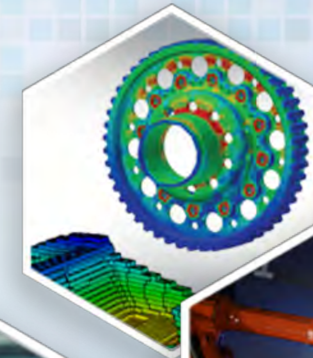
Project Portfolio
January 2019

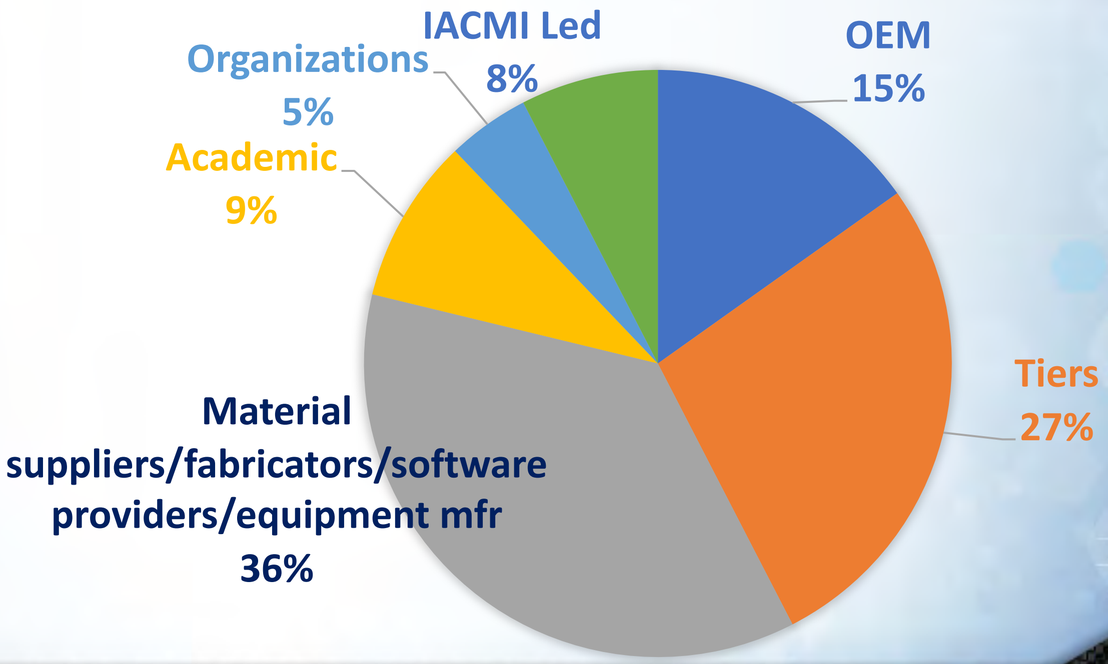
John F. Unser
Technology Impact Manager

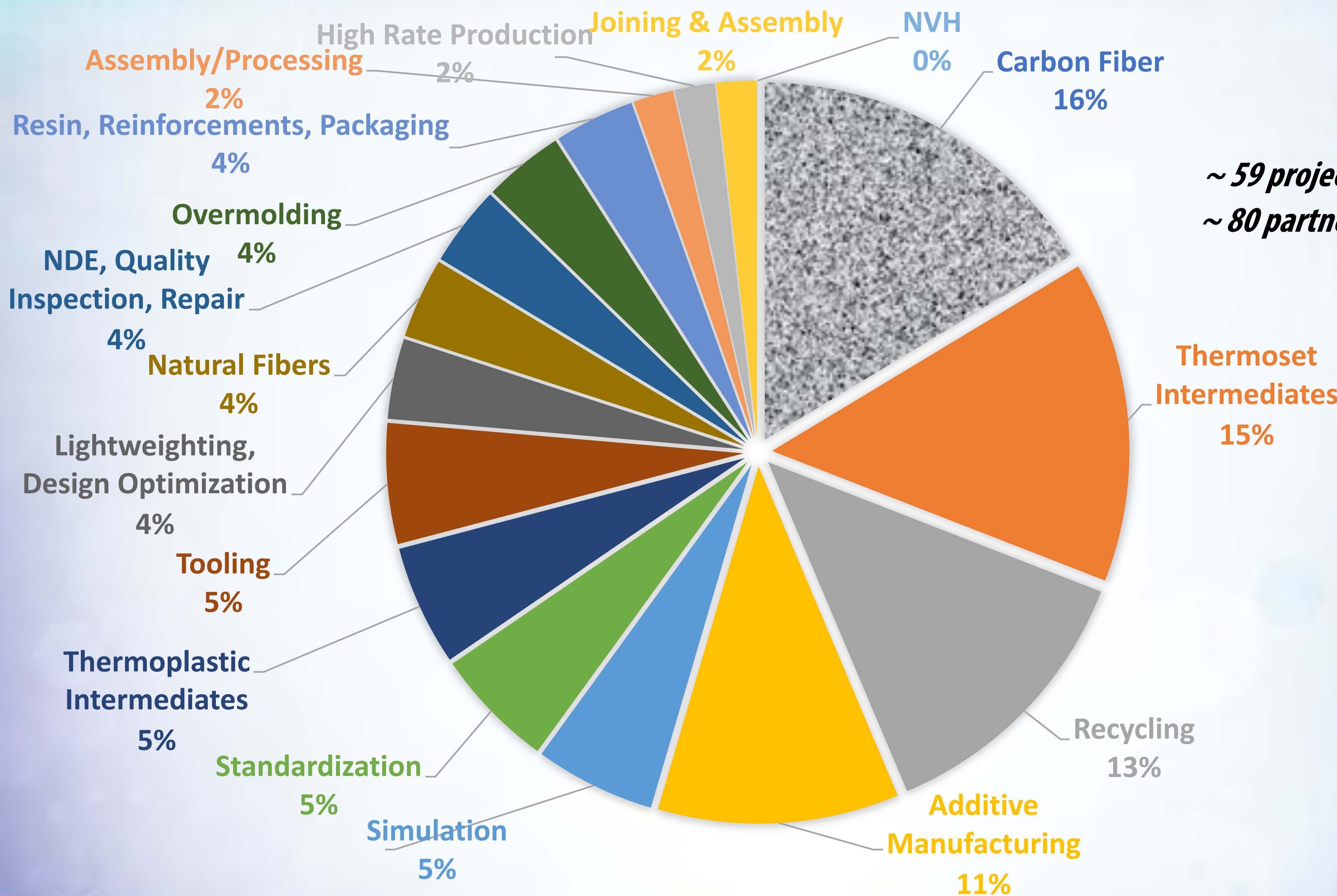

Project Portfolio

Status	Number
Completed	7
Underway	30
Contracting (IACMI/DOE)	15
Pre-DOE	6
TOTALS	**59**

80 member companies out of 160 members participating in IACMI Projects



Projects Portfolio (in alignment with Roadmap)



~ 59 projects

~ 80 partners

Vehicles Technology Area

Michigan State University and Scale Up Research Facility (SURF)

3.2 Optimized Carbon Fiber Production to Enable High Volume Manufacturing of Lightweight Automotive Components

- **Challenge:** Carbon fiber consistency and production rate, intermediate production & mechanical performance, molding cycle times, recycle of in-plant scrap.
- **Approach:** OEM-Material Supplier-Tier 1 joint development of supply chain to develop, integrate and application-optimize carbon fibers, resin, composite intermediates, molding methods, automation, modeling, and waste reduction.
- **Impact**: *Deploy carbon composite components on multiple100k+ units/yr vehicle platforms to enable early stage mass adoption of technology.*

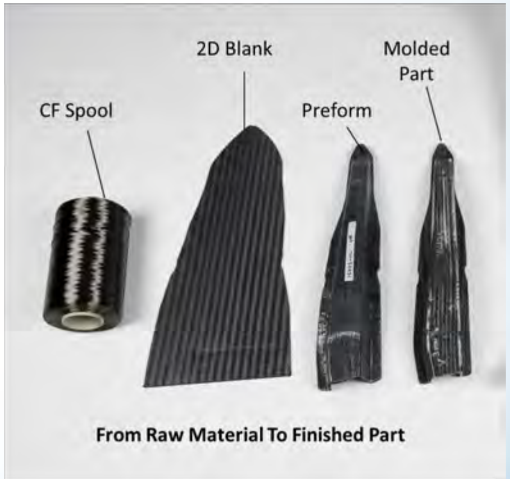
Team: Ford, Dow, Dow Aska, MSU, ORNL, Purdue, UK, UTK, Vanderbilt

Technical Area: Vehicles

Type: Enterprise – 4 years

Status: Ongoing

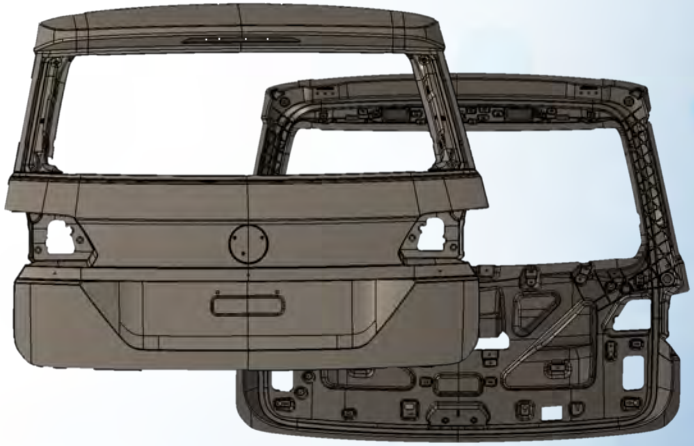
Duration: 7/1/15 to 5/30/19



approved

3.7 Reduction of CO_2 Emissions through Lightweight Body Panels

- **Challenge:** To lower the weight of vehicle structures it is necessary to substitute steel. Composites offer a promising lightweighting solution while bringing a plethora of inherent advantages to the table. However, current materials and manufacturing processes can not meet production rates and quality standards.
- **Approach:** Material, component design, and production methods will be explored for a target component to achieve costs and cycle times required for the production of up to 100,000 units annually.
- **Impact**: *Target component with similar weight but lower cost than aluminum for annual volumes.*



Team: Volkswagen, ORNL, MSU, Purdue, UTK

Technical Area: Vehicles

Type: Enterprise – 36 months

Status: Ongoing

Duration: 2/1/17 to 11/14/19

3.9 High Speed Layup and Forming of Automotive Composite Components

- **Challenge:** Current available tape layup systems cannot support high volume automotive manufacturing.
- **Approach:** DURA is leading efforts in the design and development of a body in white automotive component that meets structural requirement's to collaborate and prove out equipment supplier's concepts to produce a (BASF composite continuous fiber) tape lay-up in cycle times of less than 60s.
- **Impact:** *Commercialization of continuous fiber tape layup equipment at automotive volumes.*
  (APV > 150,000)

Team: Dura Automotive Systems, BASF, MSU, Purdue

Technical Area: Vehicles

Type: Enterprise – 36 months

Status: On-going

Duration: 7/1/17 to 5/31/20

3.11 Thermoplastic Composite Parts Manufacturing Enabling High Volumes, Low Cost, Reduced Weight with Design Flexibility

- **Challenge:** High cycle time for production of continuous CF thermoplastic composites increases costs.
- **Approach:** Novel materials and processes that allow flexible pre-pregs combined with Rapid Fabric Formation technology to provide customizable fiber orientations via thermal bonding to significantly improve cycle time, cost, and waste.
- **Impact**: *Use of emerging materials for impregnation and new approaches for tow coating and fabric formation will lower costs of high volume composites production by 20%.*

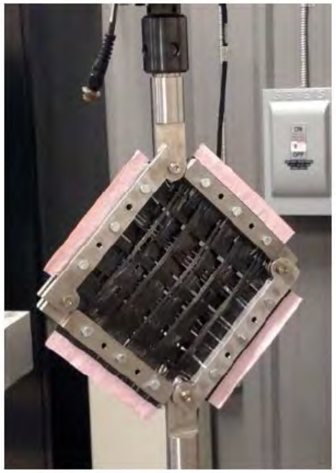
Team: DuPont, Fibrtec, Purdue,

Technical Area: Vehicles

Type: Technical Collaboration - 15 months

Status: On-going

Duration: 9/1/17 to 1/31/19



3.13 Development of Non-destructive Evaluation/Non-destructive Testing (NDE/NDT) Tools for High-Volume, High-Speed Inspection of CFRP Structures in Automotive Manufacturing

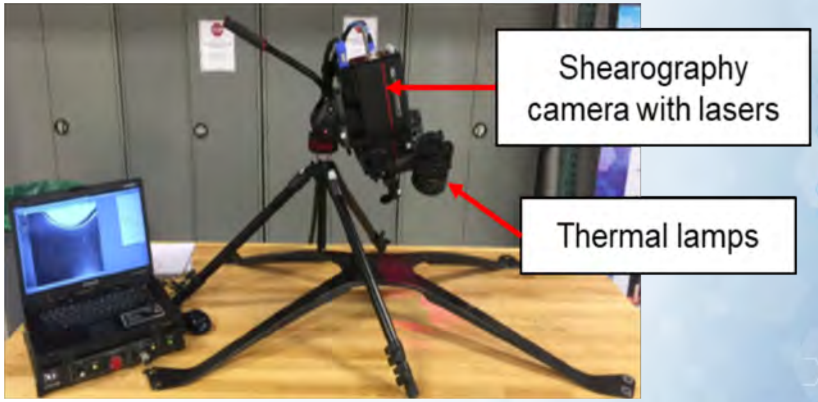
- **Challenge:** Large-scale manufacturing of CFRP components for vehicles requires low-cost, rapid, automated techniques for determining part quality.
- **Approach:** Develop a production ready prototype and end-point NDE inspection tool, that will enable high speed (1 minute or less), in-line analysis of automotive CFRP composite parts for high speed automotive production.
- **Impact**: *Creation of a standard evaluation criteria for NDE/NDT measurement systems can be used to aid in selection of systems for other applications. Methods suitable for CFRP vehicle component manufacturing will lower overall cost of production.*

Team: American Chemistry Council, Vanderbilt University, MSU

Technical Area: Materials and Processes

Type: Technical Collaboration 24 months

Status: Contracting



3.15 Carbon Fiber Reinforced Polyolefin Body Panels

- **Challenge**: There is an automotive industry need for a lightweight cost effective material for vertical body panels that will offer a weight saving over metal body panels and a cost savings compared to other polymer body panel solutions.
- **Approach:** Carbon fiber reinforced plastics offers excellent specific stiffness and when derived from reclaimed/recycled carbon fiber (rCF) compounded with inexpensive polyolefins (PO) for injection molding have the potential to meet both performance and affordability targets for lightweight paintable vertical body panels.
- **Impact**: *Light weight body panels provide a positive life cycle CO2 savings over a vehicle's life. In addition, there is an anticipated piece and investment cost opportunity compared to sheet metal and other alternative polymeric body panel materials..*

Team: Ford, MSU (Borealis vendor)

Technical Area: Vehicles

Type: Technical Collaboration – 12 months

Status: Contracting

Wind Technology Area

National Renewable Energy Lab

4.2 Thermoplastic Composite Development for Wind Turbine Blades

- **Challenge:** Fiber reinforced polymer composites are the material of choice for large scale wind turbine components, but challenges in *manufacturing costs*, *performance*, *and recyclability* are limiting.
- **Approach:** Development of thermoplastic materials to *lower production costs* and improve recyclability of wind turbine blades and applicability to components *demonstrated at large scale*.
- **Impact**: *Cost reductions in composite materials for wind turbine blades will enable lower cost of electricity; property improvements enable larger scale and increased efficiency.*

Team: TPI Composites, Johns Manville, Arkema, CSM, NREL, UTK, Vanderbilt

Technical Area: Wind

Type: Enterprise – 36 months

Status: On-going

Duration: 6/1/15 to 5/31/19

4.3 Thermoplastic Thermal Welding

- **Challenge**: Current method of joining is to bond the various blade components together with an adhesive. This involves several process steps that, if not performed correctly, can lead to manufacturing defects in the blade structure that often result in blade field failures.
- **Approach:** With the use of thermoplastic resin systems in the production of wind blades enables these use of thermal welding as a method in which blade components are joined in the factory – and potentially in the field.
- **Impact**: *The development of thermoplastic thermal welding for wind turbine blade production, addresses the IACMI goals of reducing cost, reducing embodied energy, and increasing recyclability by introducing new composite materials to the production of composite wind blades and vehicle components.*

Team: Arkema, NEG, Saertex, GE, TPI, UTK, NREL

Technical Area: Wind

Type: Technical Collaboration – 24 months

Status: On-going

Duration: 3/1/18 to 4/30/20

Compressed Gas Storage Technology Area

University of Dayton Research Lab

5.4 Injection Overmolding of Continuous Carbon Fiber Preforms

- **Challenge:** The automotive and aerospace industries have identified composite structural injection overmolding as a key technology to enable low cost, lightweight structural composite parts. Traditional plastic injection molding parts lack the mechanical properties and durability to be used in structural applications.
- **Approach:** This project proposes utilizing continuous carbon fiber reinforcement to provide the structural strength and stiffness needed, but also combining it with the rapid manufacturing and lower costs/cycle times achieved by injection molding. The enabling technology for the proposed overmolding process is tailored fiber placement (TFP)
- **Impact**: *The project provides weight, energy, and cost savings as the TFP combined with injection overmolding allows the design to be optimized to suit the actual loading conditions.*

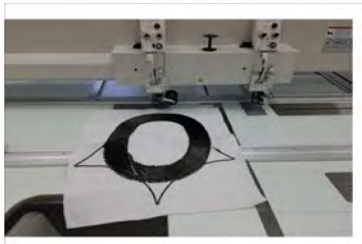
Team: Airbus Americas, Harmony Systems and Service, Hycomp, Zoltek, UDRI

Technical Area: CGS

Type: Technical Collaboration – 18 months

Status: On-going

Duration: 2/1/18 to 8/31/19



L ay-stitch (TFP)

Angle Bracket

5.5 Hybrid Additively Manufactured Tooling for Large Composite Structures

- **Challenge:** Current AM tooling suffers from high, anisotropic thermal expansion that hinders its adoption, especially on long, high temperature tooling applications.
- **Approach:** The proposed tool would feature a thin BAAM-printed surface printed with a carbon-filled high temperature polymer. Once the print is complete, it will be placed on a prefabricated, egg crate-style skeleton for support. The skeleton will be made with low CTE materials.
- **Impact**: *This program will allow for significant cost reductions in the tooling for composites (50-70%), as well as reduced manufacturing cost by way of reduced energy consumption.*

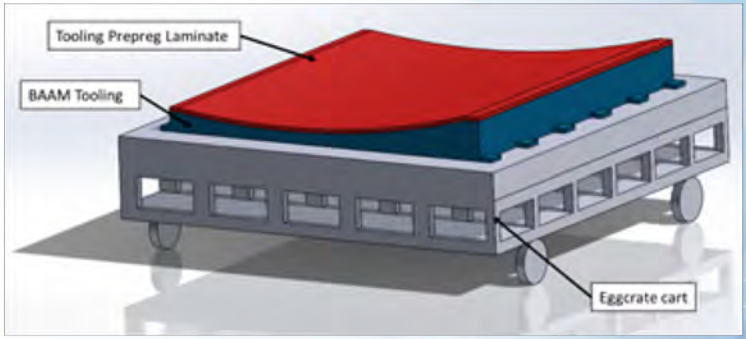
Team: Airbus Americas, Orbital ATK, Cincinnati, Inc., Additive Engineering Solutions, Purdue, UDRI

Technical Area: CGS

Type: Technical Collaboration – 18 months

Status: On-going

Duration: 2/1/18 to 8/31/19



5.6 Scale-Up of Next Generation Nano-Enhanced Composite Materials for Longer-Lasting Consumer Goods

- **Challenge:** N12's NanoStitch®, is a nano-enhanced prepreg that makes advanced composites tougher, lighter, and more durable. In order to meet the high volume demands of N12's aerospace, automotive, and consumer goods customers, the annual capacity of production must reach hundreds of thousands of square meters.
- **Approach:** N12 is teaming up with UDRI to produce the NanoStitch® product on UDRI's 60-inch wide system. This project will focus on further production capacity and quality improvements.
- **Impact**: *High volume production of NanoStitch® will enable the further reduction of cost of the product itself, but also makes the end composite parts more durable, reducing either, or both, the amount of materials needed to produce the same composite structures, or the life cycle cost of composite structures.*

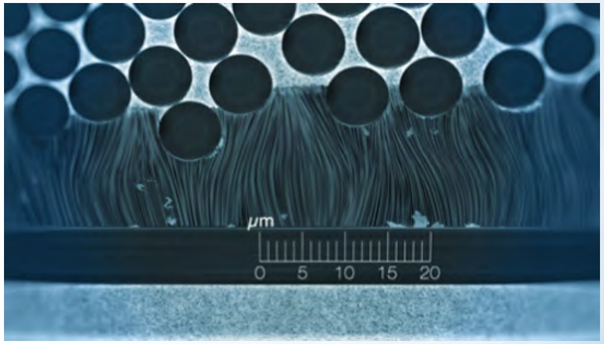
Team: N12 Technologies, Inc., UDRI

Technical Area: CGS

Type: Technical Collaboration – 24 months

Status: On-going

Duration: 2/1/18 to 4/30/19



http://www.n12technologies.com/

Material and Process Technology Area

Oak Ridge National Lab, University of Tennessee Knoxville, Vanderbilt University, University of Kentucky

6.4 Thermolyzer: A Robust, Scalable Composite Recycling Technology

- **Challenge:** At end-of-life, composite materials are difficult to recycle or re-use, contributing to a perception that composites are inferior to competing materials in terms of cradle-to-cradle sustainability. The diverse nature of the composite industry represents a key barrier to finding a universal, effective recycling solution.
- **Approach:** The Thermolyzer uses a low-heat pyrolysis method to recover valuable materials from dedicated or mixed stream composite waste.
- **Impact**: *This project will demonstrate a mechanical and thermal recycling approach that captures value for energy content and the residual ash/fiber supporting the 80% recyclability in 5 years.*

Team: ACMA, CHZ Technologies/KUG, Continental Structural Plastics, A. Schulman, ORNL, UTK

Technical Area: Materials and Processes

Type: Technical Collaboration – 18 months

Status: On-going

Duration: 9/1/17 to 1/31/19

Thermolyzer

6.5 Materials and process for Class A surface finish via induction heating T control

- **Challenge:** Thermoplastic materials offer many advantages. The deficiency and lack of proliferation of this material technology was CLTE (coefficient of thermal expansion) relative to steel mating components (gap control) and warpage induced by fiber orientation in the injection molding process.
- **Approach:** The project objective is to develop processing and material technologies that provide automotive Class A surface appearance and suitable mechanical properties for automotive body panels utilizing a thermoplastic resin matrix reinforced with discontinuous recycled carbon fiber (rCF)..
- **Impact**: *Significantly lower cost than carbon/epoxy, reduce weight, utilize reclaimed carbon fibers.*

Team: BASF, ORNL, UTK

Technical Area: Materials and Processes

Type: Technical Collaboration – 24 months

Status: On-going

Duration: 6/1/17 to 11/30/18 (extended)

6.6 Development of a Lower Cost, High Volume, Commercially Available, Precursor for Lower Cost Carbon Fiber for Automotive and Wind Blade Applications

- **Challenge:** Current carbon fibers (CF) that are commercially available are mostly too expensive for applications in the automotive and wind energy industries. Additionally, there is an extremely limited supply of precursors for companies that desire to enter the carbon fiber market and all precursors that are available are produced by “wet spinning” of polyacrylonitrile.
- **Approach:** The purpose of this project is to develop a high volume dry spun precursor which is less expensive due to its production in high volume textile mills and available on the open world market for any CF manufacturer to purchase and convert into CF.
- **Impact**: *This project addresses carbon fiber cost via growing a healthy precursor supply chain.*

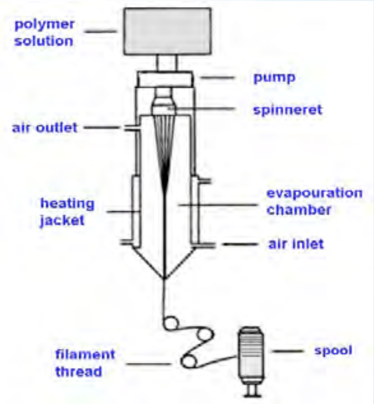
Team: **Dralon,** ORNL, UTK

Technical Area: Materials and Processes

Type: Technical Collaboration – 18 months

Status: On-going

Duration: 9/1/17 to 3/31/19



Dry Spinning

6.7 Automated Preform Manufacturing Equipment for Recycling Scrap Pre-preg

CRTC COMPOSITE RECYCLING TECHNOLOGY CENTER

THE COMPOSITES iacmi INSTITUTE

- **Challenge:** The most significant near-term issue facing manufacturers in the recycling of high-volume carbon fiber pre-preg will be the re-formatting of the trim (manufacturing offal) into a usable near-net shaped charge (or preform) at high efficiency.
- **Approach:** Create equipment capable of handling variable input scrap carbon fiber pre-preg and developing random orientation, chopped sheet for use in subsequent compression molding to manufacture parts
- **Impact:** *Enables immediate manufacturing benefits using scrap carbon composite. Initiates capability to have 100% recyclability within automotive production*

Team: **CRTC,** ORNL, UTK, Vanderbilt

Technical Area: Materials and Processes

Type: Enterprise – 18 months

Status: On-going

Duration: 6/1/17 to 2/28/19

6.8 Bamboo Bio-Composite Truck/Trailer Decking

- **Challenge:** The Apitong (Dipterocarpus grandiflorus) species of hardwood is historically the most widely used for trailer decking for 18-wheel trucks and shipping container floors, yet resources are becoming scarce.
- **Approach:** This project will utilize Resource Fiber's conditioned bamboo fiber encapsulated by bamboo bio-composites and/or synthetic resin bamboo composites to form beams for truck trailer applications.
- **Impact:** *Estimates that switching from Apitong hardwood to the proposed Resource Fiber biocomposite decking will reduce the amount of energy consumed by at least 50%*

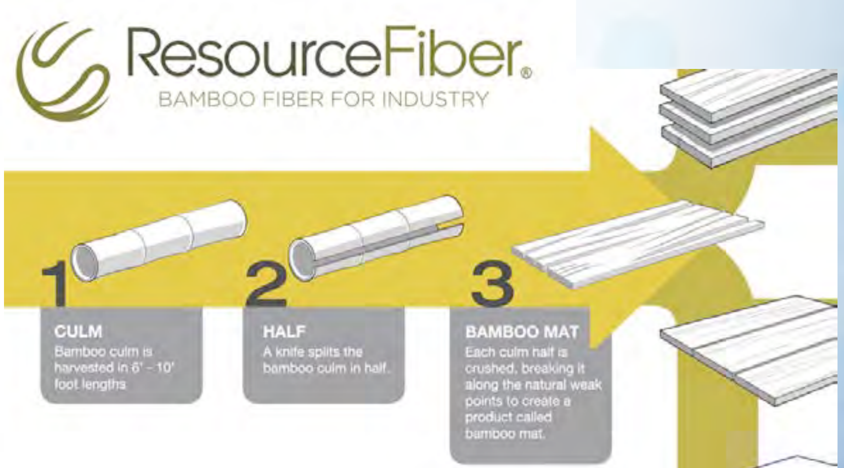
Team: Resource Fiber, ORNL, UTK, MSU

Technical Area: Materials and Processes

Type: Technical Collaboration – 12 months

Status: On-going

Duration: 2/1/18 to 1/31/19



6.9 Multiple Process Tooling

- **Challenge:** Decisions made early in the automotive design process influence material selection, which in turn dictates process, then tool design. Because of the tool build time and cost of tooling, the original path is not easily altered, even if there is compelling evidence another material or process would be beneficial.
- **Approach:** The proposed project is a tool design which will be agile enough, to allow its use in multiple processes, injection, injection compression, and extrusion-compression.
- **Impact:** *The cost of tooling is usually the bottleneck in innovation and part development. The ability to design and optimize product development with tooling applicable across multiple processes reduces significant costs.*

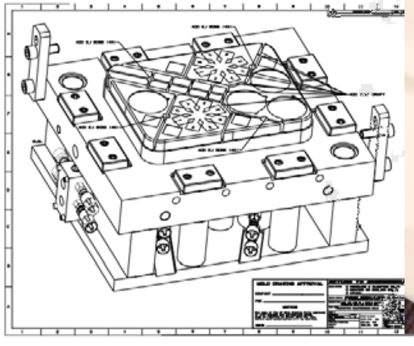
Team: **Valley Enterprise,** ORNL, UTK

Technical Area: Material and Process

Type: Technical Collaboration – 11 months

Status: On-going

Duration: 2/1/18 to 1/31/19



6.11 Discontinuous Aligned Carbon Fiber Intermediates for Automotive and Related Applications

- **Challenge:** There are several methods currently being practiced to produce aligned, discontinuous fibers. These methods, while somewhat reasonable, are not practical or economically-viable methods to produce the mats in forms acceptable to the automotive and consumer industries.
- **Approach:** This project involves building upon Neenah's patented dispersion technology, incorporating fibers of 0.5" to 1.0" in length, in combination with defined manufacturing process improvements targeted at imparting a high degree of unidirectional fiber alignment into the resulting mat (in the direction of the web movement / machine direction).
- **Impact:** *This project addresses cost, energy, and recycling with significant potential impact on all three metrics. The roadmap calls for development of aligned discontinuous carbon fiber intermediates. This is the first proposal to address that gap.*

Team: **Neenah Paper,** ORNL, UTK

Technical Area: Material and Process

Type: Technical Collaboration – 14 months

Status: On-going

Duration: 2/1/18 to 7/31/19

6.12 Textile Carbon Fiber Packaging and NCF Production

- **Challenge:** One of the remaining barriers to commercial deployment of textile carbon fibers is the current lack of capability to package these textile carbon fibers so that they can be efficiently and reliably used for producing composite intermediates or composite structures.
- **Approach:** This project aims to develop a commercially relevant approach for packaging large tow textile carbon fibers for robust delivery into downstream commercial intermediates and composites production operations.
- **Impact:** *This project enables manufacturing with textile carbon fibers, thus contributing to IACMI's cost and embodied energy metrics.*

Team: **McCoy Machinery,** Chomarat North America, ORNL, UTK

Technical Area: Material and Process

Type: Technical Collaboration – 12 months

Status: On-going

Duration: 2/1/18 to 1/31/19

http://mccoy-usa.com/composites/driven-systems/

6.13 Low Cost, High Volume, Carbon Fiber Precursor for Plasma Oxidation Processing

- **Challenge:** All commercially deployed carbon fiber oxidation ovens are based on conventional thermal processing. Plasma oxidation reduces energy requirements and residence time, and in some cases increases fiber performance. Correlation of plasma oxidation process parameters on textile-grade fiber properties needs to be better defined.
- **Approach:** Combine the processing expertise of 4M, RMX and ORNL, with the testing and analysis expertise of ORNL and UTK, an experimental design approach will be used that examines the results of oxidation and carbonization processing through detailed fiber analysis. Processing will be optimized in an iterative approach.
- **Impact:** *This project will demonstrate the significant carbon fiber manufacturing cost savings of combining the performance and cost advantages of plasma oxidation with low-cost textile grade precursor to produce a standard modulus low cost carbon fiber.*

Team: **RMX Technologies, 4M Carbon Fiber,** ORNL, UTK

Technical Area: Materials and Processes

Type: Technical Collaboration – 12 months

Status: On-going

Duration: 4/1/18 to 3/31/19

6.20 Closing the Loop on Automotive Carbon Fiber Prepreg Manufacturing Scrap

- **Challenge:** Carbon fiber has found limited use in automotive applications due, in large part, to the high material cost and the labor-intensive nature of typical composite manufacturing processes.
- **Approach:** Vartega Inc has developed a chemistry-based recycling process for uncured carbon fiber prepreg manufacturing scrap. Recycled carbon fiber can be made available at lower cost than virgin fiber. In addition, the discontinuous form of recycled material is suitable for higher throughput manufacturing processes such as injection molding.
- **Impact:** *Low-cost recycled carbon fiber will aid in reducing overall CFRP cost and embodied energy while substantially increasing composite recyclability and reducing the prepreg scrap waste stream. Low-cost recycled carbon fiber will be utilized in vehicle light weighting applications to improve fuel economy and reduce emissions.*

Team: **Vartega,** Ford, Michelman, CSM, Plasan, BASF, UDRI, ORNL, UTK

Technical Area: Material and Process

Type: Technical Collaboration – 24 months

Status: ongoing

Duration: 6/1/18 to 5/31/20

6.21 Development of Automotive Grade Carbon Fiber Composite Performance Standards to Reduce Costs and Drive Mainstream, High Volume Vehicle Production with CFRP

- **Challenge:** Currently automakers have their own proprietary material cards and models. Material suppliers must test and comply with different requirements specific to each automaker.
- **Approach:** Facilitate the establishment of material design PERFORMANCE standards for several classes of applications in automotive. Standardization of performance based material property data is a critical tool for designers to be able to reliably incorporate new materials in vehicle and other structural designs. Development of standard test methods will permit the development of performance standards for composite materials.
- **Impact:** *Development of automotive grade carbon fiber composite performance standards will reduce costs and drive mainstream, high volume vehicle production for CFRP composites for the entire integrated supply chain by standardizing test methods and performance standards.*

Team: **American Chemistry Council,** UDRI, ORNL, UTK

Technical Area: Materials and Processes

Type: Technical Collaboration – 24 months

Status: On-going

Duration: 4/1/18 to 3/31/20

6.23 SMC Reinforced by Recycled or Textile Carbon Fibers

- **Challenge:** Structural (non Class A) sheet molding compound (SMC) is an ideal application for recycled car-bon fibers (rCF) and textile carbon fibers (TCF). It is necessary to develop equipment and processes for handling the rCF and TCF product forms in compounding operations, or for converting rCF and TCF into product forms that are useable in currently existing equipment and processes.
- **Approach:** The project team will develop equipment and processes for compounding and molding CF-SMC reinforced by rCF and/or TCF meeting cost, rate, performance and quality metrics.
- **Impact:** SMC reinforced by rCF or TCF should be much lower in cost and embodied energy than currently available CF-SMC.

Team: ORNL/UTK, AOC, Ashland, ELG Carbon Fibre, Huntsman, IDI Composites, Michelman, Montefibre, Vartega, Volkswagen

Technical Area: Materials and Processes

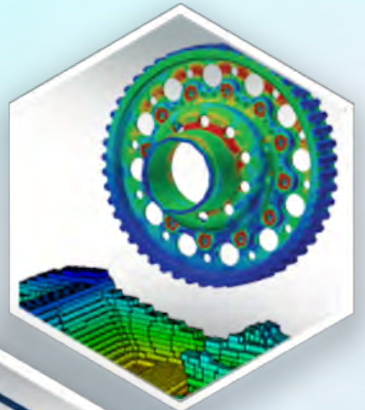
Type: Technical Collaboration – 24 months

Status: Contracting (Mod 17)

6.27 Multiple Stream Low Cost Recycling Method

- **Challenge:** The composite industry faces a significant challenge of recycling of production waste and End-of-Life parts. Because of the costs of collection, resizing and method of recovery, there does not appear to be an economic solution (aside from using the composite for energy production by pyrolysis) for fiberglass based and foam/balsa cored structures such as those used in Wabash trailers, marine craft and wind turbine blades.
- **Approach:** GreenTex (GT) has developed a patent pending approach to recycling high performance fibers. The GT method allows for any type of composite waste in any type of form to be reprocessed to make a high performance composite.
- **Impact:** *No other recycling effort incorporates all the different waste streams utilizing the same manufacturing method. The simple approach will reduce the cost of recycling composites with minimum capital investment.*

Team: **GreenTex,** Wabash Trailers, ORNL, UTK
Technical Area: Materials and Processes
Type: TC Phase I – 6 months
Status: Contracting (Mod 18)



Modeling, Simulations and Design Technology Area

Purdue University

7.2 Thermal Instability in the Manufacturing of Wind Turbine Blade Spar Caps

- **Challenge:** As wind turbine blades continue to scale in length and total mass, the acceptability of traditional approaches for the engineering of processes to build these products has reached a limit.
- **Approach:** The creation of a multi-physics model to successfully simulate the infusion, heat transfer, reaction kinetics, rheological advancement and thermos-mechanics of the composite blade structure during fabrication will have a meaningful impact on all aspects of blade manufacturing.
- **Impact:** *The final goal will be the creation of a model which includes all relevant physics which can be used to guide optimal processing conditions for speeding up processing without causing part defects.*

Team: **TPI Composites,** Purdue

Technical Area: **DSM**

Type: TC Phase 1 – 6 months

Status: Contracting

Duration: 12/1/18 to 5/31/19