SUMMER 2022
VOL 51, ISSUE 2

AUTOMOTIVE PLASTICS NEWS

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

AUTOMOTIVE COMPOSITES CONFERENCE & EXHIBITION
Novi, MI • September 7-9, 2022
Presented by SPE Automotive and Composites Divisions
WORLD'S LEADING AUTOMOTIVE COMPOSITES FORUM

COMPOSITES THE KEY TO EV
MOBILITY AND SUSTAINABILITY

SPE® ACCE 2022 PREVIEW

FIRST TWO KEYNOTE SPEAKERS ANNOUNCED

The executive planning committee for the SPE® Automotive & Composites Conference & Expo (ACCE) has announced the first keynote speaker for their ACCE 2022 event **September 7 – 9, 2022** at the Suburban Collection Showplace in Novi, Michigan. See page 6 for more information.

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AUTOMOTIVE

MEETING SCHEDULE & SPECIAL EVENTS CALENDAR

SPE Auto. Div. Board Meeting
via Webex – Contact Us for Meeting Link — 5:30 - 7:30 p.m. August 22, 2022

27th-Annual SPE Automotive Division Golf Outing
Fieldstone Golf Course, Auburn Hills, MI USA — All Day, September 6, 2022

22nd-Annual Automotive Composites Conference and Exhibition (ACCE)
Suburban Collection Showplace, Novi, MI USA — All Day, September 7-9, 2022

Innovation Awards Competition (IAG) Parts Nominations Due — September 7, 2022

IAG First Round Judging — September 15-16, 2022

IAG Blue Ribbon Judging — September 23, 2022

SPE Auto. Div. Board Meeting
via Webex – Contact Us for Meeting Link — 5:30 - 7:30 p.m. October 24, 2022

51st-Annual Innovation Awards Competition & Gala
Burton Manor, Livonia, MI USA — 4:30 - 11:00 p.m., November 2, 2022

SPE Auto. Div. Board Meeting
via Webex – Contact Us for Meeting Link — 5:30 - 7:30 p.m. December 5, 2022

Automotive Division Board of Directors meetings are open to all SPE members. All events are listed on our website at http://speautomotive.com. Email **Sassan Tarahomi** at auto-div-chair@speautomotive.com for more information.

CHAIR'S WELCOME

SASSAN TARAHOMI, SPE AUTOMOTIVE DIVISION CHAIR

My dear SPE Automotive Division members, I hope you are having a great summer. I am enjoying the summer too. If you didn't know, I live on the shores of lake Huron in Harrisville, MI and commute to downstate for face to face meetings and business. I am humbled to be your chair for the next two years. I have a big shoes to fill. My good friend Dr. Alper Kiziltas has done an extraordinary job in the last two years and it would be hard to beat, but I will promise you I would do my best to meet and exceed your expectations.

First, I like to express my gratitude and congratulate my predecessor, Dr. Alper Kiziltas for leading our division through the difficult COVID years with great results and a solid foundation for the upcoming years. Many thanks my good friend Alper!

As many of you know me, I am a busy bee and constantly working on a new SPE project. Our latest endeavor "Plastics in Electric and Autonomous Vehicle (EAV) Conference" was a great success. Thanks to the board for trusting Dr. Kakarala and I to proceed with this new conference, despite the short time and COVID limitations. Next, I want to thank many of you and the board members who made up the EAV conference committee members and worked very hard behind the scenes to make it happen. In short, we had a great team that clicked very quickly and worked hard to achieve success. Great comradery, friendship and lots of fun. Thank you.

As the chair of the division, setting goals are a requirement. So here are my 2022-2023 goals for the SPE Automotive Division:

- Getting back to work and have face to face meetings and putting COVID-19 behind us
- Making sure ACCE, EAV and Automotive Innovations Award & Gala are financially sound and successful as ever
- Increase membership
- Engage students at all levels with SPE Automotive Division activities. This may require a special "Student Committee" to make it happen.
- Build a closer relationship with other SPE divisions and sections

Finally, I'd like to let you know that I am ready and excited to serve you and am available 24/7 to listen to your ideas, suggestions and improvements related to SPE, our division, plastics and automotive industries. You can reach me by email **automotivechair@speautomotive.com** or on my cell phone **989-335-0060**.

Your division chair,
Dr. Sassan Tarahomi

A TRIBUTE TO CEDRIC BALL

CEDRIC ANTHONY BALL – AN AUTOMOTIVE AND COMPOSITES INDUSTRY CHAMPION, LEADING VOLUNTEER AND DEAR FRIEND

With a most heavy heart we are announcing that Cedric Anthony Ball, age 59, of Powell, Ohio passed away unexpectedly Saturday, February 26, 2022 at The Ohio State University Medical Center. He was an associate of Hexion in Columbus. Born and raised in Chicago, he received a bachelor's degree from the University of Illinois and a master's in business administration from The University of Michigan. Cedric was known for his love for his family and his kindness to friends. He was also a lover of house music, (commonly called a "House Head") and a genealogy enthusiast. He was preceded in death by his father, Anthony Ball. He is survived by his wife of 27 years, Libby J. Spaulding Ball; his children, Lisanne, Olivia and Donovan; his mother, Jean Cates Ball; and his sisters, Arlis Ball and Lorinne Ellis.

Cedric Ball established an outstanding global career as Innovation, Marketing and New Business development leader in composite materials with in-depth knowledge of the automotive, wind energy and building materials markets. Cedric began his career with General Motors as a chassis systems release engineer on the first-generation Saturn vehicle program. Since that time, he has served in a variety of marketing and new business development roles at Owens Corning, Ashland Performance Materials, BMC Inc. and Hexion Inc. He held a Bachelor of Science degree in General Engineering from the University of Illinois at Urbana- Champaign and co-MBA from Ecole des Hautes Etudes Commerciales (HEC Paris) and the Stephen M. Ross School of Business Administration at the University of Michigan - Ann Arbor. Cedric also was a certified 6 Sigma Black Belt.

Cedric was the Chair of the SPE Automotive Composites Conference & Expo (ACCE) in 2009 and 2010 leading the event to recognize applications in electric vehicles and be successful after challenges in the automotive industry. Cedric also volunteered on ACCE Committees for the SPE ACCE for many years and helped it to become a leading worldwide event.

As other achievements, we know Cedric from his role as Conference chairperson for SPE Annual Automotive Composites Conference and Exhibition 2009 and 2010. Cedric served several times as a board member in non-profit organizations, using his professional experi- ence to set and deliver upon strategic plans, to the benefit of communities and people.

"Cedric was one of the nicest gentlemen in the business and it was always my pleasure to work with him. I will miss him and so will the industry," — Teri Chouinard, Intuit Group, Inc.

"Cedric will be always remembered for his calm demeanor. He not only worked hard but worked with heart in his projects. His ability to envision and communicate customer's unmet and unarticulated needs was second to none. He will be missed in the technical community forever by many," — Pritam Das, Toray Composite Materials America.

"It was my honor and pleasure to serve with Cedric on many SPE programs. His profes- sional and personal support was well received and appreciated. I am saddened by his loss." — Fred Deans, Honored Service Member, SPE

Cedric Anthony Ball

Cedric Anthony Ball

Champion, Leader, Volunteer, Friend

"I met Cedric in the late nineties when he worked for Owens Corning. We remained in touch for the following twenty-five years. Across my career in plastics, I have not met a person that exemplified the terms 'gentle- man', 'businessman' and 'complete class act' more than Cedric. His work ethic was exceeded only by his integrity. His laugh was as heartfelt as it was contagious. I will deeply miss Cedric and offer my thoughts and prayers to his family." — Len Nunnery, Plenco (Plastics Engineering Company)

"Cedric was one of those people who treat- ed you as a friend from the first time you met him, and every time you crossed paths, he expressed genuine concern for how you were doing, before the topic changed to the business at hand. His contributions to the growth of the composites industry, and to the success of ACCE as contributor, sponsor and conference chair, are still accumulating and yet to be fully measured. I will miss his giant persona and salient insights." — Dale Brosius, IACMI CEO & Chief Commericalization Officer

"Cedric Ball was the consummate jack-of-all-trades. His strong technical background and business-oriented mindset meant that he was able to succeed in everything to which he set his mind. Cedric was known for his positive attitude and ability to bring people together. He always knew the best spot for dinner and was full of esoteric knowledge of every spot he visited. Vocation aside, Cedric was a personal friend to everyone he met. By taking personal interest in people's lives and with his diverse experiences was able to mentor and support budding talent like myself. I will sorely miss Cedric and grieve his death." — Ian Swentek, Westlake's Epoxy Business (formerly Hexion Inc.)

"I actually met Cedric the first time face-to- face in 2011 at ACCE in Novi where he joined our team. His involvement with the ACCE organization - as well SPE Composites divi- sion - was very clear from the start and has helped to put Hexion Westlake on the map. His commitment to growing this market was strong. More importantly, he was a trusted colleague and leader in many areas over his distinguished career. We are all better from knowing and working with Cedric." — Francis Defoor, Westlake's Epoxy Business (formerly Hexion Inc.)

"We share the feeling of missing a much-valued person. Cedric's integrity, warmth and people- oriented personality made it a pleasure to work together. He will be sorely missed, and our condolences go out to his family and friends." — Sigrid ter Heide, Westlake's Epoxy Business (formerly Hexion Inc.)

BY TERI CHOUINARD, SPE AUTOMOTIVE DIV. COMMUNICATIONS CHAIR

FIRST TWO KEYNOTES ANNOUNCED FOR SPE® ACCE 2022 EVENT

DR. H. FELIX WU

Senior Technology Manager in Vehicle Technologies Office (VTO), Office of Energy Efficiency and Renewable Energy (EERE), **U.S. Department of Energy (DOE)**

Advanced Polymer Composites for Next Generation Electric and Autonomous Vehicles (EV/AV) – Challenges and Opportunities

The presentation will provide an overview of science and innovation developed from the ongoing VTO's Composites Core Program. New research on multi-functional materials utilizing advanced polymer composites to reduce manufacturing cost and carbon footprint, overall embodied energy of the vehicle as well as weight saving of electric vehicles will also be discussed. "Multi-functional materials will allow design of automotive components capable of undertaking multiple functions, increasing battery specific energy capacity, reducing the number of vehicle components and thus overall weight and total cost," said Wu. "Such composite materials and structures systems with autonomous health management could transform the current EV/AV platform," added Wu.

For more information see **http://speautomotive.com** and **https://composites.4spe.org**. Visit the ***Society of Plastics Engineers, Inc.*** global website at **www.4spe.org**.

WARDEN SCHIJVE

Design Leader, **AZL Aachen GmbH**

Opportunities for Composite Material in Future Multi-Material Battery Enclosures

Warden led a one-year consortium project at AZL Aachen with 46 participating companies on multi-material battery casing designs. It yielded 20 different concept designs that were CAE analyzed to all relevant load cases and compared on cost and weight with a state-of the-art metal (welded aluminum) design. The keynote presentation will highlight the project results including analysis and comparisons of both thermoset and thermoplastic materials, solid laminate and sandwich solutions, short fiber overmolded solutions, various SMC options, steel, aluminum, and combinations of all these materials. All relevant load cases were considered in the CAE analysis, as defined by safety regulations, in combination with specific OEM requirements. "In total, 20 different multi-material concepts were optimized on weight and cost and compared to the aluminum battery enclosure design," said Schijve. "All production steps were cost-modelled in detail to obtain reliable cost estimates for each variant," continued Schijve. "As a result, each battery enclosure concept including composite materials resulted in different weight savings of up to 36% and cost savings up to approximately 20%, in comparison to the aluminum design," added Schijve.

Due to new requirements on fire resistance during thermal runaway, the presentation will also highlight experimental fire testing on different materials and protective layers currently being performed. This testing includes measurement of material strength under fire loading. Next to this, high-speed foreign object bottom penetration resistance of various material solutions are also being tested, to better estimate protection levels for future battery pack layouts such as cell-to-pack.

CALL FOR NOMINATIONS FOR INNOVATIVE PARTS COMPETITION

The organizing committee for the SPE Automotive Composites Conference & Exhibition (ACCE) has issued a call for nominations for its annual innovative parts competition at the group's 2022 conference, September 7-9 at the Suburban Collection Showplace in Novi, Michigan. Any registered conference participant (speaker, sponsor/exhibitor, or attendee) may nominate original equipment or aftermarket composite parts on passenger vehicles, light trucks and heavy trucks from any geography. Prototype parts are also eligible. Companies, organizations and universities are all encouraged to participate and get recognized for their innovative production parts or prototypes. The vehicle producer must give permission. The part must be displayed during SPE ACCE and be available for a formal review by judges. A total of five prizes will be awarded including four for the most innovative Production Part and Prototype Part in Materials Innovation and Process Innovation categories (selected by judges who are industry experts and members of the SPE ACCE planning committee) and one People's Choice award (selected by conference attendees) — with winning teams receiving recognition and a trophy at the event.

Nomination abstracts are due **ASAP** and final nominations are due **AUGUST 30, 2022** via email to **teri@intuitgroup.com**. For more info go to: **http://speautomotive.com/acce-conference** and **https://speautomotive.com/wp-content/uploads/2022/04/SPE-ACCE-2022-Parts-Competition-Info-copy.pdf**

CALL FOR ABSTRACTS FOR STUDENT POSTER COMPETITION

The organizing committee for the SPE® Automotive Composites Conference & Expo (ACCE) invites graduate, undergraduate, community college, and high school students to submit abstracts on innovative composites technologies, for automotive and ground transportation, for its annual student poster competition. The competition will be held during the ACCE. Judges who are industry experts, SPE board members, and members of the media will review all posters with student authors on the first day of the conference, Sept. 7, 2022.

First-, second-, and third-place awards will be presented to winners in graduate, undergraduate and high school categories during a special ceremony during the ACCE. Students interested in participating in the competition should contact Dr. Uday Vaidya, ACCE student poster competition chair as well as chief technology officer, Institute for Advanced Composites Manufacturing Innovation (IACMI) and professor and governor's chair – Advanced Composites Manufacturing at University of Tennessee-Knoxville via **ACCEposters@speautomotive.com**.

Abstracts are due by **ASAP.** Digital copies of posters are due by **AUGUST 20, 2022** for pre-review by judges. Students will need to bring printed copies of their posters to the conference. All students presenting a poster in the competition will receive free registration to the conference, a partial travel stipend, a shared hotel room provided by SPE-ACCE, and one year of free student membership in SPE. Large multi-poster panels and push pins for displaying the posters in the Student Poster Display area will be provided. The show also provides excellent networking opportunities for those close to graduating who are starting to look for a job. The poster template is online via **http://speautomotive.com/acce-forms**.

Please include in the Subject Line –
2022 SPE ACCE STUDENT POSTER COMPETITION

Poster topics may include, but are not limited to, subjects such as:

- Automotive Composites
- Composites and lightweight materials for trucks
- Bio-composites
- Nanocomposites
- Glass, carbon, and hybrid fibers
- Thermoset and thermoplastic technologies
- Recycling and green technologies
- Multi-materials
- Applications of Composites in Electric Vehicles
- Joining technologies
- Modeling and analysis of lightweight materials
- CAFE standards and mandates
- Cost-effective manufacturing
- Use of advanced materials in innovative applications
- Virtual prototyping and design
- Microstructure, failure and fracture
- Failure envelopes and theories
- Additive manufacturing of composites

Students and their posters are ranked using the following criteria:

- Content (student and poster demonstrate clarity of topic, objectives, and background);
- Motivation for research and technical relevance to conference theme;
- Methodology and approach to problem;
- Quality of proposed research results/findings;
- Conclusions are supported by information presented;
- Presentation (display aesthetics are pleasing and there is a logical flow between sections);
- Knowledgeable (presenter has a good grasp of the subject);
- Understandability (poster is effective even without student being present to explain it); and
- Overall rank vs. other posters and presenters.

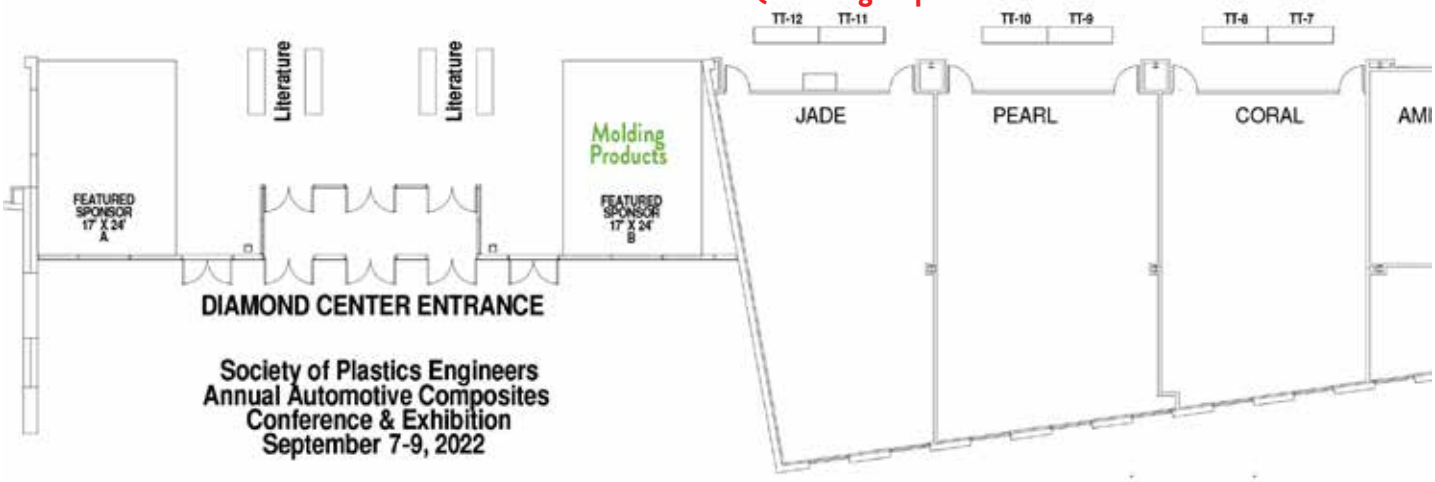
For more information contact:

- Dr. Uday Vaidya, University of Tennessee-Knoxville, 205.410.2898, **uvaidya@utk.edu**
- Dr. Douglas E. Smith, Baylor University, 254.710.6830, **Douglas_E_Smith@baylor.edu**
- Dr. David Jack, Baylor University, 254.710.3347, **David_Jack@baylor.edu**

CURRENT ACCE EXHIBITS FLOOR PLAN

A FEW Exhibitor Booths Are Still Available
Contact Teri@Intuitgroup.com or 248.701.8003 for details.

Table Top Displays Are Available Here
Contact Teri@Intuitgroup.com or 248.701.8003 for details.



Society of Plastics Engineers
Annual Automotive Composites
Conference & Exhibition
September 7-9, 2022

ACCEPTED AUTHORS AND PAPER TITLES - LAST UPDATED 8/9/2022

Atik Amin
Baylor University
Quantitative Analysis of Internal Raster Path of Additively Manufactured Components via NDT Testing

Prashanth Badrinarayanan
Olin Corporation
Rapid Curing Epoxy Systems for High Throughput Production of Lightweight Composites

Lamartini Barazzutti
Ford Motor Company, Instituto Euvaldo Lodi
A Review on the Constitutiuve Models Applied in ABS, PC/ABS Polymers and Graphene Nanocomposites

James Bono
Polynt Composites USA
Title to be Announced

Anand Bora
Moldex3D Northern America, Inc.
Measurement and Simulation of In-Plane Permeability for Resin Transfer Molding Process

Robert Brüll
FibreCoat GmbH
Aluminum Coated Basalt Fibers for Automotive Composites with Integrated EMI-shielding

Dongjie Chen
Hanwha Azdel, Inc.
Properties of LWRT with Different Formulations Produced in a Wet-laid Process

Peng Cheng
Hanwha Azdel, Inc.
Novel Lightweight Reinforced Thermoplastic (LWRT) for Automotive Applications

Dr. Dominik Dörr
University of Western Ontario (UWO), SIMUTENCE GmbH
Towards a Virtual Process Chain for GMT as Basis for Digital Product Development

Sagar Doshi
University of Delaware - Center for Composite Materials
Effect of Environmental Factors on the Properties of Resin, Interface and Composites in Automotives

Russell Elkin
3A Core Materials/Baltek Inc.
Sustainability Through Sandwich Construction and New Stronger, Lighter & Greener Core Materials

Chandra Kishore Reddy Emani
University of Michigan - Dearborn
Development of Forming Limit Diagrams for Dry Fabrics

Evan Freeman-Gibb
Teijin Automotive Technologies
Multi-material Battery Enclosures: Using Composites for Strong, Lightweight EV Structures

Kipp Grumm
BASF
Ford Featherweight Overmolded Composite Seat Structure (Ford, IACMI, Dura, BASF Partners)

Layne Gontijo
Ford Motor Company
Use of Graphene in Sheet Molding Compound (SMC) for Applications in Electric Vehicles

Tim Hall
Engenuity Ltd
Material Characterisation and Predictive Analysis of Chopped Fibre Structures

Adam Halsband
Forward Engineering North America
Development and Validation of an EMI Enhanced SMC Compound for BEV Applications

Adam Halsband
Forward Engineering North America
Structural PA-6 Organosheets-based High Voltage Battery Enclosure Concept Development

Navraj Heer
Fraunhofer Innovation Platform for Composites Research at Western University
Combined LFT-D and GMT Glass Reinforced Nylon Composite for Optimization of Part Molding and Perf.

Dr. Roman Hillermeier
STRUCTeam Ltd
Innovative EV Battery and Underbody Shield Designs

Dr. Timo Huber
HRC Group / Advanced Composite Technology Center
Innovative and Sustainable Composite Lightweight Solutions for the Mobility Sector - X2 Flying Car

Sungjun Hwang
University of Maine
Characteristics of SDCNF from Various Pulp Feedstocks and Their Utilization as Reinforcements in PP

Von Jamora
Old Dominion University
Modeling of Wrinkle Formation in Non-Crimp Dry Fabric during Preform Compaction

Sagar Kanhere
Center for Advanced Fibers and Films, Clemson University
Mesophase Pitch-based Carbon Fiber Composites for Electromagnetic Shielding and Electrostatic Dissip

Louis Kaptur
Dieffenbacher
Automation and Digitalization for the SMC Compression Molding Process

Louis Kaptur
Dieffenbacher
Replacing Metal with Continous Fiber Reinforced Thermoplastics

Garam Kim
Purdue University
Application of Thermoset Polymer Coating to Additively Manufactured Carbon Fiber Composite Tooling

Jessica Lavorata
Purdue University
High-Rate Manufacturing of Thermoplastic Composites with Electrically Conductive Constituents

Dr. Denise Maria Lenz
Ford Motor Company, Instituto Euvaldo Lodi
Preparation Methods of Graphene Textile Composites for Automotive Industry

Louis Martin
BYK USA Inc.
BYK-MAX CT 4275: Low-Density Reinforcement for Polyamides

Jim McGuire
AERO Sustainable Material Technology
AERO Sustainable Material Technology Replaces Spray Paint for Durable and Sustainable Composites

Jonathan McKay
INEOS Composites
Efforts Towards a More Sustainable Thermoset Composites Industry

Dr. Gleb Meirson
Fraunhofer Innovation Platform
HP-RTM and LCM Applications for Automotive Industry

Jacob Meyer
ATSP Innovations, Inc.
ATSP's NOWE Mold Release Coating

Mihaela Mihai, Ph.D.
National Research Council of Canada
Eco-responsible Parts for Automotive Interiors Made from Nanofibrillated Cellulose and Polypropylene

Mihaela Mihai, Ph.D.
National Research Council of Canada
Use of Nanofibrillated Cellulose in Thermoplastic Biocomposites for Eco-responsible Auto Interiors

Justin Miller
Purdue University
Fiber Spread Modelling and Effects on 3D Tow Reinforced Hybrid-molded Structures

Manjusri Misra
University of Guelph
Advanced Bio-carbon from Waste Burlap Biomass for Improved Thermal Management of Biocomposites

Victoria Muir
University of Guelph
Ocean Recycled Nylon and Lignin Biocarbon-based Sustainable Biocomposites for Auto-parts Uses

ACCEPTED AUTHORS AND PAPER TITLES - LAST UPDATED 8/9/2022

Dinesh Munjurulimana
SABIC
Thermoforming of EV Battery Top Cover Using Glass-Filled Intumescent Fire Retardant Polypropylene

Luana Nascimento Silva
Ford Motor Company
Incorporation of Graphene into Technical Textile Applied in the Automotive Industry

Daniel O'Shea
UL Solutions
KEYNOTE ADDRESS:
Material Innovations in EV Battery Enclosures

Nithin Kaliyath Parambil
Center for Composite Materials (CCM)
Predicting Crystallization-Dependent Residual Stress Development in Thermoplastic Composites

Frank Petrolli
Plasmatreat USA Inc.
The Invisible Force in Composites â€" Enabling Lightweight with OpenAir Plasma

Rodrigo Polkowski, Ph.D.
Ford Motor Company - Brazil
Current Perspectives on Graphene Polymer Composites as Automotive Coatings

Rodrigo Polkowski, Ph.D.
Ford Motor Company - Brazil
Characteristics of Biochar Produced from Cellulose for Atmosphere CO_2 Capture

Greg Poterala
Solvay Materials
High Voltage Battery Composite Enclosure Design – Beyond Lightweighting

Dr. Daniel Pulipati
Baylor University
An Automated Method to Measure Adhesive Thickness Between Metal/Composite Stuctures Using Ultrasound

Kirtunia Rahul
Baylor University
Impact from UT Uncertainty in Quantifying Ply Stack Orientation on Probabilistic Failure Envelope

Artur Rego
Ford Motor Company
Challenges of Obtaining Nanocomposites for Lightweight Electric Vehicles

Silvana Pereira Rempel
Ford Motor Company
ABS/PC Polymer Nanocomposites with Graphene and its Derivatives

Mitchell Rencheck
Oak Ridge National Laboratory
Utilizing Recycled Carbon Fiber-Based Composites for Sustainable Manufacturing

Arturo Rodriguez Uribe
University of Guelph
Upcycling of Biomass and Food Wastes in Engineering PP-based Biocomposites for Auto-parts Uses

Paul Dason Samuel
Center for Composite Materials, University of Delaware
NDE Inspection of Delamination in Plain Weave S-2 Glass Composites under High energy Impact

J. Elliott Sanders
University of Maine - Advanced Structures and Composites Center
Production and Application of Electrospun Nanofibers for Polylactic acid Composite Reinforcement

Cynthia Sangang Tchoconte
Texas Tech University
Curing Behavior of Plasmonic Spiky Gold Nanoparticles Integrated in an Epoxy System

Mohammad Nazmus Saquib
Old Dominion University
Reconstruction of Full Fiber Orientation Distribution in Molded Composites

Warden Schijve
AZL Aachen GmbH
KEYNOTE ADDRESS:
Opportunities for Composite Material in Future Multi-material Battery Enclosures

Alexander Schmidt
Westlake
Westlake Epoxy - Addressing Technical Challenges in EV Motors

Elias Shakour
BASF Corporation
Developing High Performance Pultrusion Polyurethane to Meet the High Temperature Requirements

Dustin Souza
Hexagon
Minimizing Warpage of FDM Parts

Tariq Syed
SABIC
New Materials for EV Applications

Sigrid ter Heide
Westlake Epoxy
Life Cycle Evaluation X-Spring

Gregory Treich
EVONIK
Optimization of Composite Reinforcement through Silane Analysis

Neelima Tripathi
University of Guelph
Sustainable Recycled Polycarbonate (PC)-based Blend & Their Biocomposites

Somasekhar Bobba Venkat
SABIC
Lightweighting and Thermal Management Solutions for EV Battery Pack with Specialty Materials

Somasekhar Bobba Venkat
SABIC
Reclained Carbon Fibre Based Sustainable Solutions for Automotive Structures

Rachel Weare
WMG
Multi-Material Structures for Commercial Electric Vehicle Chassis Applications

Michael Wilhelm
Fraunhofer Institute for Chemical Technology ICT
Doing it More Sustainable – In-situ Pultrusion of Profiles Based on PA6

Dr. H. Felix Wu
U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy
KEYNOTE ADDRESS:
Advanced Polymer Composites for Next Generation Electric and Autonomous Vehicles (EV/AV) - Challenges and Opportunities

June Wu
INEOS Composites
Advances in Low VOC Composite Materials for Automotive Applications

John Young
AOC
New Advances in Molded-in-Color, UV-Stable Composites for Automotive Applications

Yanxi Zhang
Netzsch Instruments North America
Characterization of Wood Plastic Composite (WPC) by Thermal Analysis

ABOUT THE SPE ACCE

Held annually in suburban Detroit, the ACCE draws over 800 speakers, exhibitors, sponsors and attendees and provides an environment dedicated solely to discussion, education and networking about advances in transportation composites. Its global appeal is evident in the diversity of exhibitors, speakers, and attendees who come to the conference from Europe, the Middle East, Africa, and Asia/Pacific as well as North America. About 20% of attendees work for automotive and light truck, agriculture, truck & bus or aviation OEMs and another 25% represent tier suppliers. Attendees also work for composite materials processing equipment, additives, or reinforcement suppliers; trade associations, consultancies, university and government labs; media; and investment banks. ACCE has been jointly produced by the SPE Automotive and Composites Divisions since 2001.

THE MISSION OF SPE is to promote scientific and engineering knowledge relating to plastics worldwide and to educate industry, academia, and the public about these advances. **SPE's Automotive Division** is active in educating, promoting, recognizing, and communicating technical accomplishments in all phases of plastics and plastic-based composite developments in the global transportation industry. The **SPE Composites Division** is dedicated to the growth of composites in multiple industries. Topic areas for both divisions include applications, materials, processing, equipment, tooling, design, and development.

REGISTRATION AND SPONSORSHIP OPPORTUNITIES

The automotive and transportation industries are advancing with composites playing a key role in the development of electric vehicles and sustainability initiatives worldwide. Lightweight composites are ideal materials for improving vehicle performance, reducing mass, extending range and compensating for battery weight. Polymer composites are enabling lower emission vehicles, reducing the carbon footprint and saving energy to benefit the environment now and in the future. Thermoset and thermoplastic composites are **THE KEY TO EV MOBILITY AND SUSTAINABILITY.**

For more information and to register, go to: **https://speautomotive.com/acce-conference/**

In addition to the new category on Composites in Electric Vehicles, the presentations are organized into the following categories: Thermoplastic Composites; Thermoset Composites; Modeling; Additive Manufacturing & 3D Printing; Enabling Technologies; Sustainable Composites; Bonding, Joining & Finishing; Carbon Composites; and Business Trends/Technology Solutions.

OEMS ATTEND FOR FREE! OEMs working directly for a transportation OEM (not their suppliers) defined as original-equipment manufacturers who directly produce automotive, heavy truck, off-highway, recreational, military, public transportation, or aerospace and/or aviation vehicles for sale, may attend the event free of charge.

SPONSORSHIP AND EXHIBIT OPTIONS offer companies the opportunity to support the event and promote their products and services to a very targeted and interested audience. All sponsorships include passes to the event including access to all keynotes, panel discussions, technical sessions and daily networking opportunities. Sponsorship also includes corporate exposure on SPE ACCE websites, advertising, publicity, social media, signage throughout the event venue and more. Companies interested in sponsorship should contact Teri Chouinard at **teri@intuitgroup.com.**

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CALL FOR NOMINATIONS

MOST INNOVATIVE USE OF PLASTICS AWARDS

The Automotive Division of the Society of Plastics Engineers (SPE®) is announcing a "Call for Nominations" for its 51st-annual ***Automotive Innovation Awards Gala,*** the oldest and largest recognition event in the automotive and plastics industries. This year's Awards Gala will be held Wednesday, **NOVEMBER 2, 2022** at the Burton Manor in Livonia, Mich. Winning part nominations **(due by September, 7, 2022)** in 11 different categories, and the teams that developed them, will be honored with a **Most Innovative Use of Plastics** award. A **Grand Award** will be presented to the winning team from all category award winners.

A special category has been added for the 51st-annual Automotive Innovation Awards: **EV and AV Systems,** to recognize innovative polymer components for Electric and Autonomous Vehicles.

- LIMITED EDITION/ SPECIALTY VEHICLES AND AFTERMARKET
- ADDITIVE MANUFACTURING
- BODY EXTERIOR
- BODY INTERIOR
- CHASSIS/HARDWARE
- ENVIRONMENTAL
- MATERIALS
- PROCESS, ASSEMBLY & ENABLING TECHNOLOGIES
- POWERTRAIN
- SAFETY
- EV AND AV SYSTEMS

SPONSORSHIP OPPORTUNITIES

This annual event currently draws over 800 OEM engineers, automotive and plastics industry executives, and media. A variety of sponsorship packages - including tables at the banquet, networking receptions, advertising in the program book, signage at the event and more are available. Contact Teri Chouinard of Intuit Group at **teri@intuitgroup.com**.

For more info and to submit nominations, go to: **www.speautomotive.com/innovation-awards-gala**

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2022 KEY DATES

SEPT 7 – Deadline for submission of nominations, Parts Due September 15
SEPT 9 – Notification of time and date for presentation to SPE Board of Directors
SEPT 15 & 16 – Presentations to Board of Directors, Location: Celanese, Auburn Hills, MI
SEPT 23 – Finalists Presentations to Blue Ribbon Panel, Location: Celanese, Auburn Hills, MI
NOV 2 – SPE Automotive Division Innovation Awards Gala, Location: Burton Manor, Livonia, MI

NOTE that the event, nomination due date and presentations are all a week earlier than in previous years to avoid having the gala the same week as the mid-term elections and Veteran's Day holiday weeks.

spe AUTOMOTIVE

PLASTICS ARE GOOD FOR THE PLANET

Welcome to our new feature "Plastics are Good for the Planet" Dedicated to the benefits of plastics and their positive impact on environmental sustainability. We hope you enjoy our debut article "Plastics Positive Impact on Climate Change" by Hal Partenheimer, featured in the July 19th issue of "Plastics Today".

PLASTICS' POSITIVE IMPACT ON CLIMATE CHANGE

Contrary to popular belief, the production of plastics generates fewer greenhouse gas emissions than alternative materials.

Hal Partenheimer | Jul 19, 2022

PLASTICS TODAY
COMMUNITY FOR PLASTICS PROFESSIONALS

In case you haven't heard, it's Plastic Free July. The annual event originated in western Australia in 2011 with the aim of encouraging consumers to reduce their reliance on single-use plastics and eliminate plastic waste. It has gained traction globally in the ensuing years. The Plastic Free July Foundation is a registered charity in Australia, and although it doesn't demonize plastics as an environmental scourge on the planet, many of its supporters do. So, it's an opportune moment, I believe, to set the record straight on the environmental impact of plastics.

There's no denying plastic waste is a growing problem. However, plastic utilization is a major player in reducing greenhouse gas (GHG) emissions that contribute to climate change. This in no way absolves us of the responsibility of properly managing our waste streams, but it's clear that there are far more egregious GHG sources impacting the climate than the polymers we produce.

The climate impact of plastics is indisputably positive. Volumes of recent research, including the "Climate Impact of Plastics" report published earlier this month by McKinsey & Co., support that plastics actually reduce GHG emissions three to four fold compared with some materials that are often touted as virtuous replacements. Let's look at some research supporting the fact that plastics are fundamentally less harmful to the environment than we've been led to believe.

"PLASTICS ARE . . . THE GREENEST OPTION"

According to polymer scientist Chris DeArmitt, who relies on the veracity of life cycle assessment (LCA) analyses, "Plastics are usually the greenest option. They are better for the environment than metal, glass, cotton, and usually paper, so replacing plastic harms the environment.

"Government agencies in the US, Canada, UK, Australia, and Denmark all agree from LCA studies that the single-use polyethylene bags we use today have a much lower environmental impact than potential replacements such as bioplastics, paper, unbleached paper, cotton, or organic cotton."

New technologies indicate plastics of the future will be even more environmentally friendly. Henrik Thunman, Professor of Energy Technology at Sweden's Chalmers University of Technology co-authored a study in which he states, "Only a fraction of the material that could be turned into new plastic is currently recycled. Researchers at Chalmers have now demonstrated how the carbon atoms in mixed waste can replace all fossil raw materials in the production of new plastic. The recycling method is inspired by the natural carbon cycle and could eliminate the climate impact of plastic materials."

THE COST IN RESOURCES AND CO_2 EMISSIONS OF PAPER BAGS

DeArmitt goes further on his excellent Plastics Paradox website, stating that replacing plastic bags with paper bags, for example, requires 2.7 times more energy, produces 1.6 times more CO_2 emissions, and consumes 17 times more water. It has also been estimated that replacing the plastic bags in the EU would entail cutting down an astonishing 2.2 million more trees per year and require the equivalent of 60,000 Olympic-size swimming pools of more water. Further, how much more unquantifiable environmental damage is caused by the loss of carbon sequestration through the destruction of millions of trees?

Lightweighting of vehicles in the automotive industry has significantly reduced fuel consumption over decades through the use of plastic parts that have replaced heavier metal components. Recent advances in recycling technology now mean new life in a different form for many previously unrecyclable plastic auto parts that otherwise would sit in a landfill or auto salvage yard.

Plastics also have a profound impact on the food industry by eliminating a massive portion of GHG production through the reduction of food waste. Food processing, transportation, and storage are all far more efficient, sanitary, and safer than they would be if other materials are used.

Food waste, averaging 30 to 40% of all landfill waste, continues to be a major source of GHG emissions globally. It would be far higher if not for the utilization of lightweight, flexible, and durable plastics. Thunberg of Chalmers University says their new technology even has the capability of bypassing food contamination in the plastic being processed, a considerable challenge for current recycling methods.

In spite of the misinformation, misguided policy making, and outright lies we have been fed by the media and activists about plastics contributing to climate change, the data tell a much different story.

For more on this, you may want to download a report published earlier this month by McKinsey & Co., "Climate Impact of Plastics." The 30-page report is available as a free download (registration required).

ABOUT HAL PARTENHEIMER

Hal Partenheimer is a freelance writer based in Dallas, TX. His passion for the environment, energy, the folly of "catastrophic" climate change, and new technologies that address them all take him to wildly exciting places. Writing about them keeps him in a state of happy harangue. Hal has a B.S. in biology and geology and has spent more than enough time in the oil patch of the Permian Basin. He can be reached at **linkedin.com/in/hpartenheimer.**

2022 EAV CONFERENCE REPORT

BY DR. SASSAN TARAHOMI, SPE AUTOMOTIVE DIVISION CHAIR, SPE EAV CONFERENCE CHAIR

The First annual SPE Automotive Plastics in Electric and Autonomous Vehicles conference was held on May 4 & 5, 2022 in Detroit Marriott in Troy, Michigan with overwhelming success.

The Plastics in Electric and Autonomous Vehicles conference or better known as the EAV conference is the only global conference that covers all family of plastics used in Electric or Autonomous vehicles. The SPE Automotive Division board members **Dr. Sassan Tarahomi, Dr. Norm Kakarala** and **Dr. Suresh Shah** planned this event to address the industry need for a comprehensive coverage of Plastics in Electric and Autonomous Vehicle Technology in one conference. This was an in-person event, and attracted a large crowd from Automotive OEM, Tiers and Supply Industry.

On May 4, the conference was kicked-off with a keynote address by **Josh Tavel,** *Executive Chief Engineer, Battery Electric Trucks from General Motors.* Josh presented the Ultium platform and future of electric trucks at GM. The second Keynote speaker was **Daron Gifford,** *Mobility Consulting Leader with Plante & Moran* who gave a great keynote speech about the Impact of Disruptive Technology Changes on Automotive Plastics.

After the keynote speech and a short break conference continued with the technical session presentations which was divided into four specific areas with superb industry leaders moderating each session.

- BATTERY AND THERMAL MANAGEMENT SYSTEM, moderated by session co-chairs, **Dr. Jeff Helms,** *Celanese Corp.* and **Dhanendra Nagwanshi,** *SABIC*
- MATERIAL INNOVATIONS AND LIGHT WEIGHTING, moderated by session co-chairs, **Mike Shoemaker,** *Borealis,* **Paula Kruger,** *Ascend Materials* and **Sunit Shah,** *LyondellBasell*
- SUSTAINABILITY, RECYCLING AND CARBON NEUTRALITY, moderated by Session co-chairs **Dr. Alper Kizilias,** *Ford Motor Co.*, **Chuck Jarrett,** *The Materials Group* and **Drew Geda,** *Hyundai-Kia America*
- NOISE, VIBRATION AND SEALING, moderated by session co-chairs, **Mark Jablonka,** *Dow* and **Tom Pickett,** *General Motors Co.*

On the afternoon of the first day, college students from **Michigan Technological University, Michigan State University; The University of Michigan, Ann Arbor; The University of Michigan, Dearborn; University of Maine; Clemson University; Washington State University; University of Tennessee University of Delaware and SUNY College of Environmental Science and Forestry** set-up and presented their poster to the attendees.

Wednesday lunch was sponsored by **SABIC** and the reception was sponsored by SPE Automotive division.

On May 5, the third keynote speaker **Dr. Ken Laberteaux,** *Senior Principal Scientist, Toyota Motor North America R&D* talked about the Modeling Future Price of Electric Vehicles. The forth and last keynote speaker was **David Pascoe,** *Chief Technology Officer, International Automotive Components Group (IAC).* David presented Impact on Plastics in Vehicle Interiors with Changes in Electrification and Automation.

Next, conference leadership recognized students from local high schools, **Renaissance High School; American International Academy; Davis Aerospace High School and University Prep Science and Math** presenting their project in a poster format to the attendees. Over 40 students attended this event.

Technical sessions continued on right after the morning break and continued on till 5:00 PM closing of the conference.

- **ADVANCED DRIVER ASSISTANCE SYSTEM (ADAS),** moderated by session co-chairs, **Dr. Rodrigo Orozco,** *DuPont* and **JP Wiese,** *SABIC*
- **EVOLUTION OF INTERIORS,** moderated by session co-chairs **Dr. Rose Ryntz,** *Ryntz & Associates, LLC,* **Jim Keller,** *Mankiewicz Coatings LLC* and **Jeff Crist,** *Ford Motor Co.*
- **ADVANCED MANUFACTURING AND ENABLING TECHNOLOGIES,** moderated by session co-chairs **Steve Vanloozen,** *Lotte Advanced Materials* and **David Kosse,** *Ascend Materials*
- **EVOLUTION OF EXTERIORS AND VEHICLE ARCHITECTURE,** moderated by session co-chairs **Mark Lapain,** *Advanced Composites,* **Dave Helmer,** *General Motors Co.* and **Dr. Akshay Trivedi,** *General Motors Co.*

CONFERENCE SUMMARY

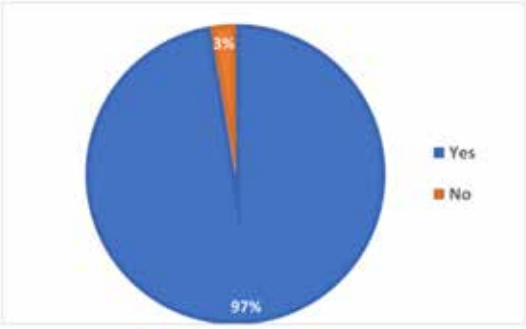
- 4 Keynote speakers
- 69 Technical presentations - 4 simultaneous tracks on two days
- Sustainability Roundtable Discussion
- College & high school students poster presentation
- 827 attendees
- 25 sponsors

AWARDS INCLUDED:

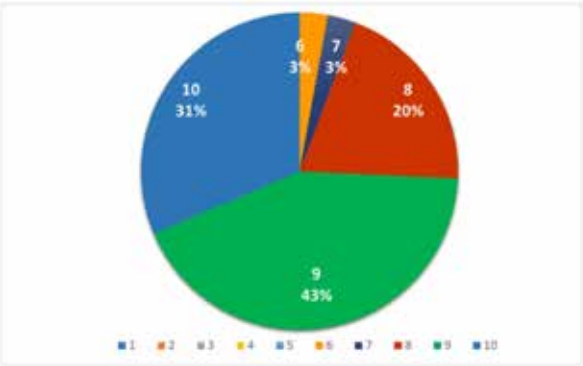
- 4 keynote speakers appreciation award
- 69 presenters appreciation certificate
- Top 3 college & top 3 high school students monetary award
- All high school student's participation certificate
- 1 sponsorship award of recognition
- 2 committee member award of recognition
- Session co-chairs recognition certificate

CONFERENCE ATTENDEE FEEDBACK

Did the Conference meet your expectations?



How would you rate the value of the Conference?



"Great technical presentations."

"Great content and speakers. Very organized."

"Podium set up and certificates for speakers is a nice touch."

"Great outreach for the student posters."

"Congratulations on the first annual Plastics in EAV Conference. I think the event was a smashing success! Great keynotes and presentations."

The 2023 SPE Automotive Plastics in Electric and Autonomous Vehicles Conference chair is **Dr. Sassan Tarahomi,** *Alterra Holdings.* The conference dates are: **April 16-19, 2023.** The conference location is TBD as of printing of this article but will be finalized by end of August 2022 and announced in our website.

For presenting in the 2023 EAV Conference, please contact **Dr. Norm Kakarala,** *retired Inteva Sr. Fellow* or **Dr. Suresh Shah,** *retired GM Fellow* at EAVConference@speautomotive.com

For sponsorship, attending or participating in the 2023 conference call **Dr. Sassan Tarahomi 989-335-0060** or sassan@compounding.us.

For any other information about the conference please visit our website **https://speautomotive.com**.

The 1st-Annual **SPE Automotive Plastics in Electric & Autonomous Vehicles Conference** was a huge success! Held at the Detroit Marriott Troy, in Troy, MI USA, the event drew more than 600 attendees from all facets of the automotive industry. Session topics included: Battery & Thermal Management System; Material Innovations; Sustainability, Recycling & Carbon Neutrality; Noise, Vibration & Sealing; Advanced Driver Assistance System (ADAS); Evolution of Interiors; Evolution of Exteriors; and Advanced Manufacturing. Also featured were 4 keynote speakers, plenary talks and student participation.

PRESENT TO INDUSTRY DECISION MAKERS IN AUTOMOTIVE PLASTICS

Be part of the 2nd-Annual **SPE Automotive Plastics in Electric & Autonomous Vehicles Conference** and learn how electric and autonomous vehicle development is driving innovative automotive solutions. This event will feature technical presentations, keynote speakers and panel discusions, networking breakfasts, breaks, lunches and receptions, and exhibits that highlight advances in this fast-growing industry.

Stayed tuned at **EAVConference@speautomotive.com** for more information about this coming years event.

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SPE PLASTICS ENGINEERING

MEMBERSHIP REPORT

SAMAR TELI, MEMBERSHIP CHAIR, SPE AUTOMOTIVE DIVISION

First, I would like to thank every member for continuous support. Membership in the Automotive division has remained strong in recent years, now with more than 1200 members. In 2022 so far, we have added about 150 new members. Despite the challenges in recent times, we continue to see membership interest from all around the world. I want to take this opportunity to welcome all new members. Your support and participation in this chapter is highly appreciated.

Membership is critical to our success and directly supports our ability to provide the educational outreach to young professionals. This will help ensure that the next generation of leaders in our industry are prepared to inspire the automotive innovations only plastics can provide. The Automotive Division is truly global with members representing many countries. We want to continue our outreach to every corner of the globe.

I encourage all members who are interfacing with international colleagues please take a moment to share the value you have derived from membership and encourage them to visit http://speautomotive.com/ and explore many benefits of membership in the SPE Automotive Division. I wish you all happy and safe rest of the 2022!

27TH ANNUAL SPE GOLF OUTING

SEPT 6 2022

PROCEEDS BENEFIT SPE STUDENT CHAPTERS

2022 SPONSORSHIP OPPORTUNITES

TYPE OF SPONSORSHIP	COST	BENEFITS INCLUDE
CONTEST HOLE	$1000. USD	1 foursome, signage, flag & more
HOLE	$750. USD	1 foursome & signage
BREAKFAST	$1500. USD	2 foursomes & signage
LUNCH	$2000. USD	2 foursomes, signage & 100 fliers printed & distributed at the event promoting sponsoring company or its products
DINNER	$3000. USD	3 foursomes, signage, company message / logo on dinner table centerpieces, 100 fliers printed & distributed at the event promoting sponsoring company or its products

Please note that Team Captains are asked to bring donations for the Prize Table.

COST:
$500. USD/Foursome
$125. USD/Player

PROGRAM:
8:30am: Sign-in & Continental Breakfast

10:00am: Shotgun Start

Box Lunch at Turn

3:30pm: Buffet Dinner

4:00pm: Awards & Prizes

SPONSORSHIP CHAIR:
Teri Chouinard, Intuit Group
+1.248.701.8003
teri@intuitgroup.com
https://speautomotive.com/spe-golf-outing/

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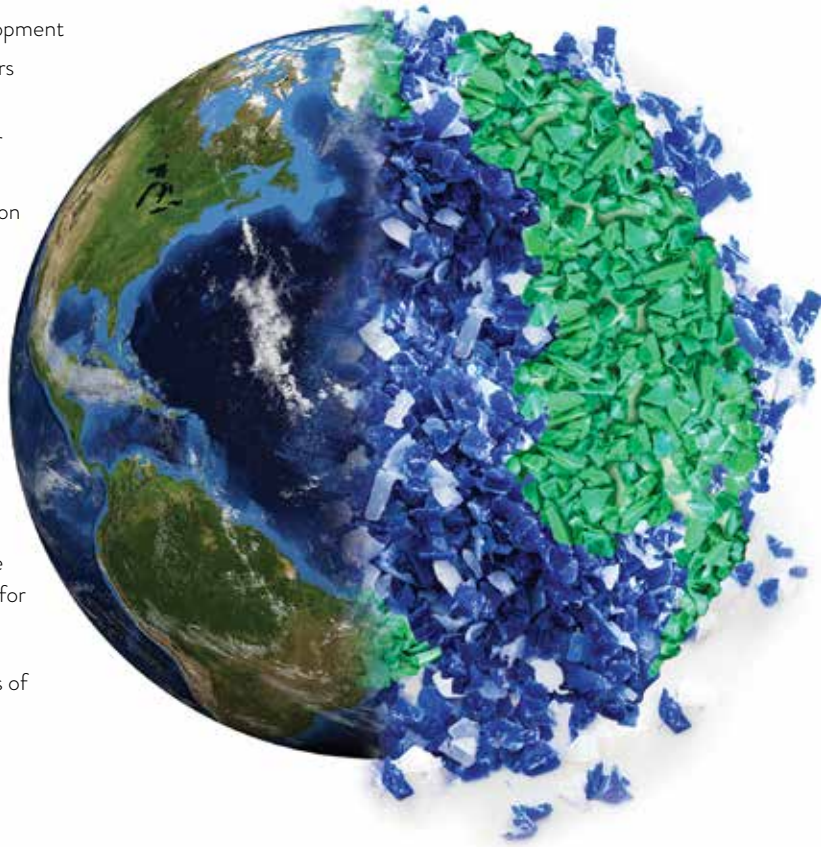
AUTOMOTIVE

SPONSOR NEWS

THE MATERIALS GROUP (TMG) HAS PROVEN TECHNICAL CAPABILITIES TO HELP AUTOMAKERS ADVANCE SUSTAINABILITY AND ACHIEVE LIGHT-WEIGHTING GOALS.

With automakers emphasis on reducing greenhouse gas emissions and mass for electric vehicles (EVs), TMG continues to help by investing in new product development and technical capabilities to deliver on these objectives. Some of the recent developments include:

- Continual OEM specification approval with Post-Industrial Recycled (PIR) based products
- Natural fillers such as basalt, cellulose, and hemp fiber product development
- Light-weighting filler, 3M glass microspheres to offset traditional fillers for density reduction
- Structural product development with the use of recycled carbon fiber or metal replacement
- Hybrid filler technologies for product cost and performance optimization
- Pairing natural fillers with PIR based resin for a truly "green" solution



Creating these products is achievable with TMG's rapid new product introduction process where an idea can become a sample product ready for injection molding trials within weeks. This streamlined process allows for OEMs to have an idea for a product or an objective they are trying to achieve and TMG's skilled staff can determine primary requirements and formulate a product very quickly without "red tape" delaying the process. TMG has invested in a lab line extruder in a clean room environment to create new products and small batch runs for product optimization. This lab extrusion line duplicates production machine specifications from our large extruders. This provides excellent correlation for new product development to production scale runs.

TMG has world class application development engineering with many years of seasoned industry professionals to help with:

- Product design and optimization
- Material properties / material card for CAE and evaluation
- Tooling guidance and filling analysis expertise
- On site molding support and troubleshooting in manufacturing plants

Fully staffed plastics lab testing and certification:

- Product material property data generation
- Lab accreditation: A2LA, ISO1725
- Issue resolution and trouble shooting
- Tensile Bar and Plaque molding with many automakers grain types

A Michigan based company with headquarters and manufacturing near Grand Rapids allows many Automakers and Tier One Suppliers to visit on site and develop products with us within a short drive. We invite you to innovate with TMG by contacting:
sales@thematerialasgroup.com
https://wwwthematerialsgroup.com/

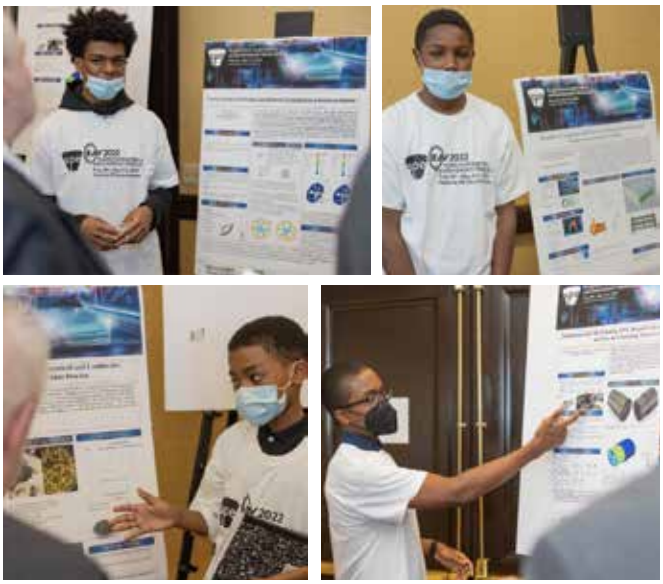
EDUCATION REPORT

BY CHUCK JARRETT, SPE AUTOMOTIVE DIV. EDUCATION CHAIR AND EVE VITALE, SPE FOUNDATION

The SPE Automotive Division continues to provide important and impactful support for the positive plastics education being driven by the SPE Foundation and its partners, Ecotek Science at Work Lab, and metro-Detroit schools. For years, the Division has been a supporter of the PlastiVan® program which serves tens of thousands of students each year with the aim of ***changing the perception of plastics one classroom at a time.*** During the school shutdown in response to the COVID pandemic, the SPE Foundation developed the PlastiVideo™ resources which were utilized by students studying at home.

PlastiVideo was so well received by schools in Detroit, that a comprehensive set of educational initiatives are being piloted to serve students with the goal of creating a previously untapped workforce pipeline for the plastics industry. The Automotive Division is partnering with the SPE Foundation to support the following initiatives:

- polymer science and plastics education added to school science curriculum through PlastiVan and PlastiVideo
- all-school PlastiVan events
- in-school and after-school SPE STEM Clubs
- teacher training in the use of PlastiVideo resources
- science fairs focusing on polymer science and plastics engineering
- supporting the investigative research of middle and high school students with research stipends
- field trips to local manufacturers
- participation in local SPE conferences, and
- mentoring students who show a strong desire to work in our industry.



Students present their posters at the EAV Conference.

In May the Division hosted 40 Detroit students at our first annual Plastics in Electric & Autonomous Vehicles conference. Two 8th graders and four 11th graders competed in a poster contest presenting a recap of their relevant investigative science projects. Students are part of Ecotek Lab, which is located on the campus of Wayne State University. Many of the graduate students at the conference were impressed with the quality of their work. At American International Academy in Inkster, MI, the Division is supporting a 6-week summer program focused on polymer science, plastics sustainability, and the development of relevant science projects for each participating student. This program will culminate with a Polymer Science Fair.

40 Detroit students at our first annual Plastics in Electric & Autonomous Vehicles conference.

SPE Automotive Division Junior Researcher Program – 5 Ecotek Lab Researchers

Detroit Teacher In-Service in Positive Plastics Education – Ecotek Lab

SPE Summer STEM Excel Program

Polymer Science Fair – American International Academy

The Division, following Arkema's lead, will be sponsoring five students in the SPE Automotive Division Junior Researcher program. By awarding middle and high school students, who are serious about their science endeavors, modest stipends, students learn to manage a budget and deliverables. This prepares them for college research and gives them the means to purchase books and supplies for their projects.

In support of one researcher, Joshua Miller, a rising senior at University Prep Science and Math High School, who is looking at ways to recycle sporting equipment, we arranged a trip to American Test Plaque so he could shred basketballs and footballs. By accommodating the request, Dan Brown, the owner legitimized Joshua's project and strengthened the relationship we are building between this bright young STEM scholar and the automotive plastics industry.

The Celanese team, led by Jeff Helms, recently hosted 40+ students at their Auburn Hills, MI location, taking them through 3 learning sessions and providing lunch and conversation about the business of specialty materials. These opportunities help students envision their own careers.

We are also supporting positive plastics education in-service training in Detroit. The SPE Foundation has noted that when teachers see the value in the PlastiVan program by experiencing it in their classroom annually, they become our advocates and are able to share the opportunities in STEM and the plastics industry with their students and parents. This introduction to the program and how it meets Next Generation Science Standards is expected to increase the number of students served by the program each year.

There are plenty of opportunities for you and your company to get involved. We need mentors for our researchers, polymer science fair judges, short presentations to SPE STEM Clubs about your career in the automotive industry as it relates to plastics, and short-termed internship opportunities.

The SPE Foundation is also seeking corporate partners to help grow the programming. At this point the demand for positive plastics education far outpaces the resources available. This is our chance to build a talented and enthusiastic workforce pipeline for your company and our industry.

For more information contact the SPE Foundation at **foundation@4spe.org**.

40 DEPSA Students visit Celanese for a day of learning

WEBSITE REPORT

BY TERI CHOUINARD, SPE IAG AND ACCE MARCOM & SPONSORSHIP CHAIR

The SPE Automotive Division website https://speautomotive.com/ is a powerhouse of information on our division and activities including conferences, events, newsletters and more. Since its debut in September 2020, it has grown to attract increasing attention in the industry making it a very valuable communications medium. Here are some key highlights:

•Website users increased each month during first quarter of 2022 – Over 1,000 users a month!

- There is increased traffic around events and conferences. April 2022 surpassed Nov. 2021 as the highest users due to EAV conference.
- ACCE is currently leading in web page views as that event nears.
- The IAG page will receive increasing views in the next few months.
- The SPE Automotive Div. website gets a bigger percentage of their traffic on desktop (rather than mobile). Which is the opposite of the world trend (most are higher percentage mobile). Why? Because people who would visit the site are likely to do it at their office/while working. (In case you were curious :)
- Supporting the SPE Automotive Div. website with sponsorship benefits the division and the Sponsor!

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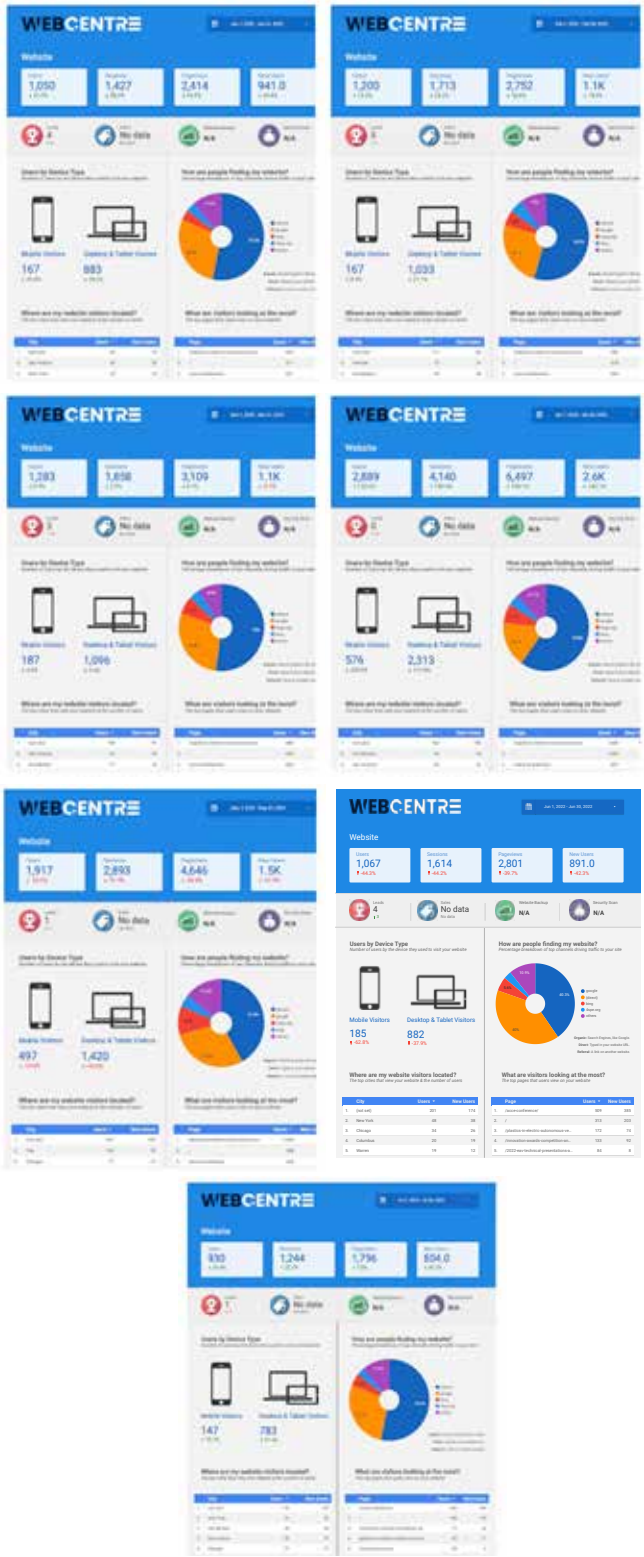
SPE AUTO DIV. WEBSITE SPONSORSHIP IS AN AWESOME VALUE: Only $3,000 for a 2-year term is a great value for a Corporate Logo/Link on the Home Page averaging over 1,000 visitors a month interested in automotive plastics and composites! Contact **Teri@intuitgroup.com**, 248.701.8003.



2022 January thru July SPEAutomotive.com statistics

WHAT AUTO OEMS AND TIERS NEED TO KNOW ABOUT PLASTICS WITH RECYCLED CONTENT

As part of their sustainability strategy, many automotive OEMs and tiers are considering replacing virgin polymers with materials containing post-consumer or post-industrial recyclate (PCR/PIR). However, concerns about the consistency, availability, quality and performance of these plastics can dissuade manufacturers from migrating to more-sustainable options.

The fact is, many of these worries are based on misconceptions. In some cases, automotive companies may be unaware that solutions or assistance from leading suppliers can mitigate or fix potential disadvantages of recycled polymers. In others, they may need to re-prioritize the benefits of using recycled plastics.

Let's dive into four common concerns about plastics containing PCR or PIR and consider how polymer suppliers can help customers feel more confident about using them in automotive applications.

1. The first misconception is that recycled content will negatively impact the **performance of end-use parts.** It's true that inconsistencies in PCR/PIR feed streams caused by waste material variations, contamination and stresses from recycling can degrade part performance. The solution lies in choosing a resin supplier that conducts rigorous testing of each incoming batch of recyclate against specifications and issues certificates of analysis (COAs) that demonstrate compliance. The supplier should also possess the technical capabilities along with the formulation expertise to generate a reliable blend of virgin and recycled resins.

2. The next issue centers on **reliability of supply.** Understandably, OEMs and tiers are concerned about the potential of production interruptions or delays due to shortages of PCR or PIR. Certain types of recycled resins, such as polyolefins, can be hard to find due to a combination of increased demand, supply chain issues and less recycling by consumers. As a hedge against a recycled plastic shortage, customers should identify a resin supplier that offers offset materials for grades with recycled content, as well as alternative grades that could be used with their applications.

3. **Cost reduction** is one of the top reasons why manufacturers turn to recycled plastics. However, reclaiming, sorting, recycling and reformulating PCR and PIR add costs that can sometimes make products with recycled content more expensive than virgin equivalents. Instead of focusing on costs, manufacturers should consider the many other business reasons to use recycled plastics, including sustainability, regulatory compliance, customer preferences and competitive advantage.

4. **Mirroring the properties of virgin resin** isn't always necessary. Although there's a belief that the tested properties of a PCR- or PIR-based grade must match those of an equivalent virgin resin, this approach can lead to over-engineering. If a lower-performing material containing recycled content meets the needs of the application, the sustainable option may be perfectly acceptable. A trusted supplier can help identify sustainable materials that have sufficient properties.

RESILIENCE® R Products from GEON

RESILIENCE® R polypropylene (PP) grades contain minimum standard levels of recycled content ranging from 10-35 percent and offer a choice of fillers and reinforcement. This broad portfolio is suitable for applications such as interior parts like trim, under-hood components and bracketry, and exterior parts like wheel arches. Performance benefits include light-weighting, high stiffness, cold temperature ductility, and resistance to heat, scratching and marring.

GEON supports the **RESILIENCE R** portfolio with not only a deep expertise in the automotive industry, but also a complete array of services and guidance, including application development services, technical support, testing, mold filling and processing trials. Learn more about RESILIENCE and GEON's solutions for the automotive industry at **www.geon.com/auto** or email **sales@geon.com** today.

COUNCILOR'S REPORT

AUTOMOTIVE

SPRING 2022 COUNCIL MEETING
VIRTUAL MEETING MARCH 30, 2022
MINUTES BY DR. SURESH SHAH

The SPE Spring Council meeting was held virtually on March 30, 2022.

OPENING REMARKS – DR. JASON LYONS, PRESIDENT OF SPE

Jason Lyons, President of SPE, welcomed the committee and reminded the anti-trust regulations. His opening remarks that **we have done a lot of last years as shown below.**

- Created the industry's first society advisory board on diversity, equity and inclusion in plastics.
- Completed the society's most profitable financial year in more than a decade, with total retained earnings of more than $990,000.
- Relaunched SPE's Plastics Engineering Magazine, with the addition of redesign look, and extended the content that explores the innovations of plastics across all industries
- Launched SPE News, a biweekly newsletter focused on SPE activities
- Expanded the reach of PlastiVan® and its impact on middle- and high-school students, with positive messaging about plastics
- Adopted a permanent, virtual HQ staffing model resulting in six-figure future savings without any negative impact on operations or member services
- Served underrepresented communities with investment in new STEM programs, including SPE-hosted after school clubs and hands-on lab work in partnership with Ecoteck labs
- SPE was nominated for one of the social-media-accounts-worth-following "Most Interesting Social Media Account in Plastics" by Plastic News.
- Awarded over 50% more scholarship to future plastics professionals than in 2020.
- Three virtual global conferences held by SPE HQs, including ANTEC, Plastics in Aerospace, and RACE Asia with 1850+ attendees.

Jason Lyons then talked about SPE Foundation. We awarded $202,850 in scholarship to 51 students at 31 universities. **Eve Vitale** is **Chief Executive of SPE Foundation** and doing excellent job.

$499,000 were generously given to support the work of the SPE foundation. PlastiVan® and PlastiVideo™ served 12,250 students, 2 continents, 2 countries, 15 states and 51 cities.

FINANCIAL REVIEW – PATRIC FARREY

Patric Farrey, CEO presented the 2021 Financial Review. Total liabilities and Equity for 2021 was $7.8 million compared to $7.3 million for 2020.

Below is breakdown of 2021 Revenue and Expenses.

The operating profit for 2020+2021 was $359,000 while Investment Income was $1,237,000. So, Total Net profit was $1,596,000.

The budget for 2022 is as follow: Revenue forecast is $3,717,400 while expenses are $3,888,300. So Budgeted Profit (loss) is -$170,900.

ANTEC 2022 – PATRIC FARREY

Then, Pat gave update about 2022 ANTEC which will be held from June 14th to June 16th.

Details are as follows:

- Tuesday morning, Chapter Leaders' Roundtable
- Tuesday afternoon, General session/Keynotes
- Tuesday evening, General Reception and SPE Meetup at NASCAR Museum
- Wednesday, Paper Presentations, three concurrent tracks
- Wednesday, SPE Honors & Awards Lunch, A Celebration of SPE's Individual Award Recipients (2020-2022)

- Wednesday evening, "Together Again," networking reception with SPE friends and colleagues
- Thursday morning, Paper Presentations, three concurrent tracks
- Thursday lunch, TBD

DIVERSITY, EQUITY AND INCLUSION – PATRIC FARREY

Then Pat talked about **new programs** on **"Diversity, Equity and Inclusion"**

- Supporting STEM education and workforce development for the plastics industry
- Teach the Geek - Helping engineers (and others) be better presenters
- SPE Leadership and SPE Advanced Leadership - Preparing the next generation of leaders

SPE STRATEGIC PLAN 21-22 STATUS & UPDATE – BRUCE MULHOLLAND

Bruce Mulholland, President-Elect discussed SPE Strategic Plan 21-22 Status and Update. The main focuses are as follows:

- Vision - Inspiring the world with plastics.
- Mission - Supporting the development of plastics professionals so they can learn from each other and inspire positive change for society and the planet.
- Impact - SPE strives to continually expand its reach while capitalizing on new markets and opportunities that support its Mission.
- Value - SPE enhances the experience for its stakeholders, creating a culture of giving back to the organization while optimizing professional and personal development.
- Operational Excellence - SPE's organizational structures and internal operations provide for the effective deployment of resources to deliver superior service to its constituents.
- Inclusivity - SPE embraces the inclusion of all voices within its community.

Three Major areas of 21-22 Strategic Plan were discussed:

1. ENHANCED REPUTATION

- Become the leading advocate for diversity, equity, and inclusion in the plastics industry.
  - Produce extensive new content to support this journey.
- Create a functional leadership development program (soft skills & technical).
  - Prepare individuals for leadership positions within the Society and other external industry roles.
- Create programs to recognize and award certain aspects of stakeholders' engagement.
  - Micro-credential recognition for participation in SPE programs, workshops, etc.
- Create programs to recognize and award certain aspects of stakeholders' engagement.
  - Plastics for Life-type competitions (recognition of members' work products, new technologies and innovations.

2. KNOWLEDGE SHARING

Develop a more robust **"Create, Curate, Connect"** knowledge-sharing program

- Connect – Develop a schedule for thematic "months of knowledge," highlighting, for example, a different division every month (i.e., Thermoforming Month). In these months, existing content will be highlighted, new content will be presented (ANTEC- style presentations, webinars, etc.), Plastics Engineering stories will center on the theme, and more.
- Create – Cultivate and grow general knowledge sharing programs by identifying SME's (people and companies) willing to share their information under the SPE brand. This includes both technical and relevant non-technical information (i.e., "soft skills," etc.).
- Curate – Review the model for hosting and retrieving SPE content to improve the visibility, searchability, and monetization of that content.

3. INCREASED ENGAGEMENT & NETWORKING

- Create more opportunities for stakeholder interactions at live events, and help attendees be able to better optimize their networking experiences.
- Teach stakeholders how to achieve maximum efficacy from our existing tools to create virtual connection opportunities.
- Explore how to better connect stakeholders around non-technical endeavors, through an expanded utilization of SPE Communities and beyond.

A MESSAGE FROM DR. SURESH SHAH

'It was great serving SPE Automotive Division as a Councilor for last SIX YEARS. It was very rewarding experience. I am thankful to all automotive division board members and members at SPE HQs for their support in this journey.' – Dr. Suresh Shah

TREASURER'S REPORT

JITESH DESAI
SPE AUTOMOTIVE DIVISION TREASURER

2022 has been a challenging and exciting year. Thank you to Bonnie Bennyhoff for tremendous guidance and coaching during transition, and continued support. I have assumed the responsibilities of Automotive Division treasurer starting April 2022. Financial status as of August 01, 2022, for the fiscal year net operating revenue of $112,621.55.

AS OF AUGUST 01, 2022, THE DIVISION'S ACCOUNT BALANCES WERE:

Checking:	$461,848.08
Savings:	$27,506.61
Total:	**$489,354.69**

Thank you, Bonnie, for doing the heavy lifting to complete the fiscal year transition to match with SPE HQ as well as making it easy for financial reporting. All the events for the year will now conclude well in advance of end of the year allowing to report more accurately the financial status.

Thank you to SPE Automotive Division for support, guidance and entrusting in me the confidence. I am looking forward to work with the team and commit to doing my best to support the organization to further our goals and carry out SPEAD mission.

SECRETARY'S REPORT

SPE AUTOMOTIVE DIVISION
VIRTUAL BOARD MEETING MINUTES, JUNE 20, 2022
BY STEVE VANLOOZEN

- Meeting initiated with Alper Kiziltis sharing calendar and thanking the board for the support over the past two years as he led the Automotive Division. The board applauded the leadership provided by Alper.
- Jitesh and Bonnie shared current finances. Despite the challenges over the past 18 months the Division expects operating revenue to exceed $100K for the full year. It was also announced that our fiscal year going forward will correspond with the calendar year.
- The 2022 SPE ACCE scheduled for September 7-9 report delivered. 32 sponsors have been secured and 32 abstracts received so far. The deadline for abstract submission was extended to July 15 with full papers due July 30.
- A new section is being added to the newsletter titled "Plastics are Good for the Planet". The section is intended to highlight environmentally beneficial innovations that would not be possible without plastics and the producers of plastics.
- Automotive Division website realized significant uptick in visitors to nearly 3,000 in April and May driven by interest in the new EAV conference held in May.
- Chuck Jarrett provided report on the primary function of SPE, Education. Details of Plastivan visits in 2022 shared along with the winners of the poster competition at the new EAV conference held in May 2022. Volunteers were requested for a new program initiated with American International Academy in Inkster, MI. This new 6 week summer program will foster STEM education for students without access to real science and engineering learning in current school system.
- First annual SPE EAV conference was a resounding success. The event drew 827 visitors over two days. 69 technical presentations were delivered and 25 sponsors were secured. Sassan extended thanks to the large group of chairs and co-chairs and called for even more volunteers to ensure even greater success for the 2023 event. Discussion on potential to secure a larger venue going forward due to the incredible interest of the automotive community for the first year of this important new conference.
- Jeff Helms announced first round judging for the 2022 Innovation Awards Gala set for September 15 and 16 at the Celanese office in Auburn Hills. E-mail will be sent to call for judges and set judging schedule.
- Vote to elect new Automotive Division Chair called. Sassan Tarahomi being nominated by Norm Kakarala. The nomination was voted on and Sassan was elected with unanimous support and Sassan officially accepted the role of Division Chair.
- Next meeting: August 22, 2022, 5:30-7:30 PM.

INTERSOCIETY REPORT

JP WEISE,
SPE AUTOMOTIVE DIVISION INTERSOCIETY CHAIR

This report will be covering IHS Markit's US Economic Outlook & Automotive Market Highlights as well as OESA's 2Q News.

IHS MARKET ECONOMIC OUTLOOK

To no one's surprise, the biggest issue facing the US economy has been the continued story of inflation. With mortgage rates continued rise, housing starts have slowed and builder sentiment has softened. Consequently, the consumption of durable goods tends to soften as well. Further complicating things, soaring energy and food prices have also eroded consumer purchasing power and sentiment.

Globally, after growing at annual rates of 6.0% quarter on quarter (q/q) in the fourth quarter of 2021 and 3.5% in the first quarter of 2022, world real GDP fell an estimated 1.7% in the second quarter. Additionally, tightening financial conditions pose a risk to growth.

- 10-year US Treasury yield has retreated from mid-June highs to around 3.0%
- Risk spreads have widened, raising financing costs for businesses and households

As interest rates have risen, fear of a recession has also grown, and the dollar has appreciated. But with this, there have been some signs that commodity prices are beginning to retreat. The IHS Markit Materials Price Index fell 8.4% in the four weeks that ended July 15th, led by declines in prices of metals, chemicals, fibers, and rubber. The retreat in prices is filtering downstream, causing inflationary pressures on intermediate goods to soften globally. IHS Markit expects that the evidence of decelerating prices of finished goods will be more pervasive in the final quarter of 2022. Global consumer price inflation is projected to ease from 7.3% in 2022 to 4.2% in 2023.

US ECONOMIC OUTLOOK

US real GDP declined at an annual rate of 1.6% quarter over quarter in Q1, pulled down by a sharp rise in imports and a decline in exports. IHS expects a similar contraction in Q2, due to a sharp reduction in inventory accumulation. It is not expected that this contraction will meet the broad criteria for a recession, as it is difficult to square GDP losses with significant gains in employment, incomes, and personal consumption. However, the path forward is expected to be challenging.

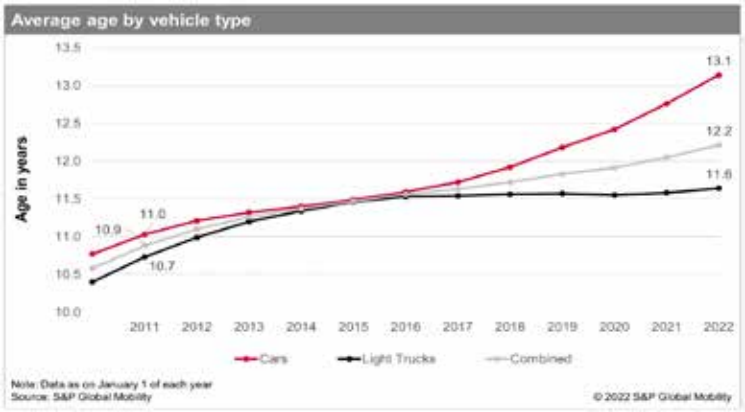
The Federal Reserve has signaled a willingness to raise interest rates enough to slow inflation to its 2% target, even if the result is a recession. The housing market boom is reversing and it is expected that businesses will rein in capital spending and hiring plans.

- Real GDP growth is projected to slow from 5.7% in 2021 to just 1.4% in 2022 and 1.3% in 2023 before picking up to 1.9% in 2024.
- With real GDP growth running below potential, the unemployment rate is expected to rise from 3.6% in June to a high of near 5.0% in 2024.

N. AMERICAN LIGHT VEHICLE PRODUCTION

- 2020 – 13 Million units manufactured.
- 2021 – 13 Million units – growth remaining flat
- 2022 – 14.7 Million units expected – though it is expected that there is still significant pent up demand for new vehicles given recent extraordinary increases in vehicle prices.

The all-time high age of vehicles on the road also suggests consumers, have been placed in the difficult position of having to hang onto their vehicles longer due to the lack of available replacement inventory.



A few notable data points on N. American vehicle consumption.

- Vehicle scrappage is also down from 15 to 11 million
- Interestingly… amidst all this… overall vehicle fleet in service has grown
- Pandemic BEV growth: now 1.44 million units (0.51% of VIO) is up 40% from previous year.
- BEV registrations led by light trucks (including SUVs) with light truck representing over 50% of new BEV registrations or 141% growth over 2021.
- BEV growth similar to overall market: truck and utility styles lead.

TECHNICAL REPORT

CHINMOYEE DAS, XINFENG XIE, College of Forest Resources and Environmental Sciences, Michigan Technological University. Houghton, Michigan

SANDEEP TAMRAKAR, DEBBIE MIELEWSKI, ALPER KIZILTAS, Research and Innovation Center, Ford Motor Company

NEWLY DEVELOPED BIOCARBON TO INCREASE CONDUCTIVITY IN SUSTAINABLE POLYAMIDE 12 COMPOSITES

ABSTRACT

Sustainable manufacture caused shift in automotive manufacturing practices. Polymer-based composites make up almost 15% mass of the entire vehicle, most importantly the fuel system of the vehicle. Poor electrical conductivity of the polymer composites leads to electrostatic deposition which can lead to further issues. Carbon based synthetic fillers like carbon fiber and carbon nanotubes are attractive options to develop electrically conductive composites, owing to their excellent electrical and mechanical properties. However, the production process of these reinforcements is highly time and energy intensive making it quite expensive and not quite sustainable. Lignocellulosic feedstock can be carbonized at a high treatment temperature of ≥ 1000°C to produce electrically conductive biocarbon filler. In this study biocarbon fibers developed using Douglas fir pulp, were incorporated into polyamide 12 matrix. The composites were fabricated using hot compression molding. At a loading of 7.5% the composites reported resistivity of 7.13 x 103 Ω cm and at 35% loading rate the composite resistivity was 2.13 Ω cm. The transverse volume resistivity value of resistivity of 5.04 x 108 Ω cm for polyamide 6 composites filled with 20 wt.% carbon fiber and longitudinal volume resistivity of 10.08 Ω cm were reported. The resistivity values for both 20 wt.% and 40wt.% carbon fibers is significantly higher than biochar filled composites at 25 wt.% and 35 wt.% biochar filler loading. This indicates the effectiveness of biochar filler as a conductive filler, in developing electrically conductive, sustainable composites.

1. INTRODUCTION

Automobiles are a major contributor to greenhouse gas emissions. As per Environmental Protection Agency(EPA) on an average 8,887 grams of CO_2 is emitted from 1 gallon of gasoline and 10,180 grams of CO_2 is emitted from 1 gallon of diesel [1]. Annually 4.6 metric tons of CO_2 is released from a typical passenger vehicle [1]. These emissions have a highly detrimental effect on the global climate scenario. Increased fuel efficiency of vehicles can lead to lower fossil fuel consumption, in turn lower greenhouse gas emissions. To achieve this, the automobile manufacturers have resorted to lightweighting of the vehicles. As per the EPA 2020 Automotive trends report, the heaviest vehicles produced in model year 2020 generate half the amount of CO_2 compared to what was generated in model year 1978 [2]. The CO_2 generated for lighter vehicles in 2020 is two thirds of what was generated in 1978, all owing to the massive design changes and advancements undertaken by the automakers [2]. Lightweighting can be done by making smaller cars or by material

substitution without compromising on the capacity and size[3]. Traditional materials are being replaced by light weight metals and largely by polymer composites. These composites are generally filled with fillers like talc, glass fibers, calcium carbonate (Cav), clay nanoparticles etc., [4], [5]. These polymer composites are lighter than the conventional metals, but the inorganic fillers have a high density making the end products bulky. Increased use of plastic in lightweighting of vehicles has also led to increase in fire accidents due to electrostatic deposition. As per the National Fire Protection Agency (NFPA) 61% of fires caused at service stations is vehicles fires caused due to sparks igniting fire during refuelling [6]. Having electrically conductive automobile parts by incorporating electrically conductive polymer composites is a solution to this issue. Electrically conductive polymer composites(ECPC) are polymer composites developed by incorporation of conductive filler material into a non-conductive matrix [7]–[10]. Electrically conductive composites can be developed by incorporation of various electrically conductive fillers in the matrix. Carbon based fillers like carbon nanotubes, carbon fibers, carbon black etc., have been reported to be used as filler and the composites have shown good conductivity values [11]–[13]. Electrically conductive polymer composites (ECPCs) have a wide range of application in sensors, electromagnetic shielding, capacitors etc. ECPCs are now being used in automobile industry to produce light weight electrically conductive parts to achieve fuel efficiency and cut down emissions. However, synthetic carbon fillers are highly energy and time intensive making procurement expensive and the whole process unsustainable. A coast effective and sustainable solution to develop lightweight electrically conductive composite is utilization of biochar as conductive filler.

Biochar is the carbon rich solid material that is left after the thermochemical conversion of biomass in an oxygen deficit environment[14]. Carbonization is a process in which the progressive conversion of a three dimensional organic macromolecular system like wood, into a macro-atomic network of carbon atoms [15]. In the process of carbonization, the biomass is heated to a certain temperature usually at a slow heating rate in an inert atmosphere using gasses like nitrogen, argon etc. As the thermal decomposition of the biomass takes place slowly the yield of solid carbon in carbonization is higher compared to other processes like pyrolysis. Biochar has been largely implemented in soil amendment and soil quality enhancement. Biochar has been reported to have improved the soil nutrient quality, has a positive effect on the soil microorganisms, owing to its high surface area and nutrient content it does a great job in soil quality improvement [16]–[18]. Biochar has been reported to be a great filler that is used for improvement of mechanical and thermal properties of polymer matrices. Das et al. 2016 [19] have reported improved tensile modulus and improved thermal stability in polypropylene filled with biochar developed from pine wood recovered from landfills. Similarly, Behazin, Mohanty, and Misra 2017 [21] incorporated ball milled switch grass (miscanthus) based biochar into a toughened polypropylene matrix and observed better mechanical properties in the composites. Nan et al. 2016 [22] developed electrically conductive Poly Vinyl Alcohol (PVA) composites by incorporating wood biochar developed from 3 different species , carbonized at different temperatures and reported electrical conductivity comparable to composites filled with carbon nanotubes in the polymer composites along with improved of mechanical properties . On a similar note, Giorcelli and Bartoli 2019 [23] developed biochar from coffee grounds by carbonizing the biomass at different temperatures and incorporated this biochar into epoxy matrix and reported electrical conductivity in composites filled with biochar carbonized at 1000°C. Biochar has been successfully implemented as a filler in many different polymer matrices to improve mechanical and thermal properties, however, not many studies have reported the incorporation of biochar as an electrically conductive filler to make non-conductive matrices electrically conductive creating a gap that needs to be addressed.

Polyamide is a ubiquitous polymer and has widespread application in daily life and in industrial manufacturing processes. Polyamide 12 is a semi-crystalline polymer. Polyamide 12 is a polymer with acid amide groups in a straight chain structure and 12 carbon atoms in its monomer [24]. Polyamide 12 has melting point range of 178 to 180°C, modulus of elasticity of 170,000 psi and specific resistivity of 1×1014 ohm.cm, it has excellent mechanical properties, chemical resistance and low water absorption compared to the other polyamide polymers [24].The exceptional properties of Polyamide 12 have attributed to its wide use in the plastic industry and the automotive industry. Recycled Polyamide 12 recovered from Selective Lase Sintering (SLS) process is now receiving a lot of traction as a potential matrix material for composites. The recycled polymer is as good as pure polyamide 12. Feng, Wang, & Wei, 2019 [25] used polyamide 12 recovered from SLS to make filaments to be used in fused deposition modelling, they reported that the mechanical properties of recycled PA 12 is only slightly impaired compared to fresh polyamide 12. Incorporation of recycled polymer in the composite along with biochar makes it a closed loop process and enhances sustainable content in the finished product. Recovery and reuse of polyamide 12 from SLS can pioneer the use of polymers recovered from recycled automobile parts for instance.

2. MATERIAL AND METHODS

2.1. BIOCHAR AND POLYAMIDE

The biochar used in this study was produced in the lab in Michigan Technological University. The Douglas fir pulp feedstock was procured from Domtar paper org. The pulp was received in the form of compressed boards and was deagglomerated prior to carbonization. The pulp was dispersed in water to deagglomerate the fibers followed by washing with alcohol and then dried overnight at 90°C. The dried fibers were deagglomerated in a coffee grinder prior to carbonization, the blades of the coffee grinder were masked using duct tape to minimize the effect of blade edges on the aspect

ratio of fibers. The fibers were then carbonized in three heating zone tube furnace (Model 23-891, Lindberg, Watertown, WI, USA). The samples were loaded into a quartz tube and the ends were sealed. The fibers were heated to 1000°C at a heating rate of 10°C. A steady flow of nitrogen was maintained at 1000cc/min throughout the process of carbonization. The samples were maintained at 1000°C for 60 minutes. The samples were weighed before and after carbonization to determine biocarbon retention The biocarbon retention after carbonization at 1000 °C was about 14 – 16%.

Recycled polyamide 12 recovered form selective laser sintering (SLS) method was used as matrix. It was provided to us by Ford Motor company. The melting point of polyamide 12 was 178°C and the density was 1.01 g/cm3. The polyamide was sieved before use to remove impurities. 20 wt. % Carbon fiber filled polyamide 6 extruded pellets were provided to us by BASF.

2.2. CHARACTERIZATION OF BIOCHAR

2.2.1. ELEMENTAL ANALYSIS OF BIOCHAR

The biochar fibers were characterized for carbon (C) and Nitrogen (N) using elemental analysis. Dried, ground, and homogenized samples were weighed into tin capsules and analyzed for carbon and nitrogen content on an Elemental Combustion System (Costech 4010, Costech Analytical Technologies, Inc., Valencia, CA) in the LEAF core facility at Michigan Technological University. The instrument was calibrated with atropine. Stability was checked with NIST 1547 every 12 samples with a relative standard deviation of 0.03 for N and 0.19 for carbon.

2.2.2. XRD ANALYSIS OF BIOCHAR

The crystallinity of wood fiber and biochar samples were analyzed using X-Ray Diffraction. The analysis was done in XDS 2000 (Scintag Inc., USA) at a scattering angle 2θ, scanned from 5° to 60° (at 1.540562 Å wavelength, continuous scanning). The data was analyzed in Microsoft excel.

2.3. COMPOSITE FORMATION

The composite samples are developed with different biochar concentrations. Biochar and nylon were weighed and dried overnight at 80°C overnight to remove moisture. The biochar fibers were dispersed in the nylon matrix in a coffee grinder with modified blades. The blades of the coffee grinder were wrapped with duct tape to mask the edges of the griding blades. This is done to ensure minimal damage to the biochar fiber aspect ratio. The carbon fiber filled polyamide 6 extruded pellets were also conditioned and fabricated into composite discs. The composites were fabricated using hot compression mounting method. The samples were placed in the die and heated to 300°C while 95psi pressure is applied on to the set up. The assembly was held at the final temperature and pressure for 30 minutes. Figure 1 shows the equipment used to fabricate the composite samples. The cured composites were then measured for diameter and thickness and characterized. The samples were lightly polished using a polishing unit (Leco Spectrum System 1000) at 100-150 rpms. An 8-inch P500 grit Alumina based polishing paper was used with water as polishing media. Each side was polished for about 3-5 minutes to achieve uniform surface texture. Figure 2 shows the entire process of fabrication of biochar filled polyamide composites. The diameter and thickness of the samples was measured.

Table I: Composite composition with different filler loading rates.

Loading rate (%)	Biochar (g)	Polyamide (g)
7.5	0.1875	2.3125
9	0.225	2.275
15	0.375	2.125
25	0.625	1.875
35	0.875	1.625

Figure 1. Heat compression mounting equipment used for fabrication of composites.

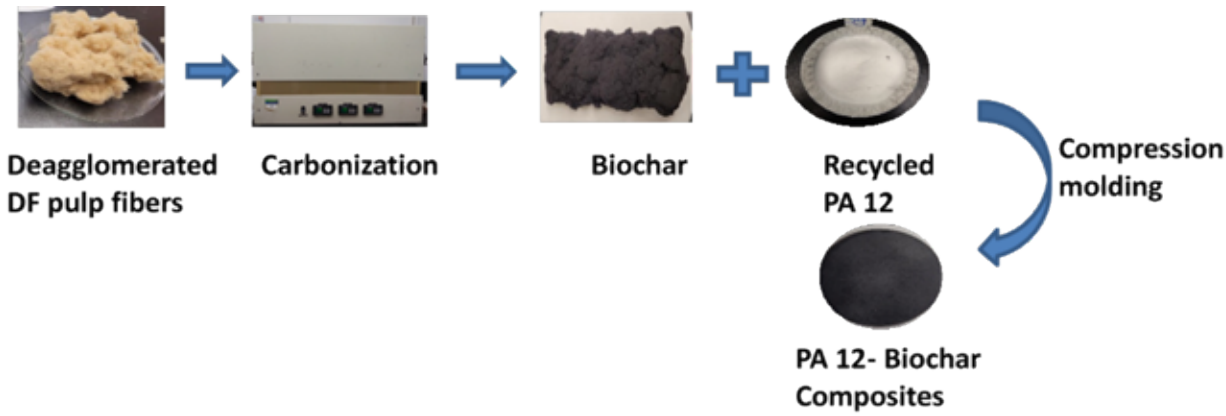


Figure 2. Composite fabrication process for development of biochar filled PA 12 composites.

2.4. ELECTRICAL CONDUCTIVITY MEASUREMENT

The composite samples were characterized for electrical conductivity using a measuring device designed in the lab in Michigan Technological University (Figure 3). The samples are placed between the electrodes and current and voltage is applied to the samples. DC current is applied using a power source (Powerbes DC power supply SPS W1203, having output of 120V and 3A), the current and voltage readings are taken using (Sigilent SDM3065X 6 ½ digit Digital Multimeter) for current and (Siglent Technologies SDM3055 5.5 Digit Digital Multimeter) for voltage. The current and voltage input values were regulated based on composite composition. The composites with higher biochar loadings were characterized using a current input of 500 mA and voltage input of 50V, while the samples with lower loading rate namely 7.5% and 9% biochar were characterized at 50V voltage and 60mA current input values respectively. 8 measurements were taken for each sample and 5 replicates were characterized for each loading rate. Average and standard deviation was calculated for each set of samples.

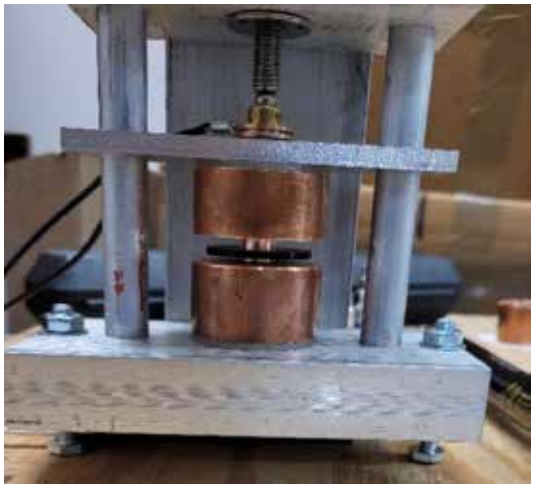


Figure 3. The resistivity of the samples was calculated using the formula;
Resistivity p = RA/l
R = Resistance of sample
A = Area
l = Thickness of the sample

2.5. DYNAMIC MECHANICAL ANALYSIS

The DMA analysis of pure polymer and biochar filled composites was done in tensile mode for 20mm long 4mm wide 1mm thick samples. The experiment was carried out by heating the samples from ambient temperature at 25°C to 150°C, at a strain amplitude of 0.01% and frequency of 1 Hz. The Tg of the samples was calculated from the peak of tan delta peaks.

2.6. THERMAL PROPERTIES

Thermogravimetric Analysis (TGA) of the composites was performed to determine the effect of biochar addition on the thermal properties of the composites. The analysis was performed using a TA Q500 TGA instrument. 10 mg of sample was procured from different spots of a composite sample and was placed in platinum sample pans and heated to 500°C at a heating rate of 10°C/min in a nitrogen atmosphere. The samples were maintained at isothermal at 500°C. The thermal behavior of pure polyamide 12 and the composites were compared to determine the effect on biochar on the thermal stability of the composites.

2.7. SCANNING ELECTRON MICROSCOPY ANALYSIS

Scanning Electron Microscopy was used to analyze the morphology of the composites. The composite discs were placed in liquid nitrogen for 5 minutes and then broken using pliers. The pieces were coated with platinum/palladium using sputter coating to make the surface conductive. The SEM was done using Hitachi S-4700 Field Emission (FE) SEM instrument. The imaging was done at 100 kV, 30 μm magnification.

3. RESULTS AND DISCUSSION

3.1. ELEMENTAL ANALYSIS

The elemental analysis of Douglas fir biochar fibers carbonized at 1000°C showed 88% carbon content in the biochar and 0.7% nitrogen content. The carbon content in the biochar is influenced by carbonization temperature and it is believed with higher carbonization temperature a higher carbon content can be achieved.

3.2. XRD ANALYSIS

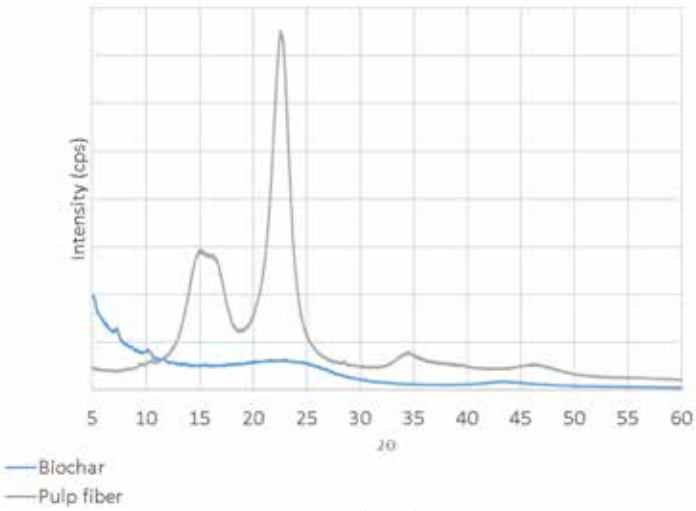


Figure 4. XRD pattern of pulp fiber vs biochar.

The Figure 4 here shows the comparison between the XRD pattern of Douglas fir pulp fiber and biochar fibers. The broad peak between 15° – 20and the sharp peak at 20° for Douglas fir pulp fiber are believed to be cellulosic peaks. These peak patterns indicate the presence of a high cellulose content in the feed stock. On the contrary, in biochar these peaks are absent. The lack of significant peaks for biochar are indicative of the amorphous nature of biochar. The short and broad peak obtained at 20° – 25° for biochar could be due to the presence of turbostatic structure obtained by carbonization at high temperature like 1000°C [26]–[28]. The transition from crystalline to amorphous could be a result of high temperature carbonization.

3.3. ELECTRICAL CONDUCTIVITY OF COMPOSITES:

Improved electrical properties were observed in the composites compared to pure polyamide 12 that has a volume resistivity between 1012 - 1014 Ω cm. At low biochar loading level of 7.5wt % the resistivity of the composite samples was reported to be 7.13 x 103 Ω cm indicating drastic drop in electrical resistivity compared to pure polymer. The electrical resistivity was reported to have further dropped with increasing filler concentration in the composites. At 35% filler concentration the resistivity value reported by the composites was 2.13 Ω cm . Clingerman 2001 [29] reported transverse volume resistivity value of resistivity of 5.04 x 108 Ω cm for polyamide 6 composites filled with 20 wt % carbon fiber and longitudinal volume resistivity of 10.08 Ω cm for 40% carbon fiber filled polyamide 6 composites. The resistivity values for composites filled with both 20 wt.% and 40 wt. % carbon fiber is much higher than biochar composites having a relative biochar fiber filler concentration with respect to carbon fiber concentration. This is an indicator of the effectiveness of biochar as a conductive filler. Several factors affect the electrical properties of biochar which in turn affects the overall composite properties. A major factor contributing to the electrical conductivity of biochar is the carbonization temperature. Several studies have reported good electrical conductivity in biochar carbonized at ≥ 1000°C [22], [30]–[32]. The carbonization of feedstock at a high temperature results in a turbostatic structure in biochar which is composed of discontinuous highly ordered crystalline phases [15], [33]. The turbostatic structure of biochar is responsible for the conductivity of biochar. The loading rate is another factor, as it can be observed in the study that with increasing filler concentration results in improved composite electrical properties, similar trend is also observed in other studies conducted using biochar as an electrically conductive filler [22], [32]. Morphology of filler is also a contributing factor to the electrical conductivity of composite [34]. The fibrous morphology of the biochar fibers incorporated in the polyamide12 matrix in the study has contributed to the improved electrical properties even at low filler concentration. The electrical resistivity of biochar filled composites was compared to 20 wt.% carbon fiber filled polyamide 6 composites. The carbon fiber filled composites reported a resistivity of 27.85 Ω cm that lies between the resistivity value of biochar composites filled with 25 wt.% biochar having a resistivity of 11.7332 Ω cm and 15 wt.% biochar filled composites having resistivity of 84.95 Ω cm. The carbon fiber composites at 20 wt.% have resistivity higher compared to 25 wt.% biochar filled composites. This indicates the good electrical conductivity of biochar fibers, that is reflected in the electrical properties of the composites.

The electrical resistivity of biochar filled composites is presented in Table II. A thing to notice here is the high coefficient of variation in the composites. This indicates high variation in resistivity values among the composites. The variation is quite pronounced in composites with lower filler concentration having higher resistivity compared to higher loading rates.

Table II: Electrical resistivity of biochar filled composites.

Filler Loading (%)	Resistivity (Ωcm)	Std Dev	COV (%)
7.5	4.98E+06	1.11E+07	222.932209
9	1.43E+06	3.05E+06	161.8607
15	84.95289	30.59879	36.0185
25	11.7332	1.736095	14.7964
35	2.058804	0.492097	23.9021

3.4. DYNAMIC MECHANICAL ANALYSIS

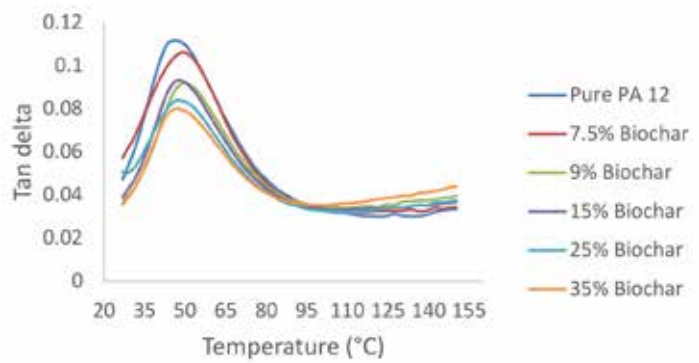


Figure 5 (a). Tan delta peaks for pure PA 12 and biochar filled polymer composites at 1 Hz.

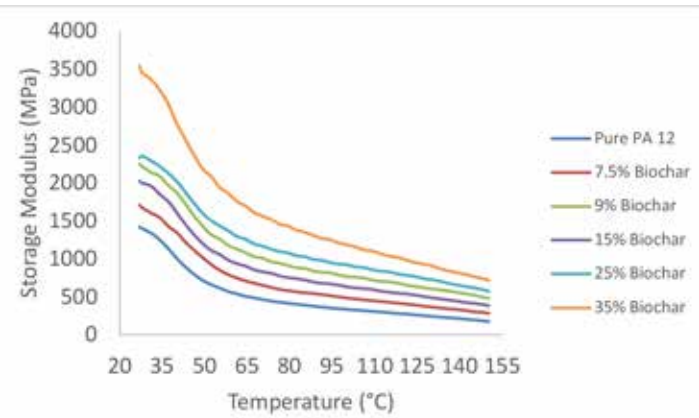


Figure 5 (b). Storage modulus trend for pure PA 12 and biochar filled composites.

The dynamic mechanical analysis of pure PA 12 and biochar filled composites show the glass transition temperature Tg of PA 12 at 46.27°C and for the composites at 47°C indicating no significant of biochar fillers on the Tg of composites as the value is very close to Tg value of pure PA12. The tan delta peaks (figure 5 (a)) show declining magnitude with increase in filler concentration, suggesting an increase in composite stiffness compared to pure PA 12 which reflects a decrease in energy absorption capacity of the composite. On the other hand, the storage modulus values (figure 5 (b)) show steady increase with increasing filler content, this improvement was expected with incorporation of filler.

3.5. THERMAL PROPERTIES

The TGA weight loss curves (figure 6 (a)) indicated a shift in the degradation temperature of the composites compared to pure polyamide 12 polymer. The onset of thermal degradation takes place at 372°C for polyamide 12 while for the composites lower loading rates 7.5% and 9% have temperatures close to the thermal degradation temperature of polyamide around 367°C. There is a significant shift in higher loading rate towards higher degradation temperatures. The temperatures for 25% and 35% filler loading composites are above 400 °C. This indicates enhanced thermal stability in composites introduced by incorporation of thermally stable biochar. A negligible amount ~1% of residue was obtained after the entire degradation cycle of polyamide 12, while in case of composites significant amount of residue was obtained on completion of the analysis. The amount of biochar residue increased with filler concentration of the composites. This is an indicator of improved thermal properties of composites as well. The residue is also indicative of the material loss during composite processing. The higher the filler retention the lower the material loss throughout the processing phase. throughout the sample specimen. The amount of residue for each loading rate indicates very less material loss during the processing of composites.

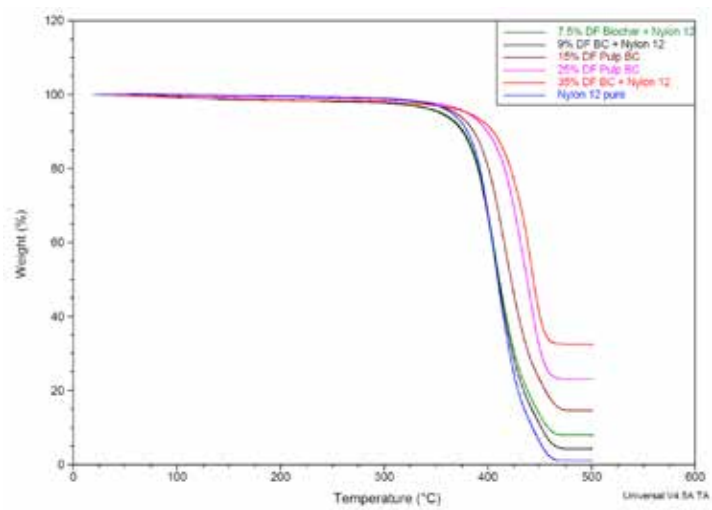


Figure 6 (a). TGA mass loss curves for biochar filled composites compared to mass loss curve for pure polyamide 12.

The DTG curves (figure 6 (b)) show the thermal decomposition of polyamide was initiated at temperature 400°C while in the case of composites for lower loading rates 7.5% and 9% the maximum degradation temperature is similar to polyamide 12 however a shift towards right is observed with increasing loading rates. 15% biochar filled composites mark the beginning of improved thermal properties and the improvement is significant in 25% and 35% samples as a significant increase in maximum degradation temperature is observed. This shift shows the improved thermal properties in the composites on addition of biochar filled to the polymer matrix.

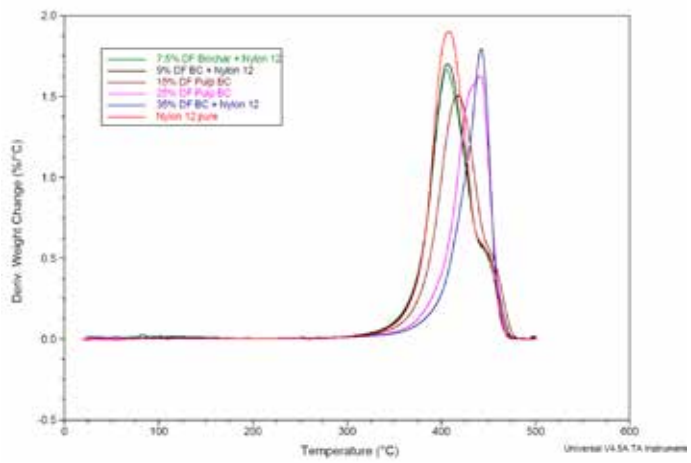


Figure 6 (b). DTG curves for biochar filled composites show significant improvement in maximum degradation temperature in composites in comparison with pure polyamide 12 polymer.

3.6. SEM ANALYSIS

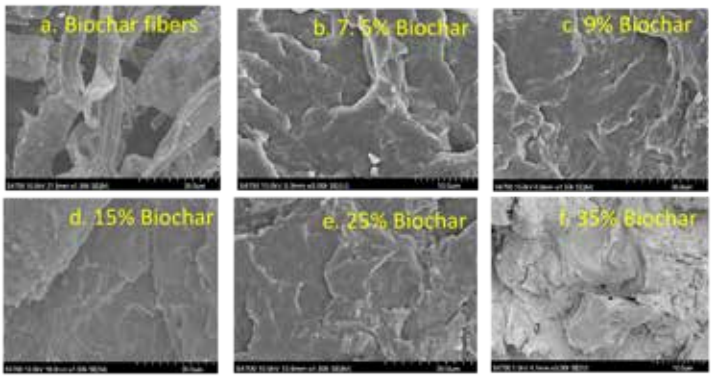


Figure 7. SEM images of biochar fibers and biochar-polyamide 12 composites, (a) Biochar Fibers, (b) 7.5% biochar filled composites, (c) 9% Biochar filled composites, (d) 15% Biochar filled composites, (e) 25% biochar filled composites (f) 35% biochar filled composites.

The Figure 7 (a) showing SEM image of biochar fibers does not show the presence of pores on the biochar surface. This is contrary to expectation since biochar is characterized by the presence of these honeycomb shaped pits. One of the reasons for the absence of these pits could be the pulping process to produce pulp from raw material that could have damaged the anatomical features of wood largely. Another reason could be the carbonization at such high temperatures that could have caused a certain amount of damage to the structure of biochar. The fibrous structure of Douglas Fir pulp fibers is quite maintained in the biochar fibers even after carbonization. In the SEM images of composites, interestingly no distinction was observed between the filler and the matrix. This could be due to the fibrous morphology of filler that makes is difficult to identify in the composites. The SEM results indicate further deeper investigation of the morphological features of composites to figure out the unique properties attributed to the incorporation of biochar fibers instead of biochar particles.

4. CONCLUSION

Incorporation of biochar as an electrically conductive filler has shown promising results. The resistivity value has shown a significant drop even at low filler concentrations. The carbonization temperature and morphology of the filler are two important factors in enhancing the electrical conductivity of biochar and hence improving the electrical properties of the composites. The thermal properties have also shown improvement by indicating higher thermal stability on incorporation of biochar to pure polyamide12 polymer matrix. These positive results definitely indicate the potential of biochar as an electrically conductive filler to be used in manufacture of automobile parts. The use of biochar fibers is pretty unique since all the studies done previously have utilized biochar particles. Utilization of recycled PA 12 from SLS waste definitely enhances the sustainability of the process and paves way for utilization of similar waste products maybe from automotive waste. Post end of life cycle automotive parts can be recycles providing raw material for development further application. The recycling and reutilization of waste will make the process circular eliminating waste generation and improving the carbon footprint in the entire lifecycle of the vehicle. Even though biochar has shown immense promise as an electrically conductive filler, one major caveat is the non-uniform distribution of filler in the matrix. The non-uniform distribution of biochar can create nonconductive blind spots in the conductive composites resulting in issues. This is going to be one of the major study points as we progress with this research having the goal of developing an electrically conductive composite with highly uniform filler distribution to have a high applicability of the finished product.

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