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

October 2011 - Volume 41, Issue 1

Innovation Awards Program 2011

The Automotive Division of the Society of Plastics Engineers announced the date, location, and theme for its 41st-annual Automotive Innovation Awards Gala, the oldest and largest recognition event in the automotive and plastics industries. This year's event will be held Wednesday, November 9, 2011 at Burton Manor in Livonia, Mich.

Jeffrey Helms, global automotive director, Ticona Engineering Polymers, who returns as the 2011 SPE Automotive Innovation Awards chair said, "This year's competition and gala theme is **Passion to Innovate**, which really captures the excitement that's in the air as the global automotive industry continues to recover from the 2008-2009 downturn. The level of innovation we've seen among nominations at the past few years' competition underscores how hard automakers and their suppliers are working to add function and value, improve aesthetics and durability, and reduce weight and cost on virtually every component throughout the vehicle. It's an exciting time to be in the automotive plastics industry and we're eagerly anticipating our review of this year's nominations for our 41st Automotive Innovation Awards Competition."

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. 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.

For more information about the SPE Automotive Innovation Awards Competition and Gala or to get information on attending, please visit the SPE Automotive Division website at **http://speautomotive.com/inno.**

Treasurers Report

Yvonne Bankowski

The SPE Automotive Division bank account balance is in very good standing with $186.1K in checking and $27.4K in savings for a total of $213.5K.

This past month, through a generous donation from PPG, 13 scholarships totaling $3000 were given out to students as part of the 2011 ACCE Student Poster Competition. The 2011 ACCE income and expenses are still being finalized.

www.speautomotive.com

Automotive Division Meeting Schedule and Special-Events Calendar

41st-Annual SPE Automotive Innovation Awards Program Burton Manor, Livonia, MI	November 9, 2011 5:30 pm
Automotive Division BOD Meeting—All invited ! American Chemistry Council, Troy, MI	January 30th, 2012
Automotive Division BOD Meeting—All invited ! American Chemistry Council, Troy, MI	April 2, 2012
AutoEPCON MSU Education Center Troy, MI	May 1, 2012
Automotive Division BOD Meeting—All invited ! American Chemistry Council, Troy, MI	June 18, 2012

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

Call Anthony Gasbarro at (248) 721.0276 for more information.

Chair's Message

Anthony Gasbarro

Well a good day to you! I hope this newsletter is finding you in good spirits and in good health.

We at the Automotive Division have been busy of late. We are putting the finishing touches on the Innovation Awards Gala (IAG) which is to be held at the Burton Manor in Livonia, MI on November 9th starting at 5:00pm. This event has really continued to grow and become a showcase for the latest technological innovations in the fields of Automotive Plastics. I encourage you to join us on the 9th. You are sure to be encouraged by the hard work of your peers and it is always a good place to see some old friends and to meet some new ones. There is usually around 600-700 people that come to the Gala, so put it on your calendar and come and join us! For more information, head to www.speautomotive.com/inno

The team working to prepare the IAG is led by Past Chair of the Automotive Division Jeffery Helms of Ticona Engineering Polymers. He has spent countless hours coordinating the efforts of folks like Peggy Malnati, Monica Propkyshen, Kevin Pageau, Mark Lapain, and many others. This group does a phenomenal job making this event a truly world class event.

It has been really wonderful to see all of the hard work that the automotive supply base has put into new technology that continues to save money, save weight, make things safer, add features and keep innovation alive in the automotive plastics world. The automakers have been doing well of late and I am convinced that the innovations we are seeing directly contribute to that success. The old adage of "If you keep doing what you have been doing, you will keep getting what you have been getting" is true – and the automakers with the help of all of us have changed what they have been doing, and it shows. I heard rumors that these things called profit-sharing checks have been spotted in S/E Michigan – is that true? What a glorious thing.

We have had a few new people join our Board of Directors which is encouraging. We are always looking for a few fresh faces – please consider coming to a Board of Directors meeting – they are always open to our members and are held at the American Chemistry Council offices on Crooks Rd. in Troy, Mi. We also have a call in number for people out of town – you could always join in that way. Shoot an email through our website (www.speautomotive.com) if you care to join in that way.

Our Automotive Division is quite healthy at this time – membership is slightly up, we have had great conferences and events – so keep up the great work, stay active and contribute when you can to our society. We are financially stable but continue to look for ways to increase revenue so that we may be able to give back to our community through efforts such as the Plastivan, Scholarships and awards for College Students participating in events.
I look forward to seeing more of you at our events and feel free to say hello to me personally at anthonygasbarro@yahoo.com if you have any questions or comments about our Division.
Thank you and make it a great day.

11TH-ANNUAL SPE® ACCE BREAKS ATTENDANCE RECORDS, SHOWCASES KEYNOTES HIGHLIGHTED TRENDS, OPPORTUNITIES FOR AUTOMOTIVE COMPOSITES

The eleventh-annual SPE Automotive Composites Conference & Exhibition (ACCE) broke its all-time attendance records last month at the MSU Management Education Center in Troy, Mich., on September 13-15, 2011. With the automotive industry beginning to rebuild from the 2008–2009 downturn, nine keynote speakers, two panel discussions, and 56 technical presentations highlighted important trends impacting composites for ground transportation and provided a picture of emerging opportunities for suppliers and OEMs.

Nine Keynotes Address Emerging Technologies, Lessons Learned

Tuesday morning, September 13, featured a keynote just before lunch on NTP's Cancer Assessment for Styrene — Science, Policy and Implications by John Schweitzer, senior director – Government Affairs of the American Composites Manufacturers Association, who discussed the implications of new U.S. legislation that impacts molders working with styrenic polymers.
After lunch on Tuesday afternoon, C. David Warren, manager, Transportation Materials Program, Oak Ridge National Laboratory, gave a talk on Lower-Cost Carbon Fiber in High Volumes for 21st-Century Industries – The Obstacles to Getting There, which included updates on new work that may help reduce the cost of carbon fiber precursors.

Late on Tuesday afternoon, Antony Dodworth, director of Dodworth Design, gave a talk on Stiffer is Better: Lessons Learned in Composites Design of Lightweight Automotive Structures. Dodworth has designed structural carbon composite components for numerous iconic supercars and race cars throughout his career.

On Wednesday afternoon, September 14, right after lunch, Mr. Patrice Sinthon, director-Sales & Marketing, JEC Group, spoke about Trends and Evolutions of the Global Composites Market: America, Europe, Asia. JEC, which has long organized the world's largest composites show in Paris and was a media sponsor of this year's ACCE show, will make its first foray into the North American market in November 2012 when it co-organizes a composites conference in Boston, Mass., with the Industrial Fabrics Association International (IFAI).

Next up on Wednesday afternoon, Chuck Kazmierski, program manager at Lucitel, a global management-consulting and market-research firm with expertise in the composites arena, spoke about Growth Opportunities in the Global Composites Market 2011–2016. The presentation covered composites' competitiveness vs. traditional materials, market trends driving change, plus growth opportunities and strategic insights.

11TH ANNUAL AUTOMOTIVE COMPOSITES CONFERENCE & EXHIBITION
World's Leading Automotive Composites Forum
SOCIETY OF PLASTICS ENGINEERS
AUTOMOTIVE & COMPOSITES DIVISIONS

Late Wednesday afternoon, Nathan Armstrong, president and director of Motive Industries, gave a keynote titled Return of the Small Car Maker. Motive, which has significant experience providing vehicle design, engineering, and prototyping for composite-bodied electric vehicles (EVs), announced last year that it will be producing prototypes of an all-Canadian-content, biocomposites-intensive EV named the Kestrel that is targeted for commercial introduction in 2012.

This talk was followed by one titled Winning with Composites in a World Seeking Sustainable Solutions, given by Ashish Diwanji, vice-president-Innovation for the Composites Solution Business of Owens Corning. Diwanji discussed how conversion of traditional materials to composite applications can enhance energy efficiency and productivity, reduce energy consumption and greenhouse gas emissions, and offer additional benefits such as durability, corrosion resistance, and added safety.

Thursday morning, September 15, David Lashmore, vice-president of R&D at Nanocomp Technologies, Inc., presented a talk on Carbon Nanotube Composites Fabricated From Multiwall Carbon Nanotube (MWCNT) Mat. Lashmore addressed the challenge of translating the

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Plastic Technology Books from SAE

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Engineered Tribological Composites
By Roy Cox

This book provides readers with a thorough presentation of the topic. From there, details about the processes of wear and the components of tribological systems are presented. Methods of manufacturing friction materials are described, and the elements of friction material are detailed—binders, fibers, abrasives, and lubricants.

e book available

Product Code R-401, Coming December 2011, List Price $89.95

Automotive Carbon Fiber Composites
By Jackie D. Rehkopf

This book provides a high-level summary on carbon reinforced fiber composites specific to the automotive industry today and its vision for the next 5 to 10 years. It is applicable for those involved in technical material strategy and research, plus those who need to understand the basics of this subject to support better business decisions.

e book available

Product Code T-124, Coming November 2011, List Price $100.00

Engineering Plastics and Plastic Composites in Automotive Applications
By Kalyan Sehanobish

Plastics have proven to be cost effective while providing automakers with the design freedom to accommodate safety, styling, and comfort. This publication focuses on some of the various types of plastics and plastic composites and their applications and advantages within passenger vehicles.

e book available

Product Code T-122, Published April 2009, List Price $199.00

Design of Durable, Repairable, and Maintainable Aircraft Composites

This guidebook will assist in the design and integration of composite commercial aircraft structures. The book identifies problems that have occurred with various composite components and provides potential problem-solving recommendations.

e book available

Product Code AE-27, Published August 1997, Sale Price $79.99

Plastics and the Environment
By Francis Gardiner, Eleanor Earnshaw

This book provides readers with a look into the environmental issues of plastics products throughout the complete product lifecycle, from material selection to product design to recycling. Written by some of the leading researchers and practitioners on this topic, it is a distinctive look at how to maximize profitability through environmental compliance in the plastics supply chain.

Product Code B-RAP-004, Published by Rapra Publishing, January 2010, List Price $165.00

Lightweighting in Automotive Design and Manufacturing

This first-edition report focuses on the drivers behind lightweighting including consumer behavior, government legislation and advances in technology. It explores how the different OEMs and their supply base are tackling lightweighting for the various product groups including chassis and suspension, body, powertrain, closures and interiors, etc.

e book available

Product Code MR-SB-089, Published by SupplierBusiness, May 2011, List Price $1,830.00

Plastics in Automotive Construction Report

The use of plastic system solutions has taken on an increasingly significant role in the automotive industry in the last few years. Used increasingly in the body and exterior, interior and trim, glazing and even under the hood, plastics offer forming and processing advantages, weight saving opportunities, economies as well as many other benefits.

e book available

Product Code MR-SB-028, Published by SupplierBusiness, May 2009, List Price $1,470.00

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11TH-ANNUAL ACCE

Continued from page 4

extraordinary properties of nanosize particles to macroscale products that are usable by industry, and discussed some solutions his company has developed to help make nanotubes more effective composite reinforcements.

The final keynote of the conference was presented by Mark Voss, lead composites engineer at General Motors Co. who gave an overview of GM's Lightweighting Strategy for Composites. According to Voss, the justification for future composites executions is evolving rapidly at GM. He mentioned initiatives at the automaker and discussed what is required from the supply community for future applications.

Panel Discussions Debate Role of Composites in EVs, Sustainability

The SPE ACCE is well known for its lively panel discussions and opportunities for audience members to participate by asking questions of panelists. This year's conference was no exception, with two different topics featured at the end of the first two days of the conference.
On Tuesday afternoon, a panel explored The Role of Composites in Battery Cases & Trays for Fleet Electrification. Battery packs that power hybrid- and battery-electric vehicles (HEVs & BEVs) bring their own special challenges for vehicle designers yet provide an excellent opportunity for composites to shine. First, batteries are heavy, making it important that trays be structural and able to support significant mass without creeping over a wide range of temperatures for the life of the vehicle.

Furthermore, owing to consumer "range anxiety" and the desire to extend practical driving range on these vehicles, it is highly desirable to take weight out wherever possible. Still another challenge is that batteries are caustic, so it is important that both cases and trays be corrosion resistant and able to withstand the aggressive chemicals inside. Last, metal-oxide batteries operate at high temperatures, so materials for battery cases and trays need to also provide sufficient thermal performance. This panel discussion will evaluate the challenges and opportunities

presented by fleet electrification and the materials technologies that are working and those that are not.

Moderated by Drew Winter, editor-in-chief, Ward's AutoWorld magazine, panelists included: Jim Dutchik, manger-Business Development, Asahi Kasei Plastics North America, Inc.; Frank Henning, deputy director, Fraunhofer Institute of Chemical Technology; Stu Sonta, lead composites engineer, General Motors Co.; and Joe Bodary, manager-Engineering & Prototype, Continental Structural Plastics.

On Wednesday afternoon, a second panel discussed Measuring the Sustainability Proposition of Composites. The automotive industry faces numerous new green initiatives, including end-of-life materials recovery, significantly boosting average vehicle fuel economy, and reducing its carbon dioxide (CO2) footprint – both during production and throughout the use life of its vehicles. This makes it increasingly important for the composites industry to be able to provide quantitative data on just how sustainable composites are as a materials technology vs. metallic alternatives. However, defining just what is green and how that should be measured is a significant hurdle at present. This panel discussion will evaluate some of the more useful tools currently available, such as life-cycle analysis (LCA), and consider how to accurately and fairly begin the process of quantifying the sustainability proposition of composites.

Moderated by Jeff Sloan, editor-in-chief of CompositesWorld.com, panelists included Ashish Diwanji, vice-president of Innovations, Owens Corning; Antony Dodworth, managing director, Dodworth Design; Mark Voss, lead composites engineer, General Motors Co.; C. David Warren, program manager-Transportation Materials & Carbon Fiber, Oak Ridge National Laboratory, and Jaap van der Woude, director-Science & Technology Europe, Environmental, PPG Industries.

For those who attended the conference, many keynotes and regular papers that were received too late to be included on the conference CD are now available for downloading at http://speautomotive.com/comp. Content from the entire 2011 SPE ACCE will be available free of charge at year's end. In the meantime, program guides and conference proceedings from all ten previous SPE ACCE shows are available at no charge at http://speautomotive.com/aca.

SPE® ANNOUNCES BEST PAPER AWARD WINNERS FOR 2011 AUTOMOTIVE COMPOSITES CONFERENCE & EXHIBITION

Four winners – one from industry and three from academia – were honored for excellence in technical writing during opening ceremonies at the eleventh-annual SPE® Automotive Composites Conference & Exhibition (ACCE) on September 13, 2011. Dr. Hannes Fuchs, senior engineer at Multimatic Engineering received the highest score this year; Xian Jiang, a doctoral candidate in the department of Chemical Engineering and Material Science at Michigan State University received the second highest score; and Dr. W.H. Katie Zhong, a professor in the School of Mechanical and Materials Engineering, at Washington State University (WSU) and Francesco Deleo, a doctoral candidate in the Department of Aeronautics & Astronautics at the University of Washington and also a 2010-2011 SPE ACCE scholarship award winner both tied for third place. The winners received the highest average rank by the conference peer review committee out of a field of 49 contenders (31 of whom submitted formal papers) that cleared peer review early enough this year to be considered.

Hannes Fuchs gave a paper entitled Automotive Composites Consortium Composite Underbody Component & Assembly Structural Test-Analysis Correlation in the Finalizing the Design & Development of a Structural Composite Underbody session. The paper, co-authored by Eric Gillund, lead Structures Engineer, also at Multimatic Engineering, discussed preparation and fabrication of underbody test assemblies for the United States Council for Automotive Research's (USCAR's) multi-year study on the feasibility of a structural-composite underbody for a midsize car.

Fuchs, who also won an SPE ACCE Best Paper Award in 2010, is a senior engineer at Multimatic Engineering and has 19 years of experience in advanced engineering and research and development of composite and lightweight structures. He came to the automotive industry from the NASA-Virginia Tech Composites Program and from post-doctoral research activities at the NASA Langley Research Center. Initially joining then General Motors Corp.'s Research & Development department, Fuchs conducted research on advanced lightweight and crashworthy carbon composite automotive structures.

After nearly six years, he joined Multimatic where he has managed and directed engineering activities including design engineering, computer-aided engineering, prototype and production manufacture, tooling, and testing of a wide range of advanced and composite structures. He is recognized as an industry expert in the design and application of lightweight structures and materials and holds BSME and MSME degrees from the University of Maryland as well as a Ph.D. from Virginia Tech.

Xian Jiang, who shared authorship of the paper with Dr. Lawrence T. Drzal, University Distinguished Professor Chemical Engineering and Materials Science, Mechanical Engineering at Michigan State University, presented a paper on Synthesis of Bipolar Plates for Fuel Cells Based on Exfoliated Graphene Nanoplatelets Filled Polymeric Nanocomposites in the Nanocomposites session. The objective of Jiang's research was to investigate the potential of using exfoliated graphene nanoplatelets (GNP) as the conductive filler to construct highly conductive polymeric nanocomposites to substitute for conventional metallic and graphite bipolar plates in polymer electrolyte membrane (PEM) fuel cells.

Jiang is a PhD candidate in the department of Chemical Engineering and Material Science at Michigan State University. He previously received a bachelor's degree in Engineering at Zhejiang University, in China. His research interests include multifunctional composites materials, graphene nanocomposites, nano-structured materials, and bipolar plates for automotive applications. Before participating in the SPE ACCE, Jiang had published four journal articles and three papers in conference proceedings.

W.H. Katie Zhong presented her talk on Enabling Faster Resin Infusion Processing of Automotive Composites: A "Nano-Nectar" Technology Leading Epoxy to High Performance and Low Viscosity in the

Nanocomposites session. Her topic is a revolutionary new method of incorporating nanofillers into epoxy resins. Called "nano-nectar," the liquid nano-reinforcement (LNR) can easily be dispersed in the base epoxy matrix and proves highly effective for reinforcing and toughening the resin as well as for contributing dramatically to reduced viscosity, which is a significant process benefit for fiber-reinforced plastics in that it takes less energy to manufacture composite parts thanks to lower power requirements for flow and part consolidation.

Zhong is a professor in the School of Mechanical and Materials Engineering, at Washington State University (WSU). She started her academic career in 1994 in the Composites and Manufacturing Program of the Department of Materials Science and Engineering at Beijing University of Aeronautics and Astronautics (BUAA) in Beijing, China, where she received her PhD. In 1999, Zhong was promoted, becoming the youngest full professor at BUAA, and one of the youngest full professors in all of China. She has worked closely with the aerospace industries, and since 2006 she has been consultant and educator for Boeing engineers in the field of nanotechnology. She has conducted many research projects on nanocomposites, bio-nanomaterials, electronic materials, and nano-manufacturing technology. Zhong has authored more than 200 publications, including over 130 peer-reviewed journal papers, one book, four book chapters, and 70 conference papers.

Francesco DeLeo presented the results of his 2010-2011 SPE ACCE scholarship research in the Virtual Prototyping & Testing session. His paper, Crashworthiness Energy Absorption of Carbon Fiber Composites: Experiment and Simulation, was co-authored with Dr. Paolo Feraboli, assistant professor-Aerospace Structures & Materials, Department of Aeronautics & Astronautics at the University of Washington, and also director of the Automobili Lamborghini Advanced Composite Structures Laboratory (ACSL) in at the university. The presentation discussed the merits and weaknesses of a progressive failure composite material model in order to evaluate the effect of geometric features on crush behavior, both from an experimental and numerical standpoint.

Francesco Deleo is a doctoral candidate in the Department of Aeronautics & Astronautics at the University of Washington in Seattle. Since January 2011, DeLeo Francesco has been co-teaching a metal fatigue and fracture mechanics course in the U.S. as well as abroad together with Dr. Safarian of the U.S. Federal Aviation Administration. DeLeo has served as a teaching assistant for several graduate-level courses, including Integrity of Metallic Aircraft Structures, Finite Element Analysis, and Integrity of Composite Aircraft Structures. Prior to his current position, he worked first as undergraduate and then as master's student in the Automobili Lamborghini Advanced Composite Structures Laboratory (ACSL) under the direction of Dr. Paolo Feraboli. His research focused on dynamic analysis using LS-DYNA on crash and impact damage. DeLeo received a BS degree in 2007 and an MS degree in 2011 from the University of Washington. He is co-author of 4 journal publications and presented at several conferences.

ACCE COMMITTEE SELECTS WINNERS OF 5TH-ANNUAL GRADUATE SCHOLARSHIP ON AUTOMOTIVE COMPOSITES

David Inglefield, a Ph.D. candidate pursuing a dual degree in Chemistry and Biomedical Engineering at ***Virginia Polytechnic Institute & State University*** (Virginia Tech, Blacksburg, Va.), was a 2011-2012 winner of the SPE Automotive Composites Conference & Exhibition (ACCE) graduate-level scholarship in transportation composites research. Inglefield, who is from Fairfax, Va. and expects to graduate in 2014, won this year's scholarship for a research project involving the synthesis of functionalized carbon nanotubes for optimized properties in polymer composites, a project that could have broad application in automotive composites.

As Inglefield explains, since their discovery in 1991, interest in carbon nanotubes (CNTs) has grown rapidly and their use has expanded into areas as diverse as electronics and bionanotechnology. One of their most promising areas of usage is to improve the properties of polymer composites by increasing mechanical strength (without raising resin weight or density as most reinforcements do) and conferring electrical and thermal conductivity to materials that normally provide neither property. However, wider usage has been limited by many factors, including high production costs and challenges effectively dispersing the nanoparticles into polymer matrices. Developing a functionalized CNT that effectively interacts with the resin in which it is incorporated remains a significant challenge in expanding usage of this technology.

"My work involves functionalization of multiwall carbon nanotubes for more efficient incorporation into polymer composites by increasing dispersion and interactions with the polymer matrix," says Inglefield. "In their native form, carbon nanotubes don't interact well with organic groups on most polymers. However, I've been able to introduce functionality through the acid oxidation of the pristine nanotubes, increasing dispersion in the polymer matrix. I've also worked on the functionalizing nanotubes with metal nanoparticles, which increase conductivity and improve their function in specialized electronic applications. Carbon nanotubes can also be aligned in a magnetic field for anisotropic conductivity in polymer matrices via magnetic nanoparticles. I'm investigating a combination of these techniques for enhanced conductivity at low loadings for specialty electronics applications to preserve polymer properties that otherwise can be negatively affected by high reinforcement loadings."

David Inglefield, holds a B.S. degree in Biochemistry from Virginia Tech, which he received in 2009. Since graduating, he has worked as a graduate research assistant under his undergraduate and graduate research advisor, Dr. Timothy E. Long, professor of Chemistry and associate dean of Strategic Initiatives, Department of Chemistry, College of Science at Virginia Tech. The focus of their graduate work together has been synthesis and characterization of novel functionalized multiwall carbon nanotubes (MWCNT) and MWCNT composites. Inglefield's undergraduate work with Long involved synthesis and characterization of cinnamate functionalized ultraviolet (UV) cross-linkable ammonium ionenes. Since receiving his undergraduate degree, Inglefield also has worked as teaching assistant (undergraduate Organic Chemistry lab for non-majors) at Virginia Tech and has been an American Chemistry Society (ACS) short-course presenter, where he was responsible for demonstrating various polymerization techniques.

His current research expertise is in organic functionalization of MWCNT for polymer composites; electrospinning of polymers and MWCNT composites; performing transmission-electron and scanning-electron microscopy, nuclear magnetic-resonance spectroscopy, differential scanning calorimetry, thermogravimetric analysis, Raman and infrared spectroscopy, cryomicrotomy, dynamic light-scattering analysis, and rheology. In addition he has co-authored two publications presented at industry conferences.

The second scholarship winner this year was **Thomas (Tom) G. Loken**, a doctoral candidate in Mechanical Engineering at ***University of Wisconsin-Madison*** (Madison, Wisc.) as well as a project engineer at The Madison Group (Madison, Wisc.). Loken, who is from Winona, Minn. and expects to graduate in 2014, won this year's second scholarship for a research project analyzing the effects of processing conditions on fiber-length distribution in short-fiber composites.

Short-fiber thermoplastic composite materials are widely used in the automotive industry. These materials offer enhanced mechanical properties over unfilled resins, yet remain viable for high-volume production methods, such as injection molding, making metals replacement cost-effective thanks to parts consolidation, weight reduction, and elimination of secondary-finishing operations. However, the mechanical properties of fiber-filled composites are strongly influenced by orientation and length/ diameter (L/D) ratios of reinforcing fibers, making final part properties highly dependent upon processing conditions. In the case of injection molding, fiber damage and attrition can occur during processing, reducing final L/D ratio. Therefore it is useful to understand which process parameters have the greatest effect on final fiber length distribution.

"The focus of my research is to study the effects of varying process conditions on the final fiber-length distribution in short-fiber thermoplastic composites," explains Loken. "I am studying injection molding of a commercially available grade of short-glass/ polypropylene and the influence of process variables like injection speed, screw speed, mold temperature, and barrel temperature. Injection speed controls the shear rate of the resin as it passes through the nozzle, runner, gate, and into the mold cavity. Screw speed controls the shear rate of the material during plastification in the barrel. Barrel temperature impacts the resin viscosity. And mold temperature affects material flow into the tool. Once test specimens have been molded, they will tensile tested per ASTM-D638 specifications to obtain tensile strength and modulus values, which will be studied as response variables. Samples with the most varied tensile properties will be selected for fiber-length distribution measurements. I've set my project up as a two-level factorial design of experiments (DOE) study to evaluate interaction between process variables. Because temperatures are hard to change, a split-plot design will be used. From personal experience, I've found that experimental designs are useful because full randomization is neither cost effective, nor practical. However, careful examination of the treatment variables to account for the split-plot design and randomization restrictions is necessary. I hope that the results will show which variable or variables have the greatest influence on tensile properties, what process interactions are present, and how varying process parameters influences the final fiber L/D ratio and measurement technique."

Thomas Loken holds a B.S. degree in Composite Materials Engineering from Winona State University (Winona, Minn.), which he received in 2009. During his undergraduate studies he worked as a testing intern at the school's Composite Materials Technology Center (COMTEC), where he conducted mechanical and analytical testing on composites and plastics. He also worked as a process engineering intern at RTP Co. (Winona, Minn.) in the extrusion/ compounding of thermoplastics and short-fiber composites. At RTP, Loken was responsible for SPC charting, corrective actions, and process studies.

After graduating, he served as the manufacturing engineer at Rolco Inc. (Kasota, Minn.) where he managed work instructions, corrective action requests, and process optimization, and project managed four family tools used to produce automotive parts using glass-filled polyamide – from mold inspection, to sampling, to production. Loken also conducted considerable research – using factorial screening experiments, response surface experiments, and validation – on secondary spin-welding operations for these parts to ensure a hermetic seal was achieved. He is currently a project engineer at The Madison Group where he conducts failure analysis of plastics and provides consulting services to the plastics community. Loken is concurrently a full-time graduate student in the Mechanical Engineering department at the University of Wisconsin-Madison working with Drs. Tim Osswald and Paul Gramann.

This is the fifth year the SPE ACCE – co-organized by SPE's Automotive and Composites Divisions – has sponsored the scholarships, which are funded by proceeds from the previous year's ACCE. Both scholarship winners will return next year to present the results of their work at the 12th-annual SPE ACCE, September 11-13, 2012.

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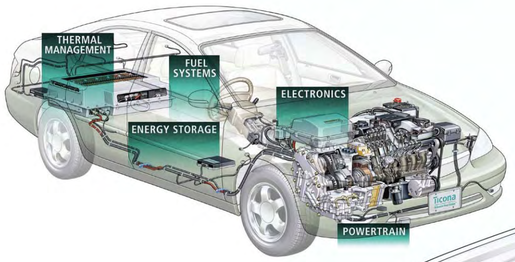

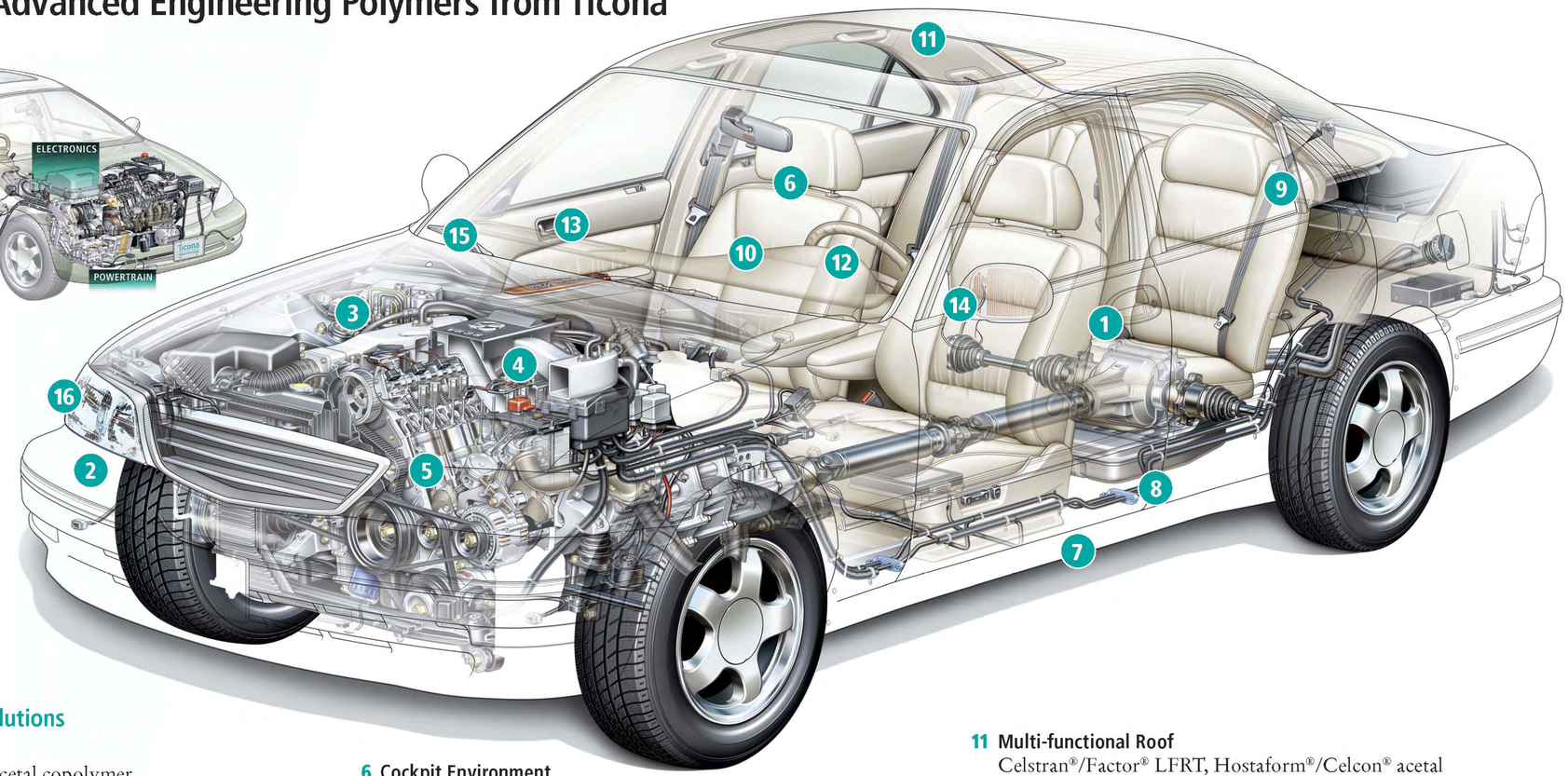

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Automotive Division Board Meeting Minutes

August 15, 2011

Monica Prokopyshen—Secretary

ATTENDEES

Yvonne Bankowski, Teri Chouinard, Anthony Gasbarro, Brian Grosser, Jeff Helms, Chuck Jarrett, Norm Kakarala, Peggy Malnati, Mike Masserant, Tom Pickett, Bill Pippine, Monica Prokopyshen, Jay Raisoni, Nippani Rao, David Reed, Suresh Shah, Sheldon Brown, Ron Price, Bonnie Bennyhoff

Meeting was held at ACC in Troy, 5:30 p.m. – 7:00 p.m. Amended June 13, 2011 minutes were approved.

Administrative (Anthony Gasbarro) The 2011 offices services contract will be renewed on a quarterly basis until the long term plans for the ACC facility are finalized. Elections were held and the following positions were filled: Chair Elect (Jeff Helms), Vice Chair (Yvonne Bankowski), and Treasurer (Jackie Rehkopf). Suresh Shah offered to act as backup for the Automotive TPC lead until the position is filled. Brian Minges of Owens Corning has expressed interest in joining the board.

Councilor Report (Tom Pickett) No council meetings have transpired since the last report. The next meeting is scheduled for SPE Eurotec 2011 (Nov. 12-15) in Barcelona, Spain.

Education (Monica Prokopyshen) The American Chemistry Council (ACC), Plastics Division is leading a College for Creative Studies (CCS) transportation design program again this fall. A motion to contribute $3000 and mentors was passed. A request to confirm that last year's contribution was invoice and paid was requested by the BOD; an inquiry was sent to the ACC who confirmed receipt of last year's contribution.

Membership (Bill Pippine) Contact information, excluding positions filled August 15th were submitted to SPE headquarters.

SPE Social Programs Brian Grosser and Suzanne Cole proposed the following division events for the 2011-2012 fiscal year:

1. OEM Designers' Social, at Meadowbrook Hall (Sept.-Oct.);
2. SPE Ski Social (Jan. / Feb. 2012)

Wine Tasting (May 2012).

Treasurer's Report (Yvonne Bankowski)

Current Balance as at August 14, 2011

Current Balance:

Checking: $150.1 K
Savings: $27.4 K
Total: $177.5 K

AutoEPCON – (Nippani Rao) Next year's conference will be held at the same location (MSU extension in Troy) on May 1, 2012.

MARCOM (Peggy Malnati)

The 2011 ACCE conference comprises 9 keynote speeches and 57 presentations in 8 technical sessions (Sept. 13-15). PPG is the undergraduate and graduate poster competition sponsor. The exhibit space is sold out. Please register before September 1, to ensure an accurate food order —food is the highest event expense.

Three press releases for the 2011 IAG program (November 9th, 2011) have been issued to date and the photography RFQ (request for quote) has been issued. 18 ad swaps have been negotiated to date, including a co-promotional campaign with Crain's Lightweight and Electric Vehicles Conference. SPE AD ads have been designed and sent to media partners and the IAG Program Guide page designs have been completed.

The automotive division web traffic continues to trend upwards and reached a new record of 27, 466 in July.

Twitter followers have risen to 215 (from 179 in June).

The new WordPress blog: http://speautomotive.wordpress.com/ has 25 posts. Sign up to keep up with news and events.

IAG (2011 Dates Finalized)

As of August 15th, two nominations have been received (awards@spe.automotive.com). Ford has 15 nominations in process. Hall of Fame (HOF) nominations must be submitted to Nippani Rao by September 01, 2011.

Newsletter / Sponsorship

Next newsletter submissions TBD.

New Business/Other

A bumper information inquiry will be forwarded to the BOD.

Next BOD Meeting

Date / Time: Thursday & Friday Sept 29 & 30, 8:00 a.m. – 5:00 p.m.

Location: Ticona Engineering Polymers, Auburn Hills, Mi (BOD Judging)

PROCESS, MATERIAL AND PART CHARACTERIZATION OF THE INNOVATIVE DIRECT SMC PROCESS

Tobias Potyra[1], Frank Henning[1], Matthias Graf[2], Erik Reuther[3]

1.Fraunhofer ICT, Jospeh-von-Fraunhofer-Str. 7, 76327 Pfinztal, Germany
2.Dieffenbacher GmbH + Co. KG, Heilbronner Straße 20, 75031 Eppingen, Germany
3.DSM Composite Resins Deutschland GmbH, Zeiloch 20, 76646 Bruchsal, Germany

Abstract

For manufacturing of compression moulded parts with long fibre reinforcement and thermoset matrix the Direct Sheet Moulding Compound Process (D-SMC) has been developed. In this process the compound is being inline manufactured and subsequently directly moulded. In that way a consistent compounding process with constant material treatment is achieved, with very short processing times of minimum 15 minutes from mixing to molding.

A prototype manufacturing D-SMC line has been set up in full industrial scale in conjunction with a 3600 tons press. The process control is fully integrated from raw material dosing over compound manufacturing until compression moulding of parts. In this paper the characteristics of this new and innovative process have been investigated with respect to the achievable material and part properties.

Introduction

Over the last years the Direct SMC process has been developed in order to establish an integrated fully automated processing method for thermoset fiber reinforced compression moulded parts from raw material supply to the ready moulded parts. Multiple ways of continuous processing have been explored by several consortia and have been characterised, respectively. For obtaining material and part properties equal to SMC parts the way of incorporating the fibers needed to be optimized. The state of the art technology is nowadays the combination of a badge-to-continuous dosing unit for the liquid raw materials, compounding the resin filler paste in a twin screw extruder, compounding the fibers in on a sheet machine with subsequent fast maturation and direct compression moulding of the parts. In the following the process set up is described (cf Figure 1).

First resin, additives and filler are gravimetrically dosed into a twin screw extruder where the resin filler paste is being compounded as shown in the schematic process drawing in. As a twin screw extruder is being used for this compounding step a higher mixing quality in terms of dispersion, homogeneity and air entrapments can be realized compared to dissolver equipment. The resulting resin filler paste contains all necessary raw materials like resin, LPA, processing and wetting additives, peroxide and additives for controlling the paste viscosity. This mixture is being split into two equal streams and transferred into doctor boxes of the direct compounding machine. There the continuous glass fibre rovings are fed in, cut and compounded in between the resin filler paste sheets. After a fast maturation under elevated temperature the carrier film is being peeled off, the sheet is cut into the charge pattern and subsequently being stacked. The whole stack of charge pattern is than directly placed in the mould and the part is manufactured by compression moulding. Depending on sheet width, through put and material formulation the time from raw material to the ready moulded part is minimum 15 minutes.

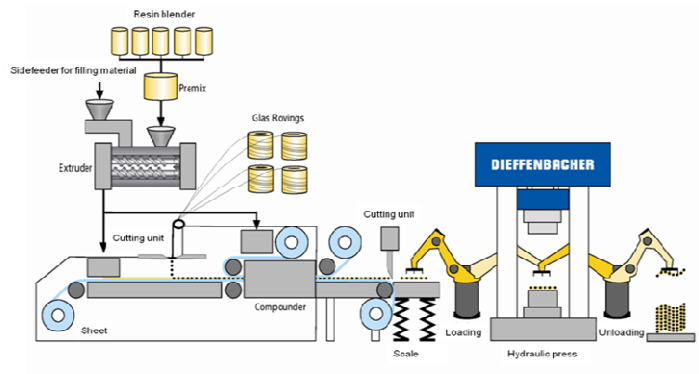

Figure 1 Schematic drawing of the process sequence of the integrated Direct SMC process

A new pilot line is in operation for approx. one year at the Fraunhofer ICT in Germany. Many trials with different formulations and tests with different complex parts to characterize the material properties and quality consistency have been performed.

Experimental Work

In order to characterise this manufacturing method a Design of Experiment study has been carried out. The major target was to identify the effect material and process parameters on the material properties. Furthermore these parameters should be qualified within the investigated boundaries.

A Class A material formulation was chosen which represents the state of the art in conventional SMC technology. The glass fiber content was 28%wt and the $CaCO_3$ filler content was 180phr. The formulation also contained internal mould release agent, wetting agent and peroxide. All material parameters were kept at a constant level throughout this investigation except the thickening agent. The content of magnesium oxide has been varied.

The used Direct SMC line is a prototype line manufactured by Dieffenbacher and is in operation at the press center at the Fraunhofer ICT, Pfinztal, Germany. The Direct SMC line is in full industrial scale and has an output rate from 1 kg/min up to 8 kg/min. The sheet width is flexible and can be adjusted between 400mm and 800mm. In this trial campaign the sheet width was constant at 800mm and the throughtput was constant at a rate of 1kg/min. The moulded part geometry was a Volkswagen Golf hood with

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Class A finish. The compression moulding pressure was at 100 bars and was reduced to 30% after 30 seconds. The whole curing time was 150 seconds.

For investigating the link between process parameters, thickening behaviour and resulting mechanical properties a Design of Experiment study has been executed utilizing the software MODDE 8.0. A screening model was chosen in an interactive D-optimal design. The parameters of the investigated parameter magnesium oxide content, temperature in the fast maturation zone and penetration depth of the rolls in the impregnation zone are given in Table 1.

Table 1 Investigated parameters in the Design of Experiment study

Exp No	Exp Name	MgO Content [phr]	Maturation Temperature [°C]	Impreg. Penetration Depth [mm]
1	N1	1,5	60	30
2	N2	3,5	60	30
3	N3	1,5	90	30
4	N4	3,5	90	30
5	N5	1,5	60	50
6	N6	3,5	60	50
7	N7	1,5	90	50
8	N8	3,5	90	50
9	N9	1,5	60	40
10	N10	2,5	60	50
11	N11	2,5	75	40
12	N12	2,5	75	40
13	N13	2,5	75	40

The investigated responses to the parameters are flexural stiffness, flexural strength and Charpy impact strength. The flexural testing was executed according to the standard DIN EN ISO 178 and the Charpy impact test was executed according to the standard DIN EN ISO 179. The specimens were taken out from the charge pattern area of the molded hood and from the edge of the molded hood representing the flow area of the part. All specimens have been taken out in the same orientation transversal to the flow direction. In the following it will be distinguished between results from the charge pattern area and the flow area.

Results and Discussion

Based on the achieved results of the mechanical testing the best model was created describing the interaction between the investigated parameters and the mechanical characteristics within the borders of this investigation. The values for R_2, representing the fit of the model to the measured data, and Q_2, describing how good the model would deal with new, unmeasured data, are given in Figure 2. The R_2 value should be close to 1 and Q_2 should be higher than 0.5 for further use of the model. As this is the case except for the fit value (R_2) for flexural stiffness in the charge pattern area, the model is being used for the further investigation.

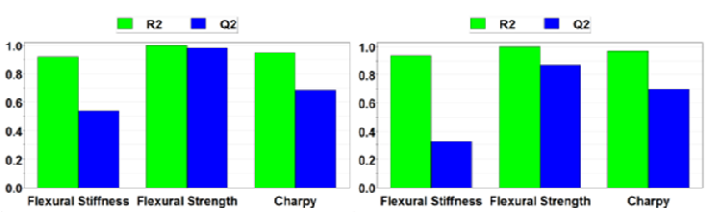

Figure 2 Characteristic values for R2 and Q2 of the DoE model for the charge pattern area (left) and the flow area (right) for the investigated response of the mechanical properties

In Figure 3 the results for the flexural stiffness from the charge pattern area and from the flow area are shown. In both cases the flexural stiffness is shown depending on the investigated factors maturation temperature, MgO content and penetration depth of the impregnation rolls unit.

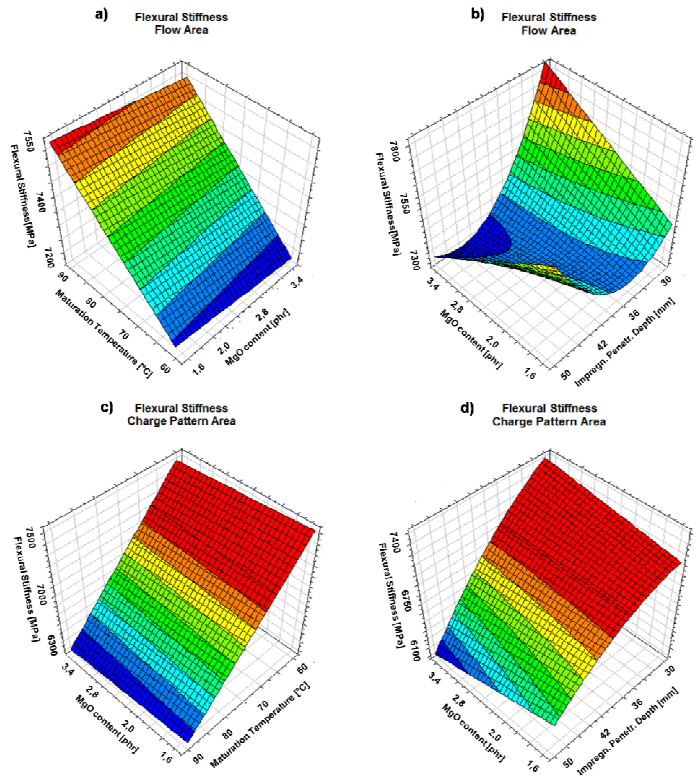

Figure 3 Flexural stiffness in the flow area depending on a) maturation temperature and MgO content and depending on b) impregnation penetration depth and MgO content; Flexural stiffness in the charge pattern area in dependency on c) maturation temperature and MgO content and depending on d) impregnation penetration depth and MgO content.

In the flow area it can be observed that with an increase of the maturation temperature the stiffness increases in a linear way, respectively. The MgO content doesn't affect the flexural stiffness in the same way. In the flow area the flexural stiffness remains on the same level within the investigated variation of the MgO content (Figure 3 a) and b)).That suggests that the temperature increase has a higher effect on the thickening compared to the MgO content. For the charge pattern area we can observe a contrary effect of the maturation temperature (Figure 3 c)). With an increase of the maturation we can observe a decrease of the flexural stiffness. That can be explained by the higher viscosity, which leads to an improved fiber and filler transport in the compression molding step. The transported fibers and fillers lead to a local decrease of the

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stiffness in the charge pattern area and a local increase in the flow area, respectively. The MgO content has a low effect on the stiffness in the charge pattern area (Figure 3 c) and d)).

The increase of penetration depth of the impregnation rolls leads to a decrease of the flexural stiffness in the flow area and in the charge pattern area (Figure 3 b) and d)). This effect is higher at higher thickening levels. In the flow area the model suggest a strong decrease of the flexural stiffness with an increase of the penetration depth up to a local minimum. From this minimum the flexural stiffness increases with an increase of the penetration depth of the impregnation roll up to a certain level which is lower than at low penetration depths of the impregnation rolls. This local minimum cannot be observed in the charge pattern area, where the flexural stiffness decreases with decreasing penetration depth. Generally it can be stated that too high penetration depth applies too high pressure on the SMC sheets in the manufacturing process which leads to a squeeze out of the resin filler paste. That would explain the lower filler concentration and the lower flexural stiffness at deeper penetration depth of the impregnation unit.

The results for the flexural strength are shown in Figure 4 a)-d) in dependency of maturation temperature, MgO content and penetration depth of the impregnation unit. Generally a similar behavior of the flexural strength can be observed compared with the flexural strength.

The flexural strength increases linearly in the flow area with an increase of the maturation temperature (Figure 4a)). If the amount of MgO as thickening agent is increased, the flexural strength in the flow area is nearly constant with a slight increase at higher MgO values. In the charge pattern area the effects of higher maturation temperature and higher MgO contents is contrary, as the flexural strength decreases (cf Figure 4c)). This behavior can be explained by an enhanced fiber and filler transport in the compression molding step at higher viscosities. The viscosity is increased through higher maturation temperature and through higher MgO content, whereas the maturation temperature seems to have a stronger effect than the thickening agent content. The improved fiber transport leads to a local increase of the fiber content in the flow area and to a local decrease of the fiber content in the charge pattern area, respectively. As the glass fibers are the reinforcement in the material, higher mechanical loads can be borne in the flow area and lower loads can be borne in the charge pattern area, respectively.

In the flow area we can observe a quadratic curve of the flexural strength in dependency of the penetration depth of the impregnation unit (Figure 4 b)). In the range of 30mm to 40mm of penetration depth the flexural strength decrease and reaches a local minimum. At higher values

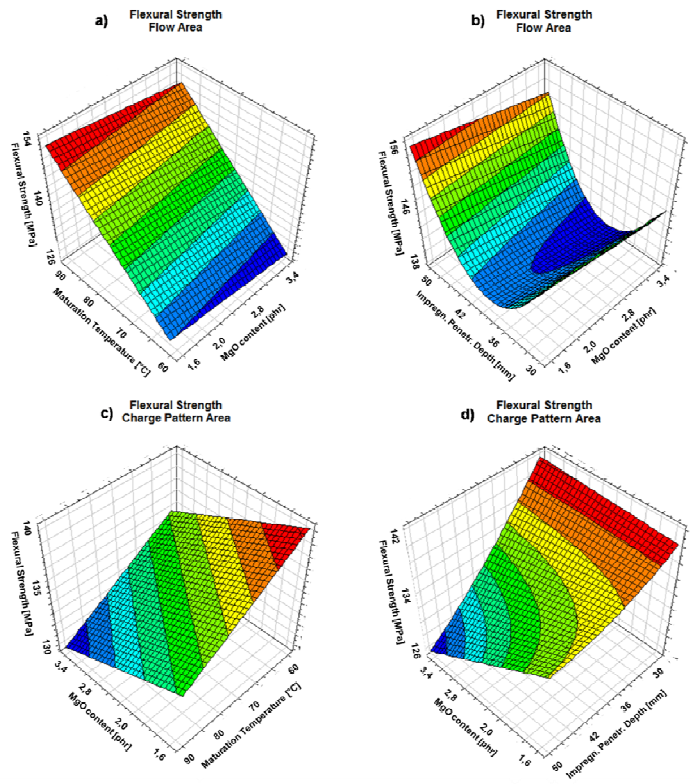

Figure 4 Flexural strength in the flow area depending on a) maturation temperature and MgO content and depending on b) impregnation penetration depth and MgO content; Flexural strength in the charge pattern area in dependency on c) maturation temperature and MgO content and depending on d) impregnation penetration depth and MgO content

for the penetration depth from 40mm to 50mm we can observe an increase of the flexural strength. The flexural strength at higher penetration depth has a higher value compared to the values at the initial low penetration depth. In the charge pattern area we can observe a contrary behavior (Figure 4 d)), as the flexural strength decreases at higher penetration depths of the impregnation unit. This effect is amplified at higher thickening agent loading. A possible explanation is that the deeper penetration depth of the impregnation unit applies higher pressure to the sheets in the manufacturing process. That leads to a squeeze out of the resin filler paste and to higher overall fiber content. At higher viscosities these fibers are then transported into the flow area, where we can observe the improvement of the flexural strength.

The Charpy impact strength in dependency on the maturation temperature, MgO content and the penetration depth of the impregnation unit is given in Figure 5 a)-d). The overall behavior is contrary to the discussed properties flexural stiffness and flexural strength.

All four graphs show that the Charpy impact strength is increasing with an increase of the thickening agent MgO. That can be explained through the wet through of the fiber bundles. If the wet through of the fiber bundles is too high and the wet out of the fibers is too good, the energy uptake in case of impact loads is decreasing. Once the

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viscosity is increasing the impregnation behavior of the resin filler paste is decreasing. This leads than to a worse wet out at higher MgO contents.

The maturation temperature is affecting the Charpy impact strength contrarily. With an increase of the maturation temperature we can observe a decrease of the Charpy impact strength (Figure 5 a) and d)). The MgO is added upstream in the manufacturing process compared to the timing when the maturation temperature is applied. At that time in the process the material is already quite highly viscous and the elevated maturation temperature lowers this viscosity. With the reduced viscosity the wet through of the fiber bundles is enhanced leading to a reduction of the Charpy impact values.

In Figure 5 b) and d) it can be observed that the Charpy impact strength is increasing with higher penetration depth of the impregnation unit. In the flow area this behavior can be explained by the higher applied pressure in the impregnation unit at higher penetration depth levels. This improves the wet through of the fiber bundles and reduces the impact strength, respectively. In the charge pattern area a quadratic behavior can be observed, where the Charpy impact strength first increases with deeper penetration to a local maximum. After this local maxim the Charpy impact strength decrease to the same level as initially. This behavior needs more investigation of either the generated DoE model or the material itself.

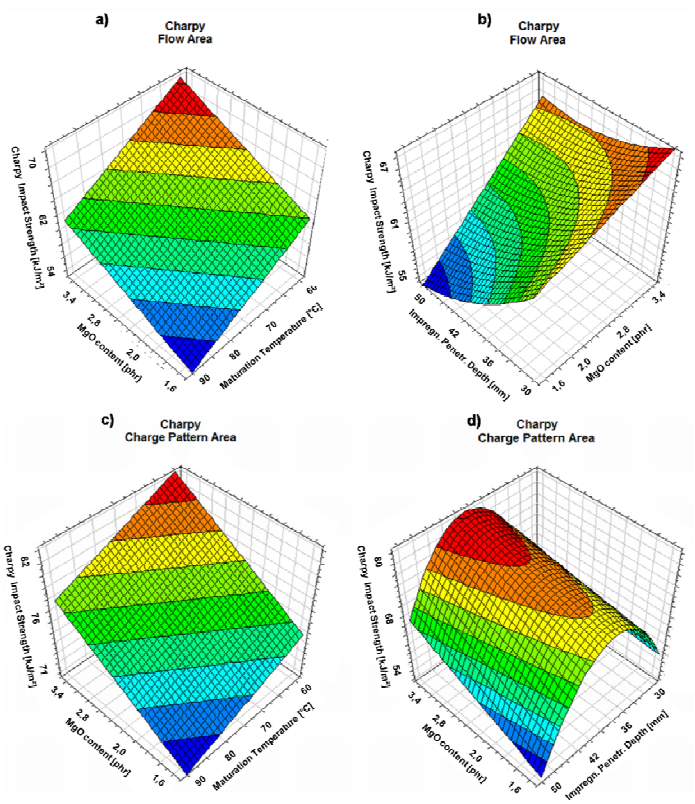

Figure 5 Charpy impact strength in the flow area depending on a) maturation temperature and MgO content and depending on b) impregnation penetration depth and MgO content; Charpy impact strength in the charge pattern area in dependency on c) maturation temperature and MgO content and depending on d) impregnation penetration depth and MgO content

Conclusion

In this presentation the material properties of the D-SMC process have been linked with the parameters maturation temperature, MgO content as thickening agent and penetration depth of the impregnation unit. It was found out that the material properties can be adjusted in the process by varying these parameters. For the mechanical properties flexural stiffness and flexural strength the compound viscosity seem to be the dominating factor, which is determined more by maturation temperature than by thickening agent content. The variation of the Charpy impact strength is more dominated by the content of thickening agent than by the maturation temperature. So depending on the requirements of the application the investigated material characteristics can be adjusted in the Direct SMC process. The penetration depth of the impregnation unit has a strong effect on the investigated material characteristics. In general for the investigated model it can be stated that with deeper penetration depth the mechanical properties decrease. At some properties the shape of the graph seems to be quadratic but this needs to be investigated further.

The Direct SMC process offers a unique chance where material properties of one formulation can be changed by adjusting parameters in the process online. This adds new degrees of freedom to the material class of compression molded long fiber reinforced thermoset composites. Future needs of applications in terms of higher diversity can be served through this.

Acknowledgments

The authors wish to acknowledge the companies Dieffenbacher GmbH and DSM Composite Resins for supporting this project. Furthermore the authors want to thank the team of technicians from Dieffenbacher GmbH, DSM Composite Resins and Fraunhofer ICT for their passionate work and support to this project.


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Nippani Rao, Director Emeritus
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(248) 444.1753

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Rao and Associates, Inc.
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