

# **Carbon Fiber Composites Market - Global Industry Size, Share, Trends, Opportunity, and Forecast, 2018-2028 Segmented By Matrix Material (Polymer, Carbon, Ceramics, Metal, Hybrid), By End Use (Aerospace, Automotive, Wind Turbines, Sport & Leisure, Civil Engineering, Marine, Others), By Region and Competition**

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## **Abstracts**

Global Carbon Fiber Composites Market has valued at USD 2.23 billion in 2022 and is anticipated to project robust growth in the forecast period with a CAGR of 6.50% by 2028. Carbon Fiber Composites is a slender, elongated material composed predominantly of carbon elements. These carbon elements are organized in tiny crystals, typically oriented in parallel along the fiber's length. Carbon fiber, also referred to as graphite fiber, is a type of polymer. It is renowned for its exceptional strength-to-weight ratio, surpassing that of steel. This outstanding attribute makes it a preferred choice for fabricating various components, including sporting equipment, automotive parts, aircraft body structures, and more.

### **Key Market Drivers**

#### **Rising Demand of Carbon Fiber Composites in Aerospace Industry**

The aerospace industry has always been at the forefront of innovation, constantly pushing the boundaries of technology and materials to improve performance, reduce weight, and enhance fuel efficiency. In recent years, carbon fiber composites have emerged as a game-changer in this industry. These lightweight, high-strength materials have revolutionized aircraft design and manufacturing, leading to improved aircraft

performance, reduced emissions, and enhanced passenger safety. One of the paramount challenges faced by the aerospace industry is the need to reduce aircraft weight without compromising structural integrity and safety. Carbon fiber composites have become instrumental in achieving this goal. Traditional aluminum structures are being replaced by carbon fiber-reinforced composites in critical components such as wings, fuselages, and empennages. These composites are significantly lighter than their metal counterparts, resulting in fuel savings, extended range, and reduced operating costs. The demand for fuel-efficient aircraft, driven by environmental concerns and the desire to cut operational expenses, has fueled the rapid adoption of carbon fiber composites. Aircraft components are subjected to extreme conditions, including fluctuating temperatures, high-pressure altitudes, and intense vibrations. Carbon fiber composites offer exceptional strength-to-weight ratios, making them ideal for withstanding these harsh operational environments. The high tensile strength and durability of carbon fiber composites ensure that critical structures can withstand stress and fatigue, increasing the safety and reliability of aircraft. As a result, aircraft manufacturers are increasingly turning to these materials to enhance the structural integrity and longevity of their products.

Moreover, carbon fiber composites allow for more flexible and aerodynamically efficient designs. Their malleability and ability to be molded into complex shapes enable engineers to create sleeker, more streamlined aircraft with reduced drag. This, in turn, leads to improved fuel efficiency and reduced emissions. Moreover, carbon fiber composites offer superior resistance to corrosion, a common issue with aluminum structures, further contributing to improved aircraft performance and longevity. Advancements in composite manufacturing technologies have played a pivotal role in meeting the aerospace industry's demand for carbon fiber composites. Automated layup processes, such as Automated Fiber Placement (AFP) and Automated Tape Layup (ATL), have revolutionized the production of composite components. These technologies enable precise placement of carbon fiber layers and reduce human error, resulting in consistently high-quality parts. Additionally, the development of out-of-autoclave (OOA) curing methods has further streamlined composite manufacturing, reducing production time and costs.

Furthermore, environmental sustainability has become a driving force in the aerospace industry. Airlines are increasingly conscious of their carbon footprint and are seeking ways to reduce emissions. Carbon fiber composites play a significant role in this endeavor. By enabling lighter aircraft, these materials reduce fuel consumption and greenhouse gas emissions. Additionally, the extended lifespan and corrosion resistance of carbon fiber composites contribute to a reduction in waste and aircraft disposal,

further aligning with sustainability goals, leading to the demand of market in the forecast period.

### Increasing Demand of Carbon Fiber Composites in Automotive Industry

The automotive industry is experiencing a transformative shift as the demand for cleaner, lighter, and more fuel-efficient vehicles continues to rise. At the forefront of this transformation are carbon fiber composites, a game-changing material that is redefining the way cars are designed, manufactured, and driven. Perhaps the most compelling reason for the increasing demand for carbon fiber composites in the automotive industry is the pursuit of lightweighting. Reducing a vehicle's weight directly translates to improved fuel efficiency, enhanced performance, and reduced emissions. As governments worldwide tighten regulations on emissions and fuel economy standards become more stringent, automakers are turning to carbon fiber composites to meet these requirements. These advanced materials offer a remarkable strength-to-weight ratio, making them an ideal choice for replacing heavier metal components. The rapid growth of electric vehicles (EVs) has accelerated the adoption of carbon fiber composites in the automotive sector. EV manufacturers rely on lightweight materials to maximize battery range and efficiency. Carbon fiber composites significantly reduce the overall weight of EVs, allowing for larger battery packs and longer driving ranges. Additionally, these materials are integral to EV safety structures, ensuring the protection of passengers and sensitive battery systems in the event of an accident. Carbon fiber composites are not only about weight reduction but also about enhancing safety. These materials have excellent energy absorption properties, making them ideal for reinforcing critical safety structures in vehicles. From crumple zones to roll cages, carbon fiber composites can be strategically integrated into a vehicle's design to improve crashworthiness. The demand for safer vehicles, coupled with the lightweight advantage, positions carbon fiber composites as a pivotal solution in the pursuit of enhanced automotive safety.

Moreover, the automotive industry is increasingly focused on sustainability and reducing its environmental footprint. Carbon fiber composites, while known for their energy-intensive manufacturing process, have taken strides in becoming more eco-friendly. Research and development efforts are underway to improve the sustainability of carbon fiber production, including the development of recycled and bio-based carbon fibers. Automakers are keen to adopt sustainable materials, aligning with their commitment to eco-conscious manufacturing and meeting consumer demands for greener vehicles. Carbon fiber composites are not limited to structural components but have also made their way into automotive interiors. These materials are used to create luxurious and

high-tech interiors, featuring carbon fiber trim, dashboards, and even seats. The visual appeal, combined with the lightweight properties, has led to the incorporation of carbon fiber composites in luxury and high-end vehicles. Consumers are increasingly valuing premium interiors, further driving the demand for these materials.

Furthermore, the automotive industry has witnessed significant advancements in manufacturing technologies that facilitate the integration of carbon fiber composites into vehicle production. Automated manufacturing processes, including automated fiber placement and tape laying, have streamlined the production of carbon fiber components. This automation not only reduces production costs but also ensures consistent quality, making it more feasible for automakers to incorporate these materials into their vehicles.

### Rising Demand of Carbon Fiber Composites in Wind Turbine Industry

The wind turbine industry has emerged as a beacon of hope in the quest for clean, renewable energy. As the world grapples with climate change and the need to transition to sustainable energy sources, wind energy has gained prominence. Wind turbines are symbols of sustainability, harnessing the power of the wind to produce electricity without greenhouse gas emissions. Carbon fiber composites align seamlessly with this sustainability ethos. They are vital components in the construction of wind turbine blades, tower structures, and nacelles, contributing to lighter, more durable, and longer-lasting wind turbines. The demand for wind energy continues to grow, and carbon fiber composites are instrumental in making this renewable resource more efficient and environmentally friendly. One of the key drivers of carbon fiber composite demand in the wind turbine industry is the trend towards larger and more efficient turbine blades. Longer blades capture more wind energy, resulting in higher energy output. However, with increased size comes the need for materials that can withstand immense forces while remaining lightweight. Carbon fiber composites offer the ideal solution. Their high strength-to-weight ratio allows for the construction of longer blades without compromising structural integrity. As the wind industry seeks to maximize energy capture and reduce the levelized cost of electricity (LCOE), longer blades powered by carbon fiber composites have become a focal point.

Moreover, the performance of wind turbine blades is paramount to energy production. Carbon fiber composites offer several advantages that directly impact performance. They exhibit excellent fatigue resistance, allowing blades to endure the stress of continuous wind exposure over their operational lifespan. Moreover, these materials maintain their structural integrity under varying weather conditions, ensuring consistent

energy generation. The demand for efficient and high-performance wind turbines has led to an ever-increasing reliance on carbon fiber composites in blade construction.

Furthermore, wind turbine components must often be transported to remote and challenging locations, making weight a critical factor. Carbon fiber composites contribute significantly to reducing the overall weight of wind turbine components, facilitating easier transportation and installation. Lighter blades and tower sections can be transported more efficiently, lowering logistical costs, and minimizing the environmental footprint of transportation. Along with this, as the demand for wind energy continues to surge, wind turbine sizes are reaching new heights. Offshore wind farms are seeing the deployment of massive turbines with ever-increasing blade lengths. Carbon fiber composites are instrumental in enabling the construction of these colossal turbines. These materials provide the necessary strength and stiffness to withstand the harsh marine environment while also ensuring that the turbines remain lightweight for efficient operation.

### Key Market Challenges

#### High Production Costs and Supply Chain Vulnerabilities Poses a Significant Obstacle to Market Expansion

One of the most prominent challenges in the carbon fiber composites market is the high cost of production. Carbon fiber-reinforced composites are manufactured through intricate and energy-intensive processes, involving precursor materials, high-temperature treatments, and specialized equipment like autoclaves. The expense of raw materials, such as carbon fibers and epoxy resins, further contributes to the high production costs. To remain competitive, the industry must find innovative ways to reduce manufacturing expenses without compromising product quality. This includes exploring alternative precursor materials, optimizing manufacturing processes, and adopting cost-effective curing methods like out-of-autoclave (OOA) techniques.

Moreover, the carbon fiber composites supply chain is susceptible to disruptions, including fluctuations in raw material availability and geopolitical factors affecting trade. Carbon fibers, a key component, are sourced from a limited number of suppliers globally, which can lead to supply chain vulnerabilities. Manufacturers should establish robust supply chain management strategies, diversify suppliers where possible, and invest in inventory management to mitigate potential disruptions. Furthermore, exploring alternative sources of precursor materials and carbon fibers can enhance supply chain resilience.

## Standardization and Certification

Ensuring the quality and reliability of carbon fiber composites is essential, especially in safety-critical industries like aerospace. Standardization and certification processes can be complex and time-consuming. Manufacturers must navigate various industry-specific standards and regulations to meet the requirements of their target markets. Additionally, certifying new materials and processes can be costly and time-intensive. Collaborative efforts between industry associations, government agencies, and manufacturers are essential to streamline certification processes, promote uniform standards, and reduce the burden on manufacturers.

Moreover, the carbon fiber composites market is highly competitive, with numerous manufacturers vying for market share. While competition drives innovation, it also exerts downward pressure on prices, which can impact profitability. To thrive in this competitive landscape, companies must focus on product differentiation, innovation, and cost-efficiency. Developing new composite formulations, exploring niche markets, and enhancing production capabilities are essential strategies for staying ahead of the competition. Collaboration with research institutions and industry partners can also yield valuable insights and foster innovation.

Additionally, achieving the desired material performance characteristics, such as strength, stiffness, and durability, can be a significant challenge. The composite industry is continually seeking ways to optimize material properties to meet specific application requirements. This involves tailoring fiber orientations, resin systems, and curing processes to enhance performance. Advancements in computational modeling and simulation tools are aiding in the design and optimization of composite structures. Material testing and characterization are crucial for understanding the behavior of carbon fiber composites under various loading and environmental conditions.

## Key Market Trends

### Advancements in Manufacturing Technologies

Continuous advancements in manufacturing technologies are revolutionizing the carbon fiber composites market. Traditional methods of producing carbon fiber composites, such as autoclave curing, are being complemented by emerging techniques like out-of-autoclave (OOA) curing and automated fiber placement (AFP). OOA curing methods offer cost savings and shorter production cycles, making carbon fiber composites more

accessible to various industries. Automated manufacturing processes, including 3D printing and robotic lay-up, are improving production efficiency, and reducing material wastage.

Moreover, the automotive industry is undergoing a significant transformation driven by the pursuit of lightweighting, improved fuel efficiency, and reduced emissions. Carbon fiber composites are playing a pivotal role in achieving these objectives. Automakers are increasingly incorporating carbon fiber-reinforced composites in vehicle structures, chassis, and interior components to reduce overall weight without compromising safety or performance. This trend is particularly evident in high-performance and electric vehicles where the lightweight properties of carbon fiber composites help extend the driving range and enhance handling.

### Sustainable and Eco-Friendly Composites

Sustainability is becoming a central theme in the carbon fiber composites market. Manufacturers are actively working to reduce the environmental impact of production processes and materials. Recycled carbon fibers and bio-based resins are gaining prominence as sustainable alternatives. These eco-friendly composites not only reduce carbon footprints but also cater to the growing demand from environmentally conscious consumers and industries. As sustainability continues to influence purchasing decisions, the adoption of such materials is expected to rise.

Moreover, the renewable energy sector, particularly wind energy, is another area where carbon fiber composites are making substantial inroads. Wind turbine blades, which need to be both lightweight and durable, are increasingly being constructed using these materials. Carbon fiber composites offer an excellent balance between weight reduction and structural integrity, enabling larger and more efficient wind turbine designs. As the global focus on clean energy intensifies, the demand for carbon fiber composites in the wind energy sector is expected to soar.

### Expansion of Carbon Fiber Composites in Construction

The construction industry is experiencing a paradigm shift with the integration of carbon fiber composites in various applications. These composites are increasingly used in reinforcing concrete structures, providing higher strength and durability. Carbon fiber-reinforced concrete is being employed in bridges, buildings, and other infrastructure projects to extend their lifespan and reduce maintenance costs. Furthermore, carbon fiber composites are gaining traction in architectural designs, offering lightweight and

visually appealing solutions.

Furthermore, the demand for lightweight and high-strength materials in the aerospace sector is relentless, with aircraft manufacturers increasingly adopting carbon fiber composites to reduce weight and improve fuel efficiency. The use of carbon fiber-reinforced composites in aircraft components, such as fuselages, wings, and interior structures, has become commonplace. Moreover, the rising demand for commercial aircraft, including fuel-efficient models has further accelerated the adoption of carbon fiber composites in the aerospace sector.

## Segmental Insights

### Matrix Material Insights

Based on the category of matrix material, polymer emerged as the dominant player in the global market for carbon fiber composites in 2022. In the realm of polymer materials, the polymer segment has emerged as the largest, driven by its widespread demand across various end-user applications. Notably, thermosetting polymers have witnessed substantial adoption, particularly within the defense industry, owing to their myriad advantages. The defense sector has harnessed the potential of thermosetting polymers for diverse applications, a trend mirrored in the aerospace industry. These materials offer distinct advantages, including an exceptional adhesive quality that results in a premium surface finish. The end products produced through the application of thermosetting polymers have garnered significant attention and interest from prospective global consumers.

Moreover, the metal segment is poised for growth, primarily due to the diverse advantages it brings, including fire and radiation resistance, as well as heightened transverse stiffness and strength. These qualities make these materials highly desirable, especially in demanding sectors like aerospace. For example, reinforced metal matrices offer specific mechanical properties that conventional metals lack, rendering them well-suited for aerospace applications. For instance, reinforced aluminum is utilized to manufacture composites that exhibit 30-40% greater rigidity and strength compared to unalloyed aluminum, a factor expected to positively influence the outlook of this segment.

### End Use Insights

Based on the category of end use, aerospace emerged as the dominant player in the



global market for carbon fiber composites in 2022. In the aerospace industry, carbon-fiber-based composites find essential applications in the production of various aircraft components, including clips, cleats, brackets, ribs, struts, stringers, chips, wing leading edges, and specialized parts. Additionally, there is ongoing exploration of these composites for use in larger structures such as wing torsion boxes and fuselage panels. The defense industry also leverages carbon composites for applications in missile defense, ground defense, and military marine systems. In recent years, the adoption of carbon composites in aerospace manufacturing has experienced rapid growth due to their ability to meet specific requirements such as weight reduction, exceptional resistance properties, insulation capabilities, and radar absorption. These composites consist of carbon fibers embedded in a carbon matrix, offering the additional benefit of reduced maintenance costs as they are immune to rust and corrosion.

Furthermore, these materials contribute to overall weight reduction in aircraft, leading to decreased aviation fuel consumption and enabling airplanes to achieve extended flight ranges and increased passenger capacities. This is primarily attributed to their impressive strength-to-weight ratio compared to traditional metals. The expanding investments in research and development (R&D) focused on advanced composite materials by major aerospace players, including industry leaders like The Boeing Company, General Electric Company, and Airbus SE, are pivotal factors bolstering the growth of the carbon composites market.

## Regional Insights

Asia Pacific emerged as the dominant player in the global Carbon Fiber Composites market in 2022. The growth in the region is primarily attributed to the increasing production and sales of vehicles. Additionally, the rising purchasing power of consumers, the expansion of cargo transport, growing passenger travel, increased frequency of air flights, and the availability of discounts from vehicle manufacturers are expected to be key drivers of market growth in this region.

Moreover, the demand for carbon fiber composite materials is expected to experience rapid growth in this region, driven by the substantial aircraft manufacturing activities taking place here. With the global increase in air travel, there has been a significant expansion of air routes worldwide to manage the growing passenger traffic. Key market players are actively engaged in continuous research and development programs, collaborating with aircraft manufacturers to introduce advanced materials into the market. These efforts aim to enhance the functionality and operational capabilities of aircraft.

Additionally, Europe secured the largest market share in the projected year, driven by substantial demand from the aerospace & defense and wind energy sectors. The region also serves as the headquarters for several key aerospace composite manufacturers, such as SGL Carbon, Solvay, and TenCate. The consistent growth in Airbus aircraft deliveries has led to a substantial increase in the demand for composite materials in Europe. Additionally, the region's production of military aircraft and helicopters contributes to its market prominence.

### Key Market Players

Toray Industries Inc

SGL Carbon SE

Mitsubishi Chemical Carbon Fiber and Composites, Inc.

Hexcel Corporation

Rock West Composites, Inc.

Teijin Limited

Solvay S.A.

DowAksa Advanced Composites Holdings BV

Nippon Graphite Fiber Co., Ltd.

Hyosung Advanced Materials

### Report Scope:

In this report, the Global Carbon Fiber Composites Market has been segmented into the following categories, in addition to the industry trends which have also been detailed below:

**Carbon Fiber Composites Market, By Matrix Material:**

Polymer

Carbon

Ceramics

Metal

Hybrid

Carbon Fiber Composites Market, By End Use:

Aerospace

Automotive

Wind Turbines

Sport & Leisure

Civil Engineering

Marine

Others

Carbon Fiber Composites Market, By Region:

Asia-Pacific

China

India

Australia

Japan

South Korea

Europe

France

Germany

Spain

Italy

United Kingdom

North America

United States

Mexico

Canada

South America

Brazil

Argentina

Colombia

Middle East & Africa

South Africa

Saudi Arabia

UAE

Competitive Landscape

*Carbon Fiber Composites Market - Global Industry Size, Share, Trends, Opportunity, and Forecast, 2018-2028 Seg...*

Company Profiles: Detailed analysis of the major companies present in the Global Carbon Fiber Composites Market.

Available Customizations:

Global Carbon Fiber Composites Market report with the given market data, Tech Sci Research offers customizations according to a company's specific needs. The following customization options are available for the report:

Company Information

Detailed analysis and profiling of additional market players (up to five).

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