

According to Brosius, “One positive of COVID-19 has been an increased awareness of the importance of domestic manufacturing to the country. It really impacts our capacity to respond to emergencies and ensure national security.”

When supply chain issues began impacting materials availability, MVP developed new monitoring systems to equip manufacturers with tools to track material usage. In July 2020, MVP released its catalyst alarm to help manufacturers eliminate waste and control costs by monitoring mix ratios. It’s a monitoring system that identifies inefficiencies before they create bigger problems down the line.

With that heightened attention on domestic manufacturing, IACMI has centered its future focus on two major areas: infrastructure and transportation. The investments that multiple automobile companies—Volkswagen, Nissan, GM, and Ford—are making in Tennessee has made this area ideal for composites innovation with the push towards electrification.

“There’s been a substantial shift toward electrification,” says Brosius about the automotive industry, “and this creates new opportunities for composites in particular. You are seeing more clean sheet designs, for which you are not trying to substitute an existing steel or aluminum part and compete against embedded processes and equipment that have been amortized for decades or more. You can design to and realize all the advantages composite materials provide in terms of performance, design flexibility, and embedded functionality. The ability to minimize weight is a game changer for the composites industry and potentially a game changer for the state of Tennessee.”

One example has been the design of a liftgate in sheet molding compound (SMC), replacing welded steel on the Volkswagen Atlas, the automakers largest SUV. IACMI worked with Volkswagen to validate substituting composites at scale and lower the weight by 35 percent. Lowered vehicle weight generally translates into better fuel efficiency or longer range for electric vehicles.

Focus on Sustainability

Developing the new liftgate was just one aspect of material innovation in Tennessee. IACMI connected Volkswagen with Carbon Rivers in Knoxville to address the lifecycle of their composite products, including the new Atlas liftgate. Through a process called pyrolysis, Carbon Rivers working with UT was able to reclaim the liftgate fiber reinforcement. The recycled fiber

was then used by Endeavor Composites to fabricate new nonwoven fabrics for composites manufacturing. Ginder confirms that for the underlying recycling technology, “We’re moving from R&D into the commercialization phase, with the future goal of recycling up to 200 tons per day for the first plant.”

Ginder adds, “We’re definitely moving towards finding ways to reduce the overall energy impact and emissions impact of products. We have the greatest demand on natural resources that we’ve ever had in human history. You have to think about how to more efficiently use resources to reduce pressure on raw material outlets. Recycling can create less than half the CO2 emissions of virgin fiber production.”

Spahn, who’s company is focused solely on recycling carbon fiber, agrees. “We don’t just help companies meet their sustainability goals. Recycling is often less expensive than sending materials to landfill. We have to start taking care of the planet, and if we have the capability to recycle something and put it back into use, then I’m all for it.” Carbon Fiber Recycling’s giant shredder can recycle 600 pounds an hour, can recycle all forms of carbon fiber, and can do it from the power generated solely from pyrolysis. “Nothing goes in the landfill from start to finish,” insists Spahn. “That’s what we pride ourselves on.”

Endeavor Composites has found a niche of collecting scraps of carbon fiber that were being landfilled, processing them, and converting them into nonwoven mats for new parts. Regarding focus on sustainability, Ghossein says, “It’s already started, but I’d like to see it become the backbone of the industry. Wasted material is wasted money, and wasted material hurts the environment. Our kids in the future won’t have the same opportunities we do if we’re not careful.”

Bright Future

The next few years hold great promise for the composites industry, particularly in East Tennessee’s *Carbon Valley*. Endeavor Composites hopes to grow from under 10 employees now to 100 within 5 years. Ghossein confides, “The beginning of 2020, I had one client. Today I have 16 clients. We’re now moving away from a tabletop pilot to actual production by end of 2022.”

After building a 4-million pound a year recycling facility during the COVID-19 lockdown, Carbon Fiber Recycling is looking to license its technology in the U.S. and Europe. It’s so popular, that leadership already has buyers for product the company plans to recycle the next 10

years. Spahn says, “I think carbon fiber is going to be adapted into more things than you can imagine. Recycling carbon fiber will lead to more carbon fiber being produced in the long run.”

MVP is looking at opportunities in energy, infrastructure, and transportation. One particular area that’s showing a huge demand is utility poles. Unlike wood poles, composite utility poles are lightweight, strong, and corrosion resistant. “These are all emerging market opportunities where we are already developing new products and solutions to meet the needs of the industry,” MVP’s Hannah Jay confirms. “We are highly invested in this region. We want to expand our capabilities here.”

McCay and CAG are expanding into other industries ripe for disrupting, including commercial truck bed and railcar designs with companies like Wabash and Trinity Rail. Introducing carbon composite as a hybrid element, mixing composite and traditional materials, is opening more doors.

Ginder’s newest company, Windfall, Inc., currently utilizes a pilot scale system, developed in partnership with the U.S. Department of Energy, Carbon Rivers, and UT, that can recycle existing 50-meter-long wind turbine blades, but that was not easy. “Wind turbine blades are actually really big. Identifying shredding solutions that can not only handle them but do it economically, that was a challenge initially.” As for their future, “We’re not only dealing with the demand that exists today, we’re allowing for market growth in more applications as sustainability of a product becomes more important to the overall design.”

All of this success has been and will continue to be facilitated by IACMI and its member consortium, as new businesses and applications spin off. Global shifts in major spaces make this an exciting time for composites manufacturing. With the continued goal of producing domestic, low-cost, high-volume products made with advanced composites, Tennessee is attracting investments in even more large-scale manufacturing facilities. Brosius concludes, “From a social and market perspective, it’s really astounding. You’ve got this intersection of transformational changes that really provides a once in a four generations opportunity.”



This story appeared on IACMI’s website, www.iacmi.org.

CARBON VALLEY

Tennessee has become a key epicenter for advanced composites and manufacturing innovation

IACMI-The Composites Institute realizing its vision

KNOXVILLE, TN (April 27, 2022)—Entrepreneurial successes in advanced composites in East Tennessee have business leaders like Jeff McCay calling the area *Carbon Valley*. As CEO of Tennessee-based Composite Applications Group, McCay and his business partners have been instrumental in disrupting the transportation and infrastructure markets—from lightweight composite rail cars and 18-wheeler semi-trailers to fiber-reinforced polymer (FRP) bridges.

“We’re looking for those industries that haven’t changed in 50 years with leaders who are willing to disrupt their markets,” McCay says. “Take this rural non-sexy bridge application in Morgan County, Tennessee. I want to use it to springboard and get these DOTs out of the mentality of business as usual.”

This vision is exactly what the Institute for Advanced Composites Manufacturing Innovation (IACMI) and its core partners have been working towards since IACMI’s inception in 2015. “Years of hard work innovating and then demonstrating the benefits, opportunities, and sustainability of composite materials are paying off and taking the composites industry in exciting directions,” says IACMI CEO and Chief Commercialization Officer Dale Brosius.

The Tennessee Advantage

“Tennessee is helping drive a new industrial revolution with advanced materials, composites, and manufacturing techniques. Nowhere else in the U.S. can you find such a premier composites coalition—home to IACMI, ORNL, UT, world-renowned engineers and researchers, one-of-a-kind advanced materials facilities, and composite manufacturing entrepreneurs.”

Jeff McCay
President, Composite Applications Group
McDonald, Tennessee



Tennessee is home to leading advanced composites talent such as Dr. Uday Vaidya and Dr. Hicham Ghossein.

Carbon Valley

Rejecting the status quo and re-envisioning business as usual is the goal for many composites manufacturing businesses drawn to East Tennessee’s *Carbon Valley*. “This is why we’re here,” confides Tim Spahn, co-founder of Carbon Fiber Recycling. “I believe Tennessee is turning into the carbon fiber composites network of the world. IACMI and Oak Ridge National Laboratory are taking the reins on carbon fiber production, implementing it in everything imaginable.”

Ryan Ginder, who’s worn multiple hats at the University of Tennessee (UT), Carbon Rivers and the new start-up Windfall, agrees. “It is the culmination of many, many years of investment of time, personnel, and capital to pursue new technologies for commercialization.”

Tennessee is one of the largest manufacturing regions in the United States. The state’s strong manufacturing and advanced materials eco-system helped lay the foundation for the creation of IACMI by the U.S. Department of Energy. The IACMI partner network, which includes core founding partners UT and Oak Ridge National Laboratory (ORNL) along with dozens of coalition partners, is the heartbeat of the composites industry in the state.

This region has many advantages:

- Two-thirds of the U.S. population is within a day’s drive of Knoxville

- Business-friendly and low tax environment
- Low-cost power from TVA
- Metropolitan population of 840,000 and 30,000 students at a major university
- Education excellence and high STEM concentration

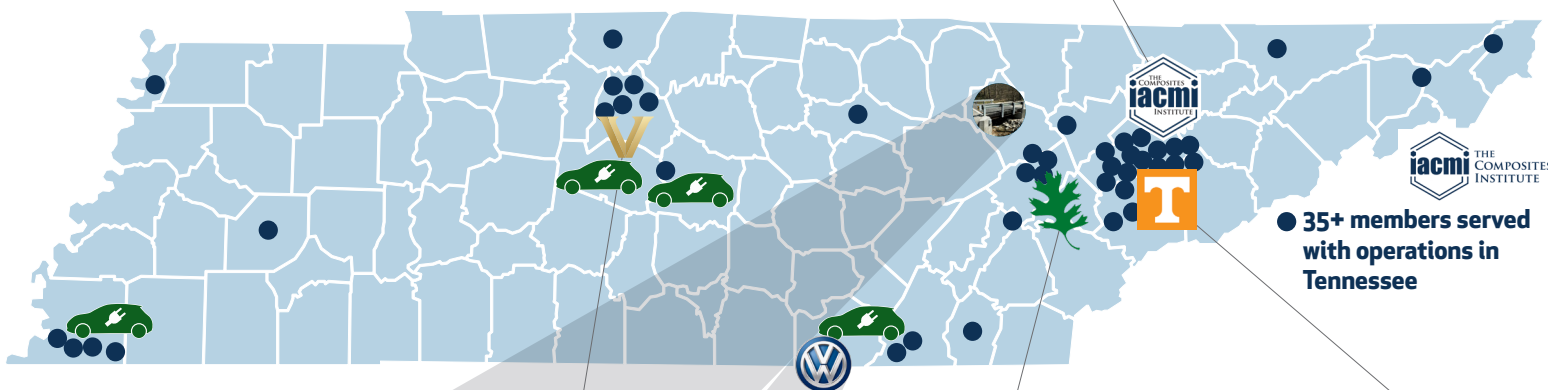
Young and old companies alike are expanding in this region to create this ecosystem. Magnum Venus Products (MVP), has been in business more than 80 years but has recently doubled the size of its production facility in Knoxville, and it is looking at acquiring a new facility with 100,000 square feet or more. MVP’s Senior Director of Business Development, Andrew Hedger, confirms, “All of our new product development is going to take place in Knoxville.”

Why here, why now?

Dating back decades, scientists at ORNL have worked to develop more effective and cost-efficient carbon fiber products. With the goal of supporting the technology development and commercial deployment of low-cost carbon fiber for use in clean energy applications, the Carbon Fiber Technology Facility (CFTF) was established by the U.S. Department of Energy (DOE) at ORNL in 2013. The CFTF features a 390-foot-long processing line capable of producing up to 25 tons of carbon fiber annually. Then in 2014, DOE’s Manufacturing Demonstration Facility (MDF) at ORNL began to focus on large-scale additive manufacturing. In its 110,000 sq. ft. facility, the MDF includes over 100 advanced manufacturing systems and has collaborated with more than 200 partners from industry and academia.

Over the past six years, new entrepreneurship and accelerator programs have been established to support start-up growth and development. These include ORNL’s Innovation Crossroads, supported by DOE, the new Spark Innovation Clean Energy Accelerator in the UT Research Park at Cherokee Farm, and

Established by Department of Energy, the **Institute for Advanced Composites Manufacturing Innovation (IACMI)** has served **35+ Tennessee-based companies and core innovation partners** that are leading innovation and commercialization of **composites** and other **advanced materials** in vehicles, aircraft, wind energy, recycling, infrastructure and construction, making Tennessee one of the largest manufacturing regions in the United States.



Innovation in Action



Disrupting U.S. Transportation and Infrastructure Markets IACMI member and Tennessee-based CAG designed and installed the state's first composite bridge in Morgan County.

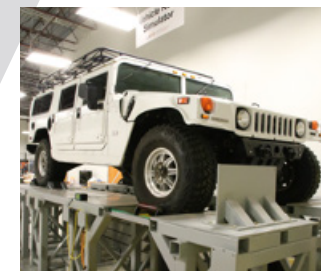


Lightening VW's Load with Composite Manufacturing An IACMI-led project created a compression molded composite liftgate for the Volkswagen Atlas, reducing weight by 35%.

Among the Tennessee facilities within the IACMI network



Laboratory for Systems Integrity and Reliability
Combines modeling and simulation tools, sensing and control techniques, and risk and reliability analytics to improve performance and dependability of manufacturing systems.



Manufacturing Demonstration Facility
Collaborates with industry to reduce risk and accelerate development and deployment of energy-efficient technologies.

Carbon Fiber Technology Facility
Offers flexible, instrumented carbon fiber line for demonstrating advanced technology scalability.



Fiber and Composites Manufacturing Facility
Enables researchers and students to work on the complete composite manufacturing process and supports collaboration with private industry for problem solving, testing and product development.



Techstars Industries of the Future Accelerator. These programs in turn attract leading composite engineers and researchers like Uday Vaidya, IACMI's Chief Technology Officer and the UT-ORNL Governor's Chair for Advanced Composites Manufacturing. Craig Blue, Advanced Manufacturing Program Manager for ORNL, adds, "ORNL and its partners have helped catalyze and drive a strategic vision for carbon fiber and composite manufacturing and recycling for more than a decade, and it is tremendous to see the ecosystem come together. IACMI, UT, ORNL, MDF, and CFTF have been cornerstones in this process."

With so many bright minds and resources in the local ecosystem, it's no surprise that East Tennessee is becoming a key epicenter of the composites industry. This comes at a promising time, as Tennessee is emerging as the national leader to develop electric vehicle and battery production.

- Ford is investing \$11 billion and building new plants in Tennessee and Kentucky to assemble electric vehicles and produce the batteries to power its EVs.
- GM is investing \$2.3 billion in its Tennessee manufacturing plant to build a new battery plant for its own line of EVs.
- Australian electric vehicle charging company Tritium is establishing its first U.S. manufacturing facility in Tennessee and plans to begin making EV battery charging stations later this year.
- Volkswagen is investing \$800 million to increase its footprint at its Tennessee assembly plant for manufacturing electric vehicles.
- Nissan already manufactures the all-new Nissan LEAF EV and batteries at its Smyrna plant.

According to Bloomberg's report in 2020, the EV and carbon fiber markets are projected to be closely tied in growth. "For years, we've been setting the stage for how these dots connect, and now they're coming together," Brosius affirms. IACMI, based in Knoxville, is a national Manufacturing USA institute established by DOE. Its core purpose is to accelerate the adoption of advanced composites in large scale markets through collaborative innovation and workforce development programs. Working with national innovation partners and more than 130 members, IACMI serves as an essential hub convening, connecting, and catalyzing impactful collaborations across education, government, and business.

Since its startup, IACMI has managed over 60 collaborative and industry led technical projects with greater than \$150 million in research and development value. More than 15 new products are now commercially available and \$400 million-plus has been invested in a broad system of open access facilities for demonstration at scale in eight states. IACMI has engaged more than 9,000 people in composites training and STEM outreach and placed more than 100 university interns with industry collaboration.

"IACMI has been there for Endeavor Composites from day one," says Hicham Ghossein, former student of Uday Vaidya and CEO of the relatively young company Endeavor Composites. Ghossein is focused on repurposing excess fibers into nonwovens for composites manufacturers and sees IACMI as the perfect incubator for a start-up to grow. "I decided to follow my dreams," says Ghossein. "IACMI helped me with connections, with member introductions, support for my grant writing, and access to facilities. When I would approach a client, knowing that I was backed by IACMI gave me a lot of credibility in the market. I wasn't just this young, crazy kid who wanted to change the world. It's been really, really vital in my success."

"IACMI is the premiere composites consortium in North America," adds McCay. "There's a tremendous network there. That has been very important to us as we've pursued multiple projects—that connection and that ability to tap into resources that IACMI provides."

"When you're making real things, there's a physical element to it that increases the value of proximity," adds Brosius. "This isn't just research in a silo. We're interested in team-based projects that connect across the value chains necessary to deliver solutions into the marketplace because that's where we impact society immediately."

Innovating Infrastructure

Back to that non-sexy bridge, McCay believes its success was finally achieved because of IACMI's direct collaboration efforts. McCay had been working with a company called Structural Composites, which designs, tests, and manufactures composite structures. They had developed a composite bridge deck back in 2009 and had gotten their technology validated by several state Department of Transportation (DOT) groups, but none of them wanted to be the first to take the risk.

So, three years ago, McCay pitched the idea of selecting a small, rural bridge in desperate need of repair to IACMI. He knew the multiple benefits of a composite bridge: improved

More than
150,000
Tennesseans work in the state's advanced manufacturing economy

IACMI network growing Tennessee composites ecosystem

\$340M

in capital investment

2,500

New manufacturing jobs

strength to weight ratio over concrete, faster and easier installation, resistance to corrosive environmental elements, and at least a 100-year lifespan. There are 150,000 crumbling bridges across the United States that need this technology; they just lacked a real test case.

The key to finding that test case was discovering that any bridge under a 20-foot span did not require DOT authorization. Through IACMI's connections, Structural Composites partnered with the road superintendent from Tennessee's Morgan County and about a dozen public-private organizations to not only replace a 16-foot bridge but make it a *smart bridge*. In less than a day in February 2021, two eight-foot, pre-manufactured, composite bridge decks were installed. A team of UT researchers and engineering students collaborated with Luna Innovations to equip the bridge with sensing equipment allowing the bridge project team to gain ongoing performance data every time a vehicle crosses, including a school bus which uses the bridge daily. These data can easily scale to much larger bridges.

In January 2022, McCay began discussions in Tennessee and Georgia (TDOT and GDOT) to address a renewed commitment to U.S. infrastructure. More composite bridges may be coming to a nearby community soon.

Progress Through the Pandemic

That bridge was just one of many stories of progress IACMI has helped to facilitate the last two years, despite a worldwide pandemic and supply-chain pressures. Concerns about our country's vulnerabilities, due to limited access to materials, have brought a welcome focus.