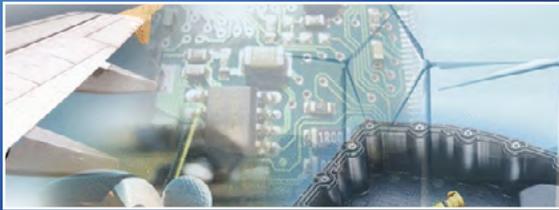




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MARCH / APRIL 2018



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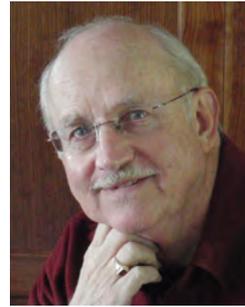
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- New BOD Members
- BOD Meeting Minutes
- Treasurer's Report
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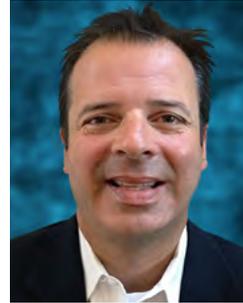
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# Please Welcome Our New BOD Members



## Hicham Ghossein



Hicham Ghossein holds a MS in Physics from the University of Alabama at Birmingham (UAB) and finishing his PhD in Mechanical engineering with the focus of

Mechanics of composites at the University of Tennessee, Knoxville (UTK) in summer 2018. Hicham worked on several industries collaboration projects throughout his graduate career, where he served as PI/team lead. These projects target concept to part challenges as well as innovating composite manufacturing methods. During his Time at UAB, Hicham was awarded the Graduate Automotive Technology Education Fellowship as well as the prestigious Ireland Research Travel Award and the Deep South Small Project Training Grant. Hicham continues his involvement in the composite community as a steering member of the founding committee for the Composites Coalition, and helping Magnet schools in the east Tennessee area establish composites educational programs and laboratories.

their product, process and market development needs using his expertise in polymers, technology scouting and market intelligence. Prior to joining Center for Industrial Research and Services (CIRAS), he was a Lead Scientist at ISU for 7 years who led research teams in areas of composites and novel compound development with renewable materials and polymer chemistry. In addition, he was an executive officer within the Indian fiber and textile manufacturing industry for 3 years, working on process optimization and productivity improvement.”

## Dr. Mingfu Zhang



Dr. Mingfu Zhang is a research manager at Johns Manville Technical Center in Littleton, Colorado. He leads the Sizing Technology Group to develop high performance fiber glass products for

thermoplastic and thermoset composites. His current research focuses on the development of fiber glass products and composite manufacturing processes for structural thermoplastic composites. Mingfu holds over 20 patents in the field of reinforcement and composites. He represents Johns Manville in several industry-academia consortiums focusing on advanced composites, including the Institute of Advanced Composites Manufacturing Innovation (IACMI).

Mingfu received his Ph.D. degree in Polymer Chemistry from University of Bayreuth (Germany) in 2004. Before joining Johns Manville in 2006, he did his postdoctoral research in the Department of Polymer Science and Engineering at University of Massachusetts-Amherst.

## Shankar (GowriShankar) Srinivasan



Shankar's background includes textiles, plastics and composites processing experience. For over 4 years, Shankar at CIRAS has been assisting manufacturers with

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- [BOD Listings](#)
- [New BOD Members](#)
- [BOD Meeting Minutes](#)
- [Treasurer's Report](#)
- [Education Update](#)
- [Membership Report](#)
- [Award Winning Paper](#)



# Board Meeting Minutes Sept 5, 2017



By: Antoine Rios

**ACCE 2017, Novi, MI  
Tuesday, September 5, 2017**

## Attendees:

Antoine Rios (p)	Andy Rich (p)
Fred Deans	Dale Brosius
Christoph Kuhn (p)	John Busel (p)
Dale Grove (p)	Enamul Haque
Rich Caruso	Ian Swentek
Jack Gillespie	Tim Johnson
Jim Griffing (p)	Mingfu Zhang
Kathy Schacht	Michael Connolly
Ray Boeman	Steve Bassetti
Frank Henning	Shankar

## Chair: Ray Boeman

- Changes at SPE
  - Russ Broome has indicated that he is leaving SPE's managing director position.
  - Kathy reported that his position may not be filled since new CEO, Patrick Farrey, is located in the US.
- Looking for volunteers to assist Communications & Membership Committees
  - John Busel has volunteered to help.
  - New elected members to help.

**Action (MC):** to distribute SOPs.

Meeting started at 4:30 pm EST

*continued on page 10...*

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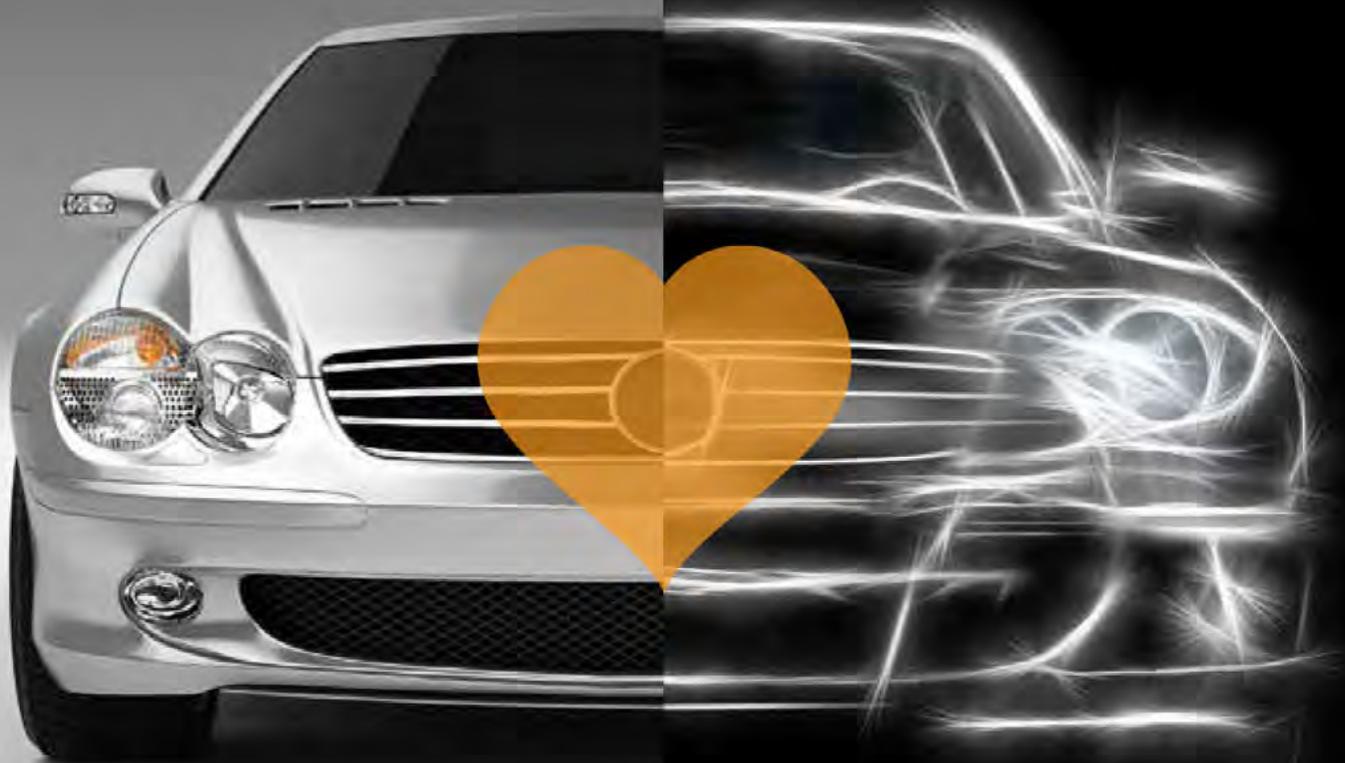
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## Minutes continued...

### Secretary: Antoine Rios

- Election Results
  - Re-elected: John Busel, Andy Rich
  - New Board Members: Christoph Kuhn, Hicham Ghossein, Mingfu Zhang, Shankar Srinivasan
- Meeting minutes from Antec were approved.

**Action (AR):** change contact sheet to reflect Shankar instead of Jim as Antec chair.

**Action (All):** review minutes from July's meeting. They were distributed today.

### Chair-Elect: Ian Swentek

- Pinnacle Award update:
  - Ian reviewing previous Pinnacle applications
  - New system for pinnacle won't be released for another year.
  - At Councilor meeting Dale B. offered COMDIV to be test case for new application.
  - Kathy & Ian to get together with Brian Landes to discuss.

### Communications: Andy. Rich

- Website:
  - Action (All):** Need feedback in regards to new website.
  - Ray Boeman indicated some video links were not active and would review other content and encouraged others to do so.
  - A special section devoted to sponsors.
  - Old website URL now pointing to SPE's hosted minisite.
  - No links to blogs or LinkedIn.
- Recruiting committee members
  - Steve Bassetti, MingFu, Christoph offered to be on communications committee.
  - After discussion, BOD agreed to provide link to ACCE site maintained by AUTODIV and not duplicate content.
  - Andy reported 1-on-1 hosting contract was cancelled and nominal charge to maintain the URL should remain. Tim J. indicated he is still seeing \$29/month but will monitor to see that it does discontinue.

*continued on page 11...*

# Board Meeting Minutes *continued...*



- Andy indicated he expects charges from SPE to assist in porting the website.
- Boeman asked for communications committee to form and meet before next meeting. Committee should report on plan to update/utilize the Blog, Twitter & LinkedIn accounts.
- Kathy was not aware if SPE has guidance using social media but would engage Connor Carlan to find out.

## **Inter/Intra-Society: John Busel**

- Report submitted.
- Presentations from members of the board at CAMX.
- Need to start thinking about planning for CAMX 2018 (Dallas in October).
- Inviting papers from board for new conference by ACMA, Recycling composites (April 11-12, 2018).
- ACMA organizing Poltrusion conference in 2019.

## **Membership: Michael Connolly**

- Michael provided a number of stats regarding membership
  - ~8500 in Society, 552 in COMDIV
  - ~2000 students, 85 COMDIV
  - COMDIV ranks number 7 in membership numbers within SPE.
- Membership is US centric. No global outreach.
- Spikes in memberships relating to ANTEC and ACCE conferences.
- Fred asked how many student chapters are currently active. AUTODIV intends to split \$5000 from golf fundraising among all Michigan chapters.

**Action (Membership Committee):** work in a statement to show value of being a member.

**Action (MC):** sent out report before next board meeting.

## **Councilor Report: Dale Brosius**

- August Council Meeting – Detroit report.
- Creig has resigned of VP Division – Bandwidth cited as reason.
- Dale B. term as councilor expires at Antec. He will consider running but hasn't decided yet
- Technical sessions now at ANTEC. Rich C and John Busel discussing how to engage.
- Dale B. exploring ways to engage Next Generation Advisory Board.

**Motion** to budget for three days for PlastiVan at \$1750/day: approved

**Action (Education Committee, Dale B.):** provide composites content to PlastiVan program.

## **Treasury Report: Tim Johnson**

- No new budget lines prior to the meeting
  - Just pasted first new line item for PlastiVan
- \$58K cash, \$70K investment
- ACCE revenue expected to increase by about \$35K

**Action (TJ):** provide investment options to Boeman to share with Executive Committee for decision. Proposing to divide \$78K into three separate funds.

## **Awards: Ian Swantek**

- SABIC Educator of the Year, Mettler-Toledo Award, Harald Giles Scholarship
- Honored Member program: HSM and Fellow applications
  - Fellow candidates: Jack Gillespie
  - HSM candidates: Uday Vaidya
- Jackie Rehkopf Scholarship
- Awards lead transferred to Dale G.
- Ian overseeing applications for Jack G and Uday V for Fellow and HSM. Applications nearly complete.

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*continued on page 12...*

# Board Meeting Minutes continued...



- Educator of the year award not getting enough candidates. Tim recommends keeping applications on file for 3 years to supplement new applications so non-winners in very competitive years are not required to resubmit.
- Michigan ACCE award would be improved next year.
- Foundation sponsoring ACCE awards – off on timing relative to foundation applications.
  - Ian reports that using the foundations online system provide opportunity to apply for 30+ awards with one application
  - Awards committee's approach to better promote awards (due at next meeting).

## Education: Uday Vaidya

- Uday sent email report to Ray. Email read.
- Uday seeking help from BOD to judge student posters.

## Technical Conference Report:

- [SPE/IEC Composites for Performance in Sports](#) (Jan 23-24, Long Beach CA) – Rich C.
  - Scott Marco putting together meeting with JEC perhaps Friday.
  - Rich will meet with Scott.
  - Rich trying to help with Speakers.
  - Rich sent note to Aaron Bartel regarding participation but still waiting.
  - Dale B. needs to think about relationship with SAMPE/ACMA as consider involvement with JEC.

*continued on page 14...*

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# Board Meeting Minutes continued...



- [Thermosets 2018](#) (February 20-21, 2018, Indianapolis, IN) – Dale B.
  - Discussing with Len nunnery on how to work together for this conference.
  - Not enough time to do a joint event in 2018.
  - Wait until 2019 or do our own.
  - Fred thinks RV and off-road would be a good topic.
  - Creig thinks pultrusion would be a good topic.
  - Tim, Fred, Michael, Dale, Creig agreed to discuss offline and bring recommendation to board.
- [ANTEC/NPE 2018](#) (May 7-10, 2018, Orlando, FL) –Rich C.
  - John Busel, Rich & Shankar have been meeting on program.
  - Technical marketing to be allowed.

- Efforts to get more industrial topics.
- Technical papers due on December 4<sup>th</sup>.
- Asking everyone in the board to help with moderating, seeking papers and keynote speakers.

## ACCE: Dale Brosius

- Preview of ACCE 2017
  - Not much impact of proximity to CAMX.
  - Sponsorship up \$40K from last year.
  - 765 attendees already registered. Expect 800-900.
  - 125+ OEM.
  - 108 sponsors.
  - 75 papers.
  - Bonnie doing great.
  - International panel hosted by Dale B.
- Tour of IACMI Vehicle Technology Area Corktown, MI facility, afternoon of Sept 5<sup>th</sup>
  - There was a foul up on registration at SPE for the tour. A second tour (50 each) was added based on registration. No one showed up to ride the bus despite registration showing it was full. Combined attendance was 30-35.
- ACCE 2018
  - Desire to engage Next Generation Advisory Board for 2018.
  - Matt Carroll from AUTODIV suggested as good candidate for conference chair in 2018.
  - Suggestion to engage Mike Whitens to secure stronger participation by Ford on committee.
  - Negotiate with Bonnie for bonus and compensation for next year.

## Newsletter: Pritam Das

No report. Pritam was not present.

Meeting adjourned at ~7:00 pm EST



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# Treasury Report

By: Tim Johnson, Treasurer



**February 14, 2018**

**T**he Composite Division continues to maintain a positive budget. The results of the ACCE again exceeded our estimation with a distribution to the division of \$53K. Currently the Division has cash on the order of \$103K and \$74K in investment. Sponsorship of the Newsletter is on track to continue to exceed the costs, which now includes one printed newsletter per year distributed at the ACCE. We have recently transferred the web hosting to SPE National with a one-time charge to facilitate a significant upgrade while reducing the running cost. Presently we are working through a transition of accounting to QuickBooks from a spreadsheet basis,

which has facilitated simplification of sponsorship invoicing and payment, and this has also permitted the termination of banking merchant services previously used for accepting credit card payments.

The Executive Committee is presently reviewing proposals for how to manage diversification of the investment portfolio, while the Awards and Education Committees look to ways further the mission through increased Scholarship awards and Education matching grants.

Tim Johnson  
SPE Composites Division Treasurer

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An advertisement for DSC Consumables Incorporated. The text reads: "DSC CONSUMABLES incorporated" in blue and orange, followed by "High quality Lab ready dsc sample pans" in blue. Below this is a blue and orange wavy graphic. At the bottom, the website "www.dscconsumables.com" is displayed in blue. The entire ad is enclosed in a black border.

# Education Update



By: Dr. Uday Vaidya

The ACCE student poster contest has excellent topics that cover a broad spectrum of biocomposites, nanocomposites, design/manufacturing and application development topics related to automotive and transportation. We are expecting a very enthusiastic poster session this time. Teri has indicated that Dassault may sponsor the poster session. We will target at least 50 posters for 2018 like we did in Fall 2017.

The education funding announcement should go out to about 20 institutions with a deadline date of April 30, 2018. The draft for this is attached – it is similar to that shared before.

At SPE ACCE we talked with SPE Detroit about STEM activities to be conducted in the Detroit schools. This has to be followed up with the SPE Plastivan personnel.

Other suggestions are welcome.

## WORKSHOP AGENDA

July 19-20, 2011

### Advanced Composites For Heavy Truck, Mass Transit & Related Transportation Applications

DAY 1: July 19, 2011 (8:30-12:30 noon)

#### Overview Of Constituents, Process Relevance and Laminate Design (Vaidya)

- Introduction
- Constituents – Reinforcing Fibers, Polymer Matrices, Interface, Cores
- Relevance of the above constituents to processes used by the truck industry
- Micro/macromechanics / Failure Theories - Recap of analysis

#### Testing and Test Methods (Vaidya)

- Static and Dynamic Test methods
- Test plaque data and scale up to structures
- Impact, durability, vibration and fatigue
- Failure analysis and evaluation
- ASTM - DIN - ISO standards
- Nondestructive testing techniques – Ultrasonic, vibration, coin-tap, X-ray, thermography and other related methods

DAY 1: July 19, 2011 (1:15-4:30 pm)

#### Processing Technologies For Transportation Vehicles Thermoset Technologies (Horner, Buckley)

- Pros and cons of various processes such as SMC, RTM, Cold Molding, DCPD BMC, Open Mold processes (Audience participation)
- Materials, structure-property relationships
- Design considerations
- Equipment requirements and process requirements for each process
- Design considerations that apply to each and best practices
- Common problems and their causes in each of the processes (fiber alignment, knit lines, thickness variation, resin rich areas etc.)
- Economic side of process selection (process versus volume)
- Material selection (process and environmental factors)

DAY 2: July 20, 2011 (8 am to 12 noon)

*continued on page 18...*

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# Education Update continued...

## **Preforming**

- Developments in Preforming and near net-shape parts (Buckley)

## **Thermoplastic Technologies (Vaidya)**

- Case studies for thermoplastic application in heavy vehicles – The following aspects will be woven within the context of the applications...
  - Discontinuous and Continuous fiber thermoplastic processes
  - Long fiber thermoplastics, extrusion-compression, D-LFT, E-LFT and related processes
  - Sheet forming, Vacuum thermoforming, Thermoforming

- Thermoplastic joining
- Design, analysis and Process modeling/simulation for thermoplastics with emphasis on automotive, mass transit and truck case studies; thermomechanical models, rheology, flow and fiber orientation prediction, structure-property relationships
- Thermoset versus thermoplastic composites at various temperatures.

Each topic will be covered for approximately 2 hours followed by questions and discussion. The content, format and times are flexible and expected to lead to interactive discussions.

*continued on page 19...*

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## Driving solutions

# Education Update *continued...*



**T**he SPE composites division invites applications for students training and exposure for state of the art in Advanced Composites Design, Modeling and Manufacturing. SPE will entertain proposals that demonstrate high level of student involvement in the areas of -

- (a) Processing Modeling and structural FEA of advanced plastics and composites (e.g. ANSYS, Hypermesh, LS-DYNA, Moldex, Moldflow, PAM-FORM, PAM-RTM, Simulia etc. - but not limited to)
- (b) Equipment for composites processing (Vacuum Infusion, Flex RTM, Injection molding, Thermoforming, Stamping etc, - but not limited to).

## **Background:**

The use of advanced composites is growing rapidly in a number of sectors – defense, automotive, power, energy, sporting goods, infrastructure etc. The next generation engineers are in urgent need of comprehensive training in the design, modeling, manufacturing and characterization of advanced composite materials and products. The SPE Composites Division is making significant efforts in enabling young engineers enter the work force with relevant training and experience that aligns with industry needs. Modeling tools for FEA and process simulations, and lab scale equipment for composites processes have tangible impact on student involvement. The goal of the SPE grant is to promote access and broadening the use of these tools.

## **Who is Eligible:**

A four-year institution/university or a 2-year community college that offers courses and/or training in engineering and technology with course offerings in Introduction to Materials, Fibers, Polymers, Composites, Manufacturing. Demonstrated involvement from Freshmen to Senior to Graduate level students and K-12 outreach students is required.

## **Level of Funding:**

SPE Composites Division will provide up to \$5000 (for each approved proposal) with an institutional cost share requirement of 1:1. For e.g. if the value of the software or processing equipment is \$10,000, SPE will contribute \$5000 towards the purchase. The institution will be responsible to provide \$5000. Indirect costs are not allowed in the application.

## **Application Process:**

The application should be organized as follows:-

Cover Page: Name of the Project, Point of Contact, Institution Name and Contact Details, Date of Submission

Body of the Application (3-5 pages max):

- 1) Background of the Lab/Center/Department/Unit/Institution
- 2) Anticipated number of users and how they will use the software/equipment- undergraduates, graduates, staff, post-docs, and other users
- 3) Description of the software/processing equipment – need, plans with the acquired capability
- 4) Budget breakdown including cost share details and justification
- 5) Letter of commitment for the cost share from the Dean, Department Head or other Institutional authority (authorized to sign on behalf of the institution)
- 6) Quote or evidence of cost based on correspondence with the vendor

## **This Issue:**

- BOD Listings
- New BOD Members
- BOD Meeting Minutes
- Treasurer's Report
- Education Update
- Membership Report
- Award Winning Paper



*continued on page 20...*

# Education Update continued...

## Review and Selection Process:

Each application will be reviewed by a team of industry and academic experts and funding will be released based on their recommendation and approval of the SPE Composites Board.

## Submission of Applications

(Two deadlines: 15 April 2016, and 15 August 2016); Limited to one application per institution per year will be considered

## Expectations if awarded

Recipients are expected to:

- Participate in one of the SPE meetings (SPE ACCE, ANTEC etc) to report on educational impact/use of the software/processing equipment. The information can be in a poster or presentation format.
- Provide a brief summary/highlights at the end of the year that could be included in the SPE Composites Division newsletter.

## Applications should be e-mailed to (with the Subject Line - SPE Education Fund Application:

Uday Vaidya, PhD; SPE Education Chair, [uvaidya@utk.edu](mailto:uvaidya@utk.edu); Phone: 205-410-2898

## Other Information:

The awards will be made at the annual SPE ACCE meeting usually held in Novi, Michigan in September of year. The awardee institution will receive a certificate and plaque. The award notifications will be made in SPE media, website and news releases.

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See page 31 for more details



COMPOSITES

# Membership Report

By: Michael Connolly

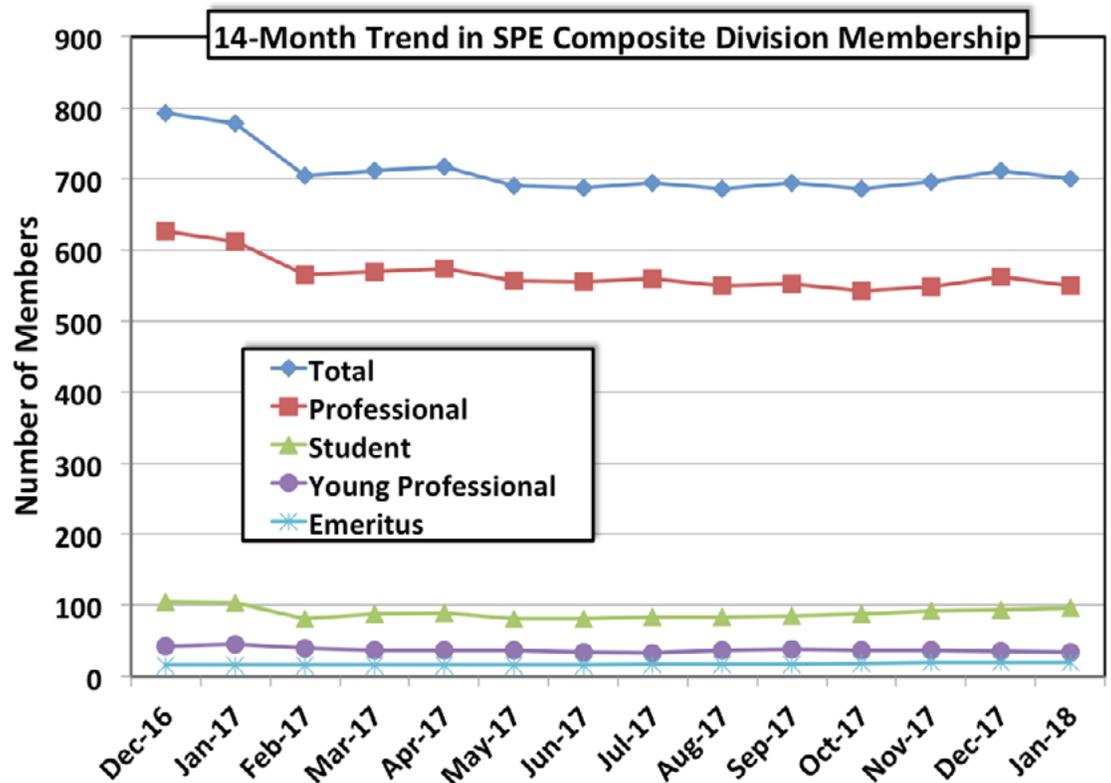


The last 14 months of overall membership in the CD is summarized in the attached spreadsheet. While there was a fairly significant (about 10%) drop in members at the end of 2016, CD membership was quite stable in 2017. SPE HQ has only been issuing reports in the current format since about 4Q '16. So, the drop at the end of 2016 may be significant or may be an outlier. I don't have data at the moment to see earlier membership numbers to find if the  $\pm 775$  members in late 2016 was consistent or just a high blip from 2015 ACCE memberships that were expiring. The Membership Committee will try to find 2015, 2016 and earlier data for comparison. However, the database itself changed in 2016 so these earlier membership numbers may not be relevant.

As for members, the CD had 136 new members in 2017 and 118 "dropped" members from Jan to Sept according to the HQ numbers.

The HQ report doesn't appear to give info on renewing members specifically. But with 701 members in Jan 2018 and 778 in Jan 2017, the CD lost 77 members overall so far in 2017. The numbers will be more clear in a few months when the "dropped" list catches up to complete the 2017 stats. Interestingly, there doesn't appear any kind of spike in CD members due to ANTEC or ACCE. We'll see if that observation remains true in the future assuming HQ keep issuing these types of reports and the HQ database remains in the same format.

The Membership Committee will convene by mid-IQ. The group will focus on soliciting all "dropped" members individually with a direct phone call or Email to determine their cause for non-renewal and entice them to rejoin. The CD BOD should discuss incentives for rejoining the CD especially for students and young professionals.



## This Issue:

- BOD Listings
- New BOD Members
- BOD Meeting Minutes
- Treasurer's Report
- Education Update
- Membership Report
- Award Winning Paper



## Award Winning Paper

# Mechanical Properties of Hybrid Basalt-Carbon Fiber-Filled Recycled Polypropylene and Polyamide 6 Composites

Douglas J. Gardner, Yousoo Han

University of Maine, Advanced Structures and Composites Center

Alper Kiziltas, Debbie Mielewski Ford Motor Company

### Abstract

**T**his paper presents results of a study examining novel hybrid recycled polypropylene and polyamide 6 composites using a combination of basalt fibers (BF) and carbon fibers (CF) for potential use in automobile applications. The composites were compounded using a laboratory scale co-rotating extrusion system, and test samples were prepared by injection molding tensile, flexure and impact test specimens. The

tensile and flexural properties of the hybrid composites were determined using an Instron testing machine and the Izod impact strength was determined on Ceast Impact tester. Density measurements were made on the resulting composites. The thermoplastic composites made using basalt fibers and carbon fibers were evaluated for their material properties and compared to the properties of composite samples reinforced by glass

*continued on page 23...*



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## Award Winning Paper continued...

fibers. Both of the two fibers (CF and BF) significantly increased mechanical properties and the blends of two fibers showed similar trends increasing mechanical fibers. Carbon fiber appears to be superior to BF in enhancing material property improvements which were found to be greater in the PA6 than in PP samples.

### Background

Research and development activities exploring the use of hybrid fillers in combination with recycled thermoplastics is gaining attention in automobile applications (Gardner et al. 2016; Koronis et al. 2013; Jawaid et al. 2011). The use of recycled materials offers the opportunity to reduce the carbon footprint and provides a sustainable way to create useful composite materials

for the automobile technology sector. The typical synthetic fibers used in automotive composites include glass and carbon fibers. There has also been interest in exploring the use of basalt (volcanic glass) fibers in thermoplastic composites (Czigány 2005). Basalt fiber has been known as a reinforcing additive since its discovery in 1923. The fiber was extensively used in military defense and aeronautical applications during World War II by the US, Europe, and the Soviet Union (Ross 2006; Colombo et al 2012; Pavlovski et al. 2007). The advantages of Basalt fibers are high thermal stability, low thermal conductivity, low heat storage, good resistance to corrosive media, high elastic modulus, and high hardness/wear resistance.

*continued on page 24...*

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## Scope and Objectives

This paper reports on feasibility of creating hybrid composites using basalt fibers and carbon fibers in recycled polypropylene and recycled polyamide 6 for automobile applications. The goal of this project is to explore the feasibility of the hybrid composites by comparisons of the mechanical properties to polymer matrix composite materials currently used in industry. Several formulations of hybrid composites were prepared, compounded, and molded into ASTM standard specimens for material property characterization.

## Materials and Methods

The Basalt fibers were supplied from Mafic Black Basalt Ltd, Ireland. The polymer matrices in this study included a grade of recycled polypropylene (RPP) and recycled polyamide 6 (RPA6). The RPP and RPA 6 were selected from grades for general extrusion supplied from The Materials Group, Rockford, MI.

The basalt fibers, carbon fibers and basalt/carbon fiber combinations were compounded with either RPP or RPA 6 using a lab-scale twin-screw extrusion system (CW Brabender Instruments Inc., Hackensack, NJ, USA). Table 1 shows the formulations of the control and hybrid composite samples. All compounds were dried again at 205°C for 4 hours and injected molded into flexural, tensile, or impact testing specimens using a lab mini-injector.

*continued on page 25...*

**Table 1. Major formulations for this study.**

Group Name	Matrix	Additives	Loading level	Note
PP	PP	-	-	Plastic control
PA6	PA6	-	-	Plastic control
PP30CF	PP	Recycled Carbon Fiber (CF)	30	Composite control
PA630CF	PA6	Recycled Carbon Fiber (CF)	30	Composite control
PP20CF	PP	Recycled Carbon Fiber (CF)	20	Composite control
PA620CF	PA6	Recycled Carbon Fiber (CF)	20	Composite control
PP30BF	PP	Basalt fiber(BF)	30	Composite control
PA630BF	PA6	Basalt fiber(BF)	30	Composite control
PP20BF	PP	Basalt fiber(BF)	20	Composite control
PA620BF	PA6	Basalt fiber(BF)	20	Composite control
PP10BF10CF	PP	BF:CF	10%:10%	Hybrid of CF and BF
PP15BF15CF	PP	BF:CF	15%:15%	Hybrid of CF and BF
PP20BF10CF	PP	BF:CF	20%:10%	Hybrid of CF and BF
PA610BF10CF	PA6	BF:CF	10%:10%	Hybrid of CF and BF
PA615BF15CF	PA6	BF:CF	15%:15%	Hybrid of CF and BF
PA620BF10CF	PA6	BF:CF	20%:10%	Hybrid of CF and BF

*The testing was performed according to ASTM D790, D638, and D256 for flexural, tensile, and impact properties, respectively. Density measurements of the composites were also measured.*

## This Issue:

- BOD Listings
- New BOD Members
- BOD Meeting Minutes
- Treasurer's Report
- Education Update
- Membership Report
- Award Winning Paper



# Award Winning Paper continued...



## Results and Discussion

Tensile properties of the composite samples are shown in Figures 1 to 4. The addition of CF and BF increases both modulus of elasticity and strength. The increases are clearer in the samples filled with CF [Fig 1] and made using the PA6 matrix [Fig 2]. The reinforcing effects of CF/BF with the PP matrix, however, were not dramatically clear regarding tensile strength while the samples with PA6 were.

Figure 1. Tensile modulus of elasticity of the samples.

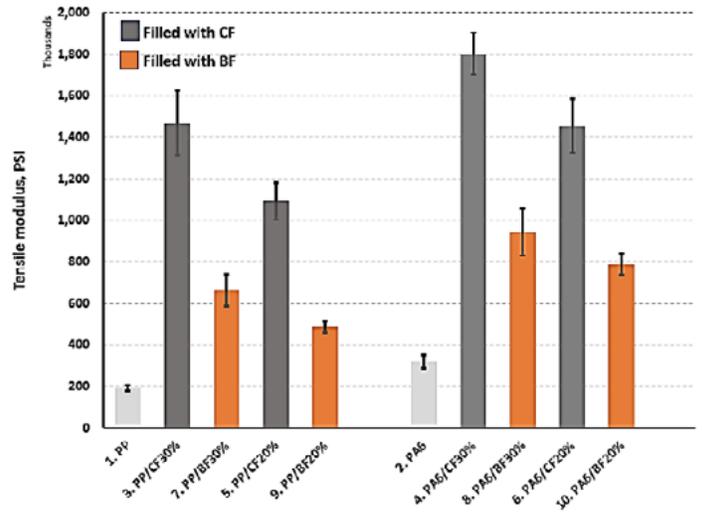
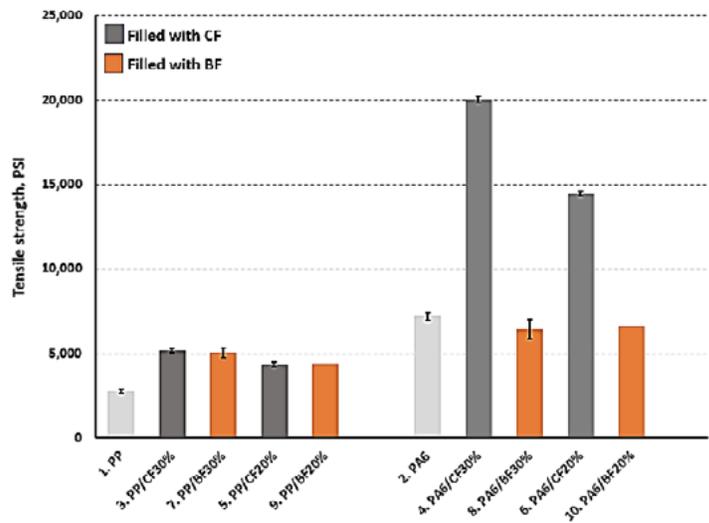


Figure 2. Tensile strength of the samples.



continued on page 26...

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Figure 3. Tensile modulus of elasticity and strength of samples made using the PP matrix.

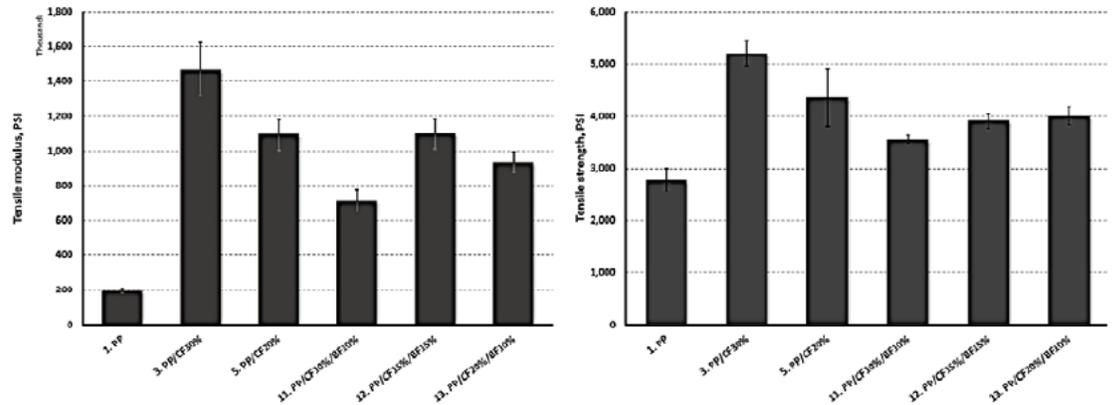
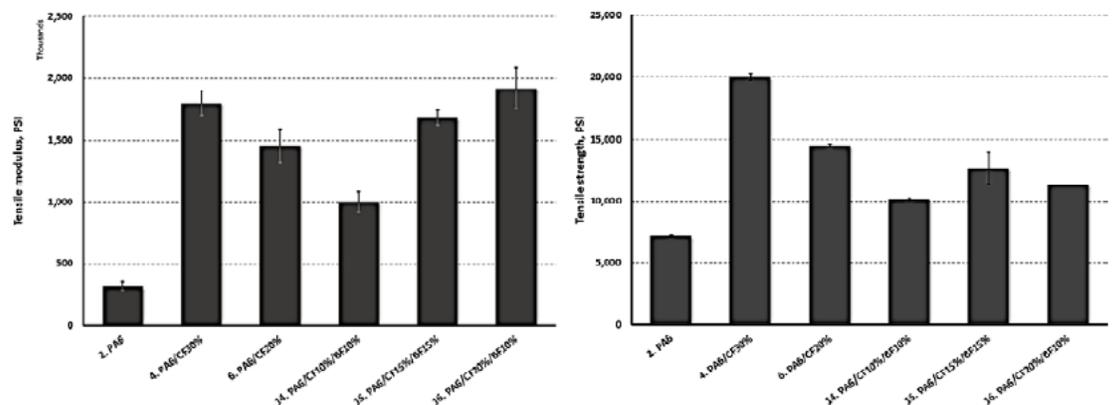


Figure 4. Tensile modulus of elasticity and strength of samples made using the PA6 matrix.



It was observed that the tensile properties of the samples, where CF is partially replaced with BF, were slightly lower in tensile properties. It implies that BF may not be a suitable alternative to CF in PP- or PA6 composites. It is, however, worthwhile to consider the use of BF as an alternative because of its lower cost since the properties are still much higher than the pure PP samples.

Flexural properties of the samples are shown in Figures 5 to 8. The results of flexural properties show similar trends compared to the

tensile property results. The reinforcing effects of CF are clearer than the samples containing BF [Figures 5 & 6]. The addition of BF in PP composite samples shows similar improvements of flexural strength compared to the CF addition [Figure 6]. Even though BF does not improve the properties to the extent that CF does, a partial replacement of CF with BF sustains the original flexural strength of the PP composite samples, which shows the potential of BF as an alternative for CF [Figure 7].

*continued on page 27...*

## This Issue:

- BOD Listings
- New BOD Members
- BOD Meeting Minutes
- Treasurer's Report
- Education Update
- Membership Report
- Award Winning Paper



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Figure 5. Flexural modulus of elasticity of composite samples filled with CF & BF.

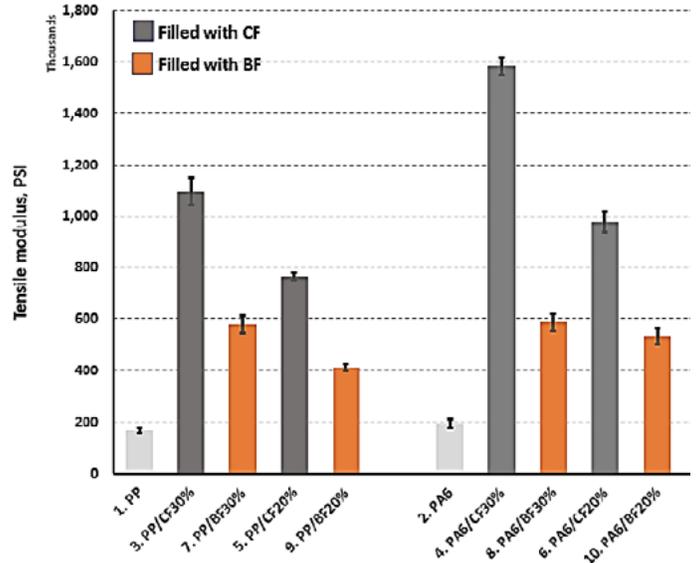
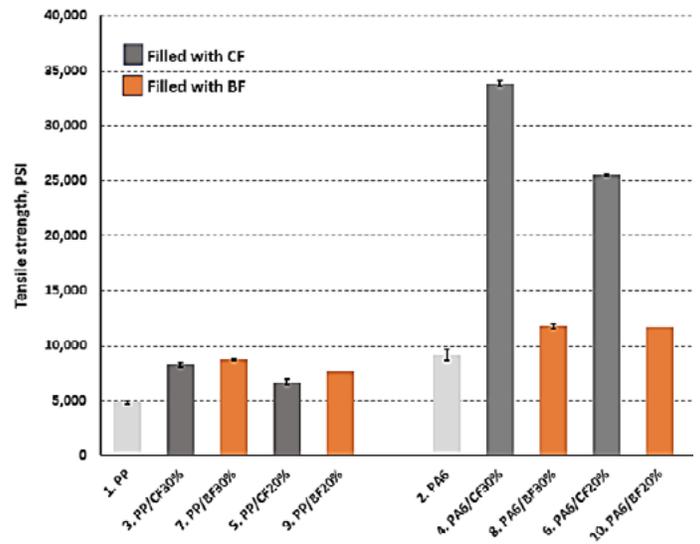


Figure 6. Flexural strength of composite samples filled with CF & BF.



continued on page 28...

# Award Winning Paper continued...

Figure 7. Flexural modulus of elasticity and strength of composite samples made using PP.

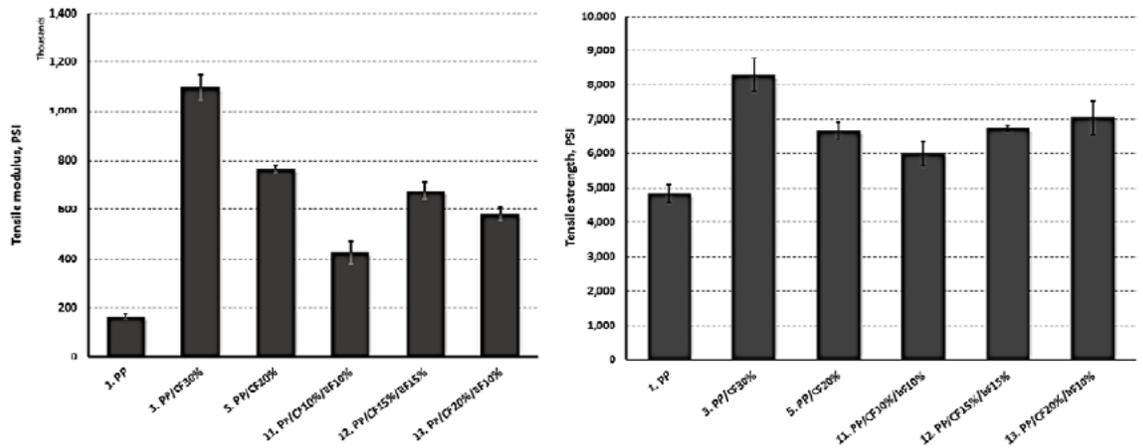
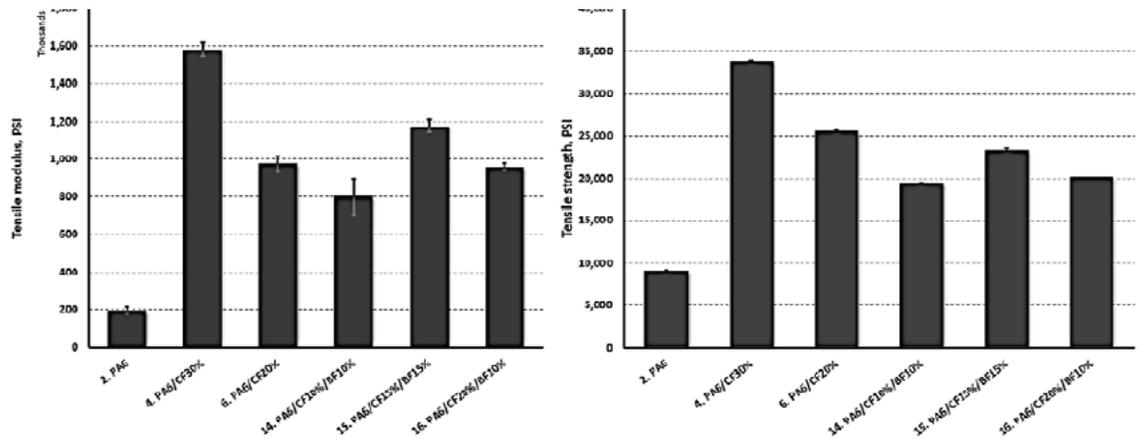


Figure 8. Flexural modulus of elasticity and strength of composite samples made using PA6.



## This Issue:

- BOD Listings
- New BOD Members
- BOD Meeting Minutes
- Treasurer's Report
- Education Update
- Membership Report
- Award Winning Paper

Impact strength of samples are shown in Figures 9 and 10. The reinforcing effects of CF and BF on the impact strength are only observed in the samples made using the PA6 matrix [Figure 9]. The composite samples made using the PP matrix were significantly reduced in impact strength since the pure PP shows superior impact proper-

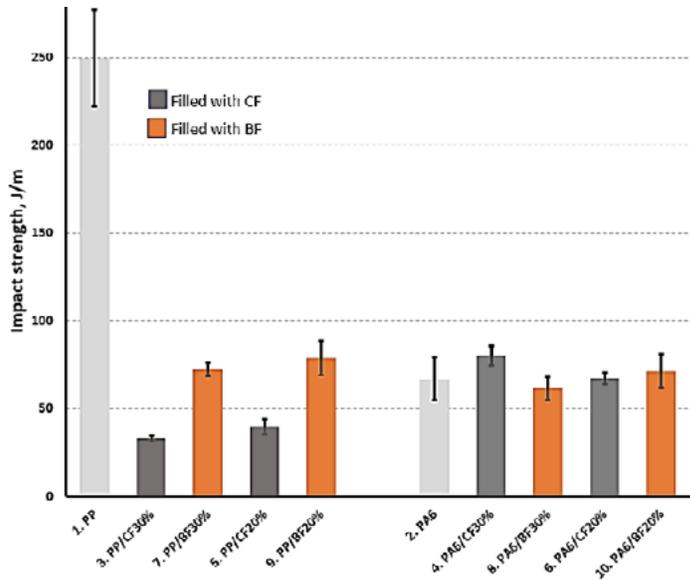
ties and the addition of fillers is known to decrease the impact properties in PP composites. The addition of BF in the PA6 composite samples showed a potential of BF as a reinforcing filler [Figure 10] since it doesn't significantly degrade the impact strength and it improves the other mechanical properties.

continued on page 29...

# Award Winning Paper continued...



Figure 9. Impact strength of composite samples reinforced with CF and BF.



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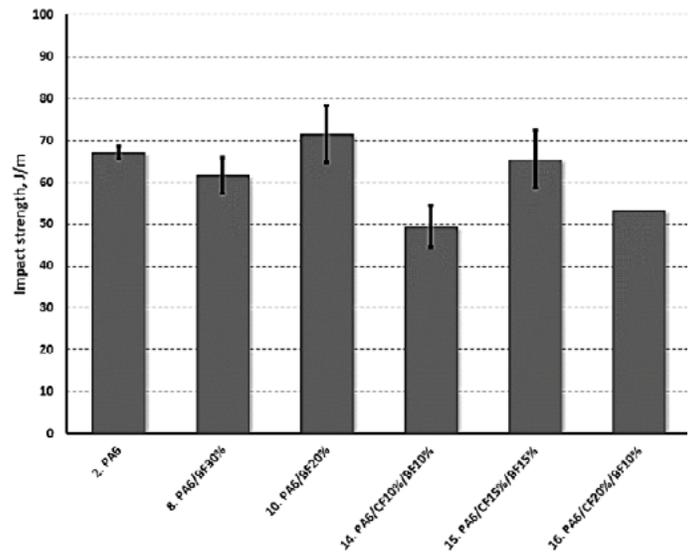
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Figure 10. Impact strength of samples made using the PA6 matrix and BF/CF.

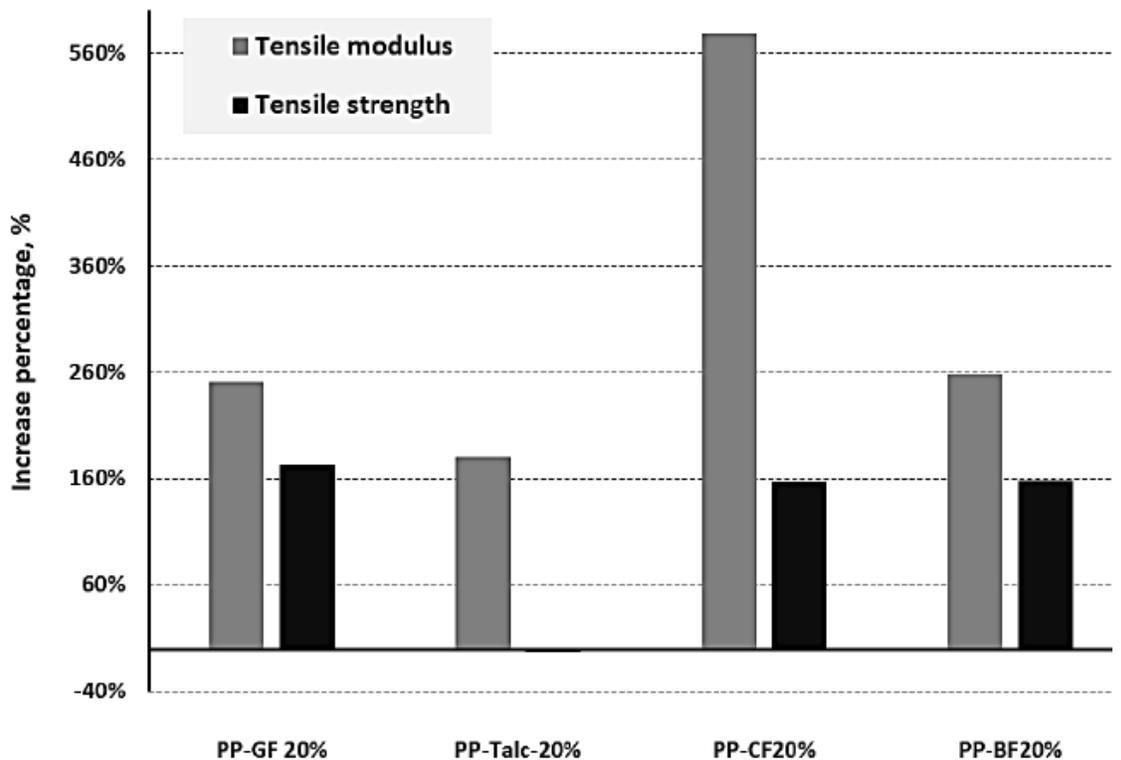


Other reinforcing fillers are compared to the CF and BF utilized in this study in Figure 11. The increased percentages are charted by the different fillers compared to the neat PP matrix. The CF and BF shows good reinforcing effects.

continued on page 30...

# Award Winning Paper continued...

Figure 11. The reinforcing effects of various fillers in PP composites on the mechanical properties [The increase percentage is based on the pure PP.]



## Conclusions and Future Work

Both CF and BF fibers increased the mechanical properties of PP/PA6 composites. The reinforcing influence was clearer in the PA6 composites than the PP composites. The potential of BF as a partial replacement of CF can be found for all mechanical properties reported. Especially, the impact properties can be clearly improved by the addition of BF or blends of BF and CF. The potential of BF needs to be studied more systematically since the use of BF can contribute to the cost savings in manufacturing.

## Acknowledgments

The authors thank Christopher West for the production and testing of the composite samples in this work. Funding for this study was provided by a grant from the Ford Motor Company.

*continued on page 31...*

## This Issue:

- BOD Listings
- New BOD Members
- BOD Meeting Minutes
- Treasurer's Report
- Education Update
- Membership Report
- Award Winning Paper

# Award Winning Paper continued...

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- BOD Listings
- New BOD Members
- BOD Meeting Minutes
- Treasurer's Report
- Education Update
- Membership Report
- Award Winning Paper



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- BOD Listings
- New BOD Members
- BOD Meeting Minutes
- Treasurer's Report
- Education Update
- Membership Report
- Award Winning Paper

