Major Lightweighting Trends Shaping the Automotive Industry

Lucintel Brief

Published: December 2020
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• Future Lightweight Technologies
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Executive Summary

- The outlook for light weight materials and composites look strong in automotive industry
  - Global lightweight materials demand is expected to reach 129 billion lbs in 2025 with a CAGR of ~4.4%
  - Global sales for automotive parts made with composites such as hood, roof, fender, etc. is likely to reach $30 Bn in 2025 with CAGR of ~2.4%

- Automotive production has been hit hard and global market is forecast to drop by 20% to 30% in 2020. Major OEMs had halted the production of vehicles in the fight against Covid-19

- Automotive industry relies heavily on cross-border shipments of parts for car manufacturing, and government restrictions on international trade has affected the automotive industry supply chain

- Carbon fiber composites offer good business case for OEMs and Tier 1 for light weight solutions – depicted by BMW and Plasan case studies
  - Increasing usage of carbon fiber in various BMW models, such as BMW M3, BMW M4, BMW i8, & BMW i3. Production of i8 has been stopped which is likely to affect the demand for carbon fiber composites in future

- Major market disruptions are expected in cost reduction, productivity and mass customization to drive competitiveness of composites
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Carbon Fiber Parts are Gaining Momentum but Mostly in High End Cars

Some of the OEMs using carbon fiber composites are: BMW, Audi, General Motors, Ford, Toyota, Ferrari, Lamborghini, and Volkswagen.

Carbon fiber composites are mostly used in high end cars, such as Lexus LFA, Mustang, R8 Spyder, Aventador LP700-4, etc.
# Key Lightweight Technologies Used to Manufacture Automotive Parts

<table>
<thead>
<tr>
<th>Key Applications (Process)</th>
<th>HSS/AHSS</th>
<th>Aluminum</th>
<th>Glass Composites</th>
<th>Carbon Composites</th>
<th>Natural Composites</th>
<th>Magnesium</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Stamping</td>
<td>• Stamping • Casting • Extrusion</td>
<td>• Compression Molding • Injection Molding • RTM</td>
<td>• Prepreg Layup • Resin Infusion (HP-RTM)</td>
<td>• Compression Molding</td>
<td>• Casting • Extrusion</td>
<td></td>
</tr>
<tr>
<td>• Usibor (A-pillar, Bumper Beam, B-Pillar, C-Pillar, Door Beam) • Fuel Tank Guard • Body in White • Door Panels • Axle Carrier • Engine Cradle • Dash Panel • Crash Box • Side Rail • Seat Frame</td>
<td>• Heat Shield, Bumpers, Hoods, and Closure Panels: (Stamping Process) • Powertrain (Engine Block, Transmission): (Casting Process) • Chassis &amp; Suspension, Heat Exchangers: (Extrusion Process)</td>
<td>• Intake Manifold: (Injection Molding) • Hood (Compression Molding) • Door Module: (Compression Molding) • Radiator End Tank: (Injection Molding) • Oil Pan: (Injection Molding)</td>
<td>• Monocoque: (Prepreg &amp; RTM Process) • Hood: (Prepreg Layup) • Door Panel: (Prepreg Layup) • Roof: (Prepreg Layup) • Body Panels: (Prepreg Layup &amp; RTM Process)</td>
<td>• Door Panel • Seat Back • Load Floor • Interior Panels • Under Body Shields</td>
<td>• Door Inner, Roof Frame, Lift Gate Inner, Pillar: (Casting Process) • Support Beam, Connectors, Side Rails: (Extrusion Process)</td>
<td></td>
</tr>
</tbody>
</table>
Future Automotive Materials Will be Dominated by Lightweight Materials


<table>
<thead>
<tr>
<th>Year</th>
<th>Lightweight Materials</th>
<th>Conventional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>310</td>
<td>82%</td>
</tr>
<tr>
<td>2019</td>
<td>375</td>
<td>75%</td>
</tr>
<tr>
<td>2025</td>
<td>424</td>
<td>70%</td>
</tr>
</tbody>
</table>

- **2010**: 82% Lightweight Materials, 18% Conventional Materials
- **2019**: 75% Lightweight Materials, 25% Conventional Materials
- **2025**: 70% Lightweight Materials, 30% Conventional Materials

**CAGR (2019-2025):**
- HSS (>550 Mpa): 6.1%
- Aluminum: 3.9%
- Plastics: 2.3%
- CFRP: 5.1%
- Other Composites: 2.0%
- Magnesium: 7.9%

Source: Lucintel
Emission Reduction Targets in the Global Automotive Industry

Source: ICCT

97 g/km of CO₂ = 54.5 mpg

Source: ICCT
In Highway Driving, 10% Weight Saving Gives about 7% Fuel Saving

Sample Size: 34 (Data from recent OEM makes)

Source: Lucintel
On City Driving, 10% Weight Saving Gives about 11% Fuel Saving

**y = -0.0082x + 49.935**

R² = ~0.90

**Sample Size: 34 (Data from recent OEM makes)**

**Source:** Lucintel
Advanced Materials Offer Considerable Weight Savings at High Costs

### Structural Application

<table>
<thead>
<tr>
<th>Material</th>
<th>Relative Part Weight</th>
<th>Relative Part Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>AHSS</td>
<td>75%-90%</td>
<td>120%-140%</td>
</tr>
<tr>
<td>Aluminum</td>
<td>50%-60%</td>
<td>150%-230%</td>
</tr>
<tr>
<td>CFRP</td>
<td>25%</td>
<td>700%-900%</td>
</tr>
</tbody>
</table>

### Non Structural Application (Fender)

<table>
<thead>
<tr>
<th>Material</th>
<th>Relative Part Weight</th>
<th>Relative Part Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>AHSS</td>
<td>75%-90%</td>
<td>110%-130%</td>
</tr>
<tr>
<td>Plastics</td>
<td>75%-80%</td>
<td>100%-110%</td>
</tr>
<tr>
<td>Aluminum</td>
<td>50%-60%</td>
<td>120%-140%</td>
</tr>
<tr>
<td>CFRP</td>
<td>30%-50%</td>
<td>500%-700%</td>
</tr>
<tr>
<td>RTM</td>
<td>75%-80%</td>
<td>100%-110%</td>
</tr>
</tbody>
</table>

**Drivers**

- **CAFÉ Requirement**
- **CO₂ Emission**

Source: Lucintel
Opportunities for Lightweight Materials in terms of Fuel Saving and CO2 emission Saving Potential

<table>
<thead>
<tr>
<th>Material</th>
<th>Weight Reduction (of Total Vehicle Weight)</th>
<th>Fuel Saving ($) (Life Time Saving Per Vehicle)</th>
<th>CO2 Emission Saving (Gram/km Per Vehicle)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSS/AHSS</td>
<td>@20%: 2.5% @40%: 4.9%</td>
<td>@20%: $170 @40%: $340</td>
<td>@20%: 4.4 @40%: 8.9</td>
</tr>
<tr>
<td>Aluminum</td>
<td>@20%: 9.3% @40%: 18.7%</td>
<td>@20%: $641 @40%: $1,283</td>
<td>@20%: 16.8 @40%: 33.6</td>
</tr>
<tr>
<td>Glass Composites</td>
<td>@20%: 7.5% @40%: 15.1%</td>
<td>@20%: $518 @40%: $1,036</td>
<td>@20%: 13.6 @40%: 27.2</td>
</tr>
<tr>
<td>Carbon Composites</td>
<td>@20%: 21.0% @40%: 42.0%</td>
<td>@20%: $962 @40%: $1,443</td>
<td>@20%: 37.8 @40%: 75.6</td>
</tr>
<tr>
<td>Magnesium</td>
<td>@20%: 14.0% @40%: 28.0%</td>
<td></td>
<td>@20%: 25.2 @40%: 50.4</td>
</tr>
</tbody>
</table>

Source: Lucintel
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How to Grow and Develop Competitive Edge for Composites

- About 129 billion lbs lightweight materials will be used in 2025 by auto OEMs
- Purchasing decisions continue to be influenced heavily by price of the component
- To develop competitive edge in automotive market, industry needs to focus on below:
  - **Price Reduction**: Look for cost reduction in composite parts from various ways such as raw material cost, labor cost, energy cost, etc.
  - **Need for Innovative Manufacturing Technologies**: Development of transformative manufacturing technologies with reduced cycle time for manufacturing complex parts.
  - **Develop Robust Supply Chain**: Invest in developing global supply chain for raw materials, design, tooling and manufacturing for composites.
  - **Develop Better Simulation and Prediction Techniques**: Marketplace needs to come up with better simulation software for manufacturing of composite parts.
  - **Need for Investment in Repair and Recycling Technologies**: Solve OEM challenges in repair and recycling by developing cost effective technologies and infrastructure
Business Case 1: Why BMW Chose Carbon Composites

Factors Driving the Use of Carbon Composites by BMW

- A. Weight Saving
- B. Emission Reduction
- C. Part Consolidation
- D. Strength and Safety gains
- E. Efficiency Improvement

Strategies Adopted by BMW to Ensure Effective Usage of CF Materials

- BMW & SGL jointly invested to establish carbon fiber manufacturing plant at Moses Lake
- The facility supplies CF and preforms for BMW i vehicles & 7 series
- This strategy helps BMW to have control over CF prices

Challenges to adopt Carbon Fiber

- High Cost of carbon fiber restricts its usage in high volume vehicles
- Continuous availability
- High cycle time
Increasing Usage of Carbon Fiber will Significantly Cut Vehicle Mass

Weight Saving in BMW Cars with Increasing Usage of Carbon Fiber

<table>
<thead>
<tr>
<th>Vehicle Mass (lbs.)</th>
<th>BMW M3</th>
<th>BMW M4</th>
<th>BMW i8</th>
<th>BMW i3</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,350</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,300</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,274</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,634</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CF Applications in BMW Car Models

- Driveshaft-M4
- Roof-BMW M3
- Trunklid-BMW M4
- Life Module-BMW i3 & i8

Note: 5% weight reduction in new BMW M3 and M4 model over its predecessors with the use of CF

Source: Lucintel
High Usage of Carbon Fiber in EVs Offers Significant Weight Saving and Improved Mileage

**Mileage Comparison**

- **Tesla Model S**
- **Nissan Leaf**
- **BMW i3**

High CF content in BMW i3 has improved its mileage

**Price Comparison**

- **Tesla Model S**
- **Nissan Leaf**
- **BMW i3**

BMW i3 price lies in between the two models & offers high weight saving and mileage which makes it more competitive

**Weight Comparison**

- **Tesla Model S**
- **Nissan Leaf**
- **BMW i3**

Note: MPGe (Miles per gallon gasoline equivalent)

Source: Lucintel
Business Case 2: Plasan Revenue Increased 20 Times in Five Years from Carbon Composites

Plasan: Revenue Analysis (2011-2025)

Company Introduction

- **Plasan Carbon Composites** is a carbon fiber component manufacturer, mainly for the automotive industry.

- Company transformed itself from low volume producer of composites components to high volume carbon composites part supplier in 10 years.

- Company targeting to achieve $150 million in 2025 from $5 million in 2011.

- Company is continuously developing carbon composites parts for OEMs offering weight saving solutions.

Source: Lucintel
Voice of the Market: Need for Light Weight Options with Good Business Case

Our top management is asking us to reduce weight by almost 50% in various platforms. We are looking into various material options. Significant weight saving potential is available in closure panels such as door panels, deck lids, and hood. We encourage component and material suppliers to come up with better solutions for our vehicle.

Product Manager, Chrysler

Cost is a challenge with bio-composites as most users are not willing to pay a premium. Scale-up is needed for bio-composite materials for better economics.

Materials Research, Ford Motors

There is an increasing demand for low density materials in automotive and commercial vehicle market. We are continuously working to develop products with lower density using different combinations of raw materials. We are closely working with Tier 1 players and also OEMs to identify the future of new materials in structural and semi structural automotive applications.

Director, Menzolit
Voice of the Market: COVID has Impacted the Production and Sales in the Automotive Industry

“We are evaluating all material options such as AHSS, Aluminum, Magnesium, Glass Composites and Carbon Composites for making automotive parts. Any material option should have a good business case without sacrificing safety, part count, and other requirements. We have closed all our facilities till 30th March, but now we will extend it for some more time. We are expecting a decline of 30% in our production & sales for the year 2020, if the situation gets worse. We are reviewing and evaluating the situation on a weekly basis”

Manager, GM

“Operations have been affected for JLR (Jaguar Land Rover). We have suspended our operation in UK till 20th of April, due to the outbreak of coronavirus. We expect significant decline in the revenue for the year 2020.”

JLR, UK

“Overall automotive business is growing at a slow pace and facing a decline of 40% to 50% currently. We are facing today are reaching out to the people for new projects and supply of raw material is also limited. Industry will face challenge of high prices of raw material due to transportation factor. As per the current market situation we are expecting that the prices will go up by 20% in near future”

Plasan Carbon Composites, USA
Voice of the Market: Material and Component Suppliers Need to Develop Better Lightweight Solutions

Government in North America has passed mandatory regulations, i.e. CAFÉ standards to improve the fuel economy. In order to improve the fuel economy, we need to work on the weight reduction in our trucks. We are looking into composites and other material options for making of our truck components.

Director, Peterbilt

We have been using composite on our components for a long time and are satisfied with its performance, though we are open to opt a newer materials offering better mechanical and aesthetic properties with lightweight. We tend to depend on component suppliers and material manufacturer for new applications for our vehicles.

Engineer, Mercedes Benz Trucks

We use many SMC components such as bumper, roof cap, cabin structure, door extensions and fenders for our Trucks. For our Bus, we use hand lay-up and RTM process to manufacture composites parts. We are looking for new materials and technologies to make various components.

Engineer, MAN SE
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**Major Disruptions are Expected to Strengthen the Competitiveness of Composites**

<table>
<thead>
<tr>
<th>Major Developments</th>
<th>Enablers</th>
<th>Impacted Industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Reduction in Carbon fiber</td>
<td>Alternative precursors, such as lignin, olefin, textile PAN, etc. Someone will launch low cost carbon fiber ($3 - $6 per lb) in future</td>
<td>• Automotive</td>
</tr>
<tr>
<td></td>
<td>Low cure resins and faster and dependable technologies. Part manufacturing process with cycle time of 1 to 2 minutes for mass production</td>
<td>• Industrial</td>
</tr>
<tr>
<td>Improvement in Productivity</td>
<td>3D printing for different composites applications especially in automotive and healthcare</td>
<td>• Aerospace</td>
</tr>
<tr>
<td>Mass Customization</td>
<td></td>
<td>• Automotive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Healthcare</td>
</tr>
</tbody>
</table>
Reduction in Carbon Fiber Costs could double Revenues from the Automotive Industry

Global Light Vehicles Production by Car Type in 2025

<table>
<thead>
<tr>
<th>Car Type</th>
<th>Forecast Production in 2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Super Cars</td>
<td>9,700</td>
</tr>
<tr>
<td>Super Luxury Cars</td>
<td>855,000</td>
</tr>
<tr>
<td>Luxury Cars</td>
<td>4.7 Million</td>
</tr>
<tr>
<td>Other/Regular Cars</td>
<td>91.9 Million</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>97.5 Million</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CF Usage in % of cars</th>
<th>Demand in M lbs</th>
<th>Demand in $M</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>2.4</td>
<td>24.3</td>
</tr>
<tr>
<td>95%</td>
<td>65.0</td>
<td>649.8</td>
</tr>
<tr>
<td>55%</td>
<td>65.1</td>
<td>651.3</td>
</tr>
<tr>
<td>3%</td>
<td>4.1</td>
<td>41.1</td>
</tr>
</tbody>
</table>

**Expected Demand of CF @ Current Price in 2025**

**Expected Demand of CF @ $5/lb in 2025**

<table>
<thead>
<tr>
<th>CF Usage in % of cars</th>
<th>Demand in M lbs</th>
<th>Demand in $M</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>2.4</td>
<td>12.1</td>
</tr>
<tr>
<td>100%</td>
<td>128.3</td>
<td>641.3</td>
</tr>
<tr>
<td>80%</td>
<td>277.4</td>
<td>1,137.2</td>
</tr>
<tr>
<td>15%</td>
<td>138.2</td>
<td>691.0</td>
</tr>
</tbody>
</table>

**Total**

<table>
<thead>
<tr>
<th></th>
<th>CF Usage</th>
<th>Demand in M lbs</th>
<th>Demand in $M</th>
</tr>
</thead>
<tbody>
<tr>
<td>136.1</td>
<td>1,366.5</td>
<td>496.3</td>
<td>2,481.6</td>
</tr>
</tbody>
</table>

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Conclusions – How Companies Should Prepare

- About 129 billion lbs light weight materials will be used in 2025 by auto OEMs.
- Although current costs for Carbon fiber composites are high, they represent good business opportunities in terms of offering light-weight solutions.
- Demand for carbon composites in the automotive industry is expected to continue to grow based on innovations in materials, technologies and applications in combination with continued cost reductions
- To develop competitive edge in automotive composites, marketplace needs to invest in cost reduction, technology development, simulation, repair, recycling and robust supply chain development.
- Companies in the composites industry need to have clear strategies and objectives for how they want to compete (what materials, applications, segments, technology, etc.)
- Lucintel can help you define and implement a strategy designed to grow your business, more specifically to:
  - **Identify and evaluate attractive opportunities:** Develop dynamic understanding of the relevant market segments you target where you should compete, broken down by segment, application, technology and region. What gaps exist to realize full potential? Also, to develop a short list of specific investment opportunities
  - **Finance your Growth:** Help you secure the financing needed to implement your chosen strategy
Appendix: About Lucintel and Case Study for Growth
Lucintel - At a Glance

- Premier management consulting and market research firm. Founded in 1998.
- Deep global insights into major industries. Team of over 120 analysts / consultants across globe
- Management comprised of PhDs, MBAs, and subject matter experts. Headquarter in Dallas, USA.

Conducted 500+ consulting projects across industries for 3M, Audi, Dupont, Carlyle, GE, etc.

Consulting Services
- Opportunity screening
- Market entry strategy
- Supply chain analysis
- Growth finance
- Strategic consulting
- Competitive assessment
- Due diligence
- M & A services

Why Lucintel
- Clients we serve: Over 1000 clients from 70 countries – Fortune 500 companies
- Strategic advice: Over 20 years of proven global strategic management consulting experience
1000+ Clients in 70 Countries Value Our Service
Case Study 1: Growth Opportunity for a Leading Prepreg Manufacturer

Challenge

- A leading prepreg supplier wanted to know about the opportunity for glass and carbon fiber prepreg in Europe and North America across various sectors

Objectives

- To estimate growth opportunities for glass and carbon fiber prepreg across sectors including rail, marine, construction, automotive, defense, infrastructure, and sporting goods in NA and Europe
- Find out prepreg consumption by molders in each sector by application and prepreg type
- Conduct Voice of Market analysis and Go To Customer List in North America and Europe

Solutions

- Lucintel identified the most attractive target applications in each region for the client based on the client’s core competency
- Lucintel conducted interviews with >700 companies to find out their prepreg consumption patterns and provided Go To Customer List of >250 molders
- Lucintel developed short, medium & long term strategy in the most attractive markets with action plan

Results

- The company’s sales for the relative growth segments grew by 25% over 2 years
Case Study 2: Growth Opportunity for a Leading Pipe Manufacturer in Composite Pipes

**Challenge**

- A leading FRP pipe manufacturer in the US wanted to know about the opportunity existing for them in composite pipes applications in the US and Canada

**Objectives**

- To identify total opportunity for FRP pipe and steel pipes
- Identify the addressable market (new/replacement) for FRP pipes for the client based on their core competencies (Diameter, pressure rating, etc.)
- Conduct market share analysis, price vs performance analysis with competing materials, customer identification, and customer requirement analysis in various diameter ranges

**Solutions**

- Lucintel identified addressable market opportunity based on client core competencies and looked into competing materials performance over the last 10 years
- Lucintel provided Go To Customer List with **$50 million dollar sales opportunity in next 10 years**
- Lucintel developed short, medium and long term strategy with detail actionable plan

**Results**

- The **company’s sales** grew by **35%** over **2 years**
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