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Laser-assisted thermoplastic AFP: CONFRONTING THE IN SITU CONSOLIDATION CHALLENGE

SEPTEMBER 2026

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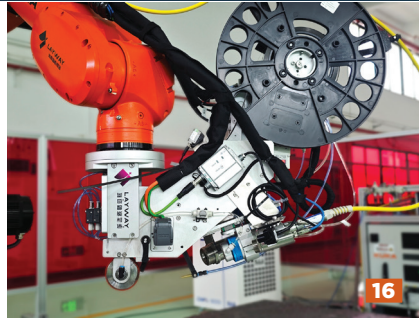
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» ON THE COVER

The cover captures a laser-assisted thermoplastic AFP (LATP-AFP) system in the process of laying TPC tapes with simultaneous heating- and pressure-assisted consolidation. Called the AFPI, it is Layway founder Dr. Fedor Antonov's approach to pulling thermoplastic AFP out of the "aerospace trap." The AFPI reaches processing temperatures up to 450°C at layup speeds around 300 millimeters/second, achieving roughly 2.5% porosity under optimized conditions, which is just short of the sub-1% threshold aerospace certification often demands, and what Antonov calls composites' largest unsolved physics problem.

See p. 16. Source | Layway



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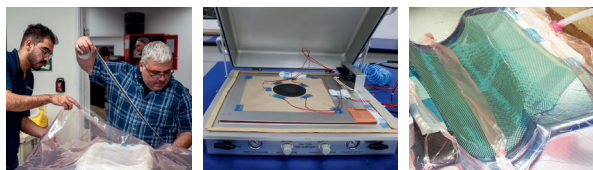
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SCOTT FRANCIS

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New Space, AFP Innovation, Top Shops and More

» As summer winds down, the CW editorial team has naturally turned its attention to industry events taking place this fall. For a few months now, we've been in the thick of planning the brand's Carbon Fiber conference, taking place Nov. 10-12 in Huntsville, Alabama. The event is shaping up to be an exciting exploration of carbon fiber applications, technologies and processes aimed at enabling high-rate production for a range of end markets including aerospace and space, defense, infrastructure and energy. The Huntsville location especially is a perfect backdrop to discuss the demand for composites innovation coming from defense and space.

Also, by the time you read this, the CW team will be deep into final preparations for CAMX 2026, which lands in Atlanta this month. There's always a particular energy present in the weeks leading up to the show — Show Daily planning, pre-show interviews, key exhibitor and industry announcements. When CAMX rolls around, it's always a useful time to step back and think about what this industry has been telling us all year, because so much of it shows up on the show floor in physical form. So many discussions this year have revolved around meeting demand, for example, creating a sense of urgency that has worked its way into several of our September issue stories.

Take our end markets report on New Space (p. 24). Composite materials have always been the quiet enablers of spaceflight, but geopolitical competition and a lunar economy that's finally coming into focus with the Artemis program is rippling straight through to composites suppliers building launch vehicles, propulsion systems, reusable spacecraft structures and constellation satellite components. It's a market where aerospace-grade quality now has to coexist with high-rate production, and that tension is driving new innovation and creativity.

Speed and accessibility show up again in a CW interview with Layway founder Dr. Fedor Antonov (p. 16), providing a reminder that the quest for high-rate solutions isn't new and remains an area of constant exploration and iteration. Thermoplastic automated fiber placement (AFP) has been a proven, high-performance manufacturing technology for more than two decades, yet high costs and limited accessibility have kept it confined mostly to aerospace and well-funded research institutions. Antonov founded Layway to change that momentum, which is echoed through his conversation about the engineering principles behind Layway's approach, the physics of in situ consolidation and what challenges the technology still needs to overcome to reach broad industrial adoption.

This issue also gives us an opportunity to recognize qualifying composites fabrication operations in the 2026 Top Shops Benchmarking Program — a data-driven program developed by Gardner Business Media (GBM) to spotlight best practices, uncover improvement opportunities and drive operational excellence.

The 2026 survey, which opened Feb. 1 and closed April 10, drew hundreds of participating businesses. Taking part in the survey gives business leaders valuable insights to assess their

2026 CW Top Shops qualifiers

- Advanced Composite Solutions Inc. (Central Point, Ore., U.S.)
- B&T Composites (Florina, Greece)
- Champion Fiberglass Inc. (Spring, Texas, U.S.)
- Compotech (Brewer, Maine, U.S.)
- GSE Dynamics Inc. (Hauppauge, N.Y., U.S.)
- Industrial Plastic Systems (Lakeland, Fla., U.S.)
- Nammo Composite Solutions (Salt Lake City, Utah, U.S.)
- Rock West Composites (San Diego, Calif., U.S.)

operations, streamline procedures and refine business strategies. Moreover, each participant receives a customized benchmarking report — a product that GBM continually works to further optimize and improve.

According to Mike Shirk, senior market research analyst, GROW Industrial Intelligence, the 2026 benchmarking pointed to a few positive overarching industry trends, including increased growth in annual sales, decreases in labor turnover and an increase in hourly wages. Less positive trends included an increase in material spending and a decreased quote-to-book ratio.

Beyond personalized insights, qualifying companies in the composites industry are recognized as CW Top Shops. This year's honorees were selected based on having met a set of benchmarks in a predetermined set of key performance indicators.

Congratulations to all of this year's Top Shops qualifiers, all of whom are highlighted above. Your commitment to benchmarking and continuous improvement sets the standard for the composites industry. And to everyone gearing up for CAMX this month, or already marking calendars for Carbon Fiber in Huntsville this November, we look forward to seeing you there. As always, thank you for reading. **CW**

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From Lamina to Laminate: The Evolution of Composite Compression Test Methods

By Dan Adams / President, Wyoming Test Fixtures Inc.

» In my May 2026 column, I discussed the evolution of standardized composite shear test methods from lamina-level characterization to multidirectional laminate testing. Composite compression test methods have undergone a similar evolution. Many of the earliest compression test methods were developed for use with thin unidirectional (UD) laminates to obtain fundamental lamina properties. However, as composite structures have become thicker and the laminates more complex, interest has grown in characterizing the compression behavior of multidirectional laminates representative of actual structural designs.

Unlike tensile testing, where load introduction is relatively straightforward, compression testing presents unique challenges. Compression specimens must be loaded without initiating bending while remaining sufficiently supported to prevent premature buckling. As laminate thickness increases and laminate stacking sequences become more complex, these challenges become increasingly difficult to manage. Consequently, the evolution of composite compression testing to laminates has largely been driven by the need to achieve valid material failures while minimizing test fixture-induced artifacts.

For many years, obtaining reliable compression properties for advanced composites was regarded as one of the greatest challenges in composite materials characterization. Unlike metals, which generally fail in compression at relatively high strains without significant stability concerns, composite laminates are highly sensitive to fixture alignment, specimen

geometry and load introduction. As a result, considerable effort was devoted during the 1970s and 1980s to developing test configurations capable of producing valid compression failures while suppressing premature buckling and other non-representative failure modes.

The earliest ASTM-standardized compression test method for composites, ASTM D3410¹, was standardized in 1975 as a lamina-level characterization method. The original standard employed the Celanese shear-loading fixture, which was later supplemented and ultimately replaced by the IITRI fixture configuration used in the current ASTM D3410 standard, shown in Fig. 1. The test uses a relatively thin specimen with bonded end tabs and transfers load into the specimen through shear loading. By avoiding direct end loading, this test method minimizes many alignment and load introduction issues that can affect compression test results.

The ASTM D3410 compression test method proved highly effective for determining compression properties of UD laminates and remains widely used today. However, as composite structures increasingly incorporated balanced and symmetric multidirectional laminates, the limitations associated with using lamina-oriented test methods to test thicker and more complex specimens became apparent. Higher failure loads, greater susceptibility to specimen bending and more complex failure modes created new challenges for compression test method developers. During this period, numerous fixture

concepts and specimen configurations were evaluated throughout industry, government and academic laboratories. The objective was not simply to increase load capacity, but to *maintain* a stable compression stress state within increasingly thick and complex laminates. These efforts ultimately contributed to the development of combined-loading approaches that sought to balance specimen stability with realistic load introduction.

Many of these challenges mirrored those encountered previously in composite shear testing. Thicker

FIG. 1 ASTM D3410 IITRI compression test fixture and specimen loading. Source (All Images) | Dan Adams



multidirectional laminates required greater stabilization during testing, while maintaining uniform loading of the specimen became increasingly difficult. Multidirectional laminates can exhibit failure mechanisms and failure-mode interactions that are less prevalent in UD specimens, including fiber kinking, micro-buckling and interlaminar delamination. These behaviors raised concerns regarding the applicability of traditional compression test configurations to more structurally representative laminate architectures. Efforts ultimately led to the development of ASTM

discontinuities or damage conditions representative of service environments. Historically, the distinction between these two groups of methods was relatively clear; D30.04 methods focused on determining fundamental material properties using simple, idealized specimens, while D30.05 methods evaluated structural response in the presence of holes, fasteners or damage. However, as multidirectional laminate tests have become increasingly common, the boundary between lamina- and laminate-level characterization has become less distinct.

This trend can be observed in both ASTM D3410 and ASTM D6641. Although ASTM D3410 originated as a lamina-property method for thin UD specimens, it continues to be used in limited cases for highly orthotropic materials and with selected multidirectional laminates where shear-loading stabilization remains advantageous. Conversely, ASTM D6641 was developed specifically to accommodate multidirectional laminates but is routinely used to generate both lamina- and laminate-level material allowables. The result is a gradual convergence of applications that were once viewed as separate categories of testing.

Thus, the evolution of composite compression testing from ASTM D3410 to ASTM D6641 reflects a broader shift in how the industry approaches material characterization. As laminate architectures become more complex, test methods must preserve continuity with established property databases while remaining capable of producing valid failures in thicker, multidirectional specimens. The traditional distinction between lamina- and laminate-level compression testing is therefore less meaningful than it once was, underscoring the need for future methods that maintain technical rigor while aligning with modern structural design practices. **CW**

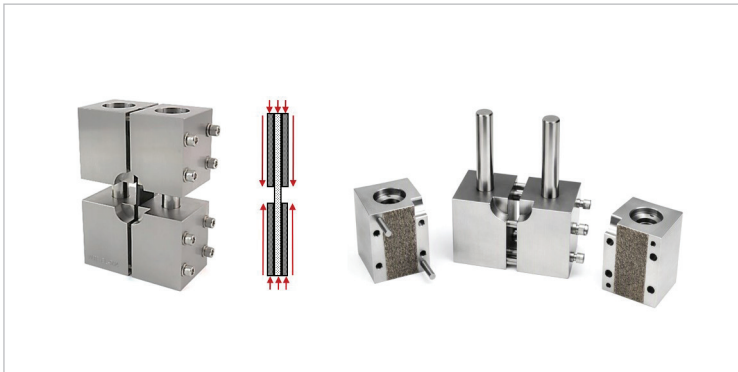


FIG. 2 ASTM D6641 combined loading compression (CLC) test fixture and specimen loading.

D6641², the combined loading compression (CLC) test method, which was standardized in 2001. Unlike ASTM D3410, which introduces load primarily through shear transfer, ASTM D6641 combines both shear loading and end loading within a single fixture configuration. This approach allows the specimen to be stabilized while simultaneously introducing a portion of the load directly through the specimen ends.

The CLC fixture (Fig. 2) represented an important advancement in composite compression testing because it broadened the range of laminate configurations that could be evaluated successfully. The combined-loading approach accommodates a wide variety of laminate architectures, ranging from thin UD laminates to thicker multidirectional and quasi-isotropic laminates commonly used in structural applications. By combining end loading and shear loading, the method enables valid compression failures with minimized buckling and fixture-induced effects. Advances in specimen design, fixture technology, alignment verification and test validation helped make this transition possible.

Within ASTM Committee D30 on Composite Materials, this evolution has also influenced the traditional distinction between material-property testing and structural-feature testing. Lamina- and laminate-level property tests are primarily developed and maintained by Subcommittee D30.04 and include tension, compression, shear, flexure and fracture-related characterization methods. Structural-feature tests — such as open-hole tension and compression, filled-hole tension and compression, bolt-bearing and compression-after-impact methods — are maintained principally by Subcommittee D30.05 and incorporate geometric

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¹ASTM D3410/D3410M-16 (2024), “Standard Test Method for Compressive Properties of Polymer Matrix Composite Materials with Unsupported Gage Section by Shear Loading,” ASTM International (West Conshohocken, PA, U.S.), 2024 (Originally issued in 1975).

²ASTM D6641/D6641M-23, “Standard Test Method for Compressive Properties of Polymer Matrix Composite Materials Using a Combined Loading Compression (CLC) Test Fixture,” ASTM International (West Conshohocken, PA, U.S.), 2023 (Originally issued in 2001).



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in engineering mechanics. Adams has a combined 45 years of academic/industry experience in the composite materials field. He has published more than 120 technical papers, is the former chair of ASTM Committee D30 on Composite Materials and co-chair of the Testing Working Group for the Composite Materials Handbook (CMH-17). He regularly provides testing seminars and consulting services to the composites industry. Dan@WyomingTestFixtures.com

CAMX SHOW PREVIEW



CAMX 2026 Heads to Atlanta

By Grace Stubbins, Senior Managing Editor

» Nothing beats the rush of attending a trade show. Collecting your badge and becoming one of many filtering into the exhibition hall. Walking thousands of steps, conveying greetings and rushing from one appointment to the next. The sounds of minds and machinery at work — lively conversations, deals struck, all against the backdrop of on-display equipment and demos.

All of these things and more are a common presence when attending CAMX. In 2025, organizers saw more than 3,700 attendees (~1,400 of them first-timers), spanning distributors, academia, suppliers, manufacturers/fabricators/molders and many other divisions. This year's event, housed within the Georgia World Congress Center, is expected to surpass these numbers, providing a continuation of successful past event features mixed with new offerings and the presence of 500+ exhibitors:

- Kickstart your learning experience with Monday's pre-conference in-depth and small-class tutorials, made for attendees seeking a deeper, hands-on dive into a single process or material system.
- Build your career with networking events and informal meet-ups — the Welcome Reception, Young Professionals Meet-up, the Hive and other related events put on at various exhibitor booths.

- Celebrate industry progress through annual events like CAMX and ACE awards.
- Progress your knowledge with technical papers, education sessions, the CAMX Industry Stage (previously the CAMX Theater) and the CAMX Innovation Stage (featured sessions, now available on the show floor).

The conference program is built around three formats: 25-minute technical papers presenting peer-reviewed research, 55-minute education sessions on case studies and best practices. A judged poster session gives university researchers and early career engineers a venue alongside the main program.

Are you taking advantage of this opportunity? Visit www.the-camx.org for schedule updates and registration. **CW**



ABOUT THE AUTHOR

Grace Stubbins joined *CompositesWorld* in 2020. As the brand's senior managing editor, she manages all press coverage and communications, monthly print/digital issue production and occasionally writes original content. She has a bachelor's degree in creative writing from Miami University in Oxford, Ohio. gstubbins@gardner.media

WHAT:

Composites and Advanced Materials Expo (CAMX) 2026

WHO:

American Composites Manufacturers Assn. (ACMA, Arlington, Va., U.S.); Society for the Advancement of Material and Process Engineering (SAMPE, Diamond Bar, Calif., U.S.)

WHEN:

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Booth AA9

AUSA Annual Meeting & Expo
Washington, DC
Oct. 12 - 14, 2026
Booth 2263



TRENDS

CW highlights Farnborough, where the focus on next-gen aircraft propulsion, eVTOL and battery-electric aerospace emphasized process and architecture; Anemoi secures Bureau Veritas approval; allied organizations will help lead nonmetallic reinforcement in construction; and an aluminum billet for IndyCar racing is redesigned using TPC.

AEROSPACE/DEFENSE

Farnborough International Airshow 2026: Progressing the Composite Advantage

The composites on display at the Farnborough International Airshow shared a common thread in that the material itself was rarely the headline. What set one demonstrator apart from the next was the thinking behind it, how the fiber was placed, how heat and pressure were applied and how a design anticipated the loads, safety cases and production rates that determine whether a part ever reaches series production. In short, composites continue to be key enablers.

Two main pressures influenced nearly everything on display. The first was the need for increased production rates. Combined narrowbody aircraft OEM announcements indicate that demand is more than 120 complete aircraft

per month, and some eVTOL programs are gearing up to produce 650 per year from some manufacturers. Traditional autoclave and prepreg processes alone cannot meet these higher demands. The second pressure is durability, which encompasses a wide range of concerns, including erosion, impact resistance, battery thermal runaway and recyclability broadly. These issues are viewed as structural challenges to be addressed rather than mere afterthoughts. Much of the exhibition showcased a supply chain poised to tackle both rate and durability simultaneously, focusing on representative hardware rather than just flat-panel samples.

Several agreements, partnerships, developments and reveals made the Farnborough headlines in which the use or consideration of composite materials were central:

- **Albany Engineered Composites (AEC) & A&P Technology:** A&P's braided composite architectures are being joined with AEC's resin transfer molding expertise for next-gen aerospace and defense structures.
- **Airbus U030 Flexrotor:** Airbus Helicopters' composites-enabled Flexrotor UAS began maritime surveillance operations in the Baltic Sea under an EMSA contract.
- **Airbus Wing of Tomorrow:** In a 3-year flight test campaign, Airbus will install full-scale, high-span wing extensions on an A321neo for the next-gen single-aisle aircraft.



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- **Archer Aviation & Anduril:** Archer unveiled *Halo* (commercial) and Anduril unveiled *Thunder* (defense), two variants of a shared dual-use VTOL airframe.
- **Embraer & Strata Manufacturing:** An MOU will evaluate work packages for advanced composite aerostructures for the Embraer *E2* family of commercial jets.
- **FACC & Kineco Aerospace:** FACC is expanding its Indian partnership with Kineco to a second composite component work package for Airbus, with serial production starting by end of 2027.
- **Hexcel & Boeing:** Hexcel announced new and extended long-term supply agreements with Boeing covering commercial, defense and space programs.
- **Kineco & The CT Engineering Group:** Kineco signed an MOU with CT Engineering Group to jointly pursue composite structures for unmanned autonomous systems across aerial, land and maritime platforms.
- **Kineco & SkyDrive:** India's Kineco Ltd. will manufacture composite aerostructures for SkyDrive's production eVTOL using a newly installed autoclave in Goa.
- **Joby Aviation & Virgin Atlantic:** The companies signed a binding multi-year agreement to launch Joby's composite-intensive *S4* air taxi service in the U.K., building on Joby's existing Delta Air Lines partnership.
- **NCC & Vertical Aerospace:** Vertical Aerospace flew its first public full-scale eVTOL demonstrator using Gen 2 composite rotor blades co-designed with NCC.
- **Park Aerospace:** A \$65 million investment is being put toward a composites manufacturing facility at Tulsa International Airport, expected to open in 2028.
- **Polar Technology & Ultima Forma:** The LEEF project produced an electroformed nickel leading edge protection layer that showed an 88-fold improvement in erosion resistance over unprotected composite structures.
- **Sikorsky:** The Lockheed Martin company completed initial flight testing of its composite-wing *Nomad 100* UAS under the EVADE program.

Although applications varied, the composites technologies showcased at Farnborough 2026 had a unified theme: the materials' ability to confer advantage, be it in weight, rate, power, performance, safety, sustainability or all of the above. Read the complete report online via the QR code.

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MARINE

Entire Anemoi Rotor Sails Portfolio Has Classification Approval

Anemoi Marine Technologies Ltd. (London, U.K.), a company that develops composites-intensive rotor sail technologies, has been awarded design assessment certificates from classification society Bureau Veritas (Paris, France) covering several versions of its Rotor Sail wind-assisted propulsion, further reinforcing the company's growing track record of independent industry validation.

The latest Bureau Veritas approvals cover Anemoi's fixed and rail-deployed 3.5 × 24.5-meter Rotor Sails, including EX-rated versions and shorter variants to suit ships with

air draft restrictions. Applications are also being progressed for approvals covering fixed and folding 5 × 35-meter sails.

With these latest approvals, the entire Anemoi

Rotor Sail portfolio is now covered by approvals from leading classification societies, including Bureau Veritas, Lloyd's Register, DNV and ClassNK. Together, these independent validations provide shipowners and operators with greater confidence in the technology while helping to reduce project risk and simplify deployment.

Beyond certification, Anemoi Rotor Sails are already operating on vessels classed by multiple classification societies, demonstrating proven performance across a range of vessel types and operating conditions.

"These latest approvals highlight how Anemoi is advancing in both technical maturity and scale of deployment, while continuing to focus on easing implementation for shipowners," says Clare Urmston, CEO of Anemoi Marine Technologies. "Verification is a crucial pillar for building confidence in Anemoi's solutions, further driving the uptake of wind-assisted propulsion across the global market."

Approvals from marine classification societies confirm that a technology can be safely manufactured, installed and operated in accordance with recognized industry standards.

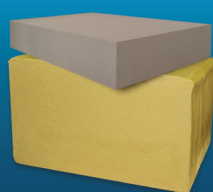


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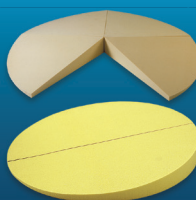
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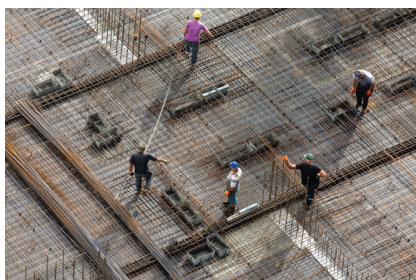


CONSTRUCTION/INFRASTRUCTURE

European Rebar Council, NEx Advance Global Nonmetallic Reinforcement

The European Rebar Council (ERC), a sectorial alliance of the European Composites Industry Association (EuCIA), has signed a memorandum of understanding (MOU) with NEx: An ACI Center of Excellence for Nonmetallic Building Materials (Farmington Hills, Mich., U.S.).

The agreement formally recognizes the ERC as an allied organization of NEx and establishes a framework for the two organizations to combine their resources and expertise in support of the wider adoption of nonmetallic materials across the built environment. Under the MOU, the ERC and NEx will work together to support the development of the codes, specifications and technical knowledge needed for the effective use of composite reinforcement, while helping to assure manufacturing quality and the



competent installation, testing and inspection of nonmetallic products.

As an allied organization of NEx, the ERC is positioned to guide the regional and national development of standards and specifications for composite rebar within Europe, and to facilitate cross-regional collaboration between North America, Europe, India and Asia. The partnership will support the promotion of nonmetallic reinforcement solutions across the European construction and infrastructure industries, including through the provision of tools such as modeling solutions appropriate for Europe and other markets.

Activities envisaged under the agreement include identifying and facilitating

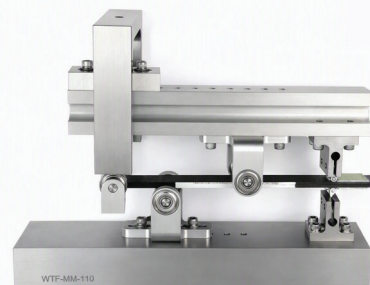
the development of consensus-based construction codes that allow for the use of nonmetallic materials, supplying the knowledge required to specify composite reinforcement with confidence, and helping to identify gaps in technical knowledge for referral to relevant standards-developing organizations. ERC and NEx will also collaborate on research into new nonmetallic technologies.

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AEROSPACE/DEFENSE

Arrow McLaren, Greene Tweed Co-Engineer Anti-Roll Bar Lever

Greene Tweed (Lansdale, Pa., U.S.) and the Arrow McLaren IndyCar Team (Indianapolis, Ind., U.S.) have co-engineered a lightweight anti-roll bar lever for the team's NTT IndyCar Series race cars using Greene Tweed's Xycomp DLF thermoplastic composite (TPC). The redesigned component reduces weight by 64 grams per car, while meeting the

strength and reliability demands of elite open-wheel racing.

The anti-roll bar lever is a critical suspension component that helps control chassis roll and maintain consistent handling balance during high-speed cornering. In IndyCar competitions, where cars regularly exceed 220 miles per hour and performance gains are measured in fractions of a

second, even small reductions in weight and refinements in mechanical balance can contribute to more consistent handling, tire management and stability.

Working closely with Arrow McLaren's engineering team, Greene Tweed evaluated the component's performance requirements, geometry, manufacturing approach and material demands before transitioning the design from 7075 aluminum billet to Xycomp DLF. The high-performance TPC material



offers a high strength-to-weight profile and is engineered to replace complex metallic components for aerospace and defense, industrial and other demanding applications.

The Xycomp DLF anti-roll bar levers were first introduced on Nolan Siegel's No. 6 car at Barber Motorsports Park and have since been implemented across all Arrow McLaren cars. Beyond the material change itself, the project also reduced internal development workload for Arrow McLaren's engineering and production groups.

"Greene Tweed's expertise in materials, manufacturing processes and the performance requirements we face made the development and production of this component seamless," says Kory Drake, design engineer, Arrow McLaren.

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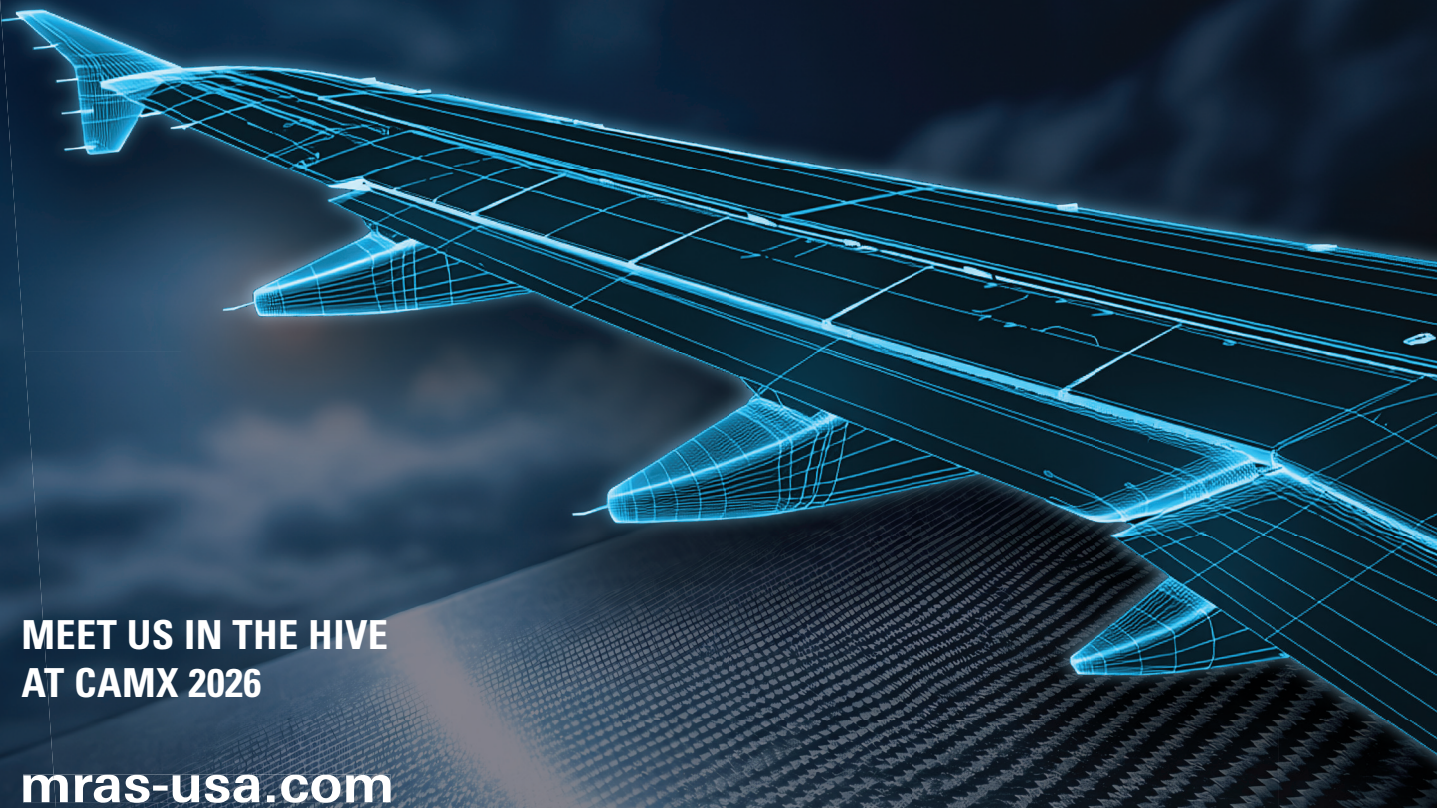
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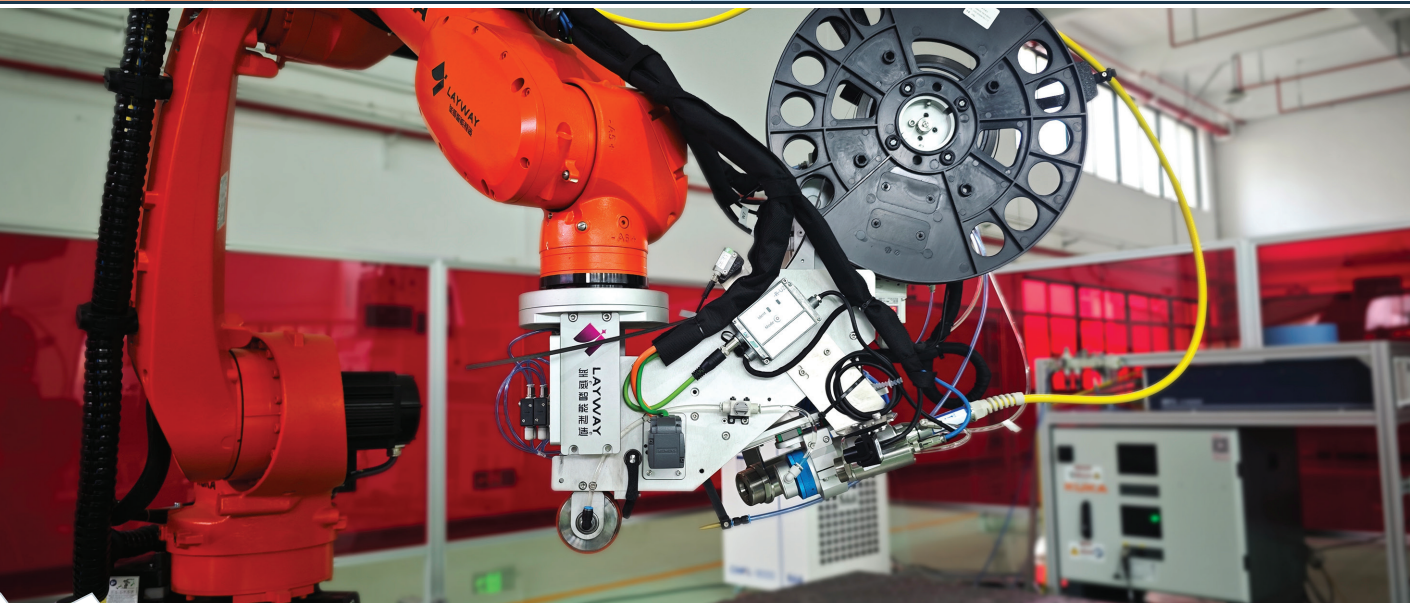
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Laser-Assisted Thermoplastic AFP In Situ Consolidation at Industrial Speed

CW talks to Layway founder Fedor Antonov on the physics of in situ consolidation, what the aerospace market failed to democratize and the central unsolved problem of industrializing this composites manufacturing technology.

By Stewart Mitchell / Technical Editor

» Thermoplastic automated fiber placement (AFP) has existed as a validated manufacturing technology for more than two decades. The process can produce some very high-performance structural composite parts with fiber volume fractions above 55%, interlaminar shear strengths exceeding 60 megapascals and the weldability and recyclability that thermoset laminates cannot offer, all without an autoclave.

Yet its industrial footprint remains narrow. Entry-level research AFP systems have routinely exceeded \$1 million and unidirectional (UD) thermoplastic tapes historically cost thousands of dollars per kilogram, while the process knowledge required to operate these systems has, for the most part, sat inside a small number of aerospace primes and well-funded European research programs.

This has all resulted in a technology that the composites industry understands well in principle but rarely uses in practice. In a bid to change that ratio, composites researcher Dr. Fedor Antonov is building accessible laser-assisted thermoplastic AFP systems through his latest company, Layway (Suzhou, China).

Antonov holds a Ph.D. in the mechanics of deformable solids from Moscow State University and spent several years at the Skolkovo Institute of Science and Technology (Skoltech) researching continuous fiber composite design optimization. In 2014, he founded Anisoprint (Esch-sur-Alzette, Luxembourg), a company built around continuous fiber co-extrusion 3D printing using a thermoset-thermoplastic bi-matrix composite filament. Layway, his second company, applies laser-assisted thermoplastic automated fiber placement (LATP-AFP) to structural composites manufacturing.

Layway currently has two main products. LabAFP is a single-tow, 2-kilowatt (kW) LATP-AFP system built on a KUKA (Augsburg, Germany) KR16 robot with a 600 × 600-millimeter (mm) working envelope which targets research, process development and education. The AFP1 is a turnkey LATP-AFP system designed for direct part production. Compatible with welding, overmolding and overprinting workflows, it is designed for industrial production.

■ LEFT: The Layway AFP1 industrial laser-assisted thermoplastic AFP system shows the tape spool and laser delivery system integrated directly into the end-effector assembly. Source (All Images) | Layway

I spoke with Antonov about how his experience has shaped the direction and challenge he looks to solve with Layway, the engineering rationale behind both of the company's systems, the physics governing in situ consolidation and what thermoplastic AFP still has to resolve.

CW: Your background is in computational mechanics and composite design optimization. Most AFP system developers come from machine-building or aerospace backgrounds. How has your starting point changed what Layway prioritizes?

FEDOR ANTONOV (FA): I tend to start from the application rather than the machine to understand where continuous fiber thermoplastic composites [TPC] create value, how structures should be designed for these materials and how the manufacturing process must adapt to specific applications, including the economics.

One major lesson I learned from years in additive manufacturing is that the machine is not the product. The *value* created for a particular customer application is the product. That perspective helps identify opportunities that a purely technology-driven approach overlooks. My role is to connect materials, mechanics, applications and system design into a coherent industrial solution. So, that's what I do.

CW: TPC have been described as "a few years from mainstream adoption" for a while. What has finally shifted that timeline, and what was still missing when you started Layway?

FA: The technology was not the limiting factor. TPC were technically ready years ago. The real constraints were scale and economics. Before founding Anisoprint, I worked on thermoplastic AFP research at Skoltech with Professor Zafer Gürdal. At that time, UD tape materials could cost hundreds of dollars per kilogram, and entry-level AFP research systems could exceed \$1 million. Broader industrial adoption was unrealistic under those conditions.

■ The compaction roller of the Layway AFP1 head shows near-infrared laser illumination at the nip point, where simultaneous heating- and pressure-assisted consolidation occur.



What has changed is convergence. Material availability improved dramatically as the number of tape suppliers grew and prices dropped significantly compared to even the early 2010s. Robotics, laser hardware and industrial automation became more accessible. But machine accessibility remains one of the largest missing pieces. Many AFP systems are still too expensive and too complex for broad industrial use. That was the central motivation behind Layway.

CW: At Anisoprint you developed a thermoset-thermoplastic co-extrusion system for continuous fiber deposition. What did that work reveal about the structural limits of extrusion-based processing, and how did those limits inform Layway's AFP approach?

FA: The most important lesson was the fundamental trade-off between geometric freedom and structural performance. Extrusion-based composite printing can produce highly complex geometries with relatively simple hardware, which is valuable for prototyping, tooling and customized, low-volume parts. For large-scale structural applications, it has fundamental limitations.

Throughput is one. High-performance composite structures require large material volumes, and extrusion is slow because material must be heated conductively, melted, transported through a nozzle and deposited layer by layer. Laser-assisted tape placement operates at much higher energy throughput. Lasers provide fast, localized heating with precise temporal control, making multi-kilogram-per-hour deposition rates realistic and cycle times below 10 minutes achievable for many structural parts.

The second limitation is consolidation. In extrusion-based printing, material is deposited without compaction pressure, which limits fiber volume fraction and mechanical properties. AFP changes this through pressure-assisted consolidation at the nip point. The compaction roller applies pressure while heat is applied and is then immediately removed. That combination solves the central contradiction in TPC deposition, which is that the interface must be hot enough to bond during placement, but solidify immediately afterward to maintain dimensional stability.

Laser heating and thermal control

CW: The LabAFP uses a 2-kW near-infrared laser at a wavelength of 1,080 nanometers with a 15 × 40-mm spot elongated in the direction of tape travel. What drove that specific geometry?

FA: The spot geometry was designed around the thermal requirements of nominal 0.5-inch-wide thermoplastic UD tape. After compaction, this tape typically reaches 14- to 14.5-mm in width. The 15-mm spot width closely matches the final consolidated tape geometry and provides tolerance for alignment variation across different material systems.

»

The 40-mm length is related to thermal exposure time. In a standard configuration, the spot is roughly split across the nip point with approximately 20 mm heating the incoming tape and 20 mm heating the substrate. This ratio is adjustable because the AFP1 head allows the laser angle to change. As laminate thickness increases, substrate heating becomes more important because more thermal mass must reach bonding temperature. With polyetheretherketone [PEEK], this configuration consistently reaches processing temperatures up to approximately 450°C at layup speeds around 300 millimeters/second [mm/s]. The rest of the laser specifications are to achieve the desired processing temperature characteristics.

CW: Carbon fiber composites absorb near-infrared radiation mainly through the fibers, not the matrix. Heat then conducts into the polymer before melt temperature is reached. What practical constraint does this mechanism place on the process at 300 mm/s?

FA: At 1,080 nanometers, thermoplastic matrices are relatively transparent while carbon fibers absorb the overwhelming majority of laser energy. The fibers act as localized heat generators at the bonding interface, with thermal energy concentrated at roughly the depth of the first exposed fiber layer, typically on the order of 10-15 microns, and conducting into the surrounding polymer from there.

Why a 1,080-nanometer NIR laser?

Layway is using a near-infrared (NIR) diode or fiber laser at a wavelength of 1,080 nanometers because this band is reasonably well absorbed by carbon fiber. This is why NIR diode/fiber lasers (rather than, say, CO₂ lasers at 10.6 micrometers) have become the standard heat source for laser-assisted AFP — they achieve good absorption at accessible fiber-laser wavelengths, decent efficiency and compatibility with fiber delivery to a compact placement head.

In AFP, only the interfacial polymer layers need to reach melting temperature to achieve bonding. Because UD tape is thin, often around 0.14 mm thick, temperature distribution through the tape becomes fairly uniform even at speeds up to 300 mm/s. The transient regimes of acceleration, deceleration, cuts and restarts are the most demanding part of the process. The absorbed power density is very high, and even a brief slowdown can create local overheating if laser power is not dynamically synchronized with robot motion. At around 200 mm/s, a typical process may require roughly 800 watts [W] for carbon fiber-reinforced polyamide (e.g., nylon) [CF/PA] and around 1,200 W for CF/PEEK, depending on optics configuration, fiber volume fraction and tape thermal properties.

CW: What is the compaction roller doing thermally at the nip point, and how is the cooling system designed around that function?

FA: The true nip-point temperature is difficult to measure directly because the roller blocks optical access. What the system measures is the temperature in the observable region immediately before the nip point. The actual interface temperature inside the contact zone is lower because heat loss begins once material leaves the laser exposure area.

The dominant function of the roller is compaction- and pressure-assisted consolidation, not heat extraction. The cooling effect is relatively moderate because it occurs mainly through conductive heat transfer at the top surface of the tape rather than at the heated bonding interface. The roller geometry and cooling system are designed around process stability, pressure uniformity and roller durability. Internal cooling is primarily necessary to prevent overheating and degradation of the roller material itself, especially when using compliant rollers operating continuously at high process temperatures.



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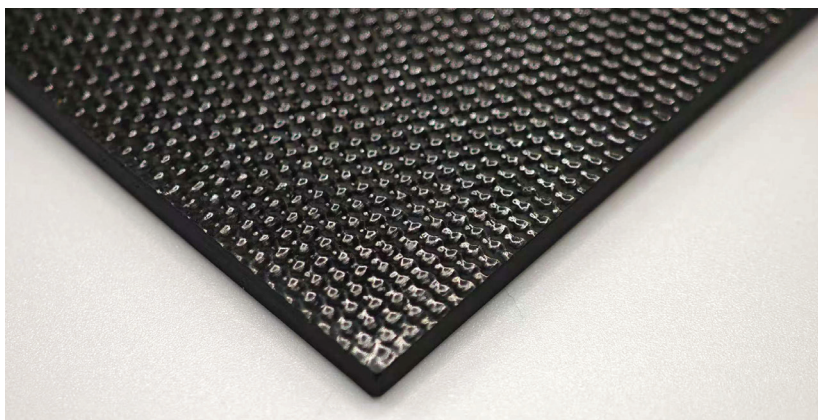
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■ Surface detail of a carbon fiber/PEEK laminate produced by laser-assisted AFP (LATP-AFP) illustrates the characteristic inter-tow texture formed during in situ consolidation. The surface morphology reflects the thermal and pressure conditions at the nip point during deposition.

Consolidation mechanics

CW: Published studies on LATP-AFP of carbon fiber-reinforced polyphenylene sulfide (CF/PPS) show in situ consolidated laminates achieving around 21-22% crystallinity versus 35%+ for hot-press consolidation, with interlaminar shear strength penalties of up to ~35%. How should that gap be interpreted, and what does Layway prioritize as a result?

FA: Crystallinity is scientifically interesting and relatively easy to study, which is why there is a large body of research on it. From an industrial processing perspective, porosity, interfacial bonding quality and consolidation consistency have a much stronger influence on mechanical properties. Porosity levels above 5% can reduce interlaminar shear strength several times over. Differences in crystallinity within typical AFP processing ranges often produce much smaller changes on the order of 10-20% in interlaminar shear strength.

Our process priorities follow that hierarchy: achieve proper interfacial melting and bonding, minimize voids and porosity, maintain stable consolidation and then optimize crystallinity within the remaining process window. There is also a strategic manufacturing question. If secondary consolidation using methods such as hot pressing or vacuum bag-only [VBO] in an oven follows AFP, crystallinity can be adjusted in that cycle, and AFP functions as a high-rate preforming process. In that route, the crystallization problem becomes much more manageable.

CW: What void content does your system achieve in practice at the stated layup speeds around 300 mm/s, and at what level does post-consolidation become necessary?

FA: At 300 mm/s, the effective consolidation dwell time under the roller is on the order of tens to roughly 100 milliseconds. Our best experimental results for true in situ consolidation at that speed reached approximately 2.5% porosity under carefully optimized conditions using high-quality source material.

Industrial in situ consolidated AFP more commonly operates in the range of 3-5% porosity. There is no universal threshold above which post-consolidation automatically becomes mandatory. The more relevant questions are how consistent the porosity distribution is, how much mechanical-property scatter it creates, and whether the designer can confidently characterize and apply the resulting properties.

In regulated aerospace applications, certification frameworks may effectively require void contents below 1% regardless of structural performance. If the »

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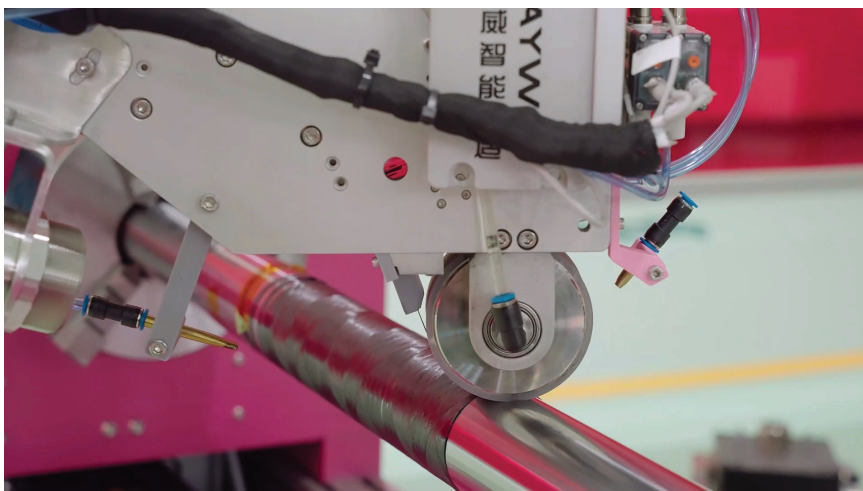


process cannot consistently meet that specification in situ, secondary consolidation becomes necessary by requirement rather than by engineering judgment.

CW: The LabAFP uses an open-architecture, closed-loop temperature control system. What are the most consequential nonlinear interactions in the system, and what misunderstandings appear most often?

FA: The most important interacting variables are laser power, deposition speed, temperature at the bonding region and compaction behavior. Temperature is a dependent variable as it is mainly the result of the interaction between laser power and layup speed, together with geometry-dependent effects.

Most people initially assume the process is linear, where higher power and/or lower speed gives higher temperature. The process becomes nonlinear once motion and geometry are introduced. Robot acceleration and deceleration change thermal exposure time. Changes in curvature alter laser incidence angle and spot geometry.



■ The Layway AFP1 head performs thermoplastic tape winding on a cylindrical mandrel, demonstrating the system's capability for curved-surface deposition.

Changes in focal distance modify power density. Even if commanded laser power and speed remain nominally constant, actual thermal and consolidation conditions change significantly during real deposition.

The most common misunderstanding is treating measured surface temperature as equivalent to interface temperature. »

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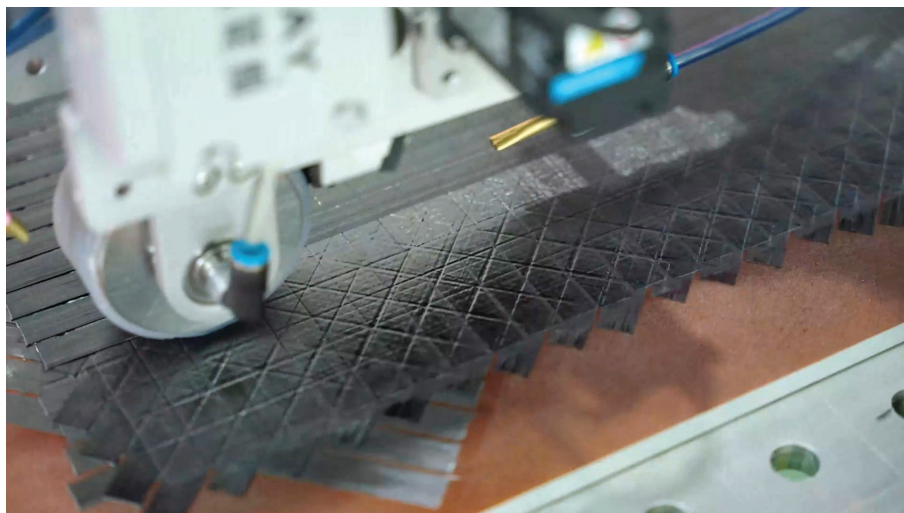
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■ A cross-ply TPC laminate is being built up on a flat tool surface during AFP processing. The visible ply boundaries at multiple orientations illustrate the layer-by-layer deposition sequence and the tow-to-tow placement.

The actual bonding conditions at the nip point depend on heat transfer, pressure, material rheology and timing simultaneously. Practical AFP process development remains empirical even where the underlying physics are well understood.

Accessibility and the aerospace trap

CW: You describe the relationship between aerospace and AFP development as an “aerospace trap.” What does that mean for the broader composites industry?

FA: Aerospace has been the primary driver of AFP and TPC because it funded much of the early development and validated the technology. But aerospace is a very unusual market. Customers are technically sophisticated and willing to pay large premiums for performance. That environment allowed AFP to mature technically, but it also insulated the technology from broader industrial realities.

One single-tow AFP machine that achieves near-net shape preforms in 5 minutes can produce ~100,000 parts/year.

Industrial scale does not come from market size in dollars, it comes from market size in tons. Aerospace remains small in production volume, highly regulated and slow-moving. Thus, AFP systems evolved into expensive, specialized platforms optimized for a small number of advanced users. When access to LATP-AFP is limited to large corporations and well-funded research centers, the ecosystem learns more

slowly. Material suppliers receive less application feedback. Process knowledge accumulates in isolated pockets instead of spreading across the industry. New applications emerge slowly because the number of people capable of testing ideas remains small.

Layway’s systems are designed to operate at a fraction of the cost of conventional industrial AFP platforms, with modular architectures and accessible process control that place thermoplastic AFP within reach of startups, university programs and manufacturers outside the traditional aerospace supply chain. It achieves this by building its systems around mature industrial robotics platforms and Asian manufacturing supply

chains, reducing hardware costs without compromising process capability, and by offering open-architecture software that exposes process parameters directly to the user rather than locking them behind proprietary control systems.

CW: Where does single-tow AFP remain competitive for production applications, and what production volumes are achievable at Layway’s current throughput?

FA: Single-tow systems are particularly valuable when parts contain relatively small features, require local reinforcement, need steering flexibility or when overall part size is small. A large, multi-tow head can become inefficient or geometrically limited because minimum steering radius, tow-drop logic and local feature resolution become restrictive.

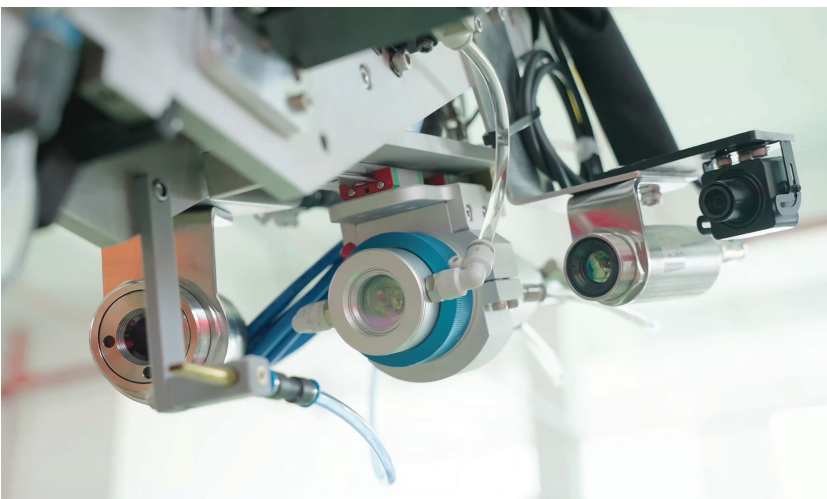
There are many industrial use cases where total material volume per part is small even if production volume is high: motor rotor sleeves, composite sliding bearings, shafts, tubes, pipes, pressure sleeves and near-net shape thermoplastic preforms for drones, robots and lightweight mobility structures. Using 0.5-inch-wide tape, with a 300 mm/s laydown rate, a cylinder 250 mm long, 50 mm in diameter and with a 2-mm wall thickness can be made in less than 5 minutes.

If a near-net shape preforming process achieves a 5-minute cycle time, a single machine can theoretically produce on the order of 100,000 parts per year depending on uptime assumptions. Single-tow AFP is a better fit for a different class of applications than the traditional large aerospace market. It is not a scaled-down version of those systems.

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■ The optical and thermal sensing package on the Layway AFP head, comprising the laser delivery optic (center, blue housing), an infrared pyrometer and an IR camera.

CW: What is the largest unsolved physics problem in LAMP-AFP, and what is Layway doing to address it?

FA: The goal is true in situ consolidation. As a practical benchmark, producing laminates below 1% porosity directly during placement represents an ultimate target for high-performance applications. The challenge is that consolidation is not one physical phenomenon.

Porosity is the outcome we measure, but the mechanisms behind it are coupled: heat transfer, melt viscosity, intimate contact formation, polymer-chain diffusion, compaction pressure, air evacuation, tape quality, crystallization behavior, cooling rate and motion dynamics. Good in situ consolidation is demonstrable in controlled laboratory conditions, especially at lower speeds or in winding processes.

Achieving the same quality consistently at industrial AFP speeds, on real geometries, with robust process windows, is still difficult. The answer is most likely a combination of incremental improvements: better thermal control, better pressure control, better trajectory planning, better tape quality and better understanding of the actual consolidation time window.

One direction is increasing effective consolidation time without sacrificing deposition speed through using multiple rollers, post-deposition reheating, multi-pass roller consolidation or localized secondary consolidation immediately after placement. We are working on that together with simulation partner OTOMComposite (Enschede, Netherlands), with the goal that physics-based process planning will eventually allow the trajectory planning software to predict thermal fields before deposition and generate numerical control code that already includes local process adjustments based on geometry, curvature, material and expected heat transfer. The central challenge is giving the material enough thermal and mechanical time to consolidate properly while keeping the process fast enough to remain industrially meaningful. That is the problem Layway is built around solving. **CW**



ABOUT THE AUTHOR

Stewart Mitchell is a Bristol, U.K.-based engineering journalist with experience covering technology in Formula 1, electric and hybrid powertrain and autonomous systems. He has a degree in motorsport engineering from Oxford Brookes University (Oxford, U.K.), and is a member of The Institution of Mechanical Engineers (London, U.K.). smitchell@compositesworld.com

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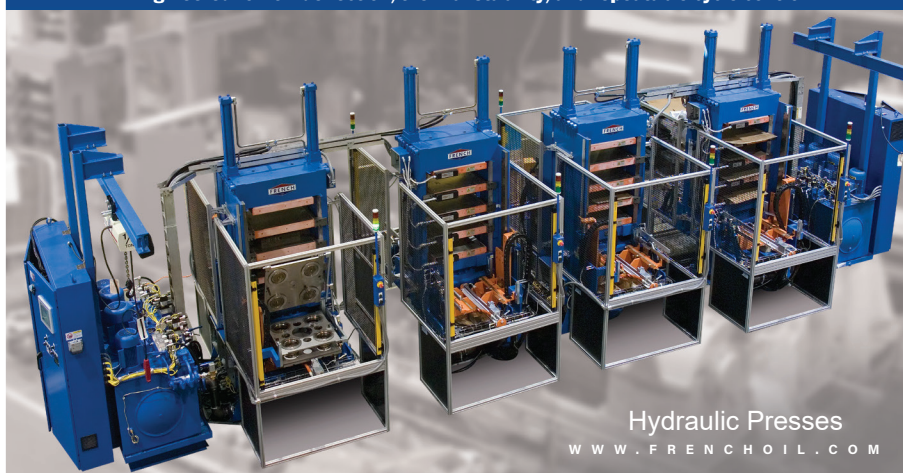
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■ The lunar surface photographed on April 6, 2026 during the Artemis II lunar flyby. Source | NASA



Composites End Markets: New Space (2026)

With the space sector in a race for strategic dominance and the lunar economy coming into view, composite materials are accelerating into an era of high-rate production, advanced autonomous manufacturing and structural innovation that would have seemed like science fiction a generation ago.

By Scott Francis / Editor-In-Chief

» Composite materials have always been enablers of the space economy. Their exceptional strength-to-weight ratio, resistance to radiation and thermal extremes, and design versatility make them indispensable for nearly everything that flies beyond the atmosphere — from the use of carbon fiber for liquid oxygen (LOX) tanks to the honeycomb core sandwich panels of satellite bus structures. In just the past year, the New Space market has not only continued to grow, but has become a domain of urgency.

According to a 2025 World Economic Forum report, the space economy is expected to be worth \$1.8 trillion by 2035 as satellite- and rocket-enabled technologies proliferate globally — an opportunity that translates into sustained and growing demand for composites at every level of the supply chain. According to BIS Research (Fremont, Calif., U.S.), the global advanced space composites market is forecast to grow from \$1.47 billion in 2023 to \$4.61 billion by 2033 at a compound annual growth rate (CAGR) of 12.11%.

Another large driver is the role dominance in space is playing in defense. Perhaps no theme was more prominent at the 2026 Space

Symposium — the 41st installment of the event — than urgency driven by geopolitical competition. Space Systems Command's Lieutenant General Philip Garrant, whose California-based command oversees a \$15.6 billion budget, delivered a blunt assessment: The era of deliberate acquisition timelines is over. Rival space nations have improved their military space capabilities to the point where U.S. satellites are at genuine risk if warfare reaches orbit, and the response has been to adopt what Garrant called “a wartime footing” for acquisition.

Major General Stephen Purdy, top space acquisition adviser to Air Force Secretary Troy Meink, echoed this, describing the billions of venture capital and private equity dollars now flowing into the sector as accelerant for a new generation of defense-oriented space programs.

The defense imperative shapes the broader market narrative in other ways. Where NASA was once the gravitational center of composites innovation in space, that pull is now shared between civil and defense programs. Panelists at the symposium noted that

the Pentagon is scouring commercial capabilities to buy services rather than build its own new constellations — a shift that expands the addressable market for New Space composites suppliers while increasing the emphasis on high-rate, repeatable production.

In the meantime, NASA's Artemis program continues to generate composites demand, not only through its own mission cadence but through the commercial partnerships it anchors. At the Space Symposium's Ignition Day session, NASA officials described an ambitious upcoming launch schedule that will bring more commercial partners to the lunar surface than ever before. Carlos Garcia-Galan, NASA's program executive for the Moon Base, told the audience that the agency has released multiple requests for information seeking commercial partners capable of building communications and position-navigation-timing networks, providing power systems, and developing spacecraft and landers capable of 8-megaton capacity — all areas where composites play enabling roles.

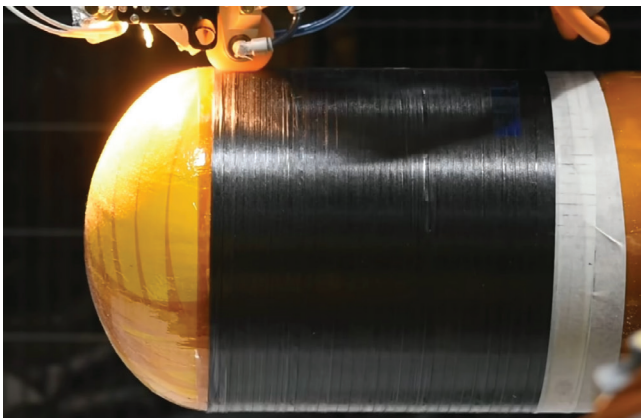
The bottom line? Growing demand in the space industry continues to ripple through the composites supply chain in both volume and performance requirements. *CompositesWorld's* coverage of the sector over the past year has involved a range of applications enabling rocket launches, lunar lander missions and satellite constellations, among others.

Launchers and propulsion systems

The launcher segment continues to be where the most dramatic composites advances are concentrated, driven by the need to simultaneously reduce structural mass and increase payload, and carbon fiber-reinforced polymer (CFRP) structures are central to that pursuit. For example, composite pressure vessels are being used in fuel delivery systems to meet the challenges of cryogenic propellant management. LOX, LH₂ and liquid methane all require containment structures that resist permeation, maintain integrity at temperatures approaching absolute zero and survive the mechanical loads of launch while contributing minimal weight.

In Canada, NordSpace (Markham, Ontario) crossed a significant milestone in June 2026 with the installation of large-scale

■ Addcomp robotic AFP systems are laying the path for NordSpace launch vehicle tanks and primary structures. Source | NordSpace



■ Under the CRETAN project, a shared cryogenic bulkhead tank promises to reduce weight up to 30% for space launchers, touting a significant competitive advantage. Source | Aciturri Aerostructures

robotic automated fiber placement (AFP) systems in its Advanced Manufacturing for Aerospace Lab (AMA Lab). Working with Addcomp — the equipment division of Bespline (Sherbrooke, QC, Canada) — NordSpace is bringing AFP manufacturing of flight tanks and primary structures in-house for its *Tundra* light-lift launch vehicle, while scaling toward its *Titan* medium-lift platform. The technology enables linerless Type 5 tanks made entirely from composites using AFP, reducing vehicle dry mass in a program segment where margins are, as the company notes, very slim. NordSpace's R&D agenda encompasses tanks up to 15 meters long and multiple meters in diameter, cryogenic propellant compatibility and application of the same techniques to engine jackets, interstages, thrust structures and fairings — essentially the full structural architecture of a launch vehicle.

In June 2026, Sonaca Spain (formerly Aciturri Aerostructures), a Tier 1 supplier for the design, production and assembly of complex structural assemblies, announced completion of an integrated Type 5 space tank demonstrator featuring a shared cryogenic bulkhead design. The innovation promises up to 30% weight reduction for space launchers compared to conventional tank approaches, which is a significant competitive advantage for European launch programs seeking to reduce structural mass. The achievement, part of the ESA-supported CRETAN project, focuses on advanced Type 5 composite tanks for fuel and LOX.

In May 2026, Infinite Composites (Albuquerque, N.M., U.S.) announced an equipment expansion that augments automated production of large composite tanks, rocket motor casings, tubes and other high-performance structures with new winders, rail systems and metering machines. The expansion positions the company to meet growing demand from launch vehicle and satellite propulsion programs.

Herone GmbH's (Dresden, Germany) braided carbon fiber/low-melt polyaryletherketone (CF/LMPAEK) tube system addresses another aspect of propulsion systems: cryogenic fuel lines. Combining tape braiding and press molding in an automated »



■ Dawn's *Aurora* spaceplane. Source | Dawn Aerospace

process, the thermoplastic composite (TPC) tubes achieve 50-60% weight reduction versus conventional metallic fuel lines for LH₂ aircraft and space launcher applications. The company's approach eliminates traditional joints, bellows and O-rings by co-consolidating flanges and fittings directly into the tube structure, reducing both weight and potential failure points. The double-wall, vacuum-insulated design also integrates a metallic permeation barrier within the composite wall itself. The use of LMPAEK enables

welding, a capability that supports manufacturing efficiency and potential on-orbit repair.

At the systems level, European research programs continue to advance the state of composite cryogenic tank manufacturing. Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM (Bremen, Germany) completed its HYTANK research project in June 2026, led by Airbus Operations GmbH (Hamburg, Germany), producing surface pretreatment, barrier coating and automated assembly processes for large-format, double-walled LH₂ tank structures. Although targeting aviation, the processes developed are applicable to space launcher tanks, and the work represents the kind of fundamental manufacturing science that will enable composite propellant containment.

Reusable space transportation

This past year also saw advances in reusable spacecraft and launch systems — vehicles designed to return to Earth where they are refurbished and redeployed with the goal of reducing the cost of spaceflight.

In June 2026, Dawn Aerospace (ChristChurch), a New Zealand-Dutch aerospace company, closed a \$25 million Series B funding round at a \$195 million valuation, led by Balerion Space Ventures. The company has established itself as a provider of nontoxic chemical propulsion, with more than 200 thrusters deployed on

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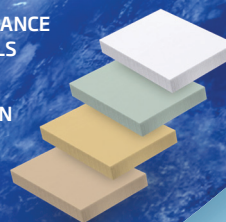
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50+ satellites, and recently made history with what was reported as “the first privately developed aircraft to fly supersonic since the Concorde.” With revenue growing over 90% in the past year, Dawn plans to expand its operations significantly, including an in-orbit refueling service called Loop launching in 2028 and a Mach 3.7 flight program in Oklahoma beginning in 2027.

In April 2026, China’s Academy of Launch Vehicle Technology (CALT, Beijing, China) unveiled a 5-meter-diameter composite propulsion cabin, the largest single-piece composite structure ever produced in China for reusable launch vehicles. The module is composed of more than 60% composite materials and is engineered to withstand thousands of tons of axial pressure. Remarkably, the structure went from design to delivery in just 7 months, thanks to a highly parallel and collaborative R&D approach. CALT leadership views this milestone as a significant step forward in advancing China’s aerospace capabilities and scaling up production for future missions.

Satellites: Production rate as a design requirement

Demand for composites for satellite production continues to intensify. The defining challenge of satellite constellation programs is no longer technical feasibility; it is production rate. Thousands of satellites must be manufactured, integrated and launched to fill the constellations that underpin broadband internet, navigation,



■ Rocket Lab is to acquire Iridium in a deal that merges launch, satellites, spectrum and global communications capabilities. Source | Rocket Lab, Iridium

Earth observation and increasingly, space-based defense architectures. This production imperative has brought automation and design for manufacturability into the foreground.

In October 2025, market intelligence group Novaspaces (Paris, France) released the 28th edition of its annual space market report, forecasting the launch of more than 43,000 satellites by 2035 and a \$665 billion market in manufacturing and launch services. Five mega-constellations are expected to account for

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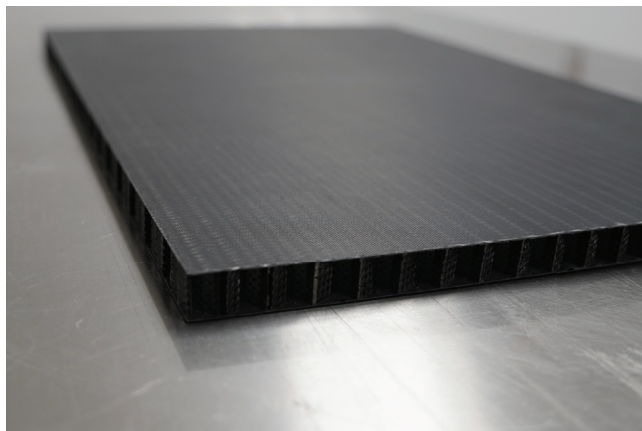
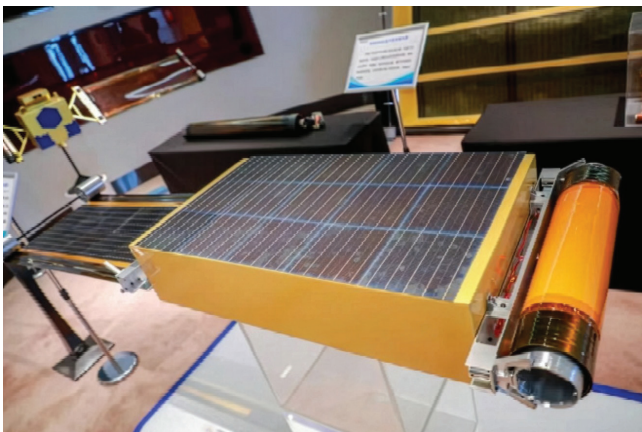
66% of launches, while defense spending remains the economic anchor at 48% of total market value.

In July 2026, Rocket Lab Corp. (Long Beach, Calif., U.S.) announced an agreement to acquire Iridium (McLean, Va., U.S.), a global satellite communications provider, in a cash and stock deal valued at approximately \$8 billion. The acquisition is being described as one of the most transformative deals in the space industry, combining Rocket Lab's launch and satellite manufacturing capabilities with Iridium's established global network, spectrum and partner ecosystem. The merged company aims to become a vertically integrated U.S. space entity, expanding into markets such as satellite IoT, direct-to-device communications and positioning, navigation and timing services. The transaction is expected to close in mid-2027.

A prime example of the work taking place on constellation satellite programs is MDA Space's *Aurora* satellite series. Airborne Aerospace B.V. (The Hague, Netherlands) and Bercella Srl (Parma, Italy) are supplying high-precision composite substrates for Sparkwing solar arrays — key components of the *Aurora* satellites. Airbus (Toulouse, France) is to supply more than 200 Sparkwing solar arrays. The fleet nature of the *Aurora* program and the involvement of multiple automated tape laying/fiber placement (ATL/AFP) suppliers shows that constellation-scale production rewards companies that have automated, repeatable manufacturing over those relying on labor-intensive hand layout.

Composite materials are also playing a role in thermal management solutions for satellite design. In June 2026, Blueshift (Spencer, Mass., U.S.), a developer of thermal protection materials, was named winner in the commercialization category of the *Aviation Week Space Tech Challenge Awards* for its AeroZero tapes — thin, flexible thermal protection tapes designed for low-Earth orbit satellites and other aerospace applications. The tapes offer significantly lower thermal conductivity and diffusivity compared to traditional polyimide tapes, addressing the extreme temperature swings LEO satellites experience up to 16 times per day.

■ Deployable on-orbit solar array using smart composite materials. Source | Suzhou Zenix Composites



■ A new approach for high volumes of small satellite structures uses low-CTE, low-cost CFRP cellular core, robust single-ply skins and modular panel systems to cut lead time, labor and cost for reflectors, solar arrays and more. Source | Rock West Composites

Off-the-shelf material solutions

All of this demand for new space applications is driving the need for faster production, lower costs and high-performance materials suited for high-volume manufacturing.

To that end, three veteran composite suppliers — Patz Materials and Technologies (PMT, Benicia, Calif., U.S.), A&P Technology (Cincinnati, Ohio, U.S.) and Rock West Composites (RWC, San Diego, Calif., U.S.) have partnered to develop a lower-cost, reduced-labor approach for lightweight, high modulus CFRP cored panels used in applications including satellite optical benches, solar array substrates, reflectors and modular building blocks for main structures.

By combining A&P's QISO braided fabric with PMT's Apex cellular core, the collaboration reduces material use and labor significantly, bringing core costs to one-tenth of traditional honeycomb alternatives while maintaining the low coefficient of thermal expansion (CTE) and high stiffness required for space applications. RWC has validated the approach through structural and radio frequency (RF) reflectivity testing, confirming near-equivalent performance to heritage materials for solar array substrates and reflectors. The innovation also compresses design-to-production timelines from years to weeks and can cut materials qualification time from up to a decade down to just 1 year.

High-temperature solutions

Space flight not only requires lightweight material solutions, but also materials that can withstand extreme temperatures, including those during reentry. This requirement along with the need for high-temperature solutions for hypersonic aerospace and defense applications are driving demand for high-temp materials including ceramic matrix composite (CMC) structures capable of surviving sustained high-velocity atmospheric flight.

As CW executive editor Ginger Gardiner has consistently reported, the high-temp materials landscape is being reshaped

by new players proliferating across materials and manufacturing capacity, driven by demand from space and defense programs that require materials capable of operating at temperatures beyond the reach of polymer matrix composites. A growing number of new materials, suppliers and manufacturing processes have emerged globally — from oxide fiber producers and prepreg systems to advanced C/C-SiC and ultra-high temperature CMC (UHTCMC) technologies. Key innovations focus on reducing production time and cost through automation, eliminating infiltration steps and enabling scalable manufacturing for higher part volumes.

On-orbit manufacturing and additive advances

One of the more forward-looking threads in composites' New Space story involves manufacturing not on the ground, but in space itself. In May 2026, The Shenyang Institute of Automation (SIA CAS) unveiled an advanced manufacturing method for CF/polyetheretherketone (PEEK) composites designed for use in space, combining pultrusion molding with laser transmission welding to create strong, reliable structural components in zero-gravity environments. The technology addresses key challenges in on-orbit construction, including efficient fabrication and durable component connections, while overcoming limitations of traditional bonding methods. A scaled-down parabolic antenna truss prototype was successfully built to validate the approach,

demonstrating its potential for automated assembly of large space structures like solar power stations and lunar base components.

In June 2026, researchers at Oak Ridge National Laboratory (ORNL, Oak Ridge, Tenn., U.S.) demonstrated a patent-pending hybrid 3D printing method that enables origami-inspired composite structures without the need for molds, integrating fiber reinforcement with a claimed 90% reduction in cost. While not space-specific, such advances in mold-less composite fabrication have direct application to the low-volume, high-mix nature of new space hardware production.

Meanwhile, NASA's Thermoplastic Development for Exploration Applications (TDEA) program is exploring how TPC could be used to build structures directly in orbit or on the Moon. CW has reported on a NASA collaboration with Agile Ultrasonics (Columbus, Ohio, U.S.) in which researchers have been developing and testing ultrasonic welding techniques to join carbon fiber-reinforced thermoplastic composite (CF/TPC) components under the extreme conditions of space. Early results are promising — welded structural brackets exceeded load requirements, with failures occurring in the base material rather than at the weld joint itself. While challenges around temperature measurement, bond quality detection and environmental testing remain, the program is laying critical groundwork for future in-space construction and assembly capabilities. »



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To the Moon

At the 41st Space Symposium, panelists described the lunar surface as being at an inflection point, comparing it to a continent-sized expansion of the Earth's economy. Financial opportunities including in situ resource utilization, mining and even the relocation of data centers were discussed as near-term possibilities. For composites suppliers, the potential to support manufacturing of lightweight lunar landing

struts, propellant tanks, habitat shells and/or thermal protection systems (TPS) represents a meaningful and growing opportunity.

Firefly Aerospace (Cedar Park, Texas, U.S.), which featured prominently in *CW*'s 2025 coverage as the company responsible for the *Blue Ghost* lunar lander, has continued to expand aggressively. In May 2026, the company announced it had doubled its Texas campus, adding 144,000 square feet of space and a clean-room 4X larger than its previous facility. The expansion enhances its carbon fiber composites, propulsion, robotics and 3D printing activities — infrastructure needed to scale production of its *Elytra* orbital vehicle and future lunar landers.

In July 2026, Firefly also announced it had secured a \$144 million NASA CLPS contract for its sixth lunar mission, targeting a 2028 launch to deliver three NASA science instruments to the Moon's near side. The company plans to complete the mission in approximately 2 years — half the time of previous efforts — by using its proven lander design, which incorporates composites in structural panels, support struts and lander legs. The mission aims to demonstrate that commercial lunar delivery can be rapid, repeatable and reliable, supporting NASA's Artemis program and Moon Base initiative.

■ ORNL's Steven Guzorek demonstrates the lab's hybrid 3D printing method, which deposits an integration layer and composite material directly onto flexible nylon fabric, creating a mold-free, flat-to-foldable structure that reduces production costs and increases design flexibility. Source | Amy Smotherman Burgess/ORNL, U.S. Dept. of Energy



■ Firefly *Blue Ghost* lunar lander. Source | Firefly Aerospace

Urgency and scale

What makes the 2026 landscape of composites in New Space distinctive compared to a year ago is the combination of urgency and scale. The ATA CFT Guangzhou Co. Ltd. (Guangzhou, China) 2025 global carbon fiber composites market report documented record demand of 224,510 metric tons globally — with the composites fabricating index reaching its strongest reading of the year in June 2026, climbing to 57.6 on a surge in new orders according to the Gardner Business Index. While aerospace and defense are not the only drivers of that figure, the sustained expansion of New Space programs contributes meaningfully to carbon fiber demand, particularly for aerospace-grade T700 and T800 materials used in structural applications.

The urgency and scale come from the geopolitical environment that has put defense space programs on a wartime footing and accelerated commercial programs. It also comes from the ambition of the cislunar economy taking shape — lunar landers, moon bases, cislunar communications networks — all of which require composite structures that don't yet exist in production-ready form.

The composites industry's response has been characteristically practical: more AFP systems, more automated inspection and more material qualification. That response underscores that composites are no longer just a material option for New Space, they are a truly enabling technology for gains in payload fraction, production rate, thermal protection and mission reliability. As the industry moves from prototype to production at scale, and from Earth orbit toward the Moon and beyond, composites continue to be a technology that helps to bridge our ambition and the next giant leap into the cosmos. **CW**



ABOUT THE AUTHOR

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Praana, 3B and Original Composites & Fiberglass: The Next Chapter

Praana's acquisition of Owens Corning's glass reinforcements business and resulting integration with 3B into Original Composites & Fiberglass brings scale, expansion into India, Asia and investment in a new model for global glass fiber composites.

» Praana Group (Mumbai, India) completed its acquisition of Owens Corning's glass reinforcements business on May 1, 2026. The business immediately began operating as Original Composites & Fiberglass, and held town hall meetings for its global workforce, which now includes 3B - the fibreglass company, previously acquired by Praana. These developments laid out the opportunity and challenge ahead for this unique entity: the only global glass fiber reinforcements business not based in China, with a U.S., Europe and India-led leadership team, integrating two companies that originated from Owens Corning, and a vision to transform the composites industry based on the common DNA of customer support, local supply, innovation and sustainability.

Two companies become one

In his introduction to the Original Composites & Fiberglass town hall meeting on May 6, company president Marcio Sandri welcomed the global team to the Original Composites Company, now under the ownership of Praana Group and the leadership

of its vice chairman, Vishal Goenka: "We are the longest running fiberglass business on the planet, and today, the newest company in the industry. We invented glass fiber almost 90 years ago, created the composites industry which did not previously exist and are now recognized as innovation leaders in new manufacturing processes, products and applications for composites. In front of us is the largest opportunity we have faced, and the market needs and wants what we have to offer. But we must work diligently as we always have because the challenge to convert this opportunity into reality is not trivial. We must continue to act with both the passion we have for this business and the ownership that is expected of us while maintaining our strong global team collaboration."

3B and the legacy glass reinforcements business will be merged into Original Composites & Fiberglass, consolidating the brands, explains Dr. Chris Skinner, VP of strategic marketing and R&D. "It makes no sense to maintain two separate brands," he explains. "We are now one company, but with shared DNA as companies that were both originally part of Owens Corning."

3B: History and integration

Skinner explains how 3B evolved. “When Owens Corning bought Saint-Gobain’s glass reinforcements business in 2007, antitrust regulators determined it now had a dominant position in Europe and required divestment of its Battice, Belgium and Birkeland, Norway manufacturing facilities. These were sold to a group called Platinum Equity, which then sold the business 5 years later to an Indian conglomerate, Binani Industries Ltd.” Primarily a cement and construction company, Binani established 3B and integrated its own glass fiber production plant in Goa. However, Binani eventually became insolvent, and put 3B up for sale, explains Skinner, “and then Goenka led Praana to purchase it in 2022.”

Prior to the integration that began this May, 3B operated three primary manufacturing sites — Battice (est. 1966), Birkeland (est. 1971) and Goa (est. 1996 as Goa Glass Fibre Ltd., integrated into 3B in 2014) — with a dedicated R&D center in Belgium originally built by Owens Corning. 3B’s primary markets included automotive, mass transit and wind power with dry/wet chopped strands, direct

“Our Q1 2026 revenue was 18% higher than Q1 2025 with an EBITDA that is already aligned with our long-term target ... We could not be in a better place than being acquired by Praana.”

— MARCIO SANDRI, PRESIDENT OF ORIGINAL COMPOSITES & FIBERGLASS

and chopped rovings and continuous filament mats (CFM) made from its Advantex E-glass and HiPer-tex glass fibers.

“3B is a smaller company, nimble, resilient and lean with a very strong entrepreneurial spirit,” says Ludovic Piraux, CEO of 3B for the past 4 years with more than 30 years of experience in the business, including in the U.S. “By combining these companies, we will

■ Ludovic Piraux (top left), the CEO of 3B for the past 4 years, is excited about this newly integrated company under the Praana Group and its great potential for growth.



New branding for a new yet old company



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Original Composites & Fiberglass is at the same time the oldest company in glass fiber and composites and the newest. Its branding thus relates to that continuity, but also to its future.

The interlocking circles represent innovation and circularity, says Chris Skinner, VP of strategic marketing and R&D for Original Composites & Fiberglass, “which are the key pillars of this integrated global business going forward, alongside our commitment to our customers. This branding unites the strength of the company’s heritage with the energy of continuous creation embodied in our tagline ‘Make More Possible’ — which includes more innovation, partnerships and sustainability.”

“Identity begins and ends with people,” says Skinner. “So, ours seeks to embrace the essence of our integrated company. A brand is more than just a logo and words — it’s who you are, how you operate and how you deliver solutions to the customers. This is how we’ll deliver on the future opportunity for this business and how we’ll continue to invest in our mission to be the leading global provider of glass reinforcements for the composites industry.”

“We chose this identity with purpose — not to look backward, but because our credibility and our future are rooted in it,” notes Skinner. “This isn’t just a ‘rebrand.’ It’s a moment to be clear about who we are, what we stand for and where we’re going. It’s about defining Original Composites & Fiberglass as we acknowledge our legacy, separate from the past and forge a new future committed to transforming the industry worldwide.”

certainly have the best balance in the industry — an outstanding product portfolio to support our customers’ needs, great assets, global reach and a committed owner, which is extremely important to fuel our future growth.”

3B’s nimble and lean structure results from its history under private equity (PE) owners, notes Skinner, “who typically focus on efficiency in an often cutthroat way. 3B has done an amazing job of surviving this and thriving as a robust, reliable supplier in thermoplastic compounds, one of the toughest markets in composites, where the trend is to commoditize everything. They’ve learned how to be agile and cost-effective, which is very valuable as Original Composites & Fiberglass moves forward.”

“If you look at our almost 20 years of history,” notes Piraux, “we had to repeatedly reinvent ourselves but we maintained focus on customer relationships, technical support and innovation. Circularity has also become key over the last few years. These are also priorities for the newly integrated business. So, we have the same DNA plus complementary products and capabilities.”

■ Original Composites & Fiberglass brings scale to the glass fiber reinforcements industry including facilities shown here in Goa, India and Birkeland, Norway.



“In some cases, we make and sell the same product,” adds Skinner, “for example, from Birkeland, Norway and L’Ardoise, France [previously Owens Corning]. And yet, there is not a lot of overlap between the two businesses. Instead, they are actually synergistic. 3B is very strong in short fiber-reinforced thermoplastics and also in wind energy where it sells fiber to weavers, while the previous Owens Corning Glass Reinforcements was supplying fabrics, preforms and kits. So, the combination of all of these offerings is beneficial and gives the new business improved coverage across regions and markets.”

Single company integrating quickly

“Moving forward, this single company will have exactly the same data sheets, MSDS, website and approach to the customers,” says Skinner. “Although it will take some time to complete some of the details, that alignment is well underway, but the business strategy and fundamental value proposition is not changing. It will be based on innovation, sustainability and local partnership.”

In the Americas, where 3B had no manufacturing and very little overlap, this integration is basically complete, says Sandri, and the face to the customer is already Original Composites & Fiberglass. “In India, where 3B has a presence in Goa, Praana quickly integrated everything under the previous Owens Corning Glass Reinforcements leadership. That single face to the market also moved very fast, because a lot of that team were previously part of

Owens Corning and knew each other. They are also aligned and passionate about building and growing the market in India.”

However, the integration in Europe will take a bit longer, he notes. “Here, the two businesses had comparable investments, but were also very complementary. We are looking at how to better use these facilities to combine product lines to strengthen the supply chain and increase production. The current capacity is still not enough to cover all of the demand — we are basically sold out in Europe. So, we have opportunity, but the integration in Europe is moving quickly and will definitely be completed by early 2027.”

New strengths, scale, strategy vs. China

“Original Composites & Fiberglass now has a large footprint in wind,” says Skinner, “which will be a continued focus for growth, not only via glass fiber, but also forward-integrated products like fabrics, kits, preforms and pre-shapes to help solve customer issues.”

“And where Owens Corning exited the DUCS market — one of the largest segments for consumption of glass fiber — the new

business is well positioned for growth,” says Sandri. DUCS (dry use chopped strand) includes products typically incorporated into thermoplastic compounds for the automotive, electrical and appliance markets.

Skinner also reiterates the larger growth possible in infrastructure, including electrification, water, construction and transportation. “Composites are enabling everything from data centers to biogas reactors,” he explains. “This is obvious in India, while 40% of the composites industry in Europe and North America is driven by infrastructure and accelerating faster than other markets.”

“The business now also has access to small furnaces enabling new glass formulations,” notes Sandri. “Labs don’t provide the commercial-level process while 100,000-ton furnaces are too large. We are integrating this capability in Europe and India for faster development and qualifying of new formulations, which will help us improve current glass fiber applications and open new opportunities.”

“Original Composites & Fiberglass also now brings scale,” says Skinner. “Even though the expansion in Amarillo, Texas, comes online in August, Owens Corning was not adding significant glass reinforcement capacity globally. Now, however, customers have a viable world scale partner in all major regions committed to being the alternative to production in China. But that requires a business that’s financially viable and capable long-term.”

“And we have that capability,” notes Sandri. “Our Q1 2026 revenue was 18% higher than Q1 2025 with an EBITDA that is already »



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aligned with our long-term target. And now we can also look at 3B's lessons learned in efficiency and cost control while adding 400,000 tons of capacity."

"There are companies exiting this market," says Skinner, "but we are growing with excellent financial performance based on local supply, innovation, sustainability and customer support instead of offering manufacturing in one place and high-risk shipping with little, if any, support. But we are 100% committed to continuing our delivery of value and service to the industry. Indeed, we are stepping up to fill the holes as others exit, to support our customers and help create innovations that will scale the composites industry."

The power of Praana's ownership

"We could not end up in a better place than being acquired by Praana," says Sandri. He points out Praana's history of acquisitions as strategic investments, including in specialty chemicals, which he sees as complementary to glass fiber reinforcements. Established in 1956, Praana companies now include Sterling Specialty Chemicals, Galata Chemicals and Artek Surfin Chemicals, as well as what was 3B Fibreglass, now integrated with what was Owens Corning's glass reinforcements business into Original Composites & Fiberglass.

"Praana does not acquire businesses to resell them; they've never had large restructurings and they value people."

"I'm very excited to be part of this large family," says Vishal Goenka, vice chairman of Praana, "integrating 4,200 people from what was part of Owens

Corning with almost 1,300

people from 3B. Praana

is a family business and

I come from a large,

extended family

with 25 people

in the same

house. Bringing

together compa-

nies and manag-

ing expectations and teams across geographies is in the DNA of our company."

"This is a new chapter for glass fiber reinforcements. We will do what is right and manage this business for the benefit of the global glass fiber and composites industry."

— VISHAL GOENKA, VICE CHAIRMAN OF PRAANA GROUP

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"This is a new chapter for glass fiber reinforcements," he continues, "I describe this as 'unshackled.' We will do what is right and manage this business for the benefit of the global glass fiber and composites industry. We see that this integrated family provides increased regional logistic benefits to customers, with the most diversified production facilities globally in these times of uncertainty. And we will strengthen this by adding capacity in India and more technological progress to the advantages Original Composites &



 Vishal Goenka, vice chairman of Praana Group, describes this new chapter for glass fiber reinforcements with Original Composites and Fiberglass as "unshackled."

Fiberglass already so clearly has, as well as transparency to every element as we continue to invest to make this business stronger."

GROWTH IN INDIA AND CHINA.

India and China are the largest and fastest-growing markets for composites, notes Sandri, "and now, under Praana, the whole region has our full commitment as a market. In India, Owens Corning had installed a manufacturing facility in Taloja

and our team was growing both the glass reinforcements and fabrics businesses but we weren't really getting support. With Praana, we have the plant that 3B built in Goa, and we have prioritized to ramp this up and bring both furnaces online."

"Regarding China, Owens Corning decided to leave almost 3 years ago," he continues. "But Praana has told us this is a key market and it has no bias regarding the geopolitics. It also wants to grow specialty chemicals there, and Praana sees Taiwan, South Korea and Japan as a source of innovation and potential licensees of its technology. It already has such licensees and sees further opportunities. Praana and Original Composites & Fiberglass will be doing a tour in Asia later this year."

OPTIMIZATION, SPEED, INVESTMENT. "Praana also has a strong bias for business optimization, which goes hand in hand with growth," says Sandri. "It expects that under its ownership we will



■ Northstar Technologies supplies glass fiber-reinforced polymer (GFRP) structures and modules for residential and commercial construction, as well as the high-growth data centers market (bottom).

become more nimble and streamlined. We are also now a privately owned company, very market-focused and supported by our parent. This focus on speed and execution is also one of the factors behind Praana's success as a holding company intent on growing its whole portfolio."

"Within weeks of closing this acquisition, we already agreed on several projects for growth," he continues. "For example, we are expanding our technical fabrics capacity by 30% globally to keep pace with the industry. Praana understands you can only grow if your customers are growing, and it is willing to invest financially to support this."

SUSTAINABILITY. "We don't think sustainability is there just to meet codes and regulations," explains Sandri, "but instead see that the capabilities we are developing can also be used for the success of our customers. This is also one of Praana's key values, which they support and is key for us and the industry long-term."

"We are continuing to scale the L'Ardoise site's capability," says Skinner, "while we've added Sustaina as a product line to our Besana, Italy facility, where we're actually using recovered ceramic waste to feed the furnace. We've reached up to 50% mass balance recycled content in product coming out of that plant and also from the plant in Kimchon, South Korea, which also uses recycled ceramic waste. Meanwhile, the Birkeland, Norway, site is also capable of running recycled content in its production. We will keep advancing how to make sustainability and circularity increasingly viable, because this is a must for the future of composites."

The transformation has begun

"This has been an incredible journey," says Skinner, "a once-in-a-career opportunity. When Marcio and I were asked by the Owens Corning board what to do with the Glass Reinforcements business, it made sense to sell it, but after so many years and so much personal investment, it was very emotional. And then the question was, 'What do we do now?' Our organization within was hyper aligned, and in

a couple of hours had defined the mission, vision and values of this glass fiber and composites company, so we could see we had made the right decision."

The leadership team then went to New York City and pitched the business for 3 weeks, he recalls. "It narrowed quickly from 140 companies who expressed interest to a short list of North American companies and Praana, which was in the first group we presented to, but we didn't think they would be there at the end. I look at it now and think VG [Goenka] is a miracle worker. It's such a great thing that Praana bought this business. By integrating it with 3B to form Original Composites & Fiberglass, it only reinforces the pivot that this business and the reinforcements industry needed."

"This business is extremely well-structured already," says Sandri, "and well-resourced in high-quality people globally. We have what it takes to deliver on our promises, and we are committed to that but also to growth."

"This is a very exciting journey for us as well," says Piroux, "and we're looking forward to writing the next chapter. We are already tackling more than 20 workstreams together. This is a journey, but we've already made great progress, and I have no doubt about our success, because we come from the same company historically and have similar DNA. We are already finding ways to work this out together, staying open to change, learning from each other and sharing openly. Every day we continue to ask, 'What can we do better, faster and cheaper?'"

"That commitment and excitement is throughout our workforce, our ownership at Praana and also our customers," adds Sandri. "We all see the opportunity to do something very new and unique, and to make a real difference in the future of the composites industry." **CW**

Practical Steps to Making Composites More Sustainable

Exel Composites discusses a practical, multi-faceted approach — including biomaterials, recycling and partnerships to build scale — as well as the industry's circularity challenges and future opportunities.

» Exel Composites (Vantaa, Finland) was founded in 1960 and entered composites in 1973 with pultruded ski poles using first carbon fiber and then glass fiber. The company continued to grow in sporting goods through the 1980s and industrial applications in the 1990s, followed by wind blade spar caps and composite cores for electrical transmission lines (i.e., conductor cores), as well as lightweight structures for transportation and solutions that increase the performance and durability of a wide range of applications in buildings, construction and infrastructure. Throughout the 2000s, it expanded its pultrusion and pullwinding beyond Finland into the U.S., Austria and China, and in 2024, completed a joint manufacturing facility with Kinenco Group in India focused on wind energy applications. Today, it is one of the world's largest suppliers of pultruded composites.

But with that leadership comes responsibility. “Composites are long-lasting, high-performance materials, and that brings both benefits and challenges, especially with end-of-life [EOL] products,” says Kim Sjö Dahl, senior vice president of technology and

sustainability at Exel Composites. “We have worked for decades to develop components that improve sustainability through long-lasting performance, but we also saw the need for improved sustainability and began to work on embedding circularity into our products and how we approached the market.”

Exel Composites doesn't claim to have all answers, concedes Sjö Dahl, “but we have developed an approach that is practical and keeps advancing. There is no single solution or definition of success. We continue to experiment with bio-based materials and recycling as well as designing products with EOL in mind.” The company's approach combines life cycle thinking, practical action and partnerships, “with the main task to keep moving forward. Our focus is not on closing one large loop but working with partners to find small loops wherever possible. And we're also helping to build and support an ecosystem.”

Bio-based materials: Starting small and scaling

“We've been working with bio-based resins for about 10 years,” says Sjö Dahl. “Our original thinking was to move from 100% petrochemical-based resins to 100% bio-based resins. But that's quite a big step.” There are multiple constituents in resins, he explains. “For example, an unsaturated polyester resin [UPR] consists primarily of an unsaturated polyester backbone made from acids/anhydrides and glycols, dissolved in styrene as a reactive diluent. When you look at how to replace these, you must understand how that will affect performance.” Exel decided to take one step at a time, not changing the whole backbone, but leaving the acid components unchanged and focusing first on introducing a bio-based glycol. “We were able to get exactly the same performance but more easily implement this over a larger volume of resins thanks to a simpler approval instead of a longer process if we tried to replace everything.”

Exel Composites started working with suppliers via pilot projects and then scaled to industrial implementation. The company began with INEOS composites — which is now Alta Performance Materials (London, U.K.) — and its ENVIREZ system, which is 23% bio-based glycol. It then worked with long-time collaborator Polynt (Bergamo, Italy), scaling to buy hundreds of tonnes of its 20% bio-based UPR that features a renewable monomer.

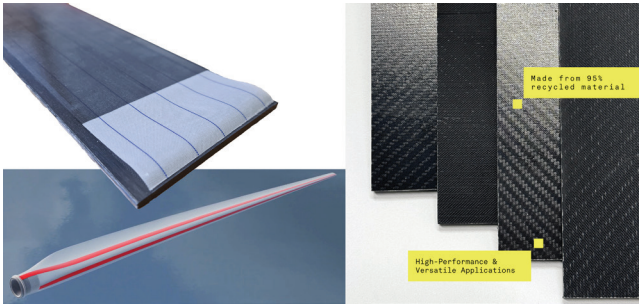
Exel has also developed applications using bio-based fibers, namely flax. “Again, we typically suggest starting with hybrids, combining the flax with glass and/or carbon fiber in order to maintain performance and gain experience while lowering the overall carbon footprint of the product. Depending on the properties required, we can then work with customers to increase the flax content and/or add bio-based resin as well.”

Recycling: Multiple avenues required

“The first route we supported is where process waste and EOL material is crushed and used in a cement-making process,” says Sjö Dahl, “keeping it out of landfill.” He refers to the KiMuRa project started in December 2020, when the Finnish Plastics Industries



■ A partner in the KiMuRa project which collects, shreds and reuses composite waste in Finland in a cement co-processing plant (top left, clockwise), Exel Composites worked with customer Qheat to make sure its glass fiber composite pipes for geothermal heating (bottom left) can be reused in this way at their end of life (EOL). Source | CLIC Innovation, QHeat, Exel Composites



■ Pultruded carbon fiber-reinforced polymer (CFRP) flats used for spar caps in longer, more efficient blades for wind turbines are being recycled by partner Fairmat into FairBoard structural panels. Source | Exel Composites, Fairmat

Federation and the Ministry of the Environment teamed with recycling company Kuusakoski Oy, cement producer Finnsementti Oy, seven composite industry companies including Exel Composites, as well as the Finnboat marine industries federation and the wind power industry association, Renewables Finland.

The result was a supply chain where glass fiber composite waste is transformed into clinker, an essential binding component in cement through a co-processing method that also recovers energy from the organic components in the resins during combustion. “We can recycle 70% of pultruded composite profile scrap — basically the glass fiber — while the remaining 30% is incinerated and used for energy,” notes Sjö Dahl. “This very stable industrial approach now uses a large amount of these alternative fuels in the cement process in Finland while the fiber waste reduces the need for virgin raw materials.”

But Exel Composites is also active in recycling composite waste back into new composites. In 2024, the company announced its partnership with carbon fiber recycler Fairmat (Paris, France). In its Nantes manufacturing facility carbon fiber-reinforced polymer (CFRP) composite scrap from the pultruder’s two plants in Finland is accepted along with other composite waste and cut into standard 10 × 4-centimeter or 6 × 6-centimeter CFRP chips. “This approach means they are not using a lot of energy because they are not breaking the part down into fibers and resins,” says Sjö Dahl.

As explained in CW’s 2026 FairFactory Plant Tour, Fairmat can supply these chips as-is, but also uses them to produce its other

“chip-based” products including: single-ply, wider FairPatch or longer FairStrip, multilayer custom Fairmat Plate laminates — including a new version optimized with a special surface treatment for molding into pipes or other tube-shaped parts — or sheets and rolls of layup-ready FairPly. The company’s FairBoard products are structural panels made from pultruded profiles like those used in wind blade spar caps and other materials supplied by Exel.

The company also sees the need for a wide array of approaches and methods. “Because composites are so complex, there really can’t be just one or two solutions,” says Sjö Dahl. “Fairmat’s approach works well for some products, but there are also pyrolysis and solvolysis methods that work for other products. These require more energy but they also separate the fibers from the resin, enabling both to be recovered and reused in various ways.”

For example, recovered glass fiber can be used to make various new products, but he notes Original Composites & Fiberglass (previously Owens Corning Glass Reinforcements) is also now taking such material and remelting it to produce new glass fiber. “Thus, you require less virgin input materials while providing a reuse for the recovered waste/EOL materials,” says Sjö Dahl. “The resin may also be recovered as pyrolysis oil or a type of solvent mixture after solvolysis that can then be further processed into new materials. So, you can rebuild new resins. We are supporting this development with several companies and trying to help them find optimal solutions.”

Circularity challenges and ecosystems

One of the largest issues for achieving circularity in composites is scale, notes Sjö Dahl, “The diverse mix of fibers and resins makes



■ Exel Composites works to connect window frame customers to companies with recycling solutions for scrap from mitered cuts of its pultruded profiles.

Source | Exel Composites

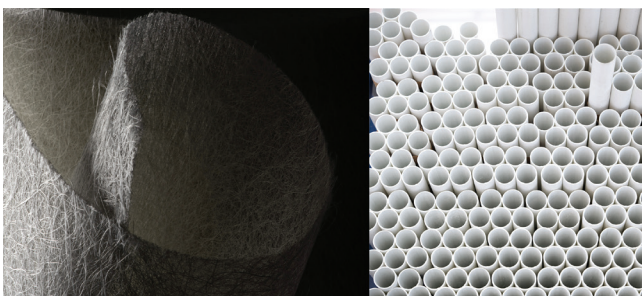
it challenging to match waste streams to recycling opportunities. One of Exel Composites’ first steps is to simply start building an ecosystem in this industry and customer base.”

“Window frames typically require mitering the profiles for the 45° corners,” explains Sjö Dahl. “These cuts generate scrap. We work with our window frame customers to help connect them with possible recycling companies. We also participate in the Nordic Circular Design Programme and the European Composite Industry Association’s [EUCIA] European Circular Composites Alliance [ECCA]. By openly sharing data on materials, waste and emissions, we can work together to enable informed decision-making along the whole value chain.”

LEARN MORE

Read the complete article online | short.compositesworld.com/exel26





Exel Composites has partnered with Original Composites & Fiberglass to use its SUSTAINA glass fiber continuous filament mat (CFM) featuring 50% circular content at a commercial scale in products like pultruded profiles and pipes.

Source | Exel Composites

Opportunities for closing loops, building scale

In July 2026, Exel Composites announced its partnership with Original Composites & Fiberglass to use SUSTAINA glass fiber continuous filament mat (CFM) for commercial-scale products across Europe, totaling several hundred tons of material in Exel products annually. SUSTAINA CFM is certified to have 50% circular content, meaning for every ton produced, at least 500 kilograms of virgin raw material will be replaced with circular feedstock.

"SUSTAINA is an example of partners working with us to help make our supply chain more sustainable, but also at industrial

scale," notes Sjö Dahl. "We do not want a separate 'green line' of products while the majority remains unchanged. Instead, we are trying to incorporate as much sustainable material as possible into our regular products. SUSTAINA lets us do that without compromising product performance or quality. But if a customer wants to work with us on a product with very high biocontent, for example, we can do that as well, and even look at 100% bio-based resins, but realizing there will be performance and cost tradeoffs to be evaluated and optimized."

There are also smaller loops that can be closed, says Sjö Dahl. "Because we are typically cutting our products in specified lengths, there is a lot of dust generated during machining. After exploring options, this dust is now collected in all our factories and used as a resin additive to replace other fillers, recovering hundreds of tons of material back into production."

"So, sustainability for us is not a single initiative, but a journey," he emphasizes. "We know we have more to learn, improve and share, and believe that sharing is key, because it will help build the trust that enables the necessary collaboration required — no single company can achieve circularity alone, but requires collaboration across the value chain." Exel Composites is trying to do its part, he adds. "Together, we can make sure composites not only deliver strength, light weight and durability — but truly improve our ability to be responsible stewards of the planet." **CW**

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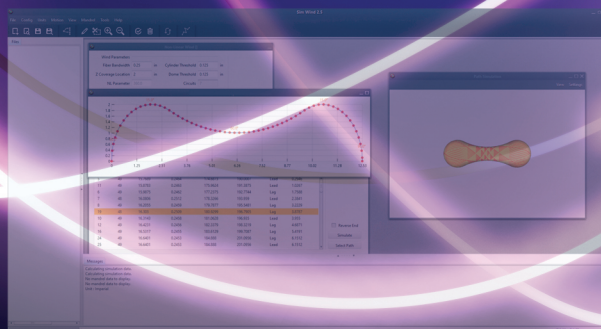
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APPLICATIONS

Recycled High-Density Transom Boards Increase Performance, Reduce Costs

REC's transom boards made from recycled composite waste offer nearly double the compression and shear strength of competing products — at a lower cost — and are already being adopted by leading marine manufacturers.

By Hannah Mason / Technical Editor

» Fiberglass-reinforced composites are the material of choice for a variety of modern boat components. While not the largest or most glamorous, transom boards are important, high-volume components found on many types of boats. These rigid panels, fixed to the boat's stern, serve to support the hull and provide a mount for an outboard motor, and must be able to withstand and absorb the weight and thrust of the engine. Plywood and aluminum options exist, but the predominant transom board in the marketplace, explains Stuart LaHaise, co-founder and VP of RiversEdge Composites (REC, New Smyrna Beach, Fla., U.S.), "is Coosa high-density fiberglass-reinforced polyurethane foam."

REC was co-founded in 2013 by LaHaise, CTO Neil Rohan and president Kristi Rohan to produce urethane sheet foam products and custom parts like stringers and bulkheads, as well as fiberglass-reinforced panels, used for various marine applications.

The only problem? "There is a lot of dust generated during this process from foam and fiberglass cutting, and typically this would be thrown into the trash for lack of another option," LaHaise says. "About 5 years ago, we decided to figure out a better solution."

Neil Rohan set to the task and brought in some initial processing equipment, with the goal of turning the scrap into new, usable materials. About 2 years later, the product was ready to begin testing out in real-world cases, and now is being sold commercially to several marine customers.

Manufacturing cheaper, higher-performing, recycled transom boards

How does this work in practice? While relatively simple, the process took multiple iterations to perfect. Depending on the material and its size (foam dust, fiberglass flakes, etc.), the scrap material



■ What started as an effort to reuse some of its own urethane foam scrap turned into a new side of RiversEdge Composites' business, manufacturing and selling transoms (top left image) and other board products made from recycled composite waste. Source | RiversEdge Composites (REC) (top images), Getty Images (bottom)

is first reduced to a uniform material size using one of several mechanical processes. These materials are then mixed with a proprietary binder and loaded into a heated press to create a new, usable board that can be machined into a final part as needed.

The main materials commercialized so far, based on REC's own scrap recovery needs, are unreinforced urethane foam and glass fiber-reinforced urethane, but REC has also begun working on processing outside material scrap, including carbon fiber prepreg. "There's a lot of prepreg waste generated by carbon fiber manufacturers and OEMs — there are freezers full of rolls of material — so we began to explore this as another opportunity," LaHaise says.

How do the boards perform? REC has had variations of its boards tested at an accredited testing lab. "These boards show better properties," LaHaise says, noting results show almost double the compression and shear properties of competing boards. "And they're viable in the marketplace," he adds. "They're roughly 20% less expensive, have high structural integrity, are circular and reduce landfill costs."

First commercial applications

Like any recycling operation, the commercial business is two-sided — requiring customers or partners to supply feedstock for recycling, and customers to buy and use the recycled materials. Alongside processing its own scrap, REC processes an OEM's materials as well. An OEM can either shred its own waste at its facility and ship REC the shredded material, or for regional companies, REC can pick up the original scrap material and convert it.

REC turns this processed material into 40-pound (lb) density recycled urethane foam boards and 80-lb density boards made from recycled urethane foam reinforced with recycled fiberglass, which it then sells. These boards can then be machined either in-house by the customer or through a machine shop partner to produce the final transoms or other parts. Boards that are perforated or grooved for infusion are also available. The 80-lb density composite boards are particularly well suited for use as high-density inserts or backing plates to support through bolting or screw retention, LaHaise explains.

Sea Pro Boats (Whitmire, S.C., U.S.) is an early adopter, manufacturing more than 160 transoms from the 40-lb density boards. In this case, the boards are made with 95% recycled waste material, up to 2 inches thick and molded to shape.

"I introduced the transom board to Preston Wrenn, one of the owners [of Sea Pro Boats]. He mentioned that he was looking for an alternative transom board as he was transitioning to cutting his own kits in-house and wanted a transom he didn't have to cut," LaHaise says. "When he reviewed the test reports with the significantly higher shear and compression numbers, he agreed to provide patterns for quote purposes. We've now shipped more than 160 transoms that are molded to shape and then trimmed and perforated for quick install at the Sea Pro plant." The REC transoms have given the structural integrity Wrenn needs for today's higher-horsepower motors.

While the 40-lb density boards were the first available to customers, REC now also sells its recycled fiberglass in 80-lb density boards to customers like Sea Fox Boat Works (Moncks Corner, S.C., U.S.) and Edgewater Boats (Edgewater, Fla., U.S.).

Beyond boatbuilders, these same boards are used as a tooling board for rapid prototyping, molding and plug cutting by CNC machine shop Hamilton Millworks (Lutz, Fla., U.S.). According to

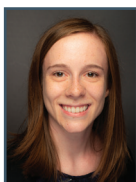
owner Dan Hamilton, "The fact that this board is recycled is secondary to the fact that it's a superior tooling board that machines fast and clean with more structural integrity [versus traditional materials]. Oh, *and* it's recycled. *And* less expensive."

Expansion goals and market challenges

REC aims to scale up and build the marketplace, with the goal of building a dedicated plant to increase production and lower costs.

However, there are several challenges moving forward. One is simply the enormity of the composite waste that is produced, LaHaise says. "This type of waste is being generated all over the country in huge numbers." To help with this issue, "we are establishing recycling programs with many composite OEMs currently," he says, including Frontrunner Boats (Green Cove Springs, Fla., U.S.) and Nautique Boat Co. (Orlando, Fla., U.S.). REC is currently looking to partner with more manufacturers that want to reduce their landfill footprint while helping to create a sustainable solution for their waste.

Another challenge is convincing more manufacturers to adopt the panels and boards made from recycled materials. "There's a lot of resistance, simply because it's disruptive and different," LaHaise says. "We've put in the work to show that, in a regional supply chain, these boards not only perform as well as the virgin boards but are also less expensive to purchase and reduce landfill costs." **CW**



ABOUT THE AUTHOR

Technical editor Hannah Mason has been writing and editing about composites for *CompositesWorld* since 2018. She has a Master's degree in professional writing from the University of Cincinnati. hmason@gardner.media



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NEW PRODUCTS

» Oxidized PAN nonwoven

SENW Introduces Oxidized PAN Fire Protection Fabric

Southeast Nonwovens (SENW) Composites (Clover, S.C., U.S.) has introduced an oxidized polyacrylonitrile (OPAN) fire protection fabric, an engineered nonwoven designed for integration into composite structures and thermal protection systems (TPS). The material is intended for applications — including aerospace interiors, electric vehicles, battery systems, defense platforms and infrastructure — where fire safety and thermal performance are design priorities.

Oxidized PAN does not melt, soften, shrink or drip under elevated temperatures, allowing it to retain structural integrity during fire exposure. According to SENW, the fiber begins to thermally degrade at approximately 500°C and maintains dimensional stability and oxidation resistance at that threshold.

The OPAN fabric also provides low smoke and toxic gas emissions, electrical nonconductivity, low thermal conductivity and heat/oxidation resistance — properties the company positions as supporting passenger safety, equipment protection and system reliability in high-heat environments.

The fabric is manufactured in basis weights ranging from 10 gsm veils to 500 gsm felts, enabling use as thin surface veils,



thermal barriers, insulation layers or thicker fire-protection structures. SENW is also able to combine OPAN with other materials to create multifunctional composite solutions incorporating flame resistance, thermal insulation, acoustic damping, chemical resistance and conformability for complex geometries.

SENW Composites | southeastnonwovens.com

» LFAM materials

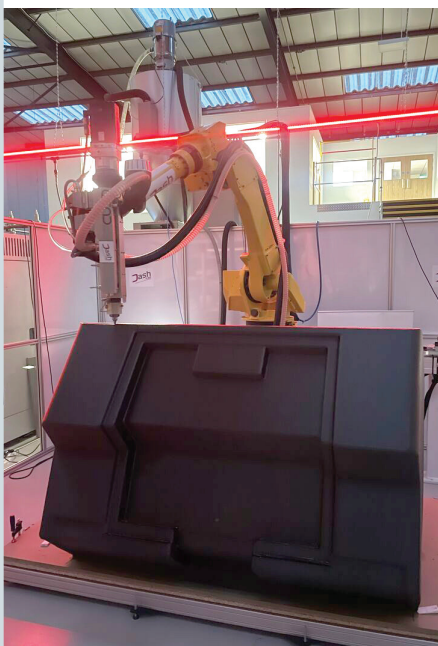
Dash-CAE Launches Dastrude 100 and 165 for LFAM Composite Tooling

Engineering firm Dash-CAE (Abingdon, U.K) has revealed a range of purpose-engineered, certified

materials — Dastrude100 and Dastrude165 — for pattern, jigging and direct tooling applications without distortion.

The approach draws on Dash-CAE's experience in large-format additive manufacturing (LFAM) tooling for composite applications in motorsports.

"When we began experimenting with



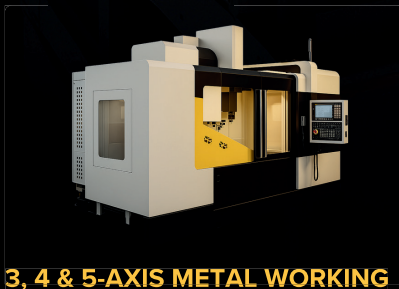
LFAM, the greatest challenge was materials," explains the company. "We set out to develop recyclable tooling for composites, but existing AM materials could not withstand the thermal cycling requirements. Three years of development followed before we had refined the system to a point where it could be offered commercially."

Dastrude100 is an optimized pattern and jig material, while Dastrude165 can be used for Class A production direct tooling. The certified materials will enable engineers to bypass the lengthy, traditional tooling phases of composite production, offering faster prototyping from CAD files to a carbon fiber monocoque, more design flexibility for updating to different race series or vehicle specifications and reducing the upfront tooling costs typically associated with supercar-level carbon fiber composite monocoques.

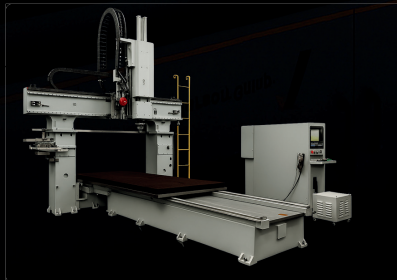
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» Fast-cure prepreg

Toray Launches Fast-Cure Prepreg Targeting High-Rate Aerospace, Defense

Toray Composite Materials America Inc. (Toray CMA, Tacoma, Wash., U.S.) presents 3960-FC, a fast-cure variant of the company's high-performance, highly toughened 3960 prepreg system. This system reduces cure time by up to 45%.

The fast-cure prepreg was developed to help OEMs and their supply chains meet increasing build rate requirements across next-gen single-aisle commercial aircraft programs, advanced air mobility (AAM) platforms and new mission-critical, mass-produced defense systems. "Increased pressure is being placed on material suppliers to provide a structural material solution with production rates now higher than what manufacturers

have historically supported, [so] 3960-FC accelerates manufacturing cycles while maintaining the mechanical and structural performance customers expect from our

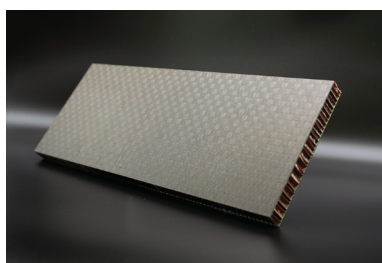
premier product," says Jeff Cross, principal director of defense programs.

The 3960 prepreg system demonstrates equivalence with the material data in the 3960 NCAMP database. It delivers optimal toughness, hot/wet performance, tensile strength, stiffness and damage tolerance. The material is also highly compatible with a broad range of automated manufacturing technologies, including AFP, ATL and traditional processing methods.

Additionally, the fast-cure variant enhances prototype capabilities by enabling the use of lower-temperature tooling, which reduces tooling costs, while expanding vacuum-bag-only (VBO) processing windows. The material is capable of compression molding consolidation, helping customers further reduce takt times and lower manufacturing costs. Unlike many accelerated epoxy systems, 3960-FC exhibits a low exotherm risk for thick structures.

Target applications for 3960-FC include primary aircraft structures, mid- to large-size UAVs, launch vehicles and rockets, and rotorcraft structures.

Toray Composite Materials America | toraycma.com

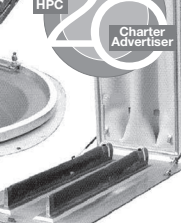


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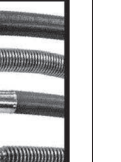
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» Acoustic camera

CCIC Launches Aegoli Acoustic Camera for Vacuum Leak Detection

The Yangtze River Delta Carbon Fiber and Composite Material Innovation Center (CCIC, Changzhou, China) introduces the Aegoli acoustic camera, an ultrasonic imaging system developed for vacuum leak detection during prepreg vacuum bag molding, vacuum infusion, resin transfer molding (RTM) and autoclave curing.

Designed for vacuum system inspection before curing, the camera helps manufacturers identify leakage in vacuum bags, sealing tapes, molds and piping systems. The system combines 140 high-sensitivity microphones with a 13-megapixel optical camera to visualize ultrasonic leak sources.

Aegoli supports ultrasonic detection from 2-100 kHz with real-time imaging at 25 frames/sec. Users can display acoustic images, visible-light images, frequency spectrum and sound pressure level information simultaneously, while adjustable inspection modes allow target-area selection and background noise filtering for operation in industrial environments. A rotatable display (0°, 90°, 180° and 270°) enables inspection in confined spaces such as autoclaves and complex mold geometries.

CCIC | changzhou.gov.cn/



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POST CURE

Highlighting the behind-the-scenes of composites manufacturing

Carbon TPC Bike Frame With Reversible Joint Connection Surpasses Classic Racing Bike Challenges

» When it comes to maximizing a carbon fiber-reinforced thermoplastic composite (carbon TPC, also known as CFRTP) bike frame's life cycle — whether recycling or repairing a damaged frame — JEC Innovation Award 2026 winner fenix composites' (Flensburg, Germany) Philipp Huber doesn't cut corners.

Unlike conventional road bikes, the carbon fiber-reinforced PA Lifecycle features a lugged frame. It combines direct metal laser sintered Ti6Al4V titanium lugs, machined for bearing seats and laser-structured for joining with the bike's thermoplastic composite profiles. The front triangle uses Fraunhofer IGCV (Augsburg, Germany) rCF/PA6 braided preforms consolidated by herone GmbH (Dresden, Germany), while the rear triangle incorporates Alformet's (Dörth, Germany) LATW-manufactured CF/PA6 tubes. Assembly relies on thermal direct joining: induction heating melts the polymer, which flows into the lug's micro-structure, creating a strong adhesive-free joint.

The result? Tubes and lugs that can be repeatedly separated and replaced, enabling full recyclability and repairability.



Source | fenix composites

"In the event of damage, only a part needs to be replaced instead of the entire frame," says Huber. "This means lower costs for the cyclist, less waste requiring recycling and fewer emissions that pollute the environment." **CW**

WEBINAR



SEPTEMBER 3, 2026 | 11:00 A.M. EST

Establishing and Monitoring Surface Cleanliness and Contamination for Adhesion Quality

This webinar explores how manufacturers can establish objective cleanliness standards, implement surface energy measurement techniques and monitor contamination throughout a product's life cycle to improve adhesion reliability, manufacturing quality and first-pass yield.

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LUCAS DILLINGHAM | Global Applications Director | Brighton Science

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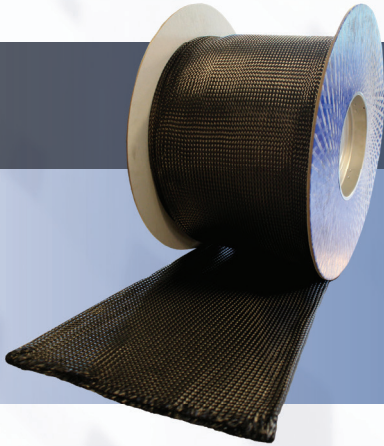
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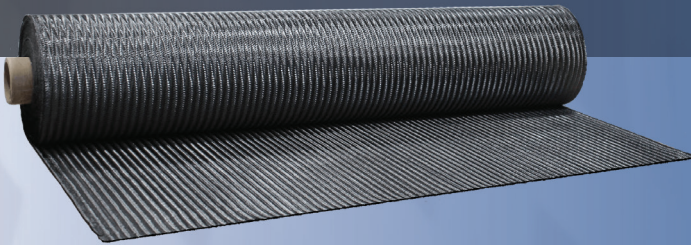
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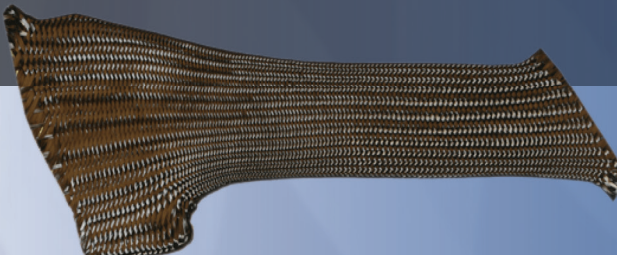
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