How to Win in the Automotive Market with Composites

PRESENTED TO

ASC Convention

PRESENTED BY/DATE

Sanjay Mazumdar, CEO, Lucintell / April 4, 2017
Table of Content

- Lucintel Background
- Executive Summary
- Future Lightweight Technologies
- Business Case for Carbon Composites
- Conclusion
Lucintel’s Expertise in Unlocking Your Potential

• Founded in 1998. Team of over 100 full time analysts and consultants - some past employees of McKinsey and Bain

• Management consulting firm (M & A, market entry, growth consulting) of choice for the composites industry with deep expertise in materials, technology & market

• Done over 200+ consulting projects in the composites. Subject matter expertise

• Great networking - over 20,000 contacts

• Strong testimonials in consulting and market research
  
  ‒ “I was very happy with Lucintel’s work. It helped us in making a confident investment decision. They delivered the project in a timely manner.” – Dave Finley, Managing Director, Sverica
1000+ Clients in 70 Countries Value Our Service
About Speaker

Sanjay Mazumdar, PhD.
CEO, Author, Thought Leader & Strategist

• Offered advisory services (M & A, market entry, growth consulting, due diligence) to hundreds of clients over 15+ yrs.
• Subject matter expert in the chemical and advanced materials market
• Worked for General Motors in ultra-lightweight project and received 2 Record of Inventions
• Awarded two Society of Plastics Engineers Awards and one DuPont Plunkett Award
• Sought-after speaker at conferences and annual board meetings, helping companies with their growth objectives. Panelist at conferences with industry leaders (Airbus, Boeing, Owens Corning, Core Molding, etc.)
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Executive Summary

• Lightweight materials market in the global automotive industry is expected to reach 221 billion lbs ($335 billion) in 2025, growing at a CAGR (2016-2025) of 7%

• Composites offer significant weight saving potential but comes with challenges

• Global opportunity for automotive parts made with composites such as hood, roof, fender, etc. is likely to reach $27.7 Bn in 2021 with a CAGR of 5.8% in the next 6 years

• Carbon fiber composites offer good business case for OEMs and Tier 1 for lightweight solutions – depicted by BMW and Plasan case studies

• Potential for carbon composites could be huge in automotive industry if the industry is able to drive innovations in materials and technologies
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### Key Lightweight Technologies Used to Manufacture Automotive Parts

#### HSS/AHSS
- Stamping
- 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

#### Aluminum
- Stamping
- Casting
- Extrusion
- Heat Shield, Bumpers, Hoods, and Closure Panels: *(Stamping Process)*
- Powertrain (Engine Block, Transmission): *(Casting Process)*
- Chassis & Suspension, Heat Exchangers: *(Extrusion Process)*

#### Glass Composites
- Compression Molding
- Injection Molding
- RTM
- Intake Manifold: *(Injection Molding)*
- Hood (Compression Molding)
- Door Module: *(Compression Molding)*
- Radiator End Tank: *(Injection Molding)*
- Oil Pan: *(Injection Molding)*

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*Key Processes*

*Key Applications (Process)*
# Key Lightweight Technologies Used to Manufacture Automotive Parts

## Carbon Composites
- Prepreg Layup
- Resin Infusion (HP-RTM)
- Monocoque: *(Prepreg & RTM Process)*
- Hood: *(Prepreg Layup)*
- Door Panel: *(Prepreg Layup)*
- Roof: *(Prepreg Layup)*
- Body Panels: *(Prepreg Layup & RTM Process)*

## Natural Composites
- Compression Molding
- Door Panel
- Seat Back
- Load Floor
- Interior Panels
- Under Body Shields

## Magnesium
- Casting
- Extrusion
- Door Inner, Roof Frame, Lift Gate Inner, Pillar: *(Casting Process)*
- Support Beam, Connectors, Side Rails: *(Extrusion Process)*

## Key Applications (Process)

## Key Processes

Cont’d
Future Automotive Materials Will be Dominated by Lightweight Materials


CAGR (2016-2025)

- HSS (>550 Mpa): 9%
- Aluminum: 5.3%
- Plastics: 9%
- CFRP: 16%
- Other Composites: 5%
- Magnesium: 8%

Source: Lucintel
Emission Reduction Targets in the Global Automotive Industry

97 g/km of CO₂ = 54.5 mpg

Source: ICCT
OEMs focusing 15% of Fuel Saving Targets from Light Weight Materials. About 900 lbs weight saving required per vehicle

Key Insights
- To meet CAFÉ 2025 regulations automotive OEMs are looking at all different alternatives, such as powertrain improvements, powertrain electrification, design improvement, and weight reduction.
- Reduction in 10% of curb weight can reduce fuel consumption by 7%.
- To get extra fuel efficiency of 4.5 MPG, about 25% weight reduction (900 lbs) is required.
- Carbon fiber will play a vital role in achieving this mark of about 25% weight reduction in future.

Source: Lucintel, NHTSA, EPA
In Highway Driving, 10% Weight Saving Gives about 7% Fuel Saving

\[ y = -0.0071x + 55.439 \]

\[ R^2 = \sim 0.80 \]

Sample Size: 34 (Data from recent OEM makes)

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

Sample Size: 34 (Data from recent OEM makes)

$y = -0.0082x + 49.935$

$R^2 = \sim 0.90$

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

<table>
<thead>
<tr>
<th>Structural Application</th>
<th>Non Structural Application (Fender)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relative Part Weight</strong></td>
<td><strong>Relative Part Weight</strong></td>
</tr>
<tr>
<td>Steel</td>
<td>Steel</td>
</tr>
<tr>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>AHSS</td>
<td>AHSS</td>
</tr>
<tr>
<td>75%-90%</td>
<td>110%-130%</td>
</tr>
<tr>
<td>Aluminum</td>
<td>Plastics</td>
</tr>
<tr>
<td>50%-60%</td>
<td>100%-110%</td>
</tr>
<tr>
<td>CFRP</td>
<td>Aluminum</td>
</tr>
<tr>
<td>25%</td>
<td>120%-140%</td>
</tr>
<tr>
<td>50%-60%</td>
<td>120%-140%</td>
</tr>
<tr>
<td>700%-900%</td>
<td>500%-700%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Relative Part Cost</strong></th>
<th><strong>Relative Part Cost</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>Steel</td>
</tr>
<tr>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>AHSS</td>
<td>AHSS</td>
</tr>
<tr>
<td>120%-140%</td>
<td>110%-130%</td>
</tr>
<tr>
<td>Aluminum</td>
<td>Plastics</td>
</tr>
<tr>
<td>150%-230%</td>
<td>100%-110%</td>
</tr>
<tr>
<td>CFRP</td>
<td>Aluminum</td>
</tr>
<tr>
<td>700%-900%</td>
<td>120%-140%</td>
</tr>
<tr>
<td>30%-50%</td>
<td>500%-700%</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>Lightweight Materials</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>2.5% (2.5%)</td>
<td>$170 (2.5%)</td>
<td>4.4 (2.5%)</td>
</tr>
<tr>
<td></td>
<td>4.9% (4.9%)</td>
<td>$340 (4.9%)</td>
<td>8.9 (4.9%)</td>
</tr>
<tr>
<td>Aluminum</td>
<td>9.3% (18.7%)</td>
<td>$641 (9.3%)</td>
<td>16.8 (18.7%)</td>
</tr>
<tr>
<td></td>
<td>18.7% (18.7%)</td>
<td>$1,283 (18.7%)</td>
<td>33.6 (18.7%)</td>
</tr>
<tr>
<td>Glass Composites</td>
<td>7.5% (15.1%)</td>
<td>$518 (7.5%)</td>
<td>13.6 (15.1%)</td>
</tr>
<tr>
<td></td>
<td>15.1% (15.1%)</td>
<td>$1,036 (15.1%)</td>
<td>27.2 (15.1%)</td>
</tr>
<tr>
<td>Carbon Composites</td>
<td>21.0% (42.0%)</td>
<td>$1,443 (21.0%)</td>
<td>37.8 (42.0%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>75.6 (42.0%)</td>
</tr>
<tr>
<td>Magnesium</td>
<td>14.0% (28.0%)</td>
<td>$962 (14.0%)</td>
<td>25.2 (28.0%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>50.4 (28.0%)</td>
</tr>
</tbody>
</table>

*Source: Lucintel*
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Reduction in Carbon Fiber Cost would Bring 100% More Revenue ($2.7 Bil) from the Automotive Industry

Global Light Vehicles Production Forecast by Car Type in 2025

<table>
<thead>
<tr>
<th>Car Type</th>
<th>Production 2025</th>
<th>CF Usage in % of cars</th>
<th>Demand in Mlbs</th>
<th>Demand in $M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Super Cars</td>
<td>8,000</td>
<td>100%</td>
<td>1.6</td>
<td>16.0</td>
</tr>
<tr>
<td>Super Luxury Cars</td>
<td>800,000</td>
<td>95%</td>
<td>60.8</td>
<td>608.0</td>
</tr>
<tr>
<td>Luxury Cars</td>
<td>5.5 Million</td>
<td>55%</td>
<td>75.6</td>
<td>756.0</td>
</tr>
<tr>
<td>Other/Regular Cars</td>
<td>112 Million</td>
<td>3%</td>
<td>5.0</td>
<td>50.0</td>
</tr>
<tr>
<td><strong>Global Light Vehicles</strong></td>
<td><strong>118 Million</strong></td>
<td></td>
<td><strong>143.1</strong></td>
<td><strong>1,430</strong></td>
</tr>
</tbody>
</table>

Expected Demand of CF @ Current Price in 2025

<table>
<thead>
<tr>
<th>CF Usage in % of cars</th>
<th>Demand in Mlbs</th>
<th>Demand in $M</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>1.6</td>
<td>16.0</td>
</tr>
<tr>
<td>95%</td>
<td>60.8</td>
<td>608.0</td>
</tr>
<tr>
<td>55%</td>
<td>75.6</td>
<td>756.0</td>
</tr>
<tr>
<td>3%</td>
<td>5.0</td>
<td>50.0</td>
</tr>
<tr>
<td><strong>143.1</strong></td>
<td><strong>1,430</strong></td>
<td></td>
</tr>
</tbody>
</table>

Expected Demand of CF @ $5/lb in 2025

<table>
<thead>
<tr>
<th>CF Usage in % of cars</th>
<th>Demand in Mlbs</th>
<th>Demand in $M</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>2.0</td>
<td>10.0</td>
</tr>
<tr>
<td>100%</td>
<td>120.0</td>
<td>600.0</td>
</tr>
<tr>
<td>80%</td>
<td>264.0</td>
<td>1,320.0</td>
</tr>
<tr>
<td>15%</td>
<td>168.0</td>
<td>840.0</td>
</tr>
<tr>
<td><strong>554.0</strong></td>
<td><strong>2,770</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Lucintel
Major Factors Driving the Usage of Carbon Composites by BMW in its Electric Vehicles

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

- High Cost of carbon fiber restricts its usage in high volume vehicles
- Continuous availability
- High cycle time

Challenges to adopt Carbon Fiber

- 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

Solutions
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></td>
<td>3,350</td>
<td>3,300</td>
<td>3,274</td>
<td>2,634</td>
</tr>
</tbody>
</table>

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

**Price Comparison**

- Tesla Model S
- Nissan Leaf
- BMW i3

**Weight Comparison**

- Tesla Model S
- Nissan Leaf
- BMW i3

Note: MPGe (Miles per gallon gasoline equivalent)

High CF content in BMW i3 has improved its mileage.

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

Source: Lucintel
In the Last Three Years, Carbon Fiber Composites in Automotive Industry was Driven by BMW i3 and i8 Model

Global BMW i3 and i8 Sales: 2014-2016

Key Insights

- High cost of carbon fiber impact the profitability of BMW i3 and i8 models, but its make the vehicle light weight
- In last three years, carbon fiber composites in automotive industry was driven by BMW i3 and i8 models
- BMW recently is facing cost pressure from other electric vehicle suppliers, which is likely to impact the carbon fiber demand
- BMW is working on ways to reduce the cost of carbon components

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

Plasan: Revenue Analysis (2011-2020)

$ Million

+8.4%

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 2020 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

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.

Manager, GM

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: 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 light weight. 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 Future Disruptions in the Composites

<table>
<thead>
<tr>
<th>Major Disruptions</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>Improvement in Productivity</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>Mass Customization</td>
<td>3D printing for different composites applications especially in automotive and healthcare</td>
<td>• Construction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Automotive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Industrial</td>
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<td>• Automotive</td>
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<td></td>
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<td>• Healthcare</td>
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</tbody>
</table>

“Mobile phones disrupted landlines, Apple iPod disrupted music industry. Similarly, composites will disrupt traditional materials in various industries. Shift to composites will potentially help the environment, OEMs, and end users”
Conclusion

• To drive growth in automotive composites market, industry needs to focus on below:
  ➢ Partner with OEMs in innovations and new product development
  ➢ Cost reduction in composite parts
  ➢ Development of transformative technologies with reduced cycle time
  ➢ Solve OEM challenges in repair and recycling technologies

• Carbon fiber composites offer good business case in terms of light weight solutions – but there is cost pressure

• Potential for carbon composites could be huge in the automotive industry if the industry is able to drive innovations in materials and technologies to increase profitability for OEMs and Tier 1s
Appendix: Case Study for Growth
### 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
Contact Us

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