Where Are We Headed? 2018 State of the Industry Report

Composites on the Ski Slopes

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About the Cover: Piers Solomon slashes down a mountain with ease thanks to equipment provided by DPS Skis, a leader in the manufacture of prepreg CFRP skis.
Photo Courtesy of Oskar Enander
Happy New Year and welcome to 2018! We finished 2017 with an incredible CAMX that showcased our industry’s resilience and innovation. Many of the people I talked to at the conference shared stories of positive experiences at the event. I hope you came away from the show with a greater understanding of where the industry currently stands and with opportunities to grow your business.

One of the ways businesses can grow is by implementing strategies based on robust market intelligence. Information like Composites Manufacturing magazine’s annual State of the Industry report (page 18) identifies where the industry’s “hot spots” are. The report shows where composites usage is growing and shape our product and sales strategies to capitalize on new opportunities. ACMA’s affinity program partners Lucintel and Amerex also provide a broad perspective on market trends.

While these broad overviews are helpful, the industry also needs accessible and specific data about composite usage. In 2018, ACMA will address this void with the launch of its statistics program. The program will make information available about the pounds of thermoset composites sold into the marine, construction, infrastructure, transportation and consumer markets. It’s exciting to think about the impact of demonstrating our industry’s success with reliable data that comes from within the industry. This kind of information can help build a foundation to support investment decisions for ACMA members looking to support growing markets.

One area that has experienced considerable growth over the past few years is thermoplastic composites. While thermoset resins currently reign supreme in the composites industry, thermoplastics are catching up quickly and manufacturers will need to adapt. Check out our article on page 12 to learn more about the latest industry research and end use applications featuring thermoplastics.

If the insights we have gained in 2017 are any indication, we are currently in the midst of an exciting era of disruptive innovation and market growth. If you’re as excited as I am about the possibilities for our industry, I encourage you to make the most of your ACMA membership this year by joining one of our many committees working to grow a wide range of markets for composites. Together, we can make 2018 another successful year.

Sincerely,

Kevin Barnett

ACMA Chairman of the Board
kibarnett@coremt.com
Composite Mold Making

GFRP molds generally are the least expensive option and normally the simplest to construct. They often can be built in days rather than months required for alternatives, such as machined metal molds. Further, GFRP molds can easily be modified or simply rebuilt if design or process changes are required. A traditional GFRP mold will likely be made in the following manner:

- Tooling gel coat (18-22 mils thick)
- Vinyl ester barrier coat (18-22 mils thick) (optional)
- Skin coat (0.045-0.090 mils thick) (optional)
- Bulking materials (0.200” + thick)
- Core materials (optional, but if used for stiffness, minimum 3/8”)
- Bulking materials (0.200”+ thick)
- Bracing materials (amount and thickness depends on size and frame stiffness required)

Gel coat should always be fresh material and designed for mold making. Look for ones marketed as “tooling gel coat.” These will be harder and more temperature-resistant than conventional production gel coats (i.e. marine, sanitary or sanding). Tooling gel coats are also designed to be more corrosion- and abrasion-resistant and able to hold a gloss far better than conventional gel coats. Previously, a second layer of tooling gel coat was used if heavy sanding/polishing of the mold was expected. More recently, especially as shrink-controlled bulking materials have evolved, less sanding has become the norm. So the second gel coat layer has evolved into using a vinyl ester barrier coat to “push” the glass fibers further away from the mold surface, while providing a layer of toughness over the more brittle second layer of tooling gel coat.

Skin coats are often applied to pick up complex mold details, especially where glass fiber bridging can occur in tight radii. These skin coats should be made with hybrid vinyl ester resins, specifically designed for thin skin cures. Any air voids
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under or within the skin coat must be ground out and repaired before proceeding. Bulking layers have evolved over the last 25 years. The method employed by most companies today involves shrink-controlled bulking technologies, where thicker layers can be used per application (0.120” to 0.200”) multiple times per day. Mold builds of one to three days are common with fast cure, shrink-controlled technologies. Core materials, such as balsa or synthetic materials, can be included in a mold build where lighter weight or stiffness is required.

Bracing materials range from wood to metal tubes/squares and should be designed to provide added mold stiffness and strength. A word of caution: Keep tab thicknesses to a minimum so as not to transfer any shock (thermal or mechanical) onto the mold surface. Cracked/broken tabs are easily repaired while in production. Gel coat repairs on molds, caused from external damage, will require the molds to be pulled from production.

**Composite Mold Maintenance**

Mold maintenance typically consists of:

- Training employees on demolding and mold maintenance.
- Cleaning off excess material and debris, blowing off and/or wiping down dust.
- Inspecting for mold damage or defects. (Small damage areas may be clayed to maintain schedules.)
- Performing preventative maintenance. Paste wax or reapply mold release as needed.
- Recording and tracking mold use and maintenance data, along with any needed repairs.
- Covering mold for storage, preferably not outside.

Mold sealers and releases take many forms and are often neglected. Today, most FRP composite manufacturers use “semi-permanent” type mold releases. In higher volume production operations, most manufacturers have standard maintenance that includes an accurate accounting of the number of cycles that a mold has experienced, especially in “low draft angle” molds. You should discuss best practices with your mold release manufacturer, but one best practice to live by is the 80 percent rule: For instance, if production discovers that 30 parts can be pulled from a mold before sticking, then reapply mold release after the 24th pull.

Running the mold until failure or repairing every part becomes expensive and limits product quality, so it should be avoided! Having a preventive maintenance system in place and training personnel is key. Proper demolding procedures and...
training will significantly improve FRP mold longevity, lower repair time and ensure employee safety.

**Mold Making Innovations**

Controlled shrink tooling materials include older, but still popular ATH filled systems (generally limited to 18 to 25 percent glass fiber by weight). Newer unfilled systems allow a much higher glass fiber content (40 percent glass fiber by weight), and the latest, infused versions allow up to 70 percent glass or carbon fiber content, along with the inclusion of well-consolidated core materials.

Many of these higher fiber content materials are finding a home in both traditional composite markets, as well as in the prepreg, 350 F cure temp markets and the thermoforming area (where temperatures in excess of 400 F are common). Thermal shock-resistant tooling gel coats are highly suggested for these applications.

Finally, a quick discussion on additive manufactured plugs and molds. Several manufacturers – such as Cincinnati Incorporated (CI), Ingersoll Machine Tools, Thermwood Corporation and 3D Platform – now offer very large formatted additive printers for rapid plug making and limited production runs with direct-to-mold 3-D printed molds. The deposition rate is no longer grams of materials per minute, it’s pounds per minute. It is common to see a “roughed in” mold (or plug) printed in a couple of hours and converted into a gel coated, high gloss surface within one to three days, depending on size.

In conclusion, GFRP molds provide some of the least costly ways to manufacture FRP composite parts, ranging from decorative figurines to 80-plus meter wind energy molds. How that will change as 3-D and subtractive mold making evolves remains to be seen. But for now, GFRP molds provide a very attractive means to quickly manufacture high-quality, non-reinforced or reinforced composite parts.

Rick Pauer is applications manager for Polynt Composites USA Inc. Email comments to rick.pauer@polynt.com. Andrew Pokelwaldt is director of certification at ACMA. Email comments to apokelewalda@acmanet.org. For detailed information on mold making, check out Polynt’s educational video “How to Build an OptiPLUS Mold” at http://vimeo.com/116892221/2417d9d953.
A few years ago, when Toby Jacobson came home from a work trip, a piece of foam he was carrying caught his seven-year-old son’s attention. Jacobson explained the company he works for, Grand Haven, Mich.-based automotive supplier Shape Corp., was collaborating with a German bed manufacturer called Thomas Technik + Innovation (TTI) on an innovative bumper project. Even at his young age, his son realized that a partnership between a company that supplies automotive components and one that makes beds was unique. “Dad, who you working with? Bed, Bath and Bumpers?” Jacobson recalls his son asking.

TTI specializes in the design and manufacturing of bedding systems, including foam mattresses and bed bases. In the early 1990s, TTI started replacing the wood in their bed slats (an alternative to box springs) with pultruded composites. After struggling to find a pultrusion shop that could produce parts that met its standards, TTI created its own pultrusion R&D team to design equipment.

Those efforts eventually led to the creation of the company’s Radius-Pultrusion™ process, which enables the continuous manufacture of curved profiles. TTI has now licensed the process to Shape to help with technology development, testing, product development and scaling up for high-volume production. “Until now there hasn’t been a way to make a continuous curved closed section composite part,” explains Jacobson, a research development engineer at Shape.

The company’s novel approach was not lost on the judging committee for CAMX-The Composites and Advanced Materials Expo. During last month’s show, Shape was a finalist for an Award for Composites Excellence (ACE) in the Infinite Market Growth category for using Radius-Pultrusion to make a urethane acrylate resin-based composite product that will soon be ready for market.

While Shape intends to market the product primarily to the automotive market due to its high demand for streamlined curved parts, the company says it has received interest from businesses who see potential for curved, closed-channel, pultruded profiles in a wide range of applications, including infrastructure, construction, agriculture, marine and storage tanks. “Very few things in the world are straight,” says Jacobson. “We need curvature, we need different radii and we need things to fit with one another.”

In traditional linear or straight pultrusion, tows and cloths are wetted via resin bath or injection box and pulled through a heated die. The die, which is typically stationary on the machine,
consolidates the materials and cures the resin matrix, resulting in a constant cross section part. The material and resultant part is pulled through the die via grippers — typically two functioning in a reciprocating mode aligned with the die. Many systems have an automated cut-off tool allowing for the production of discrete parts cut to a finished length.

However, in Radius-Pultrusion, the gripping mechanism is held stationary while the tooling elements (die, mandrels, fabric guides) move in an arc concentric to the radius of the part being pultruded.

According to Ken Workinger, a process engineer at Shape, the process can handle unidirectional, biaxial, triaxial and even quadaxial reinforcements. To date, Shape has tested fiberglass, carbon fiber, aramid, basalt and other natural fibers combined with either polyurethane or epoxy resins. Manufacturing trials have been conducted on both E-glass and carbon fiber.

While Shape says the process is highly flexible, not every reinforcement type is ideal for Radius-Pultrusion. Workinger explains that the most important criteria for selecting a material is its “drape-ability” — the ability to conform to a complex surface. Continuous filament mats, he says, are a good example of reinforcements with good drape-ability, while woven rovings are not.

“You wouldn't use a 54-ounce woven roving through this kind of process. It just doesn't have the conformability,” says Workinger. “The bundles need to be able to slide over each other to be able to behave nicely as you try to get them to conform to the shape you want as well — to conform to a curve. It's not a developable surface. You've got to be bending in two directions at once and that puts a premium on the architecture of the fabrics you choose to use.”

Due to the inherent complexity of the process, one of the most notable benefits of Radius-Pultrusion is design flexibility. It also can help OEMs save money by eliminating the need to do extra manufacturing on a straight composite part that doesn't naturally fit a vehicle's package space.

“Package space is a strong driver of part design, and we don't see a lot of straight lines on cars. While there are some straight parts, there are mostly curved parts,” reemphasizes Jacobson.

“To try to fit a part that already has the limitation of a constant cross section, and then also have the limitation of being straight only, it narrows the possibilities immensely.” Radius-Pultrusion, he says, helps eliminates some of those constraints. The company's next step is to continue improving the process to maximize throughput. Jacobson says Shape may venture into a “variable radius” — essentially being able to go from pultruding straight to curved and back again in a continuous process. In fact, in the past decade, Shape has developed a similar variable radius process for its advanced high-strength steel roll forming mills.

“Shape already has a strong history of innovation, and breaking down barriers,” says Jacobson. “If we continue to do our jobs well, the number of parts that we can make with Radius-Pultrusion becomes even greater.”

Evan Milberg is communications coordinator at ACMA. Email comments to emilberg@acmanet.org.

For more stories like this, visit CompositesManufacturingMagazine.com and check out the automotive articles under the “Market Segments” tab.
The global shipbuilding industry has long been dominated by Europe, but a shift toward new ship construction in Asian countries such as South Korea, Japan and China is under way. A consortium of 18 international entities called FIBRESHIP EU was launched in June 2017 to ensure that Europe remains a shipbuilding leader.

“The idea of the project is to consolidate the position of the shipbuilding industry in Europe. To do that you need to bring all the stakeholders together – shipbuilders, classification societies, engineers and so on,” says Anthony Comer from the School of Engineering and the Irish Composites Centre at the University of Limerick. “Composites are going to play a central role.”

The main objective of FIBRESHIP is to develop a new European-based market for large-length seagoing and inland ships made from FRP materials. To achieve this objective, the project will do the following:

- Develop, qualify and audit innovative FRP materials for marine applications
- Establish new design and production guidelines and procedures
- Devise efficient production and inspection methodologies
- Develop new validated computational analysis tools

FIBRESHIP is one of the largest innovation projects funded by the European Union, with a budget of €11 million (nearly $13 million). Consortium partners represent 11 countries and include three classification and certification organizations, four shipyards, three research centers, four ship owners and four companies specializing in shipbuilding architecture and engineering. Comer is lead principal investigator on the project’s composites element, while his colleague from the University of Limerick, Ioannis Manolakis, serves as co-investigator and project manager.

“Our role revolves around material selection – looking at a wide range of resin systems, fiber systems and core materials,” says Comer. “This is a high-level TRL [technology readiness level] project, so we are looking at materials that are already on the market or very close to market. The aim of the project is to have these vessels in the water sooner rather than later.” At the end of the three-year FIBRESHIP project, the partners plan to have a demonstrator FRP component, as well as a knowledge base and tools that shipyards can utilize to build ships.

While the marine industry was an early adopter of composites, most FRP-intensive structures to date have been limited to recreational boats, ferries, patrol boats and rescue boats under 50 meters long. FIBRESHIP intends to fill in the technology and knowledge gaps to demonstrate the feasibility of using FRP materials to construct the entire hull and superstructure of ships longer than 50 meters for three vessel categories: light merchant ships, passenger transport and leisure ships, and special service vessels.

Composites offer all the expected advantages. The primary benefit is weight reduction, which yields decreased fuel consumption and increased cargo capacity. Composites also are resistant to corrosion and fatigue. Under the
The Corrosive Chronicles

During NACE International’s CORROSION conference April 15-19, 2018, in Phoenix, ACMA will host the “Corrosive Chronicles.” The presentation will outline the use of FRP in corrosion applications, including marine industry corrosion, which accounts for $50 billion - $80 billion every year. The presentation will cover workforce safety, training and selection criteria for FRP, and workforce challenges faced by technical employees specifying FRP products. Learn more at www.acmanet.org/events-calendar.

The guidance of Comer and Manolakis, a team of four research engineers at the Irish Composites Centre will determine which particular FRP materials make the most sense for large-length vessels.

The team will select the most suitable material constituents, then manufacture test panels, extract test coupons and provide mechanical test data. The FRP materials they select will ultimately be used by a FIBRESHIP shipyard to manufacture a demonstrator component measuring approximately 8 meters cubed.

Comer’s group has just begun work on material selection. “We are trying to cast as big a net as possible and look at a wide range of resin classes, from polyester and epoxies to vinyl esters and so on,” he says. “We are even looking at some infusible thermoplastics that have fairly recently come on the market.”

Consideration of manufacturing processes is critical, too, in material selection. “We need to look at processes that are compatible with what shipyards are already using,” says Comer. “In addition, are the materials compatible with new manufacturing processes that will be coming down the line?” Liquid resin infusion is one of the candidate manufacturing processes because of the size of the components that will be produced and the suitability for use in shipyards, adds Comer.

The team at the Irish Composites Centre is making similar decisions about fibers. “Glass has traditionally been used on smaller vessels, but carbon has been creeping in recently, as well as basalt and aramid fibers,” says Comer. “Ultimately, we will look at a wide range of materials and try to come up with combinations that are deemed most suitable for applications in longer length ships.”

While Comer’s group is focused mainly on mechanical characteristics of the FRP materials, other FIBRESHIP research partners will consider fire resistance, smoke toxicity and material joining techniques. “The down selection process for materials will be challenging,” admits Comer. “There is a huge range of considerations. How do you weigh all of them accordingly and select a combination of materials you can get agreement on?”

That’s the challenge FIBRESHIP’s 18 partners have wholeheartedly taken on together. Europe accounts for approximately 40 percent of the world’s civilian and merchant shipbuilding, according to FIBRESHIP. The continent’s 150-plus large shipyards would like to retain – and even grow – that market share. So there’s a lot riding on this project, for both the shipbuilding and composites industries.

“Large-length vessels represent a potentially new market for composites,” says Comer. “It’s certainly an interesting market when you consider the vast amount of materials that would be required for vessels of this size.”

Susan Keen Flynn is managing editor of Composites Manufacturing magazine. Email comments to jflynn@keenconcepts.net.

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Research and innovations in thermoplastic composites today are centered primarily on long fiber reinforced thermoplastics (LFRTs) and continuous fiber reinforced thermoplastics (CFRTs). Market studies on ReportLinker project a global 8.5 percent compound annual growth rate (CAGR) between 2017 and 2021 for LFRTs and a 9.5 percent CAGR for CFRTs from 2017 to 2022. Short fiber thermoplastics, by contrast, can expect a CAGR of only 4.5 percent through 2021.

LFRTs are available as pellets and used primarily in injection and compression molding, while CFRTs are found in unidirectional (UD) tapes and used for woven sheets, filament winding and pultrusion. Despite the differences in form, these thermoplastic materials share many desirable characteristics.

“Longer Fibers, Increased Opportunities”

Long and continuous fiber thermoplastic composites are taking center stage in industry research and applications.

By Mary Lou Jay

The thermoplastic components used for Gulfstream’s G650 tail section elevator are joined into an inseparable unit by induction welding, eliminating costly drilling and riveting work.

Photo Credit: GKN Aerospace Fokker
recyclable,” says Kelly Wessner, global marketing director, PolyOne Advanced Composites.

Long and continuous fiber thermoplastics increase manufacturing efficiencies because they are easier to use than traditional materials and can streamline processing. In addition, they have greater flexibility to handle complex design geometries compared to metal or thermoset continuous fiber materials. “Because they can be post-formed [remelted], thermoplastics can be used in multi-material processes such as panels incorporating a PET [foam] honeycomb core or injection overmolding of tapes and laminates for localized reinforcements,” Wessner adds.

Unlike thermoset parts, which must be joined with mechanical fasteners or adhesively bonded, thermoplastic components can be welded together. That eliminates the weight and cost of fasteners, which is a major advantage in the automotive and aerospace industries. “In the airline industry, for every pound that the airline can take out, it’s a $1,000 a year cost savings,” notes Jason Lyons, manager of Arkema’s Kepstan® polyetherketoneketone (PEKK) business.

But barriers to widespread adoption of thermoplastic composites remain. For one thing, they’re not as well known or understood as thermosets. “Thermosets have been entrenched in the composite and manufacturing worlds for a longer time, so it takes a different mindset to adopt some of the thermoplastic processing techniques and to fully realize the positive return on investment,” says Mark Aubart, scientific director at Arkema. “Companies that are willing to implement these innovative technologies can see the longer view and will reap the benefits.”

Higher-end thermoplastic composites tend to have high matrix viscosity, and the material does not flow as well as it does with some of the lower viscosity resins. That creates challenges with fiber wet-out, which can affect both the performance and appearance of the part.

The upfront costs of thermoplastic composites can be problematic as well. “If suppliers limit their focus on price per pound, the inherent value of thermoplastics may be missed,” says Lyons. Arkema’s Kepstan, developed to withstand high temperatures, is more expensive than traditional thermoset systems. “We present our value as related to cycle time. If you’re looking at the time and the cost to make a finished product rather than per pound, that’s where it’s competitive,” says Lyons.

Since many manufacturers have already made significant investments in thermoset processing equipment, it may be difficult for them to contemplate spending more for thermoplastic processing equipment. But in the long term, the many benefits of the newer thermoplastic composites are likely to win over more customers.

### Reduced Environmental Impact

With more and more companies focusing on improving the sustainability of their operations, the recyclability of thermoplastics is a major benefit. “Having a material that can be recycled makes more sense than using a material made from an irreversible process where at the end of life there’s nothing else that you can do to the part except grind it down and use it as landfill or burn it,” says Bert Keestra, application development engineer at DSM Engineering Plastics.

DSM is recycling some of the prototype tanks it manufactures for experiments with hydrogen and CNG thermoplastic composite pressure vessels. The tanks, made with a polyamide liner and a thermoplastic polyamide base, are ground into 3-millimeter flakes after any metal attachments are removed. The thermoplastic flakes are then used to manufacture new parts.

“We have measured the properties of those recycled granules and compared them to the virgin equivalent; essentially, we find that we are still at 85 percent of the intrinsic original properties,” says Keestra.

DSM is also looking for other ways to make the material more sustainable, replacing oil-derived monomers in some thermoplastics with bio-renewables ingredients. The company’s EcopaXX® is a bio-based, high-performance polyamide that contains 70 percent bio-renewable materials. “It has a zero carbon footprint and has really good properties when you combine it and use it as a matrix for the UD tape to embed your carbon fibers,” says Keestra.

Arnt Offringa, director of R&D at GKN Aerospace Fokker, says that the recyclability of thermoplastics is a driver for its increasing use in the European automotive industry. But Aubert questions if there will be sufficient infrastructure in place in the near future to support recyclability and if there will be markets for the use of recycled materials.

“It will be interesting in the future to see how many OEMs, consumers and Tier 1 suppliers have started to take advantage of the recyclability of thermoplastics,” he says. Although people say they like the recyclability feature they are not purchasing thermoplastic components because of it; recycling is still in the development and demonstration phase. “They are buying thermoplastics because they have high performance and there is some kind of cost advantage, either right away or eventually,” says Offringa.

If recyclability isn’t enough, some companies may be interested in trying out certain types of thermoplastics because they are not based on styrene. “Thermoplastics have the potential to eliminate VOCs in the manufacturing process,” observes Lyons.

### Faster Cycle Times for Automotive

By volume, automotive and commercial vehicles are the largest users of CFRTs, with the most typical composition being nylon and continuous glass fiber, according to Wessner.

One reason for OEMs’ interest is thermoplastic composites’ cycle times, which are shorter than those for thermosets. Some research projects at IACMI—The Composites Institute are looking for ways to cut those cycle times even more.

“Cycle times are a big driver for energy efficient production,” says Uday Vaidya, IACMI’s chief technology officer. “The goal of IACMI production is to look at 90 seconds or less for cycle times. Thermoplastics lend themselves to faster curing anyway, and they can be shaped through processes like fiber injection molding and high-speed stamping, as well as compression molding of both discontinuous and continuous fiber.”

For one project, DuPont is supplying the thermoplastic resin and Fibertech is coating fibers with that resin and then weaving them into a very flexible fabric. Purdue University is modeling the material, simulating how the fabric drapes and how much it can stretch before it breaks.

“If you’re trying to make a door panel or something similar
for a car, this fabric has the conformability to be draped to that shape, and with the thermoplastic resin in it, it can be very quickly heated and cured,” Vaidya says. “It makes it possible to produce thick and complex parts with cycle times that are very short in duration.”

Another IACMI project involves Local Motors, which is experimenting with additive manufacturing for producing thermoplastic parts for vehicles.

One development that could speed adoption of thermoplastic automotive components is the opening of a scale-up manufacturing facility in Detroit, a joint venture by IACMI, Lightweight Innovations for Tomorrow (LIFT) and the University of Michigan. The facility will help companies working on thermoplastic composite projects move beyond small-scale test parts and produce full-scale parts for research and testing.

Meanwhile, engineers at DSM are doing their own experimenting, trying out various fibers and mixes of fibers for automotive industry thermoplastic materials with more eco-friendly flame retardants. They also are collaborating with an automotive manufacturer on thermoplastic parts that contain both DSM’s Dyneema® fiber, which has good ductility, and carbon fiber, which provides additional strength. The goal is to reduce the likelihood that pieces of a vehicle will fly off in crashes, which can happen with thermoset parts.

Keestra believes that alternatively-fueled vehicles could open up another automotive market for thermoplastic composites. DSM leveraged its expertise with fuel tanks for outdoor power equipment to move into pressurized storage containers for compressed natural gas. The next step in that evolution could be supplying the tanks for hydrogen-powered vehicles. The thermoplastic materials used in CNG tanks aren’t very different than those required for hydrogen, but the industry will have to design tanks that can handle the 700 bars of working pressure required for hydrogen versus the 200 to 250 bars that CNG tanks need.

Thermoplastic composites have many roles to play in the manufacture of all types of parts for lightweight conventionally-powered vehicles, in electric and/or hybrid electric/hydrogen fuel cell vehicles and perhaps even in autonomous vehicles, says Keestra. The added weight of sensors and cabling that is now going into vehicles will make it imperative for automakers to reduce weight in other areas wherever possible. “Light weighting cameras, cables and connectors really does make sense,” he adds.

**Toughness for Aerospace**

Aerospace manufacturers were early adopters of LFRT technology. Today, the most typical thermoplastic composition in the industry is PEEK (polyetheretherketone) or PEI (polyetherimide) with carbon, which can be woven fabric or unidirectional fibers, according to Wessner.

Offringa says that GKN Aerospace Fokker produces an array of thermoplastic composite products for aircraft, including floor panels, rudders and elevators for various Gulfstream jets, avionic housing parts for Boeing Apache helicopters and horizontal tails for Leonardo helicopters.

The material has two distinct characteristics that make it attractive for aerospace. “Thermoplastic polymers can be molten and then reshaped repeatedly. This makes processes
such as stamp forming of ribs out of blanks and welding of assemblies possible,” says Offringa. Thermoplastics also provide a high level of material toughness, which translates into lower-weight structures with improved damage tolerance. This is of particular importance for thin-gauge structures such as aircraft control surfaces and fuselages.

While thermoplastic composite aerospace components have been of relatively small size in the past, that is changing. “Today we are making the step to large primary structures in thermoplastics, both for the business jet market as well as for the airliner market,” says Offringa. This will require the introduction of processes such as automated lay-up and high-speed welding technologies. Offringa says it also implies the use of unidirectional tapes instead of fabric-based materials, as well as new design concepts such as butt-jointed stiffeners.

**Designing for New Markets**

It’s not only aerospace and automotive manufacturers who are looking for the performance that LFRTs and CFRTs can provide. “The sports and leisure markets are prime examples of industries that are moving to higher performance,” says Steve Bowen, CEO, PlastiComp. “They are less sensitive to the cost of the material. These are people who are trying to win or perform at a higher level. If the benefit is obvious, they don’t mind paying a lot more to capture the performance advantage.”

Medical equipment manufacturers are also capitalizing on the strength and light weight properties of thermoplastic composites. Frog Legs, which produces wheelchair caster wheels, has replaced the aluminum in its casters with PlastiComp’s long carbon fiber reinforced thermoplastic composites. The thermoplastic injection molding process enabled the manufacturer to produce a much more complex shape, which has reduced vibration for the wheelchair user and reduced the weight of a pair of caster wheels by one third (a half pound). PlastiComp is currently focusing on improving the processing technology for thermoplastic composites. “How do you make bigger parts? How do you design the process? We are working on extruding lineal shapes; that will be a new market,” says Bowen. Applications for materials produced through extrusion could include fencing, shovel handles, lacrosse sticks and even pier supports that need to withstand tough environmental conditions.

DSM is working with the electronics industry to provide very thin smartphone frames and connectors. “You really have to make sure that you fine-tune your materials in such a way that they can be easily molded into those structures,” says Keestra. “You need to make sure that the intrinsic viscosity – the way the materials flow into the mold – is optimized to perform well.”

To encourage manufacturers in new markets to use composite materials instead of metals, material suppliers are constantly developing thermoplastic materials with specialized properties. For example, Arkema has developed three new products geared to specific uses. Kepstan can be used in aerospace and other industries looking for extreme temperature resistance, low smoke toxicity and a continual use temperature that can approach
260 degrees C. The company’s Rilsan® Matrix, a unidirectional thermoplastics, according to the company.

Arkema also designed Elium® liquid thermoplastic resin, which processes like a thermoset but delivers thermoplastic properties. It has the low viscosity of a thermoset, wets out fiber in a variety of different processing methods and is processed at room temperature like a thermoset. But after cure it retains the properties of a thermoplastic. Dana Swan, business development manager, says the material could be used for automotive parts produced through high pressure RTM, for building, construction and automotive parts manufactured using pultrusion and for boat hulls and decks made through a vacuum infusion process.

**A Process of Education**

“Thermoplastic composites as a technology is at the beginning of its life-cycle S-curve, with huge application potential,” says Offringa. After several decades of initial development and applications for the automotive industry, he says market acceptance is now strong with most OEMs.

In other industries, however, thermoplastic manufacturers have some work to do to encourage further adoption. “We see efforts to advance customers’ knowledge about thermoplastic composite materials so that they’ll be able to better design with them to maximize value,” says Wessner.

Another determining factor in growth will be how well the composites industry is able to balance cost and performance. “They want to get the most out of these materials based on common resins in order to avoid higher end – and higher cost – engineering thermoplastics,” Wessner adds.

She expects advances in thermoplastic composite technologies will be made on several fronts: material development, process technologies and design. “There is more proactive and intentional development of systems that will enable manufacturers to take advantage of thermoplastics today, including development of equipment that can combine formed sheets with overmolding via injection or equipment that can accommodate other multi-material, multi-step approaches,” she says.

Ultimately, the inroads that thermoplastic composites make into new markets is likely to depend on how much manufacturers in those industries value thermoplastics’ biggest advantage: increased structural performance at a much lighter weight.

Mary Lou Jay is a freelance writer based in Timonium, Md. Email comments to mljay@comcast.net.
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The future of the global composites market is bright. There is increased demand for lightweight materials across market segments for products as varied as large aerospace components and small consumer goods. Composites fit the bill.

The global composites end product market is expected to reach $113.2 billion by 2022, according to market research firm Lucintel. So what does that mean for composite manufacturers and their material suppliers? Industry experts weigh in on five specific areas in this year’s annual State of the Industry report.
The Glass Fiber Market
By Dr. Sanjay Mazumdar, CEO
Lucintel

Overall, the U.S. composites industry had a strong performance in 2017, despite disruption in some raw material supplies, shortages of shipping containers, longer shipping times and plant shutdowns in the Gulf Coast and Southeast due to Hurricanes Harvey and Irma. In the fourth quarter of 2017, impact from the hurricanes stabilized, with all segments showing positive results.

In the composites industry, glass fiber is the major reinforcing material. The U.S. glass fiber market grew by 4 percent in 2017 to reach 2.5 billion pounds in terms of volume and $2.1 billion in terms of value. The market is expected to reach 3.1 billion pounds by 2023 with a compound annual growth rate of 3.4 percent.

Transportation, construction, and pipe and tank are the three major segments for glass fiber, representing 69 percent of the total volume. Increasing housing starts, automotive production and positive growth in oil and gas activities, along with growth in water and wastewater infrastructure in U.S., are expected to drive the glass fiber market through 2023 and beyond.

In terms of supply and demand, the global glass fiber capacity was 11.2 billion pounds in 2017 and is currently running at 93 percent utilization. (See figure 1.) Lucintel predicts that the glass fiber plant capacity utilization will go down to approximately 91 percent in 2018 as glass fiber suppliers increase production capacity. For example, in 2018, Owens Corning plans to build additional capacity in France and India, Jushi and Johns Manville plan to add capacity in the U.S., Taishan is investing in India and Şişecam Group is installing a new plant in Turkey.

The glass fiber market is evolving as there are more and more applications emerging in various end markets. Purchasing decisions in most of the markets continue to be highly influenced by the price of GFRP components. To drive growth and competitive edge in the fiberglass market, the industry needs to focus on the following:

**Price Reduction:** The industry needs to look for ways to reduce the cost of composite parts as it competes with steel, aluminum and concrete. There are plenty of innovation opportunities available to reduce raw material cost, labor cost and energy cost in a composite part. For example, to compete in the price-sensitive $200 billion rebar market, an FRP rebar manufacturer has to come up with an innovative technology to make rebar using glass fiber and sand to reduce the cost of FRP rebar by almost 40 percent.

**Innovative Manufacturing Technologies:** Development of transformative manufacturing technologies with reduced cycle time and reduced cost are needed in the industry. There are plenty of opportunities for innovation in composites, as they offer flexibility in design, material selection, manufacturing and hybridization.

**A Robust Supply Chain:** The industry needs to invest in developing a global supply chain of raw materials, design, tooling and manufacturing for composites as there are increases in globalization in many industries such as automotive, wind energy, aerospace and electronics. For example, Ford makes vehicles globally and prefers to have the same supplier for a single component to meet its global production needs, thus achieving a global footprint in the supply chain is critical.

**Better Simulation and Prediction Techniques:** The marketplace needs to invest in developing better simulation software for composite parts manufacturing. In the steel industry, there are simulation software programs that can predict tolerance, warpage, quality and reliability of parts.

**Investment in Repair and Recycling Technologies:** The industry needs to solve OEM challenges regarding repair and recycling by developing cost-effective technologies and infrastructure.

In conclusion, there will be significant innovation opportunities in the composites industry in various nodes of the value chain. As the industry emerges as a mainstream supplier in numerous markets, there will be winners and losers. Lucintel expects many new and innovative vendors to arise and address market needs.

**The Automotive Market**
By Marc Benevento, Managing Director
Industrial Market Insight

Although 4 billion pounds of composite materials are sold into automotive applications annually, composites account for only about 1 percent of the average vehicle by weight. While optimism about the growth prospects of composites is warranted due to regulatory and technological drivers, barriers to adoption of composites remain and market conditions will create a challenging environment for industry suppliers over the next few years. Composites will win new applications, but will remain in a niche position within the market.

Like other materials, composites will be selected for use only when they offer superior value in terms of overall cost, weight and performance versus the competition. While numerous factors contribute to the adoption of composites in automotive

Source: Lucintel
applications, primary drivers include global fuel economy standards and enabling technologies. Conversely, barriers include a declining sales growth rate in light vehicles and competition from other materials.

In North America and elsewhere, allowable carbon dioxide emissions from light vehicles continue to decrease, requiring automakers to develop vehicles that are more fuel efficient. By 2025 EPA-required fuel economy will be 60 percent above the 2012 level for cars and 35 percent above the 2012 level for pickup trucks. OEMs are pursuing multiple paths to reach these aggressive targets, including the reduction of vehicle mass.

As a rule of thumb, a 10 percent reduction in vehicle mass yields a 7 percent increase in fuel economy. In addition, lighter vehicles require less power to accelerate, so they remain fun to drive when paired with smaller, fuel-sipping engines. As a result, OEMs are investing in lightweight materials to deliver efficient, yet exhilarating vehicles. Composites will play a role, the significance of which will be dictated by the value they deliver versus other materials, along with their ability to fit into the automotive infrastructure.

A longstanding challenge facing the composites industry has been compatibility with joining and painting processes that were developed for metals. However, the search for weight reduction has forced OEMs to get more creative with the use of conventional materials and to consider combinations of steel, aluminum and composites that would have been inconceivable not too long ago. The use of structural adhesives, both as a primary joining method and in concert with spot welding and riveting, has enabled a lot of this lightweight innovation.

Automotive suppliers have enjoyed consistent market growth since light vehicle sales in North America bottomed out at 10.4 million vehicles in 2009. Vehicle sales showed consistent year-over-year growth from 2010 to 2015, with annual rates of change well above gross domestic product growth rates. In 2015, vehicle sales topped 17 million units, which has been the sustainable level of demand in non-recessionary periods. Although sales remained strong in 2016 and 2017, staying above the 17 million unit mark, year-over-year growth is flat. (See figure 2.) With little headspace for the market to grow in the next few years, suppliers looking for growth will have to fight for market share with both direct and indirect competitors.

Suppliers to the automotive industry know the competition for business is fierce. Steel has long been the material of choice for OEMs, and the incumbent enjoys the advantage of an established manufacturing infrastructure and a low-cost position. The steel industry has continued to improve, raising the bar for materials hoping to displace it.

Despite these efforts, aluminum has gained significant market share due to its familiar processing, compatibility with automotive paint systems and “next best” cost position when compared to steel. Suppliers of competing materials, including composites, will need to demonstrate they have superior solutions to steel and aluminum in terms of weight, performance and cost in order to win applications. This includes demonstrating the ability to meet automotive cycle times, cost and end-of-life concerns.

Overall, the automotive market is a challenging environment, but composites are well positioned to gain share in the coming years. Composites offer a compelling combination of cost, weight and performance, particularly when designs are created that take full advantage of composite material and processing techniques. Suppliers that diligently validate their value proposition before investing human and financial capital will get the best returns in this competitive market.

The Carbon Fiber Market
By Daniel Pichler, Managing Director CarbConsult GmbH

The market for carbon fiber continues its robust growth. In 2017, the global demand for carbon fiber was approximately 75,000 metric tons. Aerospace, wind blade and automotive applications each made up about one-fifth of the market, with the remainder comprising sporting goods, compounding for injection molded plastics, pressure vessels, construction and infrastructure reinforcement, tooling, marine, oil and gas, and other smaller end use applications. In recent years, demand for carbon fiber has grown by 10 to 15 percent per year, and this same growth rate is expected to continue for the coming years.

Industry capacity for carbon fiber production is around 95,000 metric tons on an effective net capacity basis (the actual maximum that can be produced) after taking into account knock-down effects from product mix on the 125,000 metric tons of total industry nameplate capacity (the rated capacity). Of the 20 producers of carbon fiber in the world, the top six account for about 80 to 85 percent of industry production and sales. The 10 newest producers – many of them in China – account for 12 to 15 percent of world’s nameplate capacity, but less than 5 percent of world’s production and sales, so they have some catching up to do. With demand for carbon fiber expected to break through 85,000 to 90,000 metric tons in 2018-2019, demand and capacity will come into balance once again and additional capacity

![Figure 2](image-url)
will be needed or tightness of capacity will prevail.

The acceptance of CFRP in any application depends on both the technical and economic benefits they can deliver. In most applications, the technical benefits of carbon fiber include low weight from the high strength-to-weight performance of the material. For example, a steel automobile body-in-white (a car with the sheet metal components welded together) weighs approximately 400 kilograms. The body could weigh 75 percent less if constructed from CFRP – a great benefit in reducing fuel consumption of conventional vehicles or extending the driving range of battery-powered electric vehicles.

The economic challenge for adoption of CFRP in mass market applications, such as in everyday automobiles produced by the millions, has yet to be solved. Not only must the carbon fiber itself come down in cost, but so must the composite part, too. Fortunately, the solution is becoming clear: volume production.

High-volume serial production allows the use of new high-speed processes – such as resin transfer molding, compression molding, injection molding, wet molding and others – all developed for making CFRP parts and aided by robotic material handling. The end result is CFRP parts made in single minutes rather than several minutes to hours as in the past. Volume production scenarios can solve the “chicken or the egg” causality dilemma that CFRP parts have faced until now: Volume applications are needed to demonstrate mass production and low unit costs, while lower unit costs are needed for mass market high-volume adoption. (See figure 3.)

In addition, the indirect benefits of using carbon fiber to lower weight of a specific automotive component or assembly must be fully exploited throughout the vehicle. With a lower body weight, a car requires less suspension and a smaller engine, wheels and tires. The entire engineering of a car may need to be changed to fully take advantage of all that CFRP offers.

In conclusion, the market for carbon fiber and carbon fiber composites is growing robustly. Demand is catching up to available capacity. Developments in both thermoset resin systems and thermoplastics are helping CFRPs to be more largely adopted. In new mass market applications, such as automobiles, the right applications used in the right ways can bring about volume production. And volume production will result in lower costs.

### The Aerospace Market

**By Jens Hinrichsen, Engineering Manager**

**Zodiac Aerospace**

With crucial support from universities and research institutes, the aerospace industry has undergone a transformation from a metal-driven world to a composite-dominated new standard.

Over the past 15 years, we have witnessed a dramatic increase of composite applications in two new aircraft programs: Boeing’s 787 Dreamliner and the Airbus A350 XWB. Material suppliers are challenged by growing demand as production ramp-up takes place. A supply chain analysis conducted by Oak Ridge National Laboratory (Report ORNL/SR-2016/100) estimates a stunning 290 percent increase in aerospace demand for carbon fiber between 2012 and 2020.

OEMs and their component suppliers grow their manufacturing capabilities at the same steep gradient. While automation plays an increasingly important role, equipment suppliers and tool manufacturers are equally challenged with regard to throughput and required improvements: The increase of lay-up volume per hour is the overarching theme as this performance indicator translates into earnings – or losses – on the shop floor.

Future growth of composite applications and associated demand of supply hinges on the success of cost reduction initiatives. For the commercial aerospace industry, the challenge is centered on carbon fiber materials and processes (M&P), as well as enablers for cost reduction, namely automation and digitalization.

During the last decade, a revolution took place: Boeing, followed by Airbus, gave preference to composites over metallic and/or hybrid technologies, setting a new standard for the choice of material for large primary structures and resulting in more than 50 percent composite material content for both the Dreamliner and A350 XWB. Digesting the major consequences from such a revolution can be challenging.

One major effect was that OEMs and their suppliers experienced significantly higher recurring and non-recurring costs compared with projections based on early design-to-cost studies. The reasons are manifold, but are all linked to a lack of composite-specific know-how in the fields of design for manufacture, tool design, large-scale automation and real-time quality inspection that occurs during ply lay-up.

The aerospace industry is currently in a consolidation phase, engaging in an improvement process dedicated to
deployment of enablers for both cost reduction and quality improvement. It focuses on the following:

- Material handling quality optimization to adjust tackiness in the environment, reduce fuzziness, etc.
- Machine optimization: Ease of access for cleaning
- Stabilization of manufacturing environmental parameters, such as temperature and humidity
- Automation, including automated tape laying (ATL) and automated fiber placement (AFP)
- Simultaneous quality inspection, documentation and flaw assessment via digitalization

Changes to the approved design for an aircraft in production are normally ruled out because of excessive cost. However, lessons learned about the interdependency between aircraft designs and manufacturing are very valuable when it comes to M&P selections for a new aircraft program. The “middle-of-market” wide-body program at Boeing – and successors for the B737 and Airbus A320 – are candidates that can potentially benefit from improvements made during the consolidation phase.

The efforts to reduce cost must go beyond manufacturing process considerations and address factors such as structural design. Design for manufacture can be improved based on the lessons learned. This will help reduce complexity of lay-up pattern and tool design, as well as reduce costs for assembly (without compromising maintenance), process parameter control and digital recording. Also, automation of steps in subsequent manufacturing processes can support quality improvements.

As we look to the future of the aerospace industry, trends emerge in three main areas:

**Materials and Processes:** We will likely see increased application of thermoplastic material, motivated by significantly shortened process times and the opportunity to use thermoplastic welding for assembly. There also will be substitution of metal with ceramic materials in the hot sections of power plants.

**Environment/Process Control/Documentation:** Expect to see stabilization of factors in the manufacturing environment, such as temperature, temperature distribution, humidity and time to cure. The airlines also will move toward low-cost sensors, digitalization, advanced software and efficient/fast processors to enable real-time damage assessment after in-service events like lightning strike or foreign object damage (FOD) using “progressive failure analysis.” In addition, recording of process parameters and imaging of lay-up and automated image interpretation/classification will support completion of quality control work during the course of component manufacturing.

**Supply Chain:** The aerospace industry will engage in clustering through preference for suppliers who have manufacturing units located near OEM-controlled centers of excellence with a network of research centers.

**The European Market**

By Elmar Witten, Managing Director
AVK, the German Federation of Reinforced Plastics

Following the slump in European GFRP production during the economic and financial crisis between 2007 and 2009, the composites industry is now enjoying its fifth successive year of growth, increasing by 2 percent to an estimated total of 1.1 million tons compared to the previous year. (See figure 4.) As in past years, the volume of GFRP manufactured in Europe reflects trends observed in various market segments. Production of thermoplastics, used primarily in the automobile industry,
is generally still growing more strongly than production of most thermoset materials. However, in 2017, the strongest area of growth in production volume (5 percent) was continuous processing – especially the pultrusion process. The majority of continuous processes use thermosetting materials.

Within Europe, Germany has the largest GFRP production in absolute terms and the strongest growth. Growth has been consolidating in southern Europe – Italy, France, Spain and Portugal. Currently, production volume is not declining in any European country/region. Trends differ from country to country and also in terms of the major manufacturing processes and materials used. Indeed, the corresponding growth rates can diverge quite significantly.

The composites industry as a whole, and the GFRP market specifically, are extremely diverse in terms of the machinery and methods used. As in other regions of the world, the European market is characterized by a large number of small businesses. However, in many countries 80 to 90 percent of the total volume is produced by just 10 to 20 percent of the companies.

The largest buyers of GFRP components continue to be the transportation and construction markets. These each consume around one-third of total production. The key role played by these two important markets in national economies is one reason why the production of GFRP tends to follow the long-term growth trend in gross domestic product.

Although there is still excellent potential for new applications, GFRP materials are already standard products. The varied nature of the market means that fluctuations in individual customer industries are usually “smoothed out” by applications in others.

GFRP production in Europe continues to grow but is expected to lag behind the global trend, with global production volume well over 2 percent. As a result, Europe’s share of global production continues to fall despite the positive trend in absolute terms.

Often classified as futuristic lightweight materials used primarily in the automotive and aerospace industries, existing applications for composites in other markets—some of them used for decades—are frequently overlooked. These already include many applications in large-scale automotive series production. Moreover, lightweight design is not the only advantage that composites enjoy over other construction materials. FRP has many other useful properties that make it ideal in a number of specific applications, including corrosion resistance, durability and design flexibility.

However, many decision-makers are still unfamiliar with composite materials and their benefits. Improving this situation is one of the most important challenges facing the industry as a whole. The continuing automation and optimization of industrial processes—and the associated challenges of this trend toward “Industry 4.0”—remain important themes.

To continue growing, the European composites industry must deal with the difficulties of establishing composites in the construction/infrastructure markets, as well as changing requirements and developments in the area of mobility. The industry must accept and overcome the challenges it faces and work on perceived weaknesses. If it does, the European composites industry will continue along the successful path it has been following for many years.
When you tune in to watch the 2018 Winter Olympics in PyeongChang, South Korea, you will see many athletes pushing their limits on skis made with composite materials. FRP composites made their way into skis in the second half of the 20th century and since then have become pervasive. Because the materials are commonplace in skis, it’s easy to assume there are no innovations in the mature market. However, ski manufacturers strive to improve products just like their counterparts in other industries.

According to Dodd Grande, senior vice president of engineering and product development at K2, improvements to composite skis have historically been driven by the evolving needs of different types of skiers. For instance, an alpine skier relies mostly on gravity for propulsion, whereas backcountry skiers provide propulsion themselves. As a result, no two skis are the same.

Alpine Skiing

According to Grande, many of today’s alpine skis primarily feature a combination of aluminum and composites. Because there is such a wide range of dissimilar materials used to make alpine skis, choosing the right bonding material is critical. Grande says most of the industry today uses epoxy adhesives because over time, they have proven suitable for bonding nearly all substrates.

The core of many alpine skis is either wood or polyurethane, while the edges are steel. The bottom (or base) of most alpine skis features ultra-high-molecular-weight (UHMW) polyethylene. After sintering, base materials are formed in one of two ways: continuous compression molding (CCM) or scything.

Today, the company at the forefront of prepreg CFRP alpine ski production is Salt Lake City, Utah-based DPS Skis. As the company explains on its website, while many ski makers claim to make carbon fiber skis, they are actually dry carbon laminates mixed with fiberglass in a wet lay-up.

According to Alex Hunt, marketing manager at DPS, in addition to weight reduction, prepreg CFRP gives ski manufacturers more control over torsional stiffness properties and provides skiers more power and control on the slopes. CFRP skis also exhibit less fatigue than GFRP skis, which Hunt says can lose their "pop" (i.e. springiness or reaction time) after a few weeks. Prepregs can also remove the largest part of human error from the composite-building equation, reducing the likelihood of weakness for finished parts and increasing the likelihood for part consistency.

On the other side of the spectrum, there are just as many benefits to using skis made with GFRP even though it’s slightly heavier than...
CFRP, says Pete Wagner, founder of Wagner Custom Skis.

“A ski that has more mass will allow the skier to have more power and fluidity and sometimes more precision when they’re skiing on choppy or crusty snow,” Wagner explains. “A ski that has more mass will generate more force and it will tend to slice through the choppy, variable snow easier. It will tend to vibrate less, so there is less chatter when you’re skiing fast.”

Wagner Custom Skis has about 100 different combinations of materials at its disposal when designing a ski. All of Wagner’s skis are made with a UHMW polyethylene base and contain a wood core that is reinforced with structural layers of GFRP, CFRP or a combination of both. The company uses a wet lay-up process. Resins are cured with a heated pneumatic press to create the final shape of the ski.

“For us, it’s a combination of 21st century computer-controlled milling machines that fabricate all of the components,” Wagner says. “We press them all together and then it’s sort of old-world craftsmanship expert hands that do the final finishing and tuning of our products. It’s an interesting blend of modern and traditional craftsmanship.”

While some of the company’s skis feature CFRP as the primary component, Wagner is a strong proponent of glass fiber. “Fiberglass is a really great material for building skis because it’s … sort of a medium weight material that has really great strength properties, provides good torsional stiffness, has good harmonics, good vibrational absorption and reduction,” says Wagner. He adds fiberglass is a “workhorse material” because it’s versatile, durable and easy to work with.

**Backcountry Skiing and Alpine Touring**

Wagner says that when skiing uphill or straight, a lightweight carbon fiber-based ski can really be helpful because it minimizes a skier’s energy output. Grande believes that over the past three to five years, one of the biggest trends that has increased the use of CFRP in skis is an evolution toward wider skis to allow people to ski more easily on ungroomed backcountry trails.

“The wider skis got people starting to ask, ‘Hey, what can we do to control the weight?’ And so carbon became a natural tool to use,” Grande says. Additionally, there has been a rise in alpine touring – hiking up mountains before skiing down them.

One company whose skis are widely used for backcountry skiing and alpine touring is New Zealand-based C6 Skis. C6 makes skis using its Autoclave Cured Carbon Prepreg (ACCP) technology. Typically, CFRP skis are constructed using a wet lamination process involving carbon cloth soaked in resin and sandwiched together. This, according to C6 founder Craig Stirling, results in a resin-heavy laminate, adding excess weight.

The C6 ACCP ski sandwich is laminated using a unidirectional prepreg carbon fiber supplied by Gurit. The ski’s laminates are laid up in a rectangular block, and the upper laminate has a layer of twill weave carbon cloth applied to it. Then, the upper and lower laminate are cut from a pattern to C6’s desired ski shape. The upper laminate is applied to the upper mold, while the lower laminate is applied to the ski’s 1.4-millimeter polyethylene base and then applied to the lower mold. Next, the laminates are vacuum bagged and cured in an autoclave at 80 C at 7 bar. The high pressure, Stirling says, ensures the finish is perfect. The laminates are then demolded and cleaned up.

For core material, C6 uses end-grain balsa. The balsa core is machined to a tapered profile to control the longitudinal flex of the ski. The laminates are applied either side of the core, dried and then placed between the upper and lower molds. They are then vacuum infused and bonded with Adhesive Technologies’ HPR5 toughened epoxy while in the autoclave at 5 bar. The skis are then removed from the mold, cleaned up, waxed and ready for use.

**Challenges and Future Outlook**

While many in the skiing industry are singing the praises of prepreg CFRP, the same “pop” that skiers love can quickly turn into excess vibration. Hunt also acknowledges that the material can be difficult to work with. As Stirling explains, manufacturers tend to have problems controlling the finished shape of CFRP skis because it can be difficult to get the carbon fiber to contract with the resin while cooling. This, in turn, slows production.

While there aren’t many methods available yet to ease the carbon fiber contraction process, DPS is currently working to address vibration issues with its “Alchemist,” a new line of skis that pairs the company’s signature prepreg construction with proprietary dampening methods.
Overall, the sports market is no different than other markets that likely won't fully embrace CFRP until the composites industry can find a way to drive down the price of raw carbon fiber. While market intelligence firm Lucintel maintains that use of carbon fiber in the worldwide sporting goods market is growing at a lower rate than most other markets for composites, Grande says the growth of the alpine touring movement and increasing size of skis could drive up demand for CFRP. In a market that has seen game-changing innovation in every decade since the 1950s, that's good news for ski manufacturers looking to stay ahead of the curve.

Evan Milberg is communications coordinator at ACMA. Email comments to emilberg@acmanet.org.
During CAMX, ACMA unveiled components of a project to raise awareness of composites and their advantages over steel, aluminum and wood. The project includes a new website, www.discovercomposites.com, as well as marketing and public relations collateral materials that ACMA’s CGI committees and member companies can use in their own marketing and outreach.

One of the leaders of the project was Kimberly Howard, vice president of business integration at Owens Corning and the outgoing co-chairman of ACMA’s Marketing and Communications Committee. We sat down with Howard to learn more about the project and how it will impact the composites industry.

**CM: How did ACMA’s big marketing project come to fruition?**

**Howard:** One of the key components of ACMA’s strategic plan has been to drive growth in the composites industry through increased awareness. Building off this strategy, we wanted our marketing committee to truly own the positioning, end use market focus and messaging of our industry. We wanted to create a dynamic campaign that combines both traditional and new media to help our industry speak with one voice.

**CM: Who is the target audience of this project?**

**Howard:** The target audiences are those unfamiliar with composites who are decision-makers in material choices – architects, specifiers, universities, etc. We wanted them to clearly understand the possibilities, creativity and flexibility that exists by working with composites.

**CM: What about the project is most exciting to you?**

**Howard:** What excites me about this project is it is the first time we have created industry-wide messaging, themes and collateral that speak to those who do not understand this industry. As my colleague Marcio Sandri [VP/Managing Director of Owens Corning] explained during CAMX 2015, for a long time our industry has struggled to “demystify” composites. The new website and public relations components together create a full picture of the industry without overcomplicating things.

**CM: What will people come away knowing about composites that they didn’t before?**

**Howard:** People will know about the broad capability of composites - in lightweighting, durability, degrees of freedom, sustainability and safety to name a few. The intent of this campaign is to grow the utilization of composites for all end use markets, all fabricators and all suppliers. This awareness should benefit us all.

Join us in Washington, D.C. to meet with Members of Congress and agency leaders to expand the use of composites in transportation, water, and energy infrastructure applications. Gain insights, access, and leads to grow your bottom line in these federally-influenced markets.

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Jan. 18, 2018  
[www.awea.org](http://www.awea.org)  
This webinar will examine the advantages of maintaining composites in wind blades for safety, efficiency and cost. The various materials, designs and resin systems for wind blades will be discussed to further understand requirements. In the drive to make wind power more cost competitive and efficient, understanding the materials and how to repair them is a key effort. With the high cost of replacement, more advanced materials, multiple blade designs and increased length, certified specialists are needed for industry growth.

**CCT Instructors Course**  
May 1-3, 2018  
Kansas City, MO  
[www.acmaeducationhub.org/products/1070/cct-instructor](http://www.acmaeducationhub.org/products/1070/cct-instructor)  
The Certified Composites Technician Instructor course is an opportunity for current CCT qualified individuals to become qualified instructors. The 2.5-day course will combine classroom training techniques with hands-on exercises in a composites manufacturing laboratory to reinforce and show practical techniques to deliver instruction. Participants who successfully complete the course are certified to teach CCT study courses and administer CCT exams to candidates.

**Conferences**

**Global Composites Conference**  
Jan. 31 – Feb. 1, 2018  
Las Vegas, NV  
Global Composites will explore the industry from a worldwide perspective, looking at high growth areas such as the U.S., China, Brazil and the Middle East. The conference will examine the global supply chain with particular focus on carbon and glass fiber manufacture and resin production. It will also look at emerging technology trends from around the world and highlight global market information.

**Composites Recycling Conference**  
April 10-12, 2018  
Knoxville, TN  
[www.acmanet.org/recycling](http://www.acmanet.org/recycling)  
The education and networking event will bring in experts from the U.S. and around the world to highlight the most relevant technology and business developments which are turning composites recycling into a reality. Attendees will:

- Get hands-on time with the latest recycled composite products that will be on display.
- Explore the development of a self-sustaining composites recycling industry.
- Learn to reduce scrap, increase productivity and improve their bottom line.

New ACMA Members

- **Auxilius Heavy Industries**  
  Fowler, Ind.

- **Chariho Career & Technical Center**  
  Wood River Junction, R.I.

- **North Carolina State University - Department of Civil, Construction and Environmental Engineering**  
  Raleigh, N.C.

- **Project Research Planning Development and Marketing Group**  
  Ankeny, Iowa

- **Salt Lake Community College – Miller Campus**  
  Sandy, Utah

For more information on becoming a member of ACMA, email membership@acmanet.org or call 703-525-0511.

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IFC: Inside Front Cover  
BC: Back Cover
“With the broadest and deepest product line, along with the largest dedicated fleet of trucks in the composites industry, Composites One’s priority is to make sure you have what you need, when you need it.”

Laura McClain, Distribution Center Manager, Lenexa, KS

Working with Composites One gives you access to the broadest, deepest line of traditional and advanced composites PRODUCTS available – from raw materials, resins and reinforced plastics, to advanced fibers and high-performance solutions – from the industry’s top suppliers. Helping you navigate this one-stop-shop and make sure you get what you need, when you need it are technical sales experts and regional customer service reps, along with local support teams at more than 37 distribution centers across the U.S. and Canada. All are backed by the service and support that only North America’s leading composites distributor can provide.

That’s the power of One – Composites One.