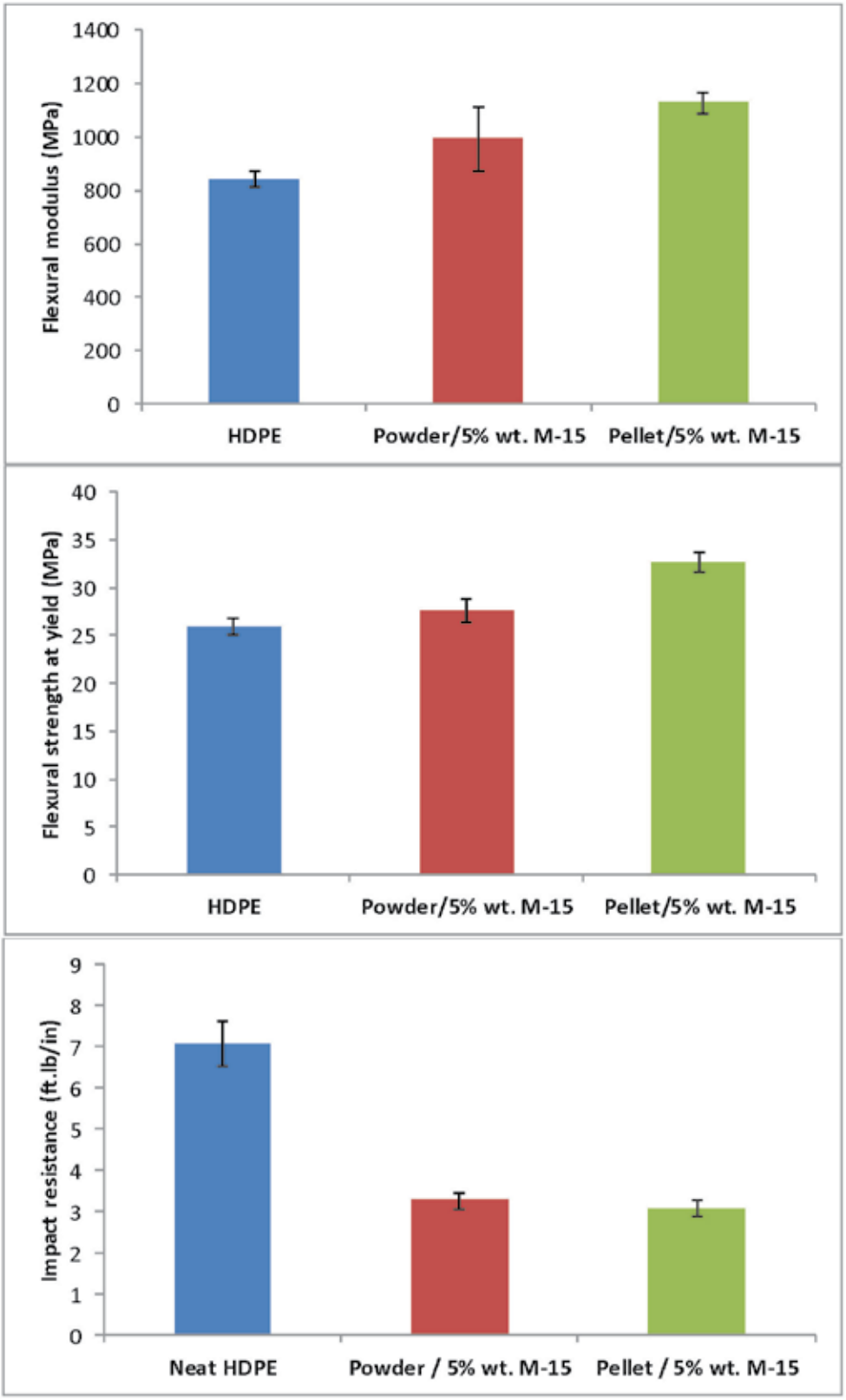

Figure 7. Mechanical properties of the melt extrusion of 5% wt. GnP -HDPE powder versus GnP -HDPE pellets.

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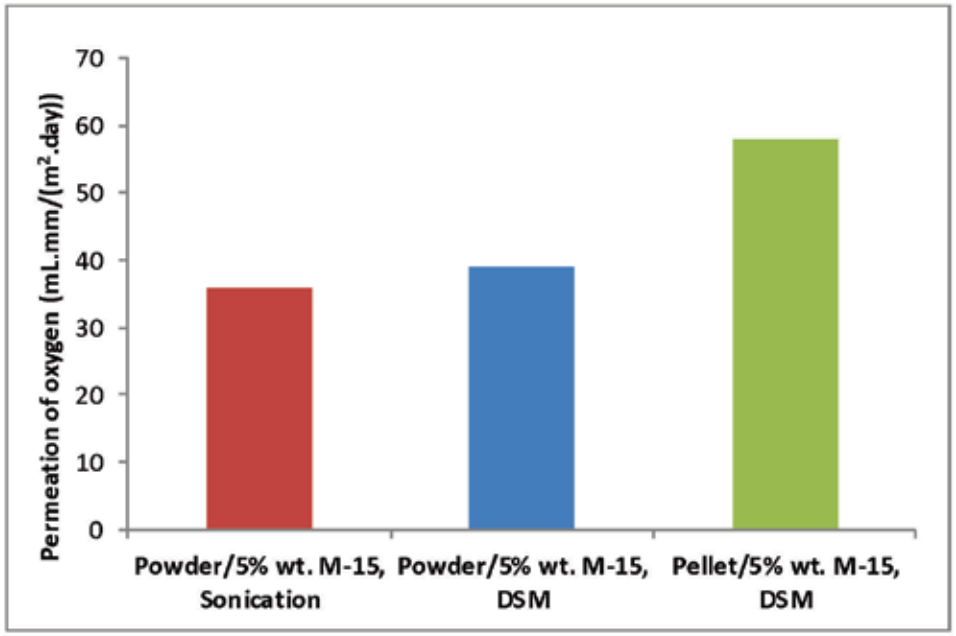

Figure 8. Barrier properties of the sonication and melt extrusion of 5% wt. GnP and HDPE powder composites compared to GnP and HDPE pellet composite.

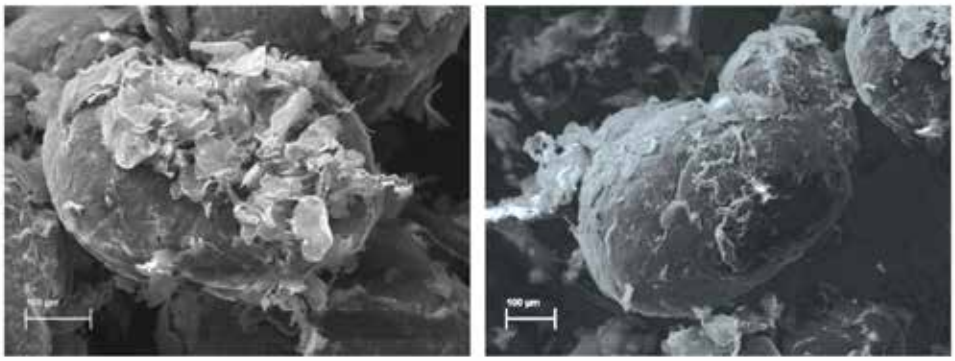

Figure 9. SEM images of HDPE powder coated with GnP-M-15 after sonication in xylene and drying.

III.4 Wax coating the GnP

It has previously been shown that a wax coating can increase the dispersion of carbon nanoparticles in a polymer matrix due to the better interaction between the wax and matrix, and similar results should be expected [4]. Two waxes compatible with HDPE were used: a paraffin wax produced by Sigma Aldrich and a low molecular weight polyethylene wax produced by Sasol that is more stable at the melt mixing processing temperature. The ratio of GnP to was was 80:20. After drying, the coated GnP platelets were processed with HDPE pellets using the same DSM procedures. The resulting mechanical properties are shown in Figure 11. A significant decrease of up to 26% in flexural strength and 37% in modulus were observed for 5% weight paraffin coated GnP samples relative to the unmodified GnP. The Sasol wax also yielded

a decrease, but was better than the paraffin wax with only a 15% decrease in flexural strength and 19% decrease in flexural modulus. However, a noticeable increase in impact resistance of up to 26% was measured for both waxes. The decrease in flexural properties may be due to the wax coating reducing the reinforcing effect of the GnP. The load transfer from the HDPE matrix to the GnP may not be as effective. On the contrary, the presence of the wax allows for some plastic deformation under the high speed loading during impact testing. This can be seen in SEM images of the impact fracture surfaces presented in Figure 10. The "cell structure" existing in the HDPE – GnP composite that was previously reported and is re-presented in part d was still present in parts a-c, but there was noticeable plastic deformation as well, revealed by the elongated filaments of matrix protruding from the surface. This explains the increase in impact resistance. Figure 12 shows that there is minimal effect on the barrier properties with the Sasol wax. An increase of the transmission rate of up to 45% was even obtained with the low molecular weight paraffin wax. While the wax coating helped

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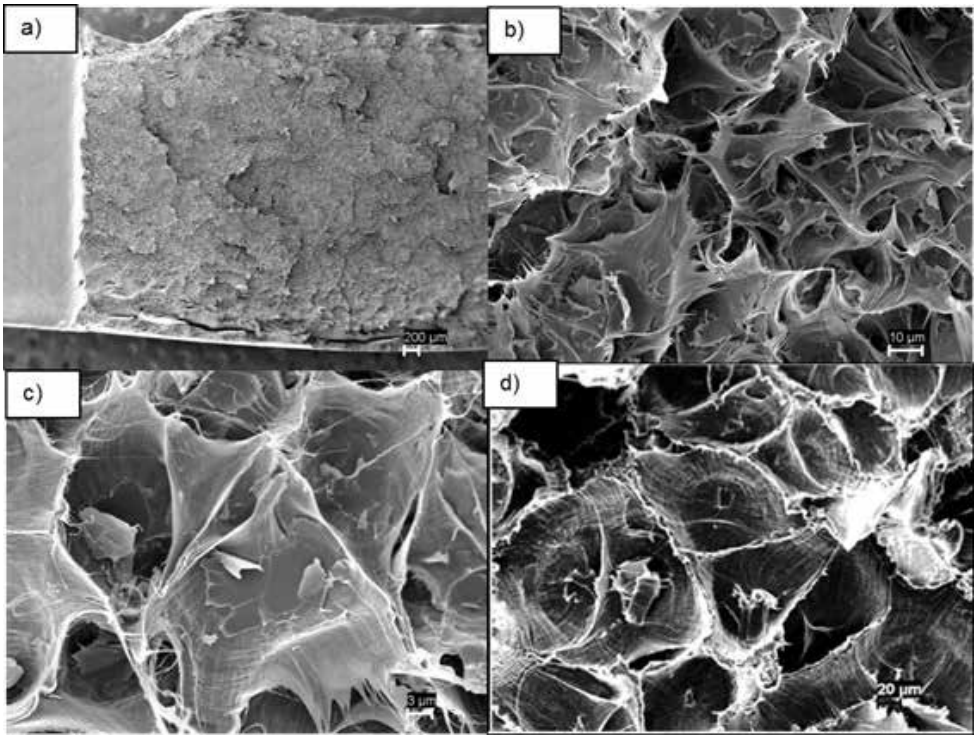

Figure 10. SEM images of the fracture surface after Izod impact test a) overview of 5% wt. Sasol wax coated GnP- HDPE, b) highermagnification of same composite, c)"cell" structure and plastic deformation of compostite, and d) 5% wt. unmodified GnP-HDPE composite.

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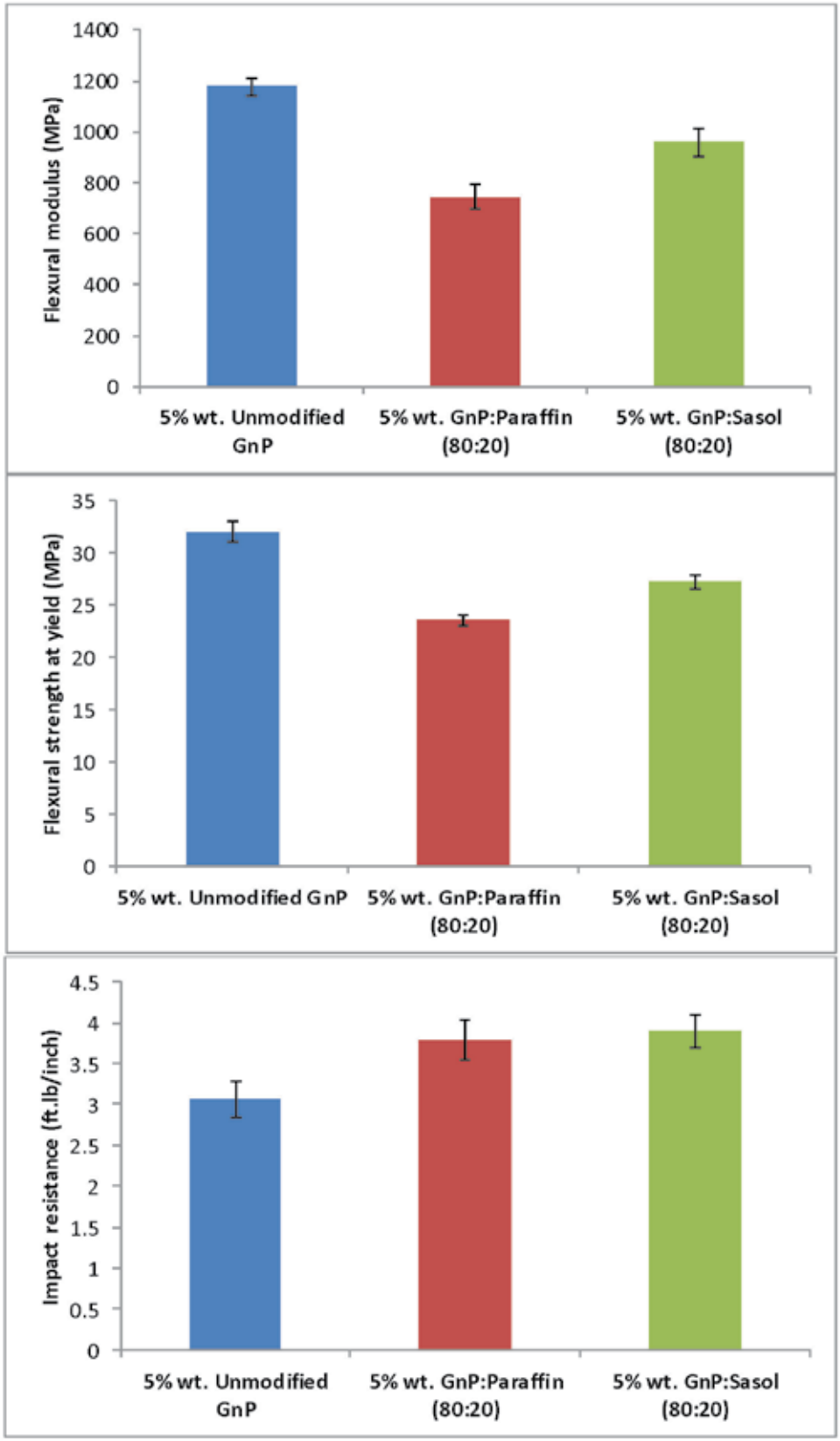

Figure 11. Mechanical properties of the 5% wt. wax coated GnP – HDPE composites.

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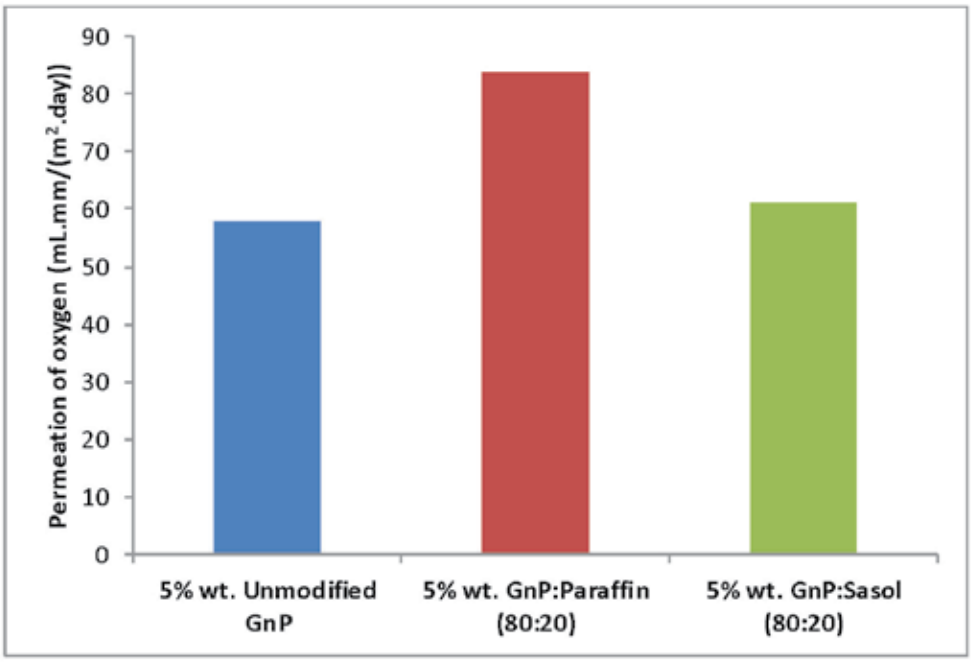

Figure 12. Barrier properties of the 5% wt. wax coated GnP-M-15 and HDPE composites.

III.5 Elastomer coating the GnP

Elastomer coating of GnP was investigated as a potential way to overcome the difference in the coefficient of thermal expansion between the GnP and HDPE, as well as a possible route to improving impact resistance when GnP is added to the HDPE matrix. Produced in a similar way to the wax coated GnP-HDPE composite sample, the elastomer (Engage 8200 from Dow Chemical) was deposited as the surface of the GnP particles by sonication in xylene at a ratio of 1:1 and then dried. The corresponding mechanical properties are shown in Figure 13. A decrease relative to the unmodified platelets was observed regarding the flexural properties. However, the values were still equivalent to those of the neat HDPE. The impact resistance was positively influenced by the elastomeric coating, yielding a 13% increase at a loading of 2% wt. elastomer coated GnP and a 34% increase at a 5% wt. loading. The reason for this increase is the increased amount of plastic deformation present when a higher amount of elastomer is used, which can clearly be seen in Figure 14. The "cell structure" with a platelet present at the center of each cell is visible, and the extensive plastic deformation resulting from the addition of the elastomer is clearly seen, especially compared to part d of Figure 11. As shown in Figure 15, the barrier properties are slightly improved compared to the unmodified GnP nanocomposites, but were not as improved as cryo-milled composites or compressed solution dispersion material, suggesting that the dispersion is only marginally improved with the polyolefin elastomer coating.

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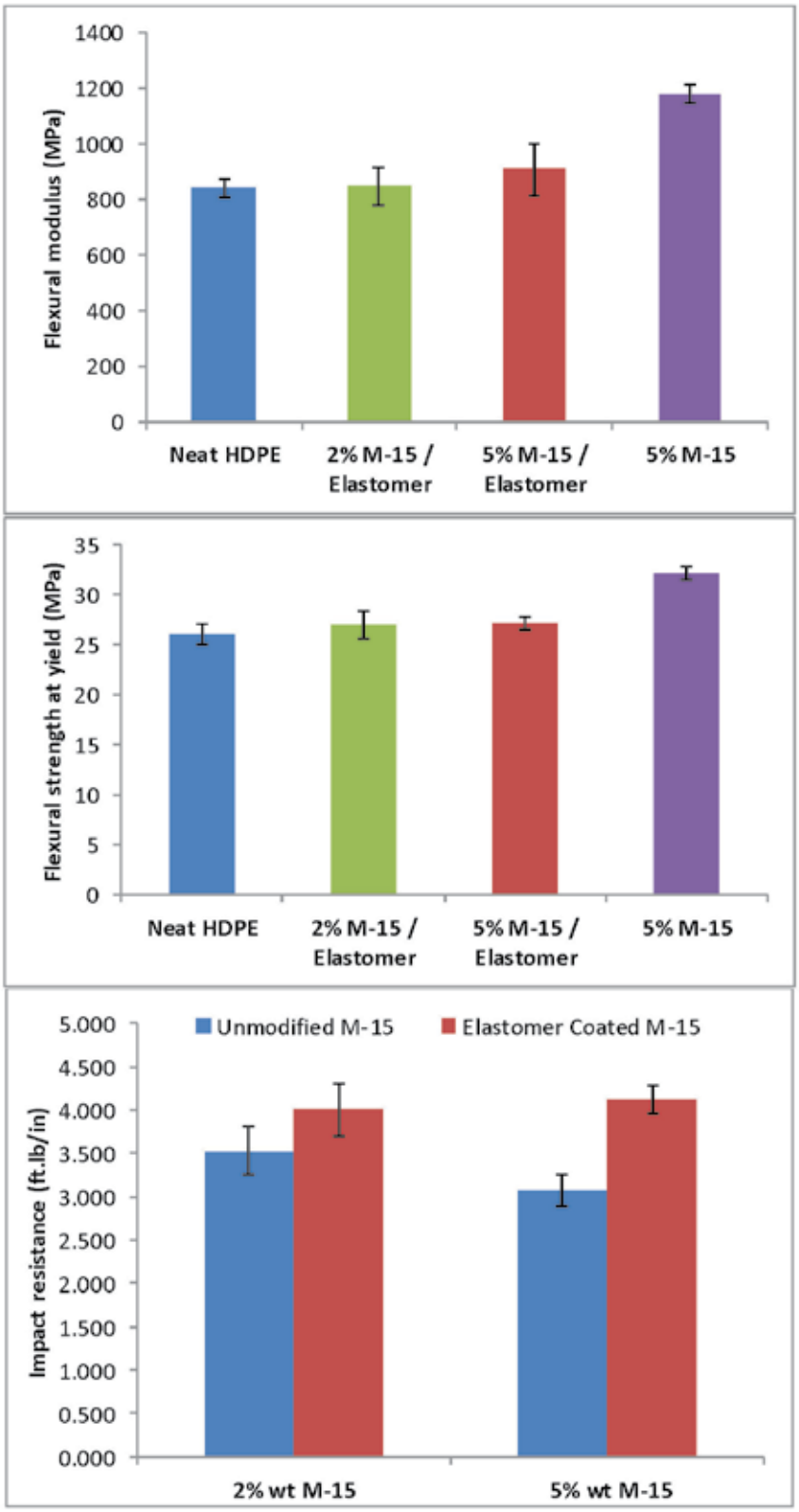

Figure 13. Mechanical properties of the elastomer coated GnP-M-15 and HDPE composites. Note: the weight percent mean there is equal parts GnP and elastomer. i.e. 5% GnP, 5% elastomer, and 90% HDPE.

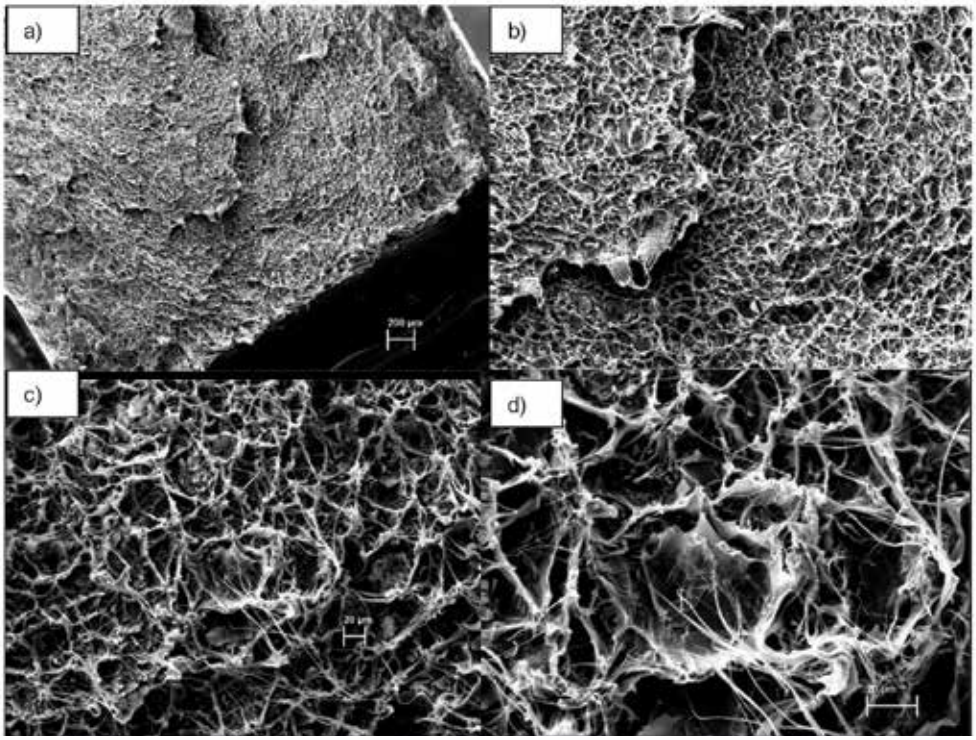

Figure 14. SEM images of the fracture surface after Izod impact test a) overview of 5% wt. elastomer coated GnP in HDPE, b) higher magnification of same composite, c) and d) "cell" structure and plastic deformation of composite.

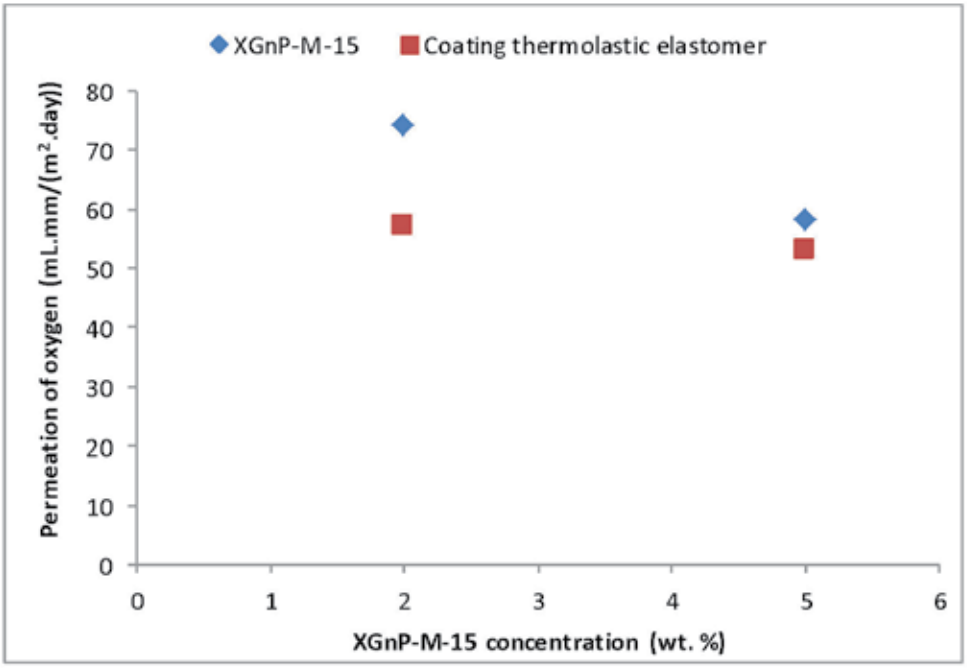

Figure 15. Barrier properties of the elastomer coated GnP in HDPE.

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IV. Conclusions

This study aimed at improving the barrier properties of HDPE-GnP nanocomposites, obtained by melt mixing and injection molding, by using alternative manufacturing processes and engineering the surface of the GnP particles. Additionally, the influence of such changes on the mechanical properties was examined as well. While each method yielded positive results, there were drawbacks associated with each. With a microlayer co-extrusion process, a high alignment of platelets was achieved and a significant increase in barrier properties at low GnP concentrations was measured, but as the GnP content increased, the same level of barrier properties was approached regardless of the processing method. This was attributed to agglomeration issues. When using the solution mixing process, the flexural properties were identical to melt mixing, but the Izod impact resistance was improved. If the dried solution mixture of HDPE/GnP is pressed into a film, a significant decrease in the oxygen transmission rate is obtained. However, once processed through the DSM, the benefits generated by the solution processing were nullified. Cryo-milling the HDPE into a fine powder resulted in an increase in barrier properties, had a negligible effect on impact resistance and decreased flexural properties. A wax coating on the GnP before melt processing with HDPE resulted in an improved impact resistance, but a negative impact on the barrier and flexural properties. An elastomeric coating of the platelets also yielded improved impact resistance and a marginal improvement in barrier properties, but a decrease in flexural properties. Overall, obtaining outstanding barrier properties without affecting the mechanical properties of HDPE-GnP nanocomposites using melt mixing extrusion and injection molding processes is very challenging. Current research is focused into combing a few of these methods to create synergistic effects.

V. Acknowledgements

The authors would like to thank INEOS Olefins & Polymers USA and XG Sciences for supplying the HDPE and GnP used in this research. Additional thanks goes to Per Askeland, Mike Rich, Edward Drown and Brian Rook from the Composite Materials and Structure Center at Michigan State University for their expertise and assistance.

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4. X. Jiang and L. T. Drzal, Improving electrical conductivity and mechanical properties of high density polyethylene through incorporation of paraffin wax coated exfoliated graphene nanoplatelets and multi-wall carbon nano-tubes," *Composites Part A: Applied Science and Manufacturing*, 2011, **42**, p. 1840-1849.
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SECRETARY'S REPORT

SPE Automotive Division Board
Sept. 29, 2014 Minutes

Next BOD Meeting: Monday Dec. 8, 2014

ATTENDEES

Teri Chouinard
Norm Kakarala
Peggy Malnati
Al Murray
Kevin Pageau
Tom Pickett
Monica Prokopyshen
Nippani Rao
Suresh Shah
Ron Price
Ed Luibrand
Peter Bejin
Steven VanLoozen
Dawn Stephens

Meeting was held at ACC in Troy, Mich., from 5:30 p.m. – 7:25 p.m.

EDUCATION – Monica Prokopyshen

An InDesign pamphlet containing "Service through Science" and "An Engineer's Life" articles will be developed for educational outreach purposes. Completion is scheduled for the 2015 Explorathon® workshops.

SOCIAL MEETING – Teri Chouinard

The next social event is planned for Tuesday, Dec. 9, 2014.

MEMBERSHIP – Steven VanLoozen

Twenty new membership applications have been processed: ten from Fiat Chrysler, five from Hyundai-Kia, and five from General Motors. Steve will send a welcome note with upcoming events to the new members

TREASURER'S REPORT – Dawn Stephens

Account balances as at Sept. 28, 2014, for the accounting period beginning July 1, 2014 are:

Checking:	$ 119,327.94
Savings:	$ 27,426.15
Total:	$146,747.09 USD

COUNCILOR'S REPORT – Tom Pickett

Details on the September Councilor's meeting were reported. SPE leaders see value in membership, but many non-leaders do not renew. The councilors broke into groups to discuss declining membership and value propositions (top benefits, ones to be added, ones to be improved) and the fee structure. Most groups were okay with a small increase in membership fees, but limited e-memberships as an alternative to full memberships were also discussed. The group also discussed how to attract and retain young professionals and next-generation members.

Divisions and sections can purchase a micro-site for $5,000 with $500 / year maintenance fees *(much costlier than SPE AD's system)*. ANTEC papers since 1980 have been entered in the system.

The bylaws will be forwarded to the board for review. For a detailed copy of the Sept. SPE councilor's meeting, please read the Councilor's Report elsewhere in this newsletter.

ANTEC – Tom Pickett

The division's Student Activity Committee donation was recognized at the Sept. 13-14th councilor's meeting.

MARCOM – Peggy Malnati

ACCE: Sept. 9-11, 2014. HQ handled the registration. There were some technical issues that affected registration. The conference had attendance of 840, the largest exhibition and program guide (90 pages) to date, and the second largest technical program to date. Fred Deans will become the 2015 ACCE event chair.

IAG: Nov. 12, 2014. Three press releases have been distributed. The Hall of Fame release is out for external approvals.

SPE AD Online: Web traffic for July, Aug., and Sept. was down year over year at 45,682, 42,455, and 39,725 unique visits. August 2013 had the highest volume on record (55,163) and July had the second highest recorded volume to date. The division doesn't pay for position.

Automotive Plastics News: The Dec. 2014 issue features the awards gala.

SPONSORSHIP – Teri Chouinard

There are 9 newsletter sponsorships totaling $32,700.

NEW BUSINESS/OTHER

A subcommittee was formed to work on the Jackie Rehkopf scholarship endowment fund.

Next meetings: Monday, Dec. 8, 2014, Feb. 9 2015, and April 13, 2015.

SOCIAL REPORT

Teri Chouinard,
SPE Automotive Div. Social Chair

Holiday Mixer for New Members

The next SPE Automotive Division social event will be a Holiday Mixer to welcome new members. It will be held at Ruth's Chris Steak House in Troy, Michigan in the Detroit suburbs just west of I-75 on Big Beaver Road on Tuesday, December 9, 2014 from 4:30–6:30 p.m. New members from local automakers, General Motors Co., Fiat Chrysler Automobiles, Hyundai America Technical Center, Inc., Ford Motor Co., Nissan Technical Center North America, and Toyota Technical Center are invited to meet the board of directors and current members. Happy-hour beverages and entrees will be served. This will be a great time, so please come network and enjoy the holiday season with old and new friends from SPE. Please register soon via http://spead-social.com/ if you are interested in attending as space is limited.

2014 SPE Automotive Division Golf Outing Recap

The 20th-annual SPE Automotive Division Golf Outing that was held on September 8th was a huge success. Just over 100 fun-loving automotive professionals (25 foursomes and a twosome) enjoyed beautiful weather and the great golf course and amenities at Fieldstone Golf Club in Auburn Hills, Michigan. "This is the social event of the year," explains Fred Deans of Allied Composites Technology LLC and who is affectionately known as *'SPE Automotive Division golf chair for life.'* "We always have a great time golfing and enjoying good company and fresh air." Proceeds from the golf outing are used to help SPE student sections. This event would not be possible without the support of our sponsors, including:

- Plastic Engineering & Technical Services, Inc. (PETS)
- Celanese
- BASF
- Addcomp North America, Inc.
- Böhler-Uddeholm Corp.
- Chromaflo Technologies
- A. Finkl & Sons Co.
- iD Additives, Inc.
- Plasan Carbon Composites
- PolyAd Services

Please mark your calendar for next year's golf outing, which is planned for Sept. 8, 2015 – the day before the SPE ACCE (Automotive Composites Conference & Exhibition).

2014 SPE ACCE Pre-Event Evening Cocktail Reception

Also on Sept. 8, 2014, we hosted an evening cocktail reception in the Fireside Lounge at the Hyatt Place Hotel (at the ACCE venue – the Diamond Center at the Suburban Collection Showplace in Novi, Michigan) to welcome ACCE attendees from out of town. Approximately 40 guests, including the SPE Composites Div. board of directors, relaxed with beverages and appetizers and enjoyed good company. "The timing was perfect as it gave our out-of-town attendees an opportunity to relax upon arrival and get a comfortable head start on networking," noted Dale Brosius, SPE Composites Division board member and ACCE 2015 co-chair. "We'll plan do this again next year and make it an annual social event to provide our SPE ACCE sponsors and attendees further value."

The purpose of the SPE Automotive Division Social Events is to nurture networking, have fun, and build membership. If you have an idea for a social event, which may include a tour of your facility or other educational and fun ideas that will interest our existing membership and draw new members, please email teri@intuitgroup.com or call +1.810.797.7242.

TREASURER'S REPORT

by Dawn Stephens

Current finances for the SPE Automotive Division remain healthy. As of November 17, 2014 we have $211,545.79 in checking, $27,427.98 in savings, and $12,450.86 in PayPal®, for a total of $251,424.63 USD.

MEMBERSHIP REPORT

Steve VanLoozen
SPE Automotive Div. Membership Chair

Our 2014 OEM membership drive

can be considered a success as we now have signed up over 20 new members from Ford Motor Co., Fiat Chrysler Automobiles, General Motors Co., and Hyundai–Kia. These new OEM members will help provide insight into where plastics will be required as the automotive industry moves into lighter vehicles to meet the requirements of new CAFE regulations and we look forward to them being key contributors to SPE going forward.

We would like to continue the growth of this program in 2015 and hope to sign up at least as many or more new OEM members in 2015. Our goal will be to gain members from some of the automakers not located in the Detroit area, and our membership team has already begun making progress toward this goal.

Our new OEM members will begin adding to our knowledge base through the "OEM Corner" column in our quarterly newsletter as well as more active participation in our annual conferences. We believe the insight that the car makers can contribute to SPE is of value to all of us in the supply chain and know they will recognize the value in making new contacts and seeing the value that the plastics industry can provide to their vehicles.

Kind Regards,

Steven VanLoozen

Steven VanLoozen
SPE Automotive Division Membership Chair

EDUCATION REPORT

by Monica Prokopyshen, SPE Automotive Division Education Chair

The 2014 SPE Automotive Innovation Awards Gala on November 12th had record student attendance and participation. Thirty-four students from Michigan schools, Ferris State University, Kettering University, and Schoolcraft College helped with pre- and post-event logistics, including set-up and tear-down of part displays, organization of trophies, assisting with registration, directing attendees, distributing boxes for floral gifts, and collecting surplus awards brochures. Midway through the 2-hour program these future automotive and plastics professionals were invited up on stage and introduced to the audience, which gave them a standing ovation. It is our pleasure to recognize these inspiring and enthusiastic students and their faculty supporters who combined a long day of study, travel, and volunteer work before, during, and after the event.

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Laura Myers
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Ryan Tracht

EDUCATION REPORT

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Automotive Division Hotline

ph: 248.244.8993, ext. 4 • web: http://SPEAutomotive.com • email: info@SPEAutomotive.com

Division Officers & Executive Committee

Steve VanLoozen, Chair
BASF
+1.734.552.2864

Yvonne Merritt, Immediate Past-Chair
Ford Motor Co.
+1.313.673.8776

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Ed Luibrand, Vice-Chair
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+1.248.512.0641

Dawn Stephens, Treasurer
SPE
+1.248.244.8993, ext. 4

Monica Prokopyshen, Secretary
Retired - Chrysler LLC
+1.248.608.6259

Tom Pickett, Division Councilor
General Motors Co.
+1.248.431.9724

Dr. Allan Murray, Director Emeritus
Allied Composite Technologies LLC
+1.248.814.8072

Nippani Rao, Director Emeritus
Asahi Kasei Plastics North America, Inc.
+1.248.444.1753

Committee Chairs

Anthony Gasbarro, ANTEC
Marubeni Specialty Chemicals, Inc.
+1.248.721.0276

Monica Prokopyshen, Education
Retired - Chrysler LLC
+1.248.608.6259

Steven VanLoozen, Membership
BASF
+1.734.552.2864

Jeff Helms, Awards Program
Celanese Corp.
+1.248.377.6895

Fred Deans, Golf Outing
Allied Composite Technologies LLC
+1.248.760.7717

Maheen Kahn, Intersociety
Lord Corp.
+1.586.864.4598

Teri Chouinard, Social, Sponsorship
Intuit Group, LLC
+1.810.797.7242

Peggy Malnati, Communications, Webmaster, Newsletter Editor
Malnati & Associates
+1.248.592.0765

Board of Directors

TO MAY 2015

Fred Deans +1.248.760.7717
Allied Composite Technologies LLC

Dr. Jay Raisoni +1.248.659.8232
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SABIC

Brian Grosser +1.248.941.9368
Samsung Chemical USA

Anthony Gasbarro +1.248.721.0276
Marubeni Specialty Chemicals, Inc.

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David Reed +1.734.674.0736
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Ron Price +1.248.563.6343
Global Polymer Solutions

Mike Whitens +1.313.805.5932
Ford Motor Co.

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Kevin Pageau +1.248.835.4999
Sonoco Protective Solutions

Dr. Suresh Shah +1.248.635.2482
SPE

Mark Lapain +1.248.567.5455
Magna International

Dr. Norm Kakarala +1.248,655.8483
Retired - Inteva Products, LLC

Ed Luibrand +1.248.512.0641
Fiat Chrysler Automobiles

Peggy Malnati +1.248.592.0765
Malnati & Associates