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WELCOME
TO THE
THERMOSET TOPCON

Madison, Wisconsin • May 9-10, 2023

Presented by SPE Thermoset Division

SEAN CAMPBELL
Division Chair
LyondellBasell

Welcome OEMs, Resin Suppliers, Compounders, Molders, Professors and Students to the **2023 SPE THERMOSET TOPCON CONFERENCE** on the beautiful shores of Lake Monona in Madison, Wisconsin. The 2023 Conference is being held in the same location as last year in 2022, and this will also be the location for the 2024 event.

The Theme of this year's conference is ***INITIATING OPPORTUNITIES***. We use the term "initiating" since our thermoset materials need to be "initiated", and we hope that people "initiate"/kick off some new projects and/or meet new people in the industry.

This year we have papers focused on **3 main areas:**

1) **Technology Developments in Thermoset Chemistry**
2) **Innovative Applications in the Thermoset Industry**
3) **Issues and Solutions to Grow the Thermoset Industry**

We will kick off Tuesday and Wednesday morning with our Keynote speeches by **Dale Brosius** from IACMI on Tuesday and **Probir Guha** from Composites Innovation Inc. on Wednesday morning which should certainly be highlights of this year's show. Another highlight will be the **Round Table Discussion** on the ***State of the Thermoset Industry*** with some of the true leaders of this industry.

Enjoy the talks and the comradery of the participants in the industry. The Thermoset Industry is a big enough Industry where true breakthroughs can happen and small enough that everyone can make a difference in improving this Industry.

Thank you,
Sean Campbell
LyondellBasell
SPE Thermoset* TOPCON *Chair 2023, 2024

WELCOME

TUESDAY, MAY 9, 2023

ALL TIMES USA EDT

7:00–8:00 NETWORKING BREAKFAST *Sponsored by* Composites International idicomposites.com & EXHIBITS

8:00–8:10 **OPENING OF THE 2023 TOPCON SHOW: Len Nunnery,** *Board Member* TOPCON - *Plenco*

8:10–8:20 **DAY 1 AM MODERATOR: Sean Campbell,** TOPCON *Chair 2023, 2024 - LyondellBasell*

8:20–9:00 **KEYNOTE ADDRESS: OPPORTUNITY BRINGS NEW CHALLENGES: THE FUTURE OF THERMOSETS**
Dale Brosius, ***IACMI***

BIO:

DALE BROSIUS is Chief Commercialization Officer for the Institute for Advanced Composites Manufacturing Innovation (IACMI), focused on composites technologies for more energy efficient vehicles, wind turbines and compressed gas storage. He is also a consultant to the composites industry since 1999, having completed numerous market studies, assisted in strategic planning, and aided companies in merger and acquisition activities across multiple market elements of the composites supply chain.

Mr. Brosius has a B.S. in Chemical Engineering and an M.B.A. and over 35 years of industrial experience in the composites industry. As a manufacturing engineer for Dow Chemical, he was responsible for a 400,000mt propylene oxide and 80,000mt propylene glycol plant. This was followed by marketing responsibilities for automotive composites in Detroit, where he led development of low density SMC, carbon fiber drive shafts, pickup truck boxes, leaf springs and infused primary structures made from thermoset resins. Subsequently, at Fiberite and Cytec, he led numerous activities related to high performance carbon fiber prepreg-based components for aerospace and industrial markets, and managed molding compound businesses in the U.S. and France, leading the acquisition of the French subsidiary.

Mr. Brosius has been involved in the production of class A carbon fiber components for a U.S. OEM, and development work with automotive and aerospace OEMs in Europe, Japan and the U.S. Prior to joining IACMI, he spent 10 years with Australia-based Quickstep Technologies, setting up demonstration sites in the U.K., Germany and the U.S. for Quickstep's innovative out-of-autoclave curing technology. He has intimate knowledge of all composite processes, from injection molding to textile preforming to autoclave, as well as glass and carbon fibers and a wide range of thermoset and thermoplastic polymers. He is the former chair of the Thermoset and Composites Divisions of the Society of Plastics Engineers, an SPE Honored Service Member and four years as chair of SPE's Automotive Composites Conference and Exhibition (ACCE). He has authored and presented numerous technical papers for conferences in the U.S., Europe, Japan and Australia, and is the author of over 150 articles and editorials for High Performance Composites, Composites Technology and Composites World magazines.

ABSTRACT: This presentation will focus on the future landscape of the thermoset industry and the challenges it must overcome to remain highly relevant. How IACMI and industry are working together to address clean energy, electric vehicles and infrastructure, urban air mobility, circular economy, life cycle analysis and decarbonization issues will be highlighted. "In the plastics industry, when performance demands are high, thermoset resins and composites come to the forefront," said Brosius. "Heat, stress, electrical resistance, corrosion prevention, fire retardance, fatigue – whatever the extreme – thermosets deliver," added Brosius. "Thermosets will continue to have a major role in the forthcoming era if the industry innovates and makes the changes needed to be the materials of choice."

9:00–9:30 **MATERIAL TECHNOLOGY: Advancements in Composite Resin Systems for Electric Vehicle Applications**
Dan Dowdall, ***INEOS Composites***

BIO:

Dan Dowdall is the Global Business Development Manager for INEOS Composites LLC (formerly Ashland Performance Materials). Dan has over thirty years of experience in the development of composite materials, processes, and applications for auto, truck, and industrial markets. Prior to joining INEOS, he held a variety of technical, commercial, and management positions with General Motors Company, Cambridge Industries, Meridian Automotive Systems, and Continental Structural Plastics. Dan has a BSME from Michigan State University, an MBA from Wayne State University, and has participated in nearly every ACCE as a speaker, exhibitor, or session organizer/moderator.

ABSTRACT: The automotive industry has used composite materials on exterior and semi-structural applications for over half a century, for their benefits in mass-reduction, tooling investment-reduction, corrosion-resistance, and styling flexibility. But the rapid growth of electric, hybrid, and autonomous vehicles have created new challenges for the material's properties, durability, and value. This presentation will summarize the past and present use of composites on EVs (battery covers, exterior panels, body structures, stowage systems), highlight composites' advantages and limitations, and review new material technologies developed specifically for EV battery enclosure systems.

9:30–10:00 **MODELING:** **Sensor Fusion for Simultaneous Estimation of In-Plane Permeability and Porosity of Fiber Reinforcement in Resin Transfer Molding**

Harshal Bhogesra, ***Moldex3D***

BIO: Harshal Bhogesra graduated from the UMass Lowell with a bachelor's degree in Plastics Engineering. He has 8+ years of combined experience in molding, customer & supplier development. He is passionate about optimizing product designs, tool development, molding processes, and quality. Currently working with plastic, rubber, LSR, MIM, RTM, Gas-Assist molding companies and help them eliminate their complex molding challenges to reduce engineering time and cost. Through Moldex3D technology, he has helped clients in various industries including automotive, medical, aerospace, electronics, consumer products, etc. who are concerned by the trial and errors on the production floor. Outside of work, he is fervent about traveling, interior designing, NFL, and adventure sports.

ABSTRACT: To meet the expectation of the industry, resin transfer molding (RTM) has become one of the most promising polymer processing methods to manufacture fiber-reinforced plastics (FRPs) with light weight, high strength, and multifunctional features. The permeability and porosity of fiber reinforcements are two of the primary properties that control the flow of resin in fibers and are critical to numerical simulations of RTM. In the past, various permeability measurement methods have been developed in the literature. However, limitations still exist. Furthermore, porosity is often measured independently of permeability. As a result, the two measurements do not necessarily relate to the same entity, which may increase the time and labor costs associated with experiments and affect result interpretation. In this work, a measurement system was developed by fusing the signals from capacitive sensing and flow visualization, based on which a novel algorithm was developed.

Without complicated sensor design or expensive instrumentation, both in-plane permeability and porosity can be simultaneously estimated. The feasibility of the proposed method was illustrated by experiments and verified with numerical simulations.

10:00–10:30 **BREAK & EXHIBITS**

10:30–12:00 **BUSINESS ROUND TABLE:**
Leon Garoufalis, Adam Brotz, Scott Balogh, Dr. Tim Osswald, Phil Beesley, Dale Brosius

LEON GAROUFALIS is the President & Chief Executive Officer of Composites One. Garoufalis has more than 36 years of experience in the composites industry, primarily at Composites One. He joined GLS Composites Distribution Corporation (which would later become Composites One) in 1988 as a Resin Product Manager. Over the past 34 years he held a variety of sales, marketing, and operations positions. Garoufalis was named COO of Composites One in 1999, President in 2002 and CEO in 2022. He started his career in sales with a specialty chemical manufacturer and then a thermoset resin producer. He holds a BS degree from Heidelberg University and an MBA from Loyola University in Chicago.

ADAM BROTZ is an accomplished manufacturing executive with over 30 years of experience in Thermosetting Resins and Composites. As Vice President of Manufacturing for Plastics Engineering Company (Plenco), Adam has a proven track record of success in leading and managing complex production operations to deliver high-quality, consistent products and services to their customers.

Throughout his operations management career, Adam has focused on driving process optimization, product quality, efficiency initiatives, energy conservation, waste reduction, and environmental health and safety. His expertise in these areas has led to significant cost savings and improved operational proficiency for Plenco.

In addition to his experience in manufacturing at Plenco, Adam has managed an international joint venture company, where he gained valuable knowledge in cross-cultural collaboration and business development.

Mr. Brotz received his Bachelor of Science in Industrial Management from Arizona State University, and his education and experience have prepared him to excel in his current role. He is a dedicated leader who is committed to delivering excellence in all aspects of manufacturing and operations management.

Besides his professional career, Adam is also a Director of a Family Foundation, a charitable organization supporting educational, social, and health care non-profit organizations. Outside of work, Adam enjoys spending time with his family while sailing, skiing, and traveling.

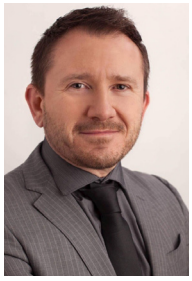
BUSINESS ROUND TABLE CONTINUED

SCOTT BALOGH, Chief Executive Officer, Mar-Bal, Inc., a Cleveland native, joined Mar-Bal in 1992. Mar-Bal, Inc, is a thermoset plastics manufacturing company that compounds resin and produces molded products for the major appliance and electrical industries. During Balogh's career, Mar-Bal has grown its annual sales by over 65 million. In addition, the company has also added manufacturing locations in not only Ohio, but Missouri and Virginia as well. Mar-Bal also opened a sales office and manufacturing location in China in 2015. Today, Mar-Bal, Inc. is one of the top thermoset injection molding manufacturers in the United States and employs nearly 500 people.

Mr. Balogh serves on the boards of the American Composite Manufacturers Association (ACMA), the Ohio Manufacturers Association (OMA) and Geauga University Hospital. He has been a member of the World Presidents Organization (WPO), Cleveland Chapter since 2004.

Mr. Balogh attended Capital University in Columbus, Ohio and graduated in 1984 with a B.A. in Business Administration and Economics. He and his wife, Stacy Banks reside in Cleveland, OH. They have three children, Maia, Madeleine and Micah.

PROFESSOR TIM A. OSSWALD is the Director of the Polymer Engineering Center at the University of Wisconsin-Madison and is Honorary Professor of Plastics Technology at the University of Erlangen-Nuremberg in Germany and the National University of Colombia. His research includes modeling and simulation in polymer processing, engineering design with plastic and composite materials, and sustainability in plastics manufacturing. Professor Osswald serves as the Chief English Language Editor for the Journal of Polymer Technology and Editor for the Americas for the Journal of Polymer Engineering. He has published over 300 peer-reviewed conference and journal articles as well as 15 books translated in five languages, including: International Plastics Handbook (2019), Polymer Processing – Modeling and Simulation (2006), Understanding Polymer Processing (2017), and Materials Science of Polymers for Engineering (2012). Professor Osswald has also served as an expert witness in polymer engineering litigation, including product failure, patents and intellectual property and is on the advisory board of multiple companies. He is currently adviser to the President of Colombia in their creation of a new Ministry for Science, Technology, and Innovation.



PHIL BEESLEY is the Business Development Director at Sumitomo Bakelite North America, where he is responsible for developing new markets and aligning the Sumitomo business model to help customers meet their strategic goals. Over the past 20 years he has developed a number of pioneering Thermoset markets in the Automotive, eMobility & Micro-Electronic industries and today uses his Executive experience leading the key divisions of Sumitomo Bakelite to help the next generation of Technology Executives achieve their growth objectives.

Prior to joining Sumitomo Bakelite, Phil held a number of Global Commercial roles in the Specialty Chemical & Thermoplastic industries with Perstorp & GE Plastics respectively and he started his career as an Engineer at Ford in his hometown of Liverpool (UK). He has always had a passion for all things Automotive and is excited to be actively involved in making the transition to a carbon-free world of mobility a reality.

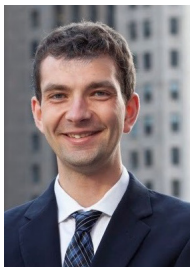
Phil earned his MBA from Henley Management College (UK) in 1997 and a B.Eng degree in Mechanical Engineering from Salford University (UK) in 1991.

See Dale Brosius' Bio on page 3

12:00–1:00 **NETWORKING LUNCHEON** *Sponsored by* MBI MAR-BAL INCORPORATED **& EXHIBITS**

DAY 1 PM MODERATOR: Len Nunnery, ***Board Member*** **TOPCON -** ***Plenco***

1:00–1:30 **MATERIAL TECHNOLOGY: Inflation Reduction Act Composites Overview**
Paul Salach, ***Owens Corning***



BIO: Paul Salach is a graduate of Michigan State University with a degree in Applied Engineering Sciences with concentrations in Supply Chain and Packaging. He began his career at Owens Corning in 2017 as a member of their Supply Chain Leadership Program. In 2020 he transitioned to marketing as a Strategy Analyst where he provided executive level recommendations on organic growth opportunities across Owens Corning's three businesses. He currently serves as Product Manager for Type 30 Single End Rovings in the Americas region while pursuing his MBA at Chicago Booth.

ABSTRACT: The passage of the Inflation Reduction Act resulted in $370BN of public funding going into green technologies. Over 60% of these funds will go directly into applications relevant to composites. Alongside wind, composites opportunities exist within electric vehicles, poles, cross arms, advanced conductors and more. Additionally there are favorable tax credits related to capacity expansions for the aforementioned applications plus any project that reduces GHG emissions by 20%. The presentation will cover growth projections for relevant composites technologies along with available tax credits that can benefit the composites industry. We will also cover high level global economic outlook, some key markets for composites, and the impact on the glass industry.

BIOS/ABSTRACTS

1:30–2:00 **BUSINESS:** **So you want to be a supplier to John Deere...**
Gregory McCunn, ***John Deere***

BIO: Greg McCunn has been developing John Deere composite components for 25 years. He makes it a mission to study and evaluate the effectiveness of applications in which OEM have implemented composite components. His background as a quality engineer supplying molded plastic interior trim parts to automotive OEMs, provides unique perspective to the supplier (molder) and customer (OEM) relationship. During his tenure as supply base manager, he developed connections between John Deere and its molder suppliers. As a materials engineer supporting product engineering, he strengthens this bond working together with suppliers to provide component design recommendations, material and process selection that align with John Deere applications.

ABSTRACT: Everyone wants to be a supplier for John Deere, except those that already are! As an original equipment manufacturer, John Deere is a leader in steel manufacturing processes. However, the purchased component content of equipment has exceeded the steel content. As a result, John Deere has driven to develop a base of preferred suppliers. To achieve this, John Deere implemented robust strategic sourcing process intended to identify high performing suppliers and align them with appropriate John Deere applications. Greg will review the criteria to become a John Deere supplier. As well as the requirements John Deere defines for ongoing production suppliers.

2:00–2:30 **MATERIAL TECHNOLOGY:** **High Performance Heat and Structural Thermoset Foams**
Fred Deans, ***ATSP Innovations, Inc***

BIO: Fred Deans has a Bachelor of Science in Mechanical Engineering (BSME) from Valparaiso University and an MBA from the University of Pittsburgh. He has experience as a Production Engineer, Technical Service Engineer, and Sales Manager – Automotive, Architectural, and Solat Products for PPG Industries, Inc. He has additional experience as Market and Industry Manager at GE Plastics and Industry Manager at AZDEL, Inc. GMT Composite Products. Fred has many Society Memberships and Industry Award Including:

- Member, Board of Directors, International Society of Plastics Engineers (SPE) – Automotive and Composite Divisions
- Past Chairman, Automotive and Composites Divisions. Past Chairman, 2001 & 2004 SPE Automotive Composites Conference & Exposition (global automotive composites conference & exposition),
- SPE Honored Service Award – 2003; SPE Composites Person of the Year, 2008; SPE Automotive Division Lifetime Achievement Recipient, 2015;

ABSTRACT: ATSP Innovations, Inc., Houston, TX is a developer of high-performance polymers and resin alloys based on their patented aromatic thermosetting co-polyesters. Recently, ATSP Innovations, Inc. has created a new class of structural thermoset polymer foam material for use in various applications. The foam has a Tg of > 300C, offers inherent FR performance, and can be fabricated with densities from 100 kgs/Cu Meter to 600 kgs/Cu Meter, can be produced in various thicknesses and sizes, making it ideal for use as light weight semi-structural structures.

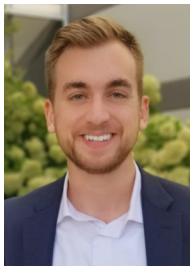
2:30–3:00 **BREAK & EXHIBITS**

3:00–3:30 **TECHNICAL:** **RCR Capillary Rheometer**
Tim Haake, ***GÖETTFERT***

BIO: Tim Haake studied physics in Germany, got an MBA in America and worked trade shows on all continents but Antarctica. He taught classes about Rheology, Organizational Change, Critical Thinking and International Marketing. He managed small and large companies, mostly being involved in the realm of measurement instruments, especially being involved in the field of rheology, in the third generation. Tim has been involved with SPE and worked with GOETTFERT for over 20 years.

ABSTRACT: Rheological analysis of the curing process of Thermosets

3:30–4:00 **TECHNICAL:** **Sensor-Based and Data-Driven Thermoset Manufacturing Optimization**
Alec Redmann, *NETZSCH Instruments*



BIO: Alec Redmann is the Business Development Manager for NETZSCH Instruments working with thermal analysis technology for polymer and composite materials. His current focus is developing solutions for in-mold material characterization and dynamic process control. Prior to joining NETZSCH, he worked in composite manufacturing and R&D roles for the wind energy and sports industries. Alec received his PhD in Mechanical Engineering from the Polymer Engineer Center at the University of Wisconsin-Madison.

ABSTRACT: Future global regulation goals regarding sustainability and energy consumption are creating a difficult challenge to overcome for the thermoset plastics industry. At the same time, the currently increasing demands of complex and cascaded processes to produce high-quality and functional parts are steadily obscuring the interrelation between process parameters and material behavior. Thermoset manufacturers have the opportunity to embrace the technological possibilities of digitization to have tools at hand that enable the simultaneous increase in quality, productivity, and sustainability.

We present a fixed, in-mold sensor solution to tackle these challenges using real-time material characterization, state-of-the-art simulation, data analytics, and artificial intelligence to detect material and process deviations during the molding process. A case study demonstrates a molding process for an automotive component where the engineers were able to dynamically adapt the parameters to achieve complete quality control. The result is an immediate improvement in waste reduction, cycle time optimization, and decrease in energy costs per part.

4:00–4:30 **TECHNICAL:** **Simulation with Thermosets Based On Material Data Collected In a Real Molding Process**
Ingo Schwarz, *Schwarz Plastic Solutions GmbH*

BIO: Ingo Schwarz completed a dual education in industrial business management (aviation industry) and then entered the family-owned plastic molding business (thermosets and thermoplastic materials) near Munich (Germany). He covered various commercial positions, followed by production and engineering tasks. Besides the German facility, a new production site in Spain was started in the early 1980s'. At that time, he became Managing Director in the group with focus on project management. To allow pushing thermosets, he focused on simulation technology from 2005. When he sold the company in 2015, he started the consulting company Schwarz Plastic Solutions GmbH with the aim, to bring scientific results and practical experience together and offer this as a package of experts to the market.

ABSTRACT: Global regulation goals for sustainability and energy consumption are forcing the industry in general and the thermoset plastics industry in particular to improve and to keep records of such improvement. Some customers are uncertain about batch-to-batch variation and the impact of fluctuations in the shop floor. And finally, the cycle times, due to uncertain curing times for thermosets are a roadblock for new projects. To reach a reduction of energy, material, and waste, and to stabilize quality and output for higher competitiveness, the thermoset industry needs better data; starting from simulation, to mold improvement and adaptable process settings in molding.

We present here how data in real production processes have been collected, analyzed by AI and transferred into simulation to show that this is not a theoretical suggestion, but a real case study from A to Z. With these trails we can offer a pre-defined database for a number of materials, which can be used by the customer from the beginning and can be upgraded with every single cycle they will run. Not only will the handling be easy, but also the documentation of success for the customer and the regulatory authorities.

4:30–5:00 **TECHNICAL TESTING:** **Flame Retardant Overview, FR Composite Development**
Glade Squires, *Omya, Inc.*

BIO: Glade Squires holds an Undergraduate and graduate study in Chemistry University of Pittsburgh and has over 40 year's experience in the Flame Retardant industry. Mr. Squires has held positions in Flame Retardant synthesis in R&D, Commercial Development, Sales and Marketing, and has experience in all Flame Retardant chemistries.

Further professional titles for Mr. Squires include Former Vice President of the Fire Retardant Chemicals Association and Former board member of the Massachusetts Chemistry and Technology Alliance.

On a personal level, Mr. Squires contributions include: Former President and Commissioner of the Pennsylvania Fish & Boat Commission; President of the West Chester Fish, Game & Wildlife Association; as well as Hunter Safety Instructor Pennsylvania Game Commission.

ABSTRACT: Although thermosets by their very nature of being crosslinked have a higher level of flame retardancy, certain more demanding applications require the addition of flame retardant additives to meet specifications. Many of these applications will require final products to be tested according to ASTM E84, Steiner Tunnel. Development of final products to meet ASTM E84 can be costly if run only in the Steiner Tunnel to gather fire performance data and make final formulation adjustments to meet required flame spread and smoke. The use of the Cone Calorimeter as a product development tool for fire performance can shorten development time and offer significant R&D savings. A test case using the Cone Calorimeter for the development of a new FR thermoset product will be reviewed.

5:00–7:00 **COCKTAIL RECEPTION** *Sponsored by* plenco **& EXHIBITS**

WEDNESDAY, MAY 10, 2023

7:30–8:30 **NETWORKING BREAKFAST** *Sponsored by* lyondellbasell *Advancing Possible* **& EXHIBITS**

8:30–8:45 **DAY 2 KICKOFF OF THE 2023 TOPCON SHOW: Sean Campbell,** TOPCON *Chair 2023, 2024 - LyondellBasell*

DAY 2 AM MODERATOR: Greg Spaeth, *Board Member* TOPCON – *Plenco*

8:45–9:30 **KEYNOTE ADDRESS: SMC - Successes, Challenges & Recent Innovations, and Thoughts on a Path Forward**
Probir Guha, ***Composites Innovation Inc.***

BIO:

Probir Guha retired at the end of 2021 after an illustrious career in the composites industry mostly with companies including The Budd Company, Continental Structural Plastics and Coats.

Over the almost 50-year career, he has held leadership positions in various companies during his career. During this period, Probir has participated in key innovations in the field as borne out by his many global patents; participated in industry technical conferences presenting several papers and holding committee leadership positions; was recognized with a Lifetime Achievement Award in 2022 from the SPE Automotive Division; an industry award received for innovation, research and advancements with the 2019 Pioneer Award by The American Composites Manufacturers Association (ACMA); and has edited a book where he coordinated the efforts industry and academic experts in the field to share concepts of how to further the composites industry

However, the 'retirement' has been short-lived! Probir has recently formed a technology consulting company, Composites Innovations Inc., to continue to pursue efforts on cost effective light weighting of products using composites, thus bringing the adoption of lightweight materials across more and more applications.

In this new role as a technology consultant, Probir is looking to establish composites as the primary material of choice in automotive applications with special focus on innovations in: sustainability & recyclability of composites; use of continuous and hybrid fibers; smart composite technologies; and use of artificial intelligence in products and for continuous improvement

Mr. Guha's education includes: Bachelors in Chemical Engineering from the Indian Institute of Technology, Kharagpur, India; Masters in Polymer Engineering from the University of Detroit, Michigan; Masters in Business Administration from the Wayne State University in Detroit, Michigan.

Mr. Guha holds 179 patents issued & pending globally as of June 19, 2022
https://patentscope.wipo.int/search/en/result.jsf?_vid=P22-L0KW9U-65948
The body of innovations include:

- **CSP / ThyssenKrupp Budd:**
  - Development and launch of TCA (Tough Class 'A' SMC) for automotive body panels (Ford, GM & Chrysler)
  - Development and launch of a structural SMC for use in the industry first Composite Pickup Box (Ford Sport Trac & Toyota Tacoma)
  - Numerous materials & process innovations in Fiber reinforced composites
  - Use of Carbon Fiber for cost effective light weighting
  - A process to reclaim Carbon Fiber from end-of-life cycle composite components
- **Coats**
  - Bringing textile expertise into mainstream composites applications with near net shape preforms using hybrid fibers & molded-in features and smart features to eliminate post-mold steps to a final product

ABSTRACT: The presentation will be a discussion on SMC, its successes & challenges, past and recent innovations and how it may move forward from here. Probir has seen the growth, changes and challenges faced by the composites industry through the years. This paper will include discussions on the SMC process and products; and brief review of a few technological innovations seen in the couple of decades. And touch upon key challenges and opportunities ahead of the composites industry.

The industry will need to use continuous glass fibers with a focus on minimizing cycle time or maximizing throughput. We will discuss techniques from the textile industry that may be used to bridge the performance gap in a cost-effective manner.

In a further utilization of techniques from the textile industry we will discuss paths to integrating smart devices and actuators into a molded composite component to add value that is not as easily and cost-effectively added via other technologies like stamping or casting.

Probir will end the session with a participative discussion on a possible path forward to re-invent composites for the future.

9:30–10:00 **MATERIAL TECHNOLOGY: How to Accomplish Low Stress while Molding Polyester BMC**
Ryan Furno, *SIGMASOFT*

BIO: Ryan Furno is a Graduate from Ferris State University with a B.S in Rubber Engineering and A.A.S Plastics Technology. He worked in the rubber industry as a Sr. materials engineer for 15 years with a concentration of rubber testing, rubber mixing and rubber to metal bonding.

ABSTRACT: Polyester molding can be challenging especially with glass filled fiber. My presentation will show you areas of stress and where to place a gate to achieve low stress. Simulations will concentrate on curing degree and filling temperature. I will be highlighting how this specific part shrinks and warps for form, fit and function.

10:00–10:30 **BREAK & EXHIBITS**

10:30–11:00 **APPLICATION: Composite Manhole Covers - Offering Never Seen Before Infrastructure Tools and Solutions**
Chad Nunnery, *Composite Access Products*

BIO: After graduating from Dartmouth College with Engineering & Chemistry degrees in 1994, Chad Nunnery started a career in composites manufacturing. For 20 years Chad formulated, sold, and managed composite raw material companies globally. He also started international facilities in Latin America residing in Mexico City for six years. During these global experiences, Chad witnessed that composites would solve many problems suffered with traditional manhole cover materials - inflow, SSOs, theft, corrosion, weight, data transmission blockage. In 2015 Chad formed CAP, located in McAllen, TX. Now used in over 500 municipalities and 46 states, CAP won the 2020 Award for Composites Excellence (ACE) from the ACMA and was acknowledged by Fulton County, GA as "key" to eliminating sewer spills.

ABSTRACT: Municipalities and other underground utility users began purchasing composite manhole covers in the late 1980s for a variety of reasons: corrosion resistance, low weight, and as a theft repellant. Massive theft of metal covers for the recycled content in China launched the first large volume production in China around 2003-2004. While China and other non-Western suppliers started with compression molded processes, they did not introduce technological advances since the main goal was an inexpensive, theft-resistant solution. The Americans and Europeans molded with resin transfer style molding – the high cost, relatively slow production cycles, and quality challenges of RTM limited large scale propagation as well as technical development.

Around 2016-2017 the first American composite compression molding of traffic-rated manhole covers began and within the first few year's new technologies were introduced. The first RFID encapsulated cover allowed users to assign data and control assets by merely pointing a scanner at the product. Molders also began to encapsulate other features to allow users to locate covers that may have been overlayed with asphalt by transportation contractors. Cosmetic technologies were also introduced that could not be accomplished with existing metal technology. Colors, stone-like appearances, and large custom logos were presented for the first time.

The ability to make a manhole cover assembly watertight submerged was also achieved by composite technologies. This breakthrough addresses a leading cause of water pollution amounting to 32 trillion gallons of pollution each year. Rainwater, river spillover, snowmelt, rising tidal waters, overflowing levees - meant to be transported into our natural waterways via storm systems - will also leak into our sanitary sewer system (Infiltration and Inflow or "I&I"). Unlike the drainage systems, the sanitary systems deliver fecal matter and toxic chemicals to wastewater treatment plants. These sanitary systems have limited capacities, and when the I&I – not requiring treatment – enters the sanitary system, volumes can exceed that capacity. The result of exceeding the sanitary capacity is that the pathogen-filled sewer water reverses, surcharges, and spills into the streets and waterways.

High-tech smart manhole covers have recently been introduced using composite materials. These covers measure important variables with sensors under the covers - such as manhole fluid levels - and transmit this data to a central office or operators' portable devices. This information can be used as an early warning alarm preventing sewer spillovers as well as allow troubleshooting to identify the major points of water inflow. Composites allow this transmission without drilling antennae holes or attaching antennae shields on the covers which are necessary when using iron because iron blocks these signals. And because the composite covers are lighter, these smart covers can be moved around the system pinpointing much greater accuracy where public work resources should be spent rather than large collection-system rehabilitation project expenditures.

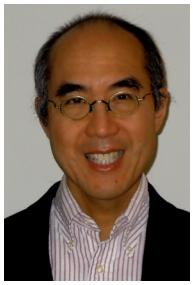
The design flexibility and beneficial material properties of composite solutions will be driving new products in the infrastructure space for the next decades. In addition to manhole covers, great strides with utility poles, fiberglass rebar, underground structures, pipe liners, and many others have begun to make significant market penetration. For the past 30 years this migration has been motivated by the end-product benefits and this will continue to accelerate the transition. But also, the large drive to reduce carbon emissions – with new composite technologies winning the sustainability argument, will push thermosets into the forefront with an even greater momentum.

11:00–11:30 **TECHNICAL:** **Advancing Sustainability of SMC & BMC Composites**
Thomas Ebeling, ***LyondellBasell***

BIO: Tom Ebeling is the R&D Manager for the Engineering Composites division of Lyondellbasell in the US/Canada region. Tom has over thirty years of experience in innovating polymeric material systems, designing their manufacturing processes, and developing new application uses for them. Prior to joining Lyondellbasell Tom held a variety of technical and management positions in GE Plastics, Hanwha Azdel and Nordson. Tom received a BS in Mechanical Engineering from North Dakota State University, a Masters & PhD in Polymer Science from Case Western Reserve University. In addition to positions in the US, he has had assignments in Europe and Asia.

ABSTRACT: For many years SMC & BMC composites have provided sustainability benefit in the use phase of their life cycle. As technologies continue to advance so do opportunities for enhancing the sustainability of these materials in other parts of the materials' life cycles. These technical advances, coupled with an increased value placed on sustainable materials by the markets, are expected to accelerate the adoption of sustainable technologies. This presentation will cover past efforts to enhance sustainability of SMC & BMC composites outside of the use phase.

11:30–12:00 **TECHNICAL:** **Cure Monitoring of Carbon Fiber Filled Composites in Manufacturing**
Huan Lee, ***Lambient Technologies***



BIO: Huan Lee is an electronics engineer with more than 30 years experience designing instrumentation for dielectric cure monitoring in the composites industry. He has graduate degrees from the Massachusetts Institute of Technology and is a co-founder of Lambient Technologies. Earlier he was a co-founder of Micromet Instruments, which first commercialized the cure monitoring technology developed at MIT.

ABSTRACT: The increasing use of carbon fiber composites in high-volume production is driving the need to know cure state in real time. Dielectric cure monitoring (also called Dielectric Analysis, or DEA) is the only method that can probe material properties during manufacturing, and a past study had demonstrated its ability to reduce average SMC press cycle times by detecting end of cure, resulting in an estimated potential saving of $70,000/year/press in labor costs alone.

Cure monitoring of pure resins or resin-fiberglass composites is generally simple and only requires placing the material on a dielectric sensor. With carbon fiber composites, however, a conductive fiber contacting the sensor will short-circuit its electrodes and cause bad, unusable measurements. Dealing with this problem typically involves the use of filters to block conductive fibers, but filters must be replaced manually after each test and add time, effort and cost, so it is necessary to avoid them in rapid, repetitive manufacturing.

Specially coated dielectric sensors allow direct contact with carbon fiber composites, can observe the entire cure without interfering with manufacturing process flow, and can detect end of cure for opening a press or mold. As a result, cure monitoring is now practical for a wide range of carbon fiber composite products, especially high-volume automotive parts such as wheel rims, roof elements and other frame components.

12:00–1:00 **NETWORKING LUNCHEON & EXHIBITS**

DAY 2 PM MODERATOR: Sean Campbell, TOPCON ***Chair 2023, 2024 - LyondellBasell***

1:00–1:30 **PROCESS TECHNOLOGY:** **Integrated Deburring / Deflashing Process In The SMC Press Automation Process**
Christian Fais, ***Schmidt & Heinzmann***

BIO: Christian Fais has held his position as President of Schmidt & Heinzmann North America since July 2018, where he is responsible for business development,sales, and technical support in North/South America. Christian has more than 20 years of experience in Technical Sales and Project Management and held several positions in the plant engineering and construction business. During the start-up phase of the Fraunhofer Project Center in London, ON he was responsible for implementing and setting up the LFT-D, D-SMC and RTM process in cooperation with the Fraunhofer selected researchers. In his current primary role, he is responsible for the business growth of the company Schmidt & Heinzmann North America Inc and runs both operations located in Chandler, AZ and Akron, OH.

ABSTRACT: The presentation will outline the newest innovative deburring/deflashing technology, which is integrated in the already developed SMC Press Automation Process.

This technology is setting new standards in the SMC part finishing process. The technology will bring following advantages:

1. Reduces manual handling processes
2. Deflashes sharp corner edges
3. No chipping with a smooth accurate edge in different forms

1:30–2:00 **MODELING:** **Thermoset Material Data Cards and Process Modeling - Game Changer for SMC Market**

Mohamed Selem, ***Owens Corning***

BIO: Dr. Selim is a senior applications development and modeling engineer at the Composites Center of Excellence in Owens Corning. He focuses his R&D work on composites application development and process modeling. He obtained his PhD degree from the Mechanical Engineering Department at University of Alabama at Birmingham in 2016 and his Master's degree from the Arab Academy for science & technology, Egypt in 2011.

ABSTRACT: Many Tier-1 molders in the automotive and transportation sectors are facing challenges when it comes to manufacturing Sheet Molding Compound (SMC) parts with complex geometries. Inherently, SMC is known to be an intricate composite material for which the part design can highly affect the performance. A typical SMC compound is made of thermoset resin, chopped glass fiber, fillers, and additives. During the compression molding process, the flow inside the mold dictates the mechanical properties. For complex designs, this leads to local variability in the performance within the part, which could lead to falling below specifications.

Owens Corning Science & Technology recognized that to achieve high accuracy of process modeling of SMCs, it is a must to start from creating accurate test methods to generate accurate Material Data Cards (MDC). Owens Corning combined existing test methods with new ones that are specifically designed for SMCs to accurately capture the anisotropic behavior this composite material. High prediction accuracy is achieved based on multiple modeling and testing capabilities development through cross-functional team collaborations. Utilizing MDC and process modeling framework enables significant productivity gains and reduces the development cost and time.

2:00–2:30 **PROCESS TECHNOLOGY:** **High-Resolution Ultrasound to Quantify Sub-Surface Wrinkles in a Woven Carbon Fiber Reinforced Thermoset**

Admay Amif, ***Baylor University***

BIO: Md Admay Amif, is a 2nd year Ph.D. student in the Department of Mechanical Engineering at Baylor University. His current research focuses on carbon fiber reinforced polymer (CFRP) composites and Non-Destructive Testing. He is currently working on quantifying sub-surface wrinkles in carbon composites, applying conventional and Phased Array techniques for detecting different types of common defects in carbon composites and investigating the structural effects of various defects on carbon composites.

ABSTRACT: Carbon fiber reinforced polymer (CFRP) composites are popular materials in aerospace and automotive industries because of their low weight, high strength, and corrosion resistance. However, wrinkles or distortions in the composite layers reduce their mechanical performance and structural integrity significantly. This paper presents a fabrication process to create consistent out-of-plane wrinkled panels with woven carbon fiber reinforced polymer (CFRP), simulating the in-service wrinkle observed in industries that utilize thick structure composites such as vertical lift or wind power. The individual lamina geometries are extracted from the fabricated coupon with an embedded wrinkle from captured ultrasonic waveforms generated from single-element conventional ultrasonic (UT) scan data. From the extracted waveforms, a method is presented to characterize the wrinkle features by each individual lamina, specifically the spatially varying wrinkle height and intensity for the wrinkle.

From visual inspection, parts are fabricated with undetectable wrinkles using a wet layup process and a hot press for curing. Scans were performed in a conventional immersion tank scanning system, and the scan data was analyzed for wrinkle detection and characterization. Extraction of the layers was performed based on tracking voltage peaks from A-scans in a time domain. Spatial Gaussian averaging was performed to smooth the A-scans, from which the surfaces are extracted for each individual lamina. The extracted winkle surface aligns with the anticipated wrinkle geometry.

2:30–3:00 **BREAK & EXHIBITS**

3:00–3:30 **PROCESS TECHNOLOGY: The Use of Full Waveform Capture to Quantify Subsurface Features in Laminated Composites**

David Jack, *Baylor University*

BIO: David holds five undergraduate and graduate degrees across the fields of Physics, Mathematics and Mechanical Engineering. David has been awarded over $16,500,000 as in externally sponsored research, of which he is the lead PI on $12,900,000. He has published over 30 peer-reviewed journal articles, 95 refereed national and international conference articles, and has six patents with eighteen patents pending. Dr. Jack's expertise crosses physics-based constitutive modeling with experimental polymer characterization. David has established himself as a leader in the numerical modeling and inspection of fiber reinforced polymer systems spanning composite railroad ties, aerospace primary structure, automotive components, and sporting goods. The techniques developed by Dr. Jack and his students have resulted in six different FAA 8100-9 Statement of Compliance with Airworthiness Standards, with three more under DER review and three more in testing. David has served for several years as the Technical Program co-Chair and is the current co-Chair for the SPE ACCE. David is also the founding and current faculty advisor for the Baylor Chapter of SPE.

ABSTRACT: The use of carbon fiber reinforced materials are becoming mainstream in the aerospace, automotive, and sporting industries due to their versatility in performance, geometric complexity, and high strength to weight ratio. However, this enhanced performance can be greatly compromised by the presence of internal geometric variability, often termed indicators in the inspection community and flaws by the structural engineers. The capture and quantification of these internal features is essential for the qualification of these high-performance parts. This paper presents an overview of the work completed by the researchers in the area of full waveform capture for ultrasonic and eddy current signals for the inspection and subsequent quantification of internal geometric features in laminated composites. Specifically, we will show how the use of the full waveform capture greatly enhances feature detection, and through the appropriate methods these features can be quantified for later use when making engineering decisions as to the final part performance. Specifically, we show how we can use this high-resolution waveform capture to identify BVID (barely-visible impact damage), FO (foreign objects), delaminations, bondline quantification, ply stack qualification, ply drops, missing adhesive, and other common defects that occur in laminated composites. For each example, the current industrial standard focuses on detectability, whereas with our approach we both detect smaller features than is currently achievable and subsequently quantify the dimensions of the internal feature.

3:30–4:00 **TECHNICAL: Coal-Derived Fillers and Resins as Economic and Sustainable Raw Materials for Thermosets**

Stefan Holberg, *University of Wyoming*

BIO: Stefan is an Associate Research Scientist at the School of Energy Resources at the University of Wyoming, USA, working on coal-derived materials and their commercial application. Before joining the University of Wyoming almost 5 years ago, Stefan worked in Denmark and Germany on the development of functional coatings for industrial customers.

Stefan, a native German, has a MSc and a PhD in Organic Chemistry from the University of Stuttgart in Germany.

ABSTRACT: Focus of this work is the application of coal char as filler in a phenolic molding resin. However, a brief overview over a conceptual coal refinery and the applications of coal extract as precursor (resin) for thermoset polymers will also be provided.

The state of Wyoming, accounting for about 40% of the total US coal production, is putting effort into developing novel, non-fuel uses for its subbituminous coal. A conceptual coal refinery, with some processes at pilot stage, shall comprise pyrolysis to produce coal char and solvent extraction to produce coal extract. While these products shall both economically and regarding their CO_2 footprint compete with crude-oil derived products, the refinery shall include additional measures to further mitigate the carbon footprint.

Subbituminous coal, with its chemical structure mainly derived from lignin, comprises molecules providing phenolic or carboxylic acid groups that can be-crosslinked with a suitable co-reactant. As coal is practically insoluble and does not melt, processing is hardly possible. By solvent extraction at mild conditions (below 400°C), for example using an alcohol as solvent, a meltable or dissolvable solid extract is obtained. Besides decarboxylation and depolymerization, main structural features, such as phenolic groups, are preserved. We have demonstrated how these groups can be crosslinked, for example, with epoxides, or can be further modified, f. ex. by esterification or reaction with ethylene oxide.

Coal char is a solid, carbon-rich, nontoxic, practically volatile-free residue from coal pyrolysis, the thermal treatment of coal under inert conditions at typically 700 - 1100°C. While metallurgical coke used to make iron is an example of coal char, the coal char used herein is produced from more economic, non-metallurgical coal by a faster, more economic process. We applied the coal char as filler in compression-molded phenolic resin composites and investigated the effects of filler concentration, particle size, and blending method on mechanical and thermal properties and morphology, in comparison to reference materials. When simply blending resin and char powders, the highest compressive strength of 246 MPa was reached using 50 wt% coal char, outperforming an equal amount of wood fiber (sawdust) as filler. When blending coal char and a phenolic resin solution, and subsequently removing the solvent, significantly improved particle dispersion allowed high filler loads, with compressive / tensile strength being 288 MPa / 75 MPa for 60 wt% coal char and 307 MPa / 37 MPa for 70 wt% coal char. While we regard the char as a promising filler for novolac resins to produce molded objects, we also consider the application as load-bearing building material, as we expect an outstanding compressive strength to cost ratio, both compared to other phenolic composites and compared to established building materials such as brick or concrete, combined with reasonable thermal stability (investigated by TGA) and low water absorption.

4:00–4:15 **CLOSING COMMENTS: Len Nunnery,** *Board Member* **TOPCON - *Plenco* | CONFERENCE ADJOURNS**

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SEAN CAMPBELL, LYONDELLBASELL - DIVISION CHAIR

Sean Campbell has been in many different roles within the Plastic Industry for the past 30 years. Sean has worked as an Account Manager and Marketing Manager at GE Plastics in both Engineering Thermoplastic and in Thermoplastic Composites. Sean worked in Senior Management for Freudenberg at the Vitech Venture as a General Manager in Plymouth, Michigan and as the Division President in Hopkinsville, KY. Sean has worked in the Thermoset Composite Industry for 5 years at A. Schulman and at LyondellBasell as a Leader in Sales and Marketing.

Sean has a Polymer Science Degree from Pennsylvania State University and an MBA from St. Joseph University in Phil, Pa. Sean has 3 grown children and enjoys golf, working out and long distant swimming.

RICK FAULK, MAR-BAL – PAST DIVISION CHAIR

Rick has been in the Thermoset industry for over 30 years. He has worked in most areas associated with the manufacturing and sale of composite materials and molded components. As product manager, Rick is responsible for taking composite applications from concept into full scale production. This business development process requires him to collaborate with OEM's, custom molders, captive molders, and the associated support functions. Mar-Bal, Inc., is headquartered in Chagrin Falls, Ohio and Rick has been there for the last six years. He has enjoyed participating with the MBI team and contributing to their sales growth, technological advancements and overall success.

Rick brings a wide variety of knowledge, experience, and an extensive business network to the SPE- Thermoset Division Board of Directors. He has served in various positions on the board and has been active member with SPE since 2006.

GREG SPAETH, PLENCO – SECRETARY

Greg Spaeth is Project Engineer at Plastics Engineering Company (PLENCO). PLENCO is headquartered in Sheboygan, WI and is a leading North American manufacturer of phenolic resins and thermoset molding materials. Mr. Spaeth holds a BS in Mechanical Engineering. He carries out special research and development projects, including material development and specific part functionality testing. With the PLENCO Technical Service Department, he works with customers to prototype new tooling and cut costs through process improvement projects. His work now includes providing part optimization and design input utilizing PLENCO's Finite Element Anaylysis capabilities.

JESSICA WARNER, OMYA – TREASURER

Jessica Warner is a Technical Service Engineer with Omya, based out of the Omya Technology Center in Cincinnati, Ohio. She has been with Omya in industrial minerals since 2016, providing technical support to many customers in PVC, polyolefin, and thermoset applications. Over the past few years, her work has shifted to focus on developing collaborative projects for the thermoset market. In that capacity, her primary collaborators are manufacturers of thermoset composites, mainly in North America. Jessica has developed extensive knowledge of physical properties testing for polymer composites in the lab, as well as experience in polymer processing and extrusion. She has worked to develop statistical models and predictive calculators for efficient product evaluations.

Jessica is responsible for providing technical support to customers on the use of Omya products for applications in the Technical Polymers Applications segment in North and South America. She also manages the process for the qualification of new additives in North and South America operations. Recent projects focus on understanding particle flow and movements as well as suspension viscosity. Jessica presented an overview of this work at TOPCON 2019. Jessica earned her bachelor's degree in Chemical Engineering from Miami University in Oxford, Ohio, in 2018.

LEN NUNNERY, PLENCO – DIVISION COUNSELOR

Mr. Nunnery's career has been spent leading the commercial organizations of various composite, elastomer (rubber / silicone), plastics and resin interests through mixed organic and inorganic growth initiatives. He has worked under vertically integrated models that include the development and manufacture of highly customized materials complimented by the production of precision components and assemblies (employing same said material products). Mr. Nunnery possesses a unique depth of knowledge in composites, plastics and elastomer technologies, the markets served, the commercial landscapes associated and the regulatory issues affecting the spaces.

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LEN NUNNERY CONTINUED

Mr. Nunnery's career endeavors have been supplemented by extensive exposure to private equity organizations, M&A, enterprise integration, product rationalization and exit processes. The ability to build strong strategic plans, institute and administer mission focused KPIs, select and manage the most effective people and deliver / report growth results to the investment and finance industry's most reputable sponsors have been critical aspects of his success. Mr. Nunnery has excelled under sponsored portfolio business models.

Across his twenty-five years in technical / commercial roles, Mr. Nunnery was directly involved with numerous material conversion programs (metal to polymer based solutions) involving the transportation (both light and heavy), medical device, industrial, infrastructure, military, aerospace, sport, food service and appliance markets. These conversions have led to over $1B in industry sales.

Mr. Nunnery has produced original technical content and authored several white papers. He has presented his work (including overviews of a composites processing patent he was issued) at dozens of international university, association and trade events. In addition, he has written numerous articles and technical overviews for a collection of industry tabloids and corporate briefs.

WALTER SCHUTZ, ICT MOLDING SOLUTIONS – BOARD MEMBER

Walter "Bud" Schutz Jr is president of ICT MOLDING SOLUTIONS INC a company he founded in 2014 which specializes in Injection / Compression and Transfer molding of Thermoset molding compounds consisting of both polyester & phenolic along with many other well-known materials including most engineered and commodity Thermoplastic resins.

Over his 27 year career, Walter has been involved in many aspects of the manufacturing & business sector of molding and all its related facets. He served as a tool and die apprentice and over the years evolved up to Production Engineer of molding and secondary sub-assemblies. To go along with the manufacturing side Walter also possesses strong leadership skills serving many years as Director of Operations and Director of New Business Development.

Moving forward Walter is eagerly pursuing many cutting edge technologies to help the Thermoset industry stay strong and prosperous, some of which include high speed molding techniques along with environmentally friendly low impact mold building design practices. He currently resides in Northwest Pennsylvania with his daughter, Emily.

TOM HAAG, FOX VALLEY MOLDING – BOARD MEMBER

Tom Haag is President of Engineering, Quality and Sales for Fox Valley Molding, a custom processor of thermoset molding compounds and engineering grade thermoplastics. He has a BS in Mechanical Engineering from the University of Illinois, Champaign. Mr. Haag has been with Fox Valley for 15 years and has 22 years of experience within the plastics industry. His various roles included Manufacturing Engineer, Injection Molding Process Engineer, mold design, quality control and sales. He resides in New Lenox with his wife and children.

DALE SILVERNELL, IDI COMPOSITES INTERNATIONAL – BOARD MEMBER

Dale Silvernell began his career at Caribe GE in Patillas, Puerto Rico in 1992, where he learned about Thermoset Molding Compounds while working at supporting electrical vehicle controls assembly. Dale joined IDI Caribe, Inc., Salinas, PR in 1993. He has been a Senior Manager since 2005. Dale was Site Operations Manager Shanghai, China for two years and stayed in China until 2015. Currently reporting to GM and VP of North America. Since being with IDI, Dale has lived and worked in Puerto Rico; San Luis Potosi and Mexico City, Mexico; Shanghai, China and now Noblesville, IN USA.

'I have had the opportunity to travel and support customers throughout most of South America, North America, Western Europe, and a large amount of Asia. Have seen the massive opportunities for thermosets with a multitude of applications and markets... basically everything except "clear". I know a little about a lot of "stuff"... molding; tooling; formulating; a little management here and there. Primary role today is supporting global electrical OEMs, this of course due to doing the same thing in multiple countries for more than two decades (damn I'm old)', says Dale.

Dale is a US Army Veteran, 1985 - 1991 Desert Storm. Dale holds a Bachelor of Business Administration from Columbia College Caguas, Puerto Rico, 1999.

VINOD ARORA, CORE MOLDING TECHNOLOGIES – BOARD MEMBER

Vinod Arora is Director of Materials and Technology with Core Molding Technologies, a custom molder and processor of engineered composites headquartered in Columbus, Ohio. Prior to Core, Vinod has worked with other custom processors in similar industries and also in the paper and rubber industry. He has a BS and MS in Chemical Engineering. Mr. Arora has been with Core Molding for 15 years and has more than 30 years of professional experience in materials, design, processing and manufacturing including compression, transfer and injection molding. He resides in Spartanburg, SC with his wife, has 4 grandchildren, enjoys tennis and teaches Yoga and Pranayam.

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