

## A carbon fiber cluster grows in South Carolina

**Teijin breaks ground on a \$600 million plant in Greenwood as global demand grows for the strong, lightweight material**

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*Carbon fiber spools staged for packaging. Solvay makes the fiber in Greenville, S.C.*

At the June 1 groundbreaking for Teijin's \$600 million carbon fiber plant in Greenwood, S.C., the local high school orchestra serenaded guests. Flags from the U.S. and Japan, Teijin's home country, flanked the podium. Gov. Henry McMaster told the 75 people sitting under a fan-cooled tent how proud he was "to have a new partner join us." And the Japanese consul general in Atlanta, Takashi Shinozuka, greeted the crowd with a "Good morning, y'all," relating that in Japan, "South Carolina is well known as a great place to do business."

Certainly, South Carolina seems like a great place for carbon fiber producers to do business. Just two years before Teijin broke ground, fellow Japanese firm Toray Industries started work on a \$1.4 billion plant in Spartanburg. And Solvay, which has been producing carbon fiber in nearby Greenville since 1981, expanded in 2016.

Consultants attribute the unusual carbon fiber buildup to the state's business-friendly policies, low taxes, and moderate energy costs.

The three companies are also taking advantage of global trends that favor use of composites of plastic and carbon fiber in airplanes, wind turbines, and electric vehicles. The fiber's high strength relative to its weight makes it an alternative to steel and aluminum. However, some users indicate that high prices are the fiber's Achilles' heel and could slow its adoption, especially in automotive uses.

Teijin's choice of Greenwood as the site for its fiber plant has a historical resonance for the county and the state. Once upon a time, a great deal of South Carolina business centered on the textile fiber industry. In Greenwood, the local textile mill loomed large over the town's business landscape. But not anymore.

The world has changed, and though Greenwood Mills still exists, many of the jobs associated with the apparel industry have migrated to Asia.

**"South Carolina is the least costly of the 48 contiguous U.S. states for manufacturing."**

**John Boyd, principal, Boyd Co.**

Other echoes of the textile past live on in South Carolina. The Ascend Performance Materials nylon plant in Greenwood, dating to 1960, continues to employ nearly 500 workers who provide industrial and carpet fibers to regional customers.

But since 1990, Greenwood has begun to support some high-technology operations. They include Fujifilm's North American research and printing-plate operations and a gelatin-capsule-making facility run by the pharmaceutical services firm Lonza.

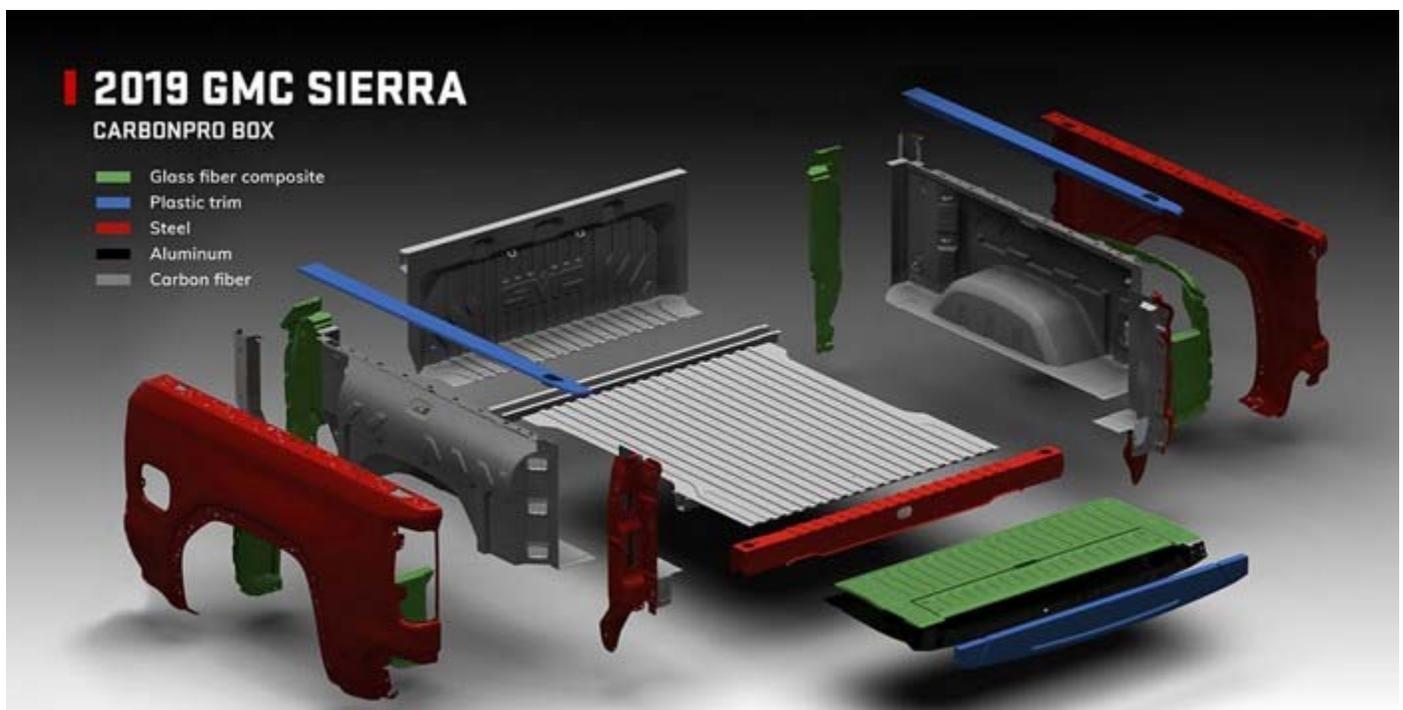
South Carolina in general has embraced high-technology manufacturing. The state hosts one of BMW's largest auto assembly plants. Aircraft maker Boeing assembles its Dreamliner wide-body plane in Charleston. Both companies happen to use carbon fiber. According to the South Carolina Department of Commerce, 66,000 people work in automotive jobs and 108,000 in aerospace jobs in the state.

At the June groundbreaking, Greenwood's textile past aligned with a high-tech future. Like Greenwood, 100-year-old Teijin has textiles in its blood, getting its start making rayon fiber. The firm began producing carbon fiber in Japan in 1975 and has made it in Rockwood, Tenn., since 2004.

Teijin executives at the groundbreaking told C&EN that the plant should start up in 2020. The company expects to employ 220 people by 2030.

Production from the plant will at first supply aerospace composite customers, said Toshiya Koyama, head of the company's material business group. Within 10 years, the firm expects to make automotive-grade fiber. For the time being, the raw material to make the fiber, polyacrylonitrile (PAN), will come from Teijin's plant in Mishima, Japan. The firm could decide in the future to make PAN at the Greenwood site.

While much of Teijin's carbon fiber now goes to customers who make composite parts, Koyama said the firm's strategy is to move downstream into composites itself. To make that plan a reality, Teijin bought Continental Structural Plastics (CSP) in 2016 for \$825 million.



*The base plate and interior of the GMC Sierra's cargo box is made of a carbon fiber composite and is 28 kg lighter than the steel version.*

Michigan-based CSP is already a supplier of composite components to automakers. Most of CSP's composites are reinforced with glass fiber. But CSP is making a limited number of carbon-fiber-reinforced cargo beds for the 2019 GMC Sierra Denali pickup trucks. The notion of the cargo bed actually emerged from a carbon composite research alliance Teijin formed with General Motors in 2011. The CSP acquisition provided the means to make a carbon composite

cargo bed to replace GMC's steel version. Koyama said the cargo bed project bodes well for Teijin's future auto composite plans.

Given all the carbon fiber soon to come from South Carolina, the question of oversupply arises. The Solvay plant and the Teijin and Toray plants under construction are all within 100 km of each other.

Shukei Inui, manager of Teijin's carbon fiber business unit, pointed out that carbon fiber is a worldwide commodity. At least in Teijin's case, the plan is to export some of the fiber to other countries. The decision to locate in Greenwood had mostly to do with utility and labor costs plus state incentives and support from community leaders.

Teijin competitor Toray also cites strong government support as a reason for setting up its fiber plant in Spartanburg. The company started to scout for new sites as it was running out of room at its fiber operations in Decatur, Ala., according to Yasuo Suga, senior vice president of Toray's advanced composite division.

Another reason was the proximity of Boeing's composite-making operations in Charleston, Suga added. The Spartanburg plant will begin to supply Boeing in 2019 after going through the aircraft maker's accreditation process, he said.

John Boyd, principal at Boyd Co., a location consulting firm, is not surprised that South Carolina ranks high on carbon fiber makers' site list. "South Carolina is the least costly of the 48 contiguous U.S. states for manufacturing," he said. Other benefits are the low rates of unionization and the Port of Charleston, which he calls one of the best managed and least congested ports on the East Coast.

Also figuring into the Japanese makers' choice to locate in the state is the relatively low cost of shipping carbon fiber, said Dan Pichler, a carbon fiber expert at CarbConsult. The fibers range in cost from about \$17 per kilogram for industrial-grade fiber to \$80 for most aerospace-grade material. It costs "only 1 to 2% of the fiber's value to ship it anywhere in the world," he said.

And carbon fiber is set for a significant increase in demand, Pichler said. He expects global fiber consumption to more than double from 60,000 metric tons in 2015 to about 150,000 metric tons in 2025.

Industrial applications, including for automotive, wind turbine, and other high-tech uses, will account for the lion's share of growth, Pichler predicted. Aerospace use will continue to grow, but other industrial uses will outshine it, he said.

However, a recent move by BMW suggests that at least some in the auto industry are having second thoughts about wide use of carbon fiber. In November 2017, BMW sold its 49% stake in an automotive carbon fiber joint venture to its partner, the German carbon fiber maker SGL.

BMW said it would continue to buy carbon products from SGL for its high-end i3, i8, and 7 Series automobiles and that it would maintain its 18% interest in SGL. But it also indicated in 2016 that carbon fiber is too expensive a raw material for lower-priced cars.

Still, consultants are gung ho on carbon fiber growth. While producers have an excess of capacity today, by 2025 demand for the fiber will outstrip capacity, according to Cecilia Gee, an analyst with the market research firm Lux Research.

Gee expects greater use of carbon fiber among automakers through 2020 as they take advantage of the fiber's light weight and strength. Likely uses are high-impact or structural components like driveshafts or the chassis.

Gee is enthusiastic about the growth of carbon fiber in the wind energy market, which she predicts will surpass the aerospace and automotive markets in both tonnage and value. Strong government support and zooming offshore installations are behind the growth, she said.

Yes, high fiber costs are holding back growth. But while "cost reduction from process and other improvements is not coming on-line as quickly as we thought," she said, carbon fiber is still "on a positive trajectory now."

If she's right, all the bets on South Carolina should pay off.