

State of the Composites Industry

Dr. Sanjay Mazumdar
January 1, 2016

A Look at Materials, Manufacturing Processes and Markets in 2016 and Beyond

In the composites industry, one of the best ways to judge success is to look at end product demand. The demand for composite end products – ranging from utilitarian underground pipes to high-performance aircraft – reached \$21.2 billion in 2014 and stayed the course in 2015, reaching \$22.2 billion.

The U.S. composite materials industry grew 5.6 percent in 2015 in terms of dollars shipped and reached \$7.5 billion overall. Looking ahead, the key economic indicators and market dynamics suggest 2016 growth at approximately 5.4 percent to reach \$7.9 billion. Approximately 5.7 billion pounds of composite materials were shipped in the U.S. in 2015 and that number is forecast to grow to 6.9 billion pounds in 2021 at a compound annual growth rate (CAGR) of 3.2 percent.

Raw Materials Outlook

Any examination of the industry requires a closer look at the status of reinforcements and resins. This year, Lucintel expects increased innovation in the development of low-cost carbon fibers across a wide variety of mass volume applications. Carbon fiber is significantly more expensive than glass fiber, so it is mainly used for high-performance applications where weight saving requirements are critical. There are a growing number of research projects around the use of lignin or other precursors to reduce the price of carbon fiber. Specific applications are driving

carbon fiber demand in the U.S., including the rising use of carbon fiber in next-generation aircraft, electric and sports cars, and wind turbine blades, which are getting increasingly longer.

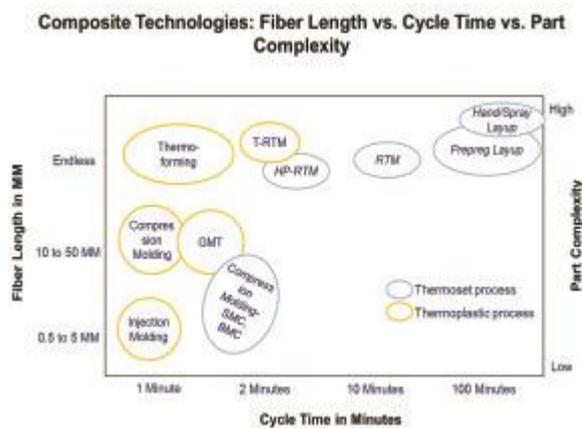
While carbon fiber is making inroads in the industry, glass fiber remains in high demand. Over the last 70 years, glass fiber has been used in thousands of applications and has thus demonstrated an excellent track history. Lucintel anticipates increased development of high-performance glass fibers to meet higher mechanical and chemical requirements, as well as development of high-strength natural fibers to increase penetration in automotive, construction and other industries.

In the resin market, four trends will continue for next year: shorter cure times for mass volume applications, development of resins with optimum gel times for long wind blades, development of low-cost and high-strength nano-resins, and development of bio resins for various applications. Despite these advances, in many industries – such as construction, marine and automotive – polyester resin continues to be the workhorse because of its low cost and high corrosion resistance.

One issue in the composites industry remains the lack of standardized grades of raw materials, which hinders widespread use of CFRP and GFRP.

A Shift in Manufacturing Processes

In the U.S. composites industry, fabrication processes have long included hand lay-up, spray-up and filament winding. Currently, there is big shift taking place as many manufacturers are transitioning from these open molding processes to closed molding, such as resin transfer molding (RTM), compression molding and vacuum infusion processing.



Source: Lucintel

The fabrication method is typically dictated by volume or the shape and size of the composite part. Compression molding, injection molding and RTM are the preferred manufacturing processes for mass volume applications, whereas hand lay-up and vacuum assisted RTM are preferred for applications requiring less than 1,000 parts annually. Filament winding, roll wrapping and centrifugal casting are ideal for making tubular parts.

The graph to the left shows how fiber length, cycle time and part complexity also converge to affect selection of a fabrication process.

Market Segment Trends

U.S. Composite Materials Demand Forecast (\$Billion)

Applications	2015	2021	CAGR (2015-2021)
Transportation	2.4	3.3	5.2%
Marine	0.4	0.5	3.2%
Wind Energy	0.2	0.4	8.0%
Aerospace	0.8	1.4	9.5%
Pipe & Tank	0.7	0.9	3.0%
Construction	1.4	1.8	4.1%
Electrical & Electronics	0.7	0.9	3.8%
Consumer Goods	0.4	0.5	3.6%
Others	0.4	0.5	5.7%
Total (\$B)	7.5	10.2	5.1%

Source: Lucintel

Source: Lucintel

Transportation, construction and aerospace were the largest market segments within the composites industry in 2015, representing 62 percent of its total value. The growth of composite materials in newer airplanes such as the Boeing 787 and Airbus 350 and 380, has played a part in aerospace overtaking the pipe and tank market in the top three last year. The chart to the left provides forecasts for several composites market segments from 2015 to 2021 in terms of billions of dollars shipped. Out of all markets listed, aerospace has the highest potential for growth, with a CAGR of 9.5 percent over the next six years.

Now let's take a closer look at five markets.

Automotive: The automotive sector continues to be the largest market for composite materials, with annual growth of 4.1 percent in 2015 in terms of volume of shipments. OEMs are continuously looking for innovative materials to curb vehicle weight and achieve fuel efficiency and carbon emission targets.

Perhaps the biggest trend in the automotive industry is the development of technologies for making carbon fiber parts for mass volume vehicles. Automotive OEMs continue to form strategic alliances with carbon fiber suppliers, composite part manufacturers, machine suppliers, research institutes and universities to address various challenges, such as cycle time, raw material cost, tooling, repair and recycling.

Mapping of Recent Strategic Alliances in the Automotive Industry Related to Carbon Composites



Source: Lucintel

U.S. production of light vehicles increased from 7.6 million in 2010 to 11.7 million vehicles in 2015, representing a 54 percent growth. Light vehicle sales also have grown by 50 percent since 2010, rising from 11.6 million to 17.4 million vehicles in 2015. Light vehicle production will continue growing next year but may plateau in 2017. A variety of factors influence the growth in automotive demand, including lower fuel prices, job gains, easy availability of credit and increasing consumer confidence.

Currently, prepreg lay-up and resin infusion process are the primary manufacturing methods for making CFRP parts for mass volume applications in the automotive industry. But both automotive OEMs and carbon fiber stakeholders are heavily betting on technologies such as high pressure RTM, prepreg lay-up and continuous fiber reinforced thermoplastics, as the figure below indicates.

Construction: Composites demand within the construction segment registered 6.2 percent growth from 2014 to 2015 in terms of the volume of shipments. Construction continues to be the second largest market for composite materials after transportation. The growth in housing starts is driving the demand of FRP bathtubs, doors, windows, panels and other applications.

Overall, U.S. housing starts grew for the sixth consecutive year, reaching approximately 1.14 million units in 2015. The growth was propelled by a continuous increase in employment, low mortgage rates and slowing house price inflation. Other major drivers for the market are the easing of lending standards and increasing funding support from state and local construction measures.

Aerospace: The aerospace industry is one of the largest and most important segments within composites. Lucintel estimates that composite materials demand in the U.S. aerospace industry

grew by 9 percent in 2015 in terms of the volume of shipments and is likely to experience similar growth in the next five years.

Composite materials consumption has increased significantly in the commercial aerospace sector. In the 1990s, aircraft contained 5 to 6 percent composite materials, whereas today's advanced aircraft programs utilize more than 50 percent composites content. Major OEMs, such as Boeing, Airbus and Bombardier, have robust plans to increase the monthly production rate of their major platforms. Boeing, the largest U.S. composite consumer in the aerospace industry, is expected to experience a 6.5 percent increase in annual commercial aircraft deliveries to 770 units in 2016.

Pipe & Tank: Demand for composite materials in the pipe and tank market declined by 5.5 percent in 2015 due to a huge drop in oil and gas activities. U.S. oil and gas companies decommissioned more than half their rigs and sharply cut investments in exploration and production. One main cause is the plunging price of oil, which decreased by more than 40 percent per barrel in 2015. According to Baker Hughes Inc., the rig count has fallen by more than 45 percent to an average of 1,026 during the first nine months of 2015.

Wind Energy: In the U.S., the total composites market in wind energy grew by 24.2 percent in 2015. Last year, the Department of Energy funded \$1.8 million for the support of research and development to improve the manufacturing, transportation and assembly of wind turbine blades larger than 60 meters. This initiative shows the United States' commitment to the development of renewable energy.

The U.S. wind energy growth is predominantly dependent on the Production Tax Credit (PTC). Approximately 6,500 megawatts (MW) of new wind capacity was anticipated to be installed by the end of 2015, which is a 34 percent increase from 2014, but still short of the record 13,124 MW installed in 2012. However, however, the industry witnessed strong federal and state incentives to invest in new wind facilities in 2015 and 2016. There are uncertainties in a PTC extension beyond 2016, which could lead to a boom and bust cycle in the market.

Opportunities and Challenges

In the next 50 years, there will be significant innovations in the composites industry as demand picks up across all market segments. Many of the innovations will be aimed at increasing performance, reducing cost and process time, and making applications more environmentally friendly.

The anticipated growth of the composites industry is likely to create a huge demand for well-trained composite technicians, engineers and designers. The skillset required today and in the future will not be same as 20 years ago, when composite parts were made using manual chopped guns, buckets and brushes. The composites industry is continuously moving toward automated manufacturing processes, such as HP-RTM, automated tape lay-up and automated fiber placement. There's also an influx of better design and simulation tools. These techniques and tools necessitate that composite designers and engineers have a deep understanding of composite materials to identify solutions for current and future challenges.

However, the composites industry struggles to attract and educate new talent. There's a huge need for universities to create undergraduate degree programs focused on the design, testing, manufacturing and repair of composites. The challenge for companies is not only to attract young graduates but also to retain existing skilled technicians and designers. Lucintel envisions

an emergence of training institutes in next five years to develop skilled laborers for the composites industry.

Another challenge for the composites industry has been its inability to leverage its potential. Composites account for only about 1 percent of the total structural materials market by volume. This provides ample opportunity to grow in various industries by replacing traditional materials, such as steel and aluminum. The industry needs to work on four areas to drive growth and thus gain a competitive edge over traditional materials:

1. **Education to engineers and designers** about the benefits and use of composites for mass volume markets. Most engineers are unaware of the advantages of composites and still rely on black metal for structural applications. Educating engineers is the first step toward designing innovative parts in new applications.
2. **Development of a cradle-to-grave infrastructure**, thereby addressing composites repair and recycling issues.
3. **Development of a mature advanced manufacturing process** targeting one to two minutes cycle time for mass volume markets where high cycle time is critical. Most current composite part manufacturing processes are either completely manual or partially automated and don't meet the required cycle times.
4. **Reduction in the price of advanced fibers and parts** to make them competitive with steel and aluminum parts. Most of the major markets for composites are highly cost sensitive. The high price of composites, especially carbon fibers, restricts potential leverage in many applications. For example, automotive OEMs demand carbon fiber within the range of \$5 per pound, whereas the current price is approximately \$10 to \$15 per pound for automotive applications. Industry leaders are working on alternative precursors and advancements in manufacturing processes to curb material costs and reduce the overall energy cost with the ultimate goal of producing low-cost carbon fiber.

Overall, Lucintel is optimistic about the composites industry for 2016 and beyond. If all major players in the industry work together – researchers, suppliers and manufacturers – the future is bright.