Opportunity and Challenges in Automotive Composites Industry

PRESENTED TO

Lucintel Webinar

PRESENTED BY/DATE

Dr. Sanjay Mazumdar, December 12, 2013

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Executive Summary

- **Global composite materials shipment in automotive industry was estimated at 3.6 billion lbs in 2012, and is likely to grow with a CAGR of 6% in next 6 years to reach 5.1 billion lbs in 2018**
  - Composite materials accounted for ~1.1% of the global automotive materials market in 2012, an average consumption of ~45 lbs per vehicle
  - In 2012, Glass fiber composites dominated with 91.8% of the total composite materials in automotive industry, followed by natural fiber composites with 7.6% and carbon fiber composites with remaining 0.6%
- **CAFÉ standards of 36.6 mpg by 2017 and 54.5 mpg by 2025, EU mandate of CO_2 emission to the level of 130 g/km by 2015 and 95g/km by 2020, passenger safety concern and parts consolidation are the major drivers of composite materials in the auto industry.**
  - Improved powertrain, aerodynamic design, and increased use of lightweight materials are the major areas for improving fuel efficiency and mitigating CO2 emission.
  - Reduction in vehicle mass by 10% improves fuel efficiency by 6.5%
- **Glass fiber composites is likely to remain aligned with its domain (exterior, interior, and under the hood) and gain more market share in coming years**
  - Short fiber thermoplastic (SFT) is likely to remain leading type of glass composites in coming years, mainly driven by small complex shaped components in under the hood applications.
- **Increasing use of natural fiber composites in major applications such as door panel and seat backs are expected to drive the market in coming years**
- **Carbon composites have excellent weight saving potential than other materials but price is very high (CF price is 10-12 times higher than that of HSS)**
  - Ongoing R&D on mitigating carbon fiber cost and improving part fabrication cycle time to the desired level
  - In the last 10 years, CFRP gained momentum in monocoque application in sports, luxury and electric vehicles
  - Challenges with carbon composites: Low awareness towards benefits of carbon composites, high cost, high cycle time.

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Major Raw Materials and Its Applications in Automotive Industry

Steel (37.5%)

- Chassis
- Suspension arms
- Door frame
- Car hood hinge
- Exhaust system
- Bumper beams
- A, B, C pillars

Aluminum (8.5%)

- Wheels
- Powertrain mount
- Cylinder block / Engine
- Auto transmission case
- Suspension arms
- Bumper beams
- Intake manifolds

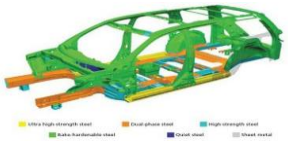
Iron (5.5%)

- Engine blocks
- Drum breaks
- Front & rear calipers

Plastics (8.3%)

- Dashboards
- Bumpers
- Seats
- Interior & exterior trim
- Electrical components
- Under the bonnet components

High Strength Steel (16.8%)



- Body in White
- Chassis
- B pillars
- Front end structures
- Bumper beams

Glass Composites (1%)

- Instrument panel
- Air intake manifold
- Fender
- Bumper
- Roof
- Door Module
- Headlamp

Carbon Composites (0.007%)

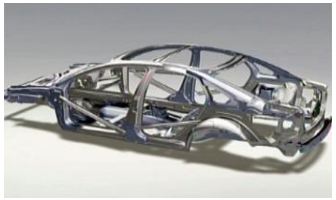
- Roof
- Chassis / monocoque
- Fender
- Tailgate
- Bumper

Others (22.4%)

- Windshields
- Mirrors
- Sunroofs
- Windows
- Dashboards

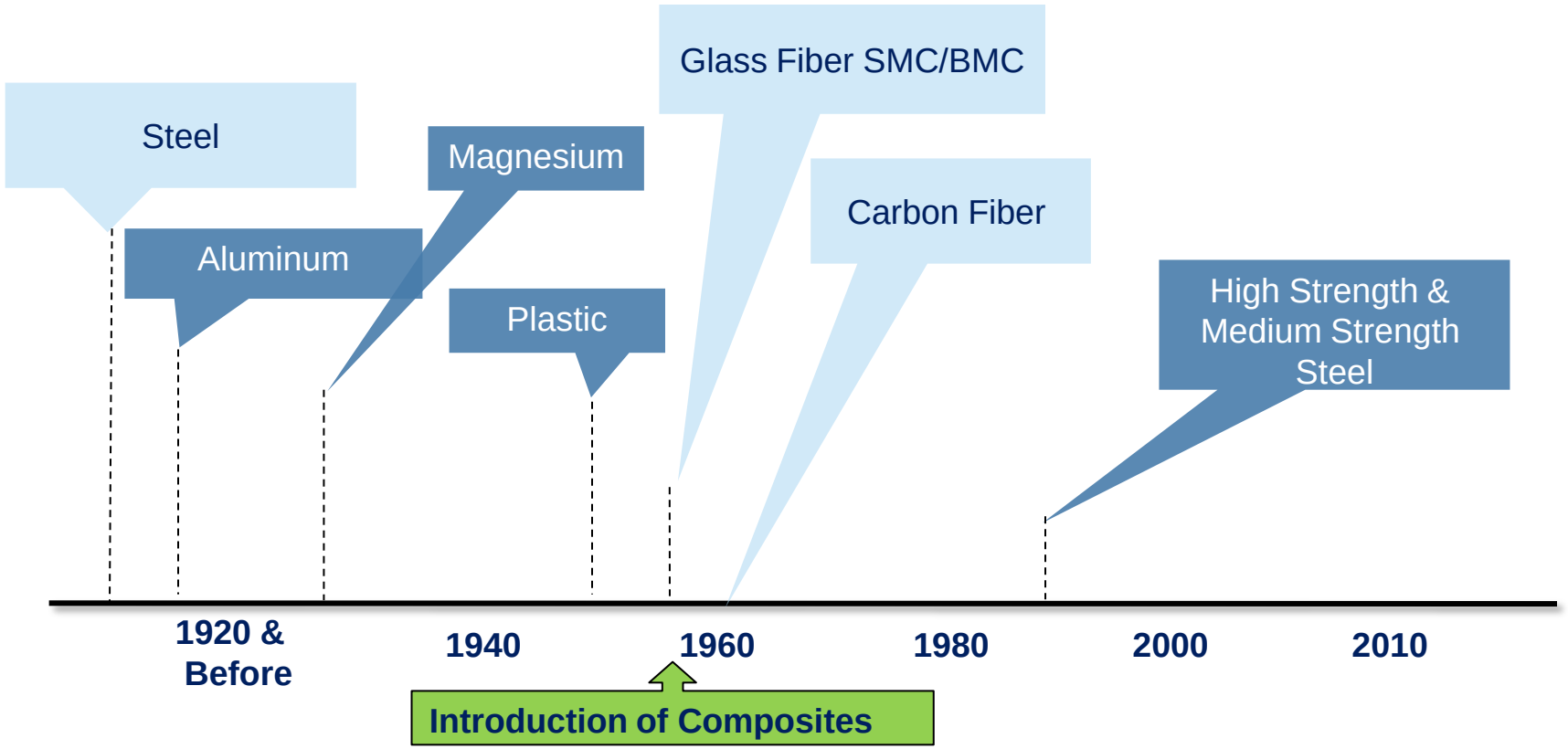
% represents weight distribution of total vehicle weight

Raw Materials Used in Major Segments of Automotive Industry

Structural (30%)	**Power Train** (22%)	**Interior** (23%)	**Exterior** (11%)	**Electrical/Electronic & Others** (14%)
				
• Chassis • Body in White	• Engine • Suspension • Transmission	• Dash board • Floor • Door panel • Steering • Seat	• Door modules • Hood • Trunk lid • Bumper	• Switches & Modules • Wiring and lamps
• Steel • HSS • Carbon Composites	• Steel • Aluminum • Magnesium • Carbon Composites • Titanium	• Plastics • Steel • Glass Composites • Carbon Composites • Magnesium	• Steel • Aluminum • Plastics • Glass Composites • Carbon Composites	• Plastics • Rubber • Glass Composites • Magnesium

% represents weight distribution of total vehicle weight

Evolution of Raw Materials in Automotive Industry

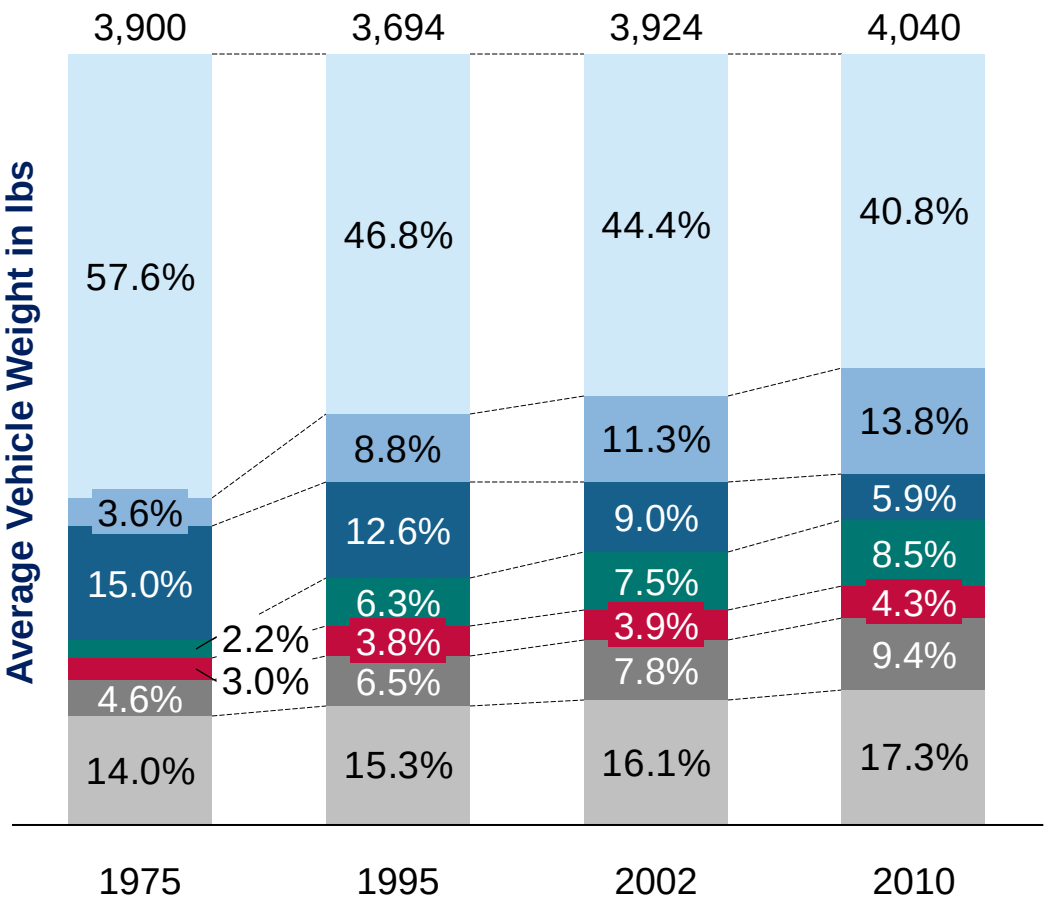


Key Insights

- High emphasis on greenhouse gas reduction, improvement in fuel efficiency, and safety concerns led to the evolution of advanced lightweight materials in the automotive industry.
- To achieve lightweight construction without compensating properties, auto OEMs came up with solution of replacing conventional materials with HSS, AHSS, aluminum, magnesium, composites etc.

Material Trends in Automotive Industry

Automotive Material Mix from 1975 to 2010 (Average Vehicle Weight in lbs)



Change in Materials Usage Per Vehicle from 1975 to 2010 (in lbs)

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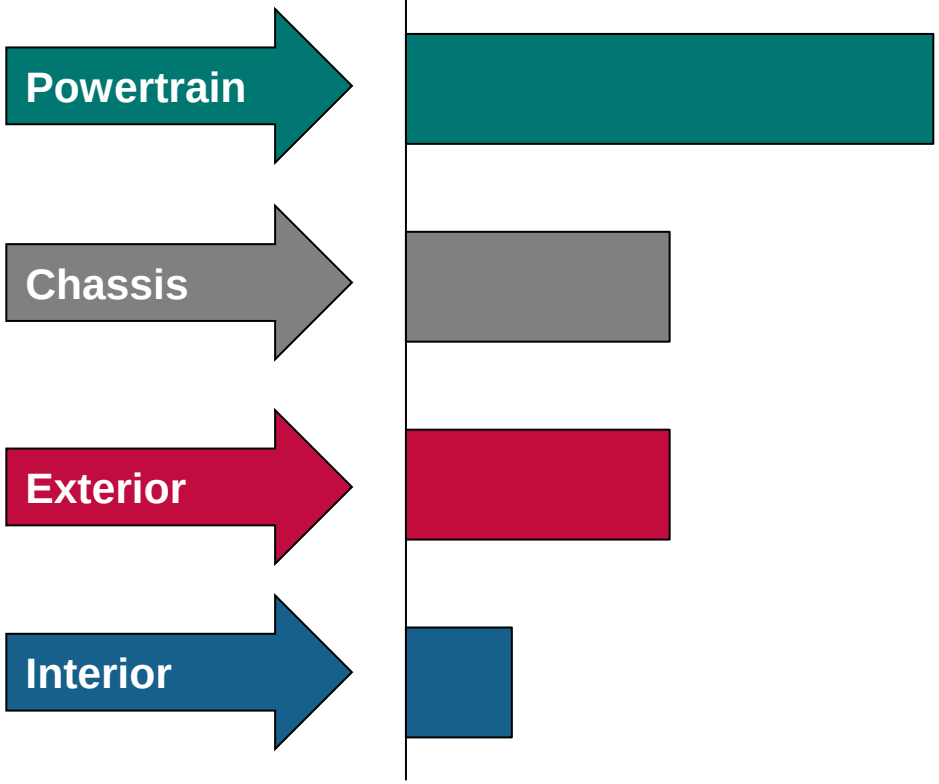
Current Major Problems Encountered By Automotive Industry

- **Demand of Fuel Efficient Vehicles:**
  - The Obama Administration's CAFE (Corporate Average Fuel Efficiency) standards of 36.6 mpg by 2017 and 54.5 mpg by 2025. Currently, per vehicle fuel efficiency in US is about 28.9 mpg
  - CO_2 Emission Reduction: The European Union mandate of CO_2 emission to the level of 130 g/km by 2015 and 95g/km by 2020. Currently, per vehicle CO_2 emission in Europe is about 132.2 g/km
- **Increasing Passenger Safety Regulations:**
  - FMVSS (Federal Motor Vehicle Safety Standards and Regulations) 216 3.0 X GVW
- **Technology Innovation challenge:**
  - Develop new material products to reduce cost, improve efficiency and speed to market
- **Manufacturing Implementation Challenge:**
  - High cycle time of new materials
- **Product Complexity Challenge:**
  - Demand of more sophisticated cars with high functionality
- **Demand of Cars with Better Aesthetic Property**
- **Supply Chain Challenge:**
  - Parts count consolidation, securing carbon fiber supply, etc.

Auto OEMs are ready to pay in the range of $15-$25 per kilogram saved depending on the vehicle segment

To Address the Current Problems, Powertrain is Likely to Experience Greatest Change in Materials, followed by Chassis and Exterior



Currently Dominant Materials	Future Dominant Materials
Steel, Iron and Aluminum	Aluminum, HSS/AHSS
Steel, HSS/AHSS	HSS/AHSS, Composites
Steel, Aluminum, Plastics, Composites,	Steel, HSS, Aluminum Plastics, Composites,
Steel, Plastics, Composites	Plastics, Composites

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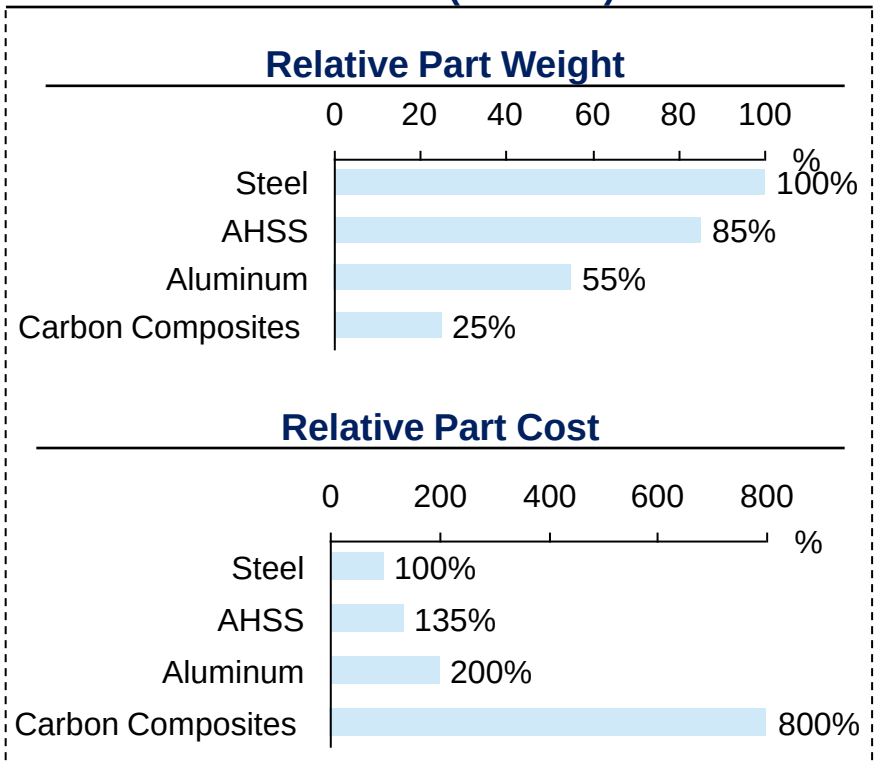
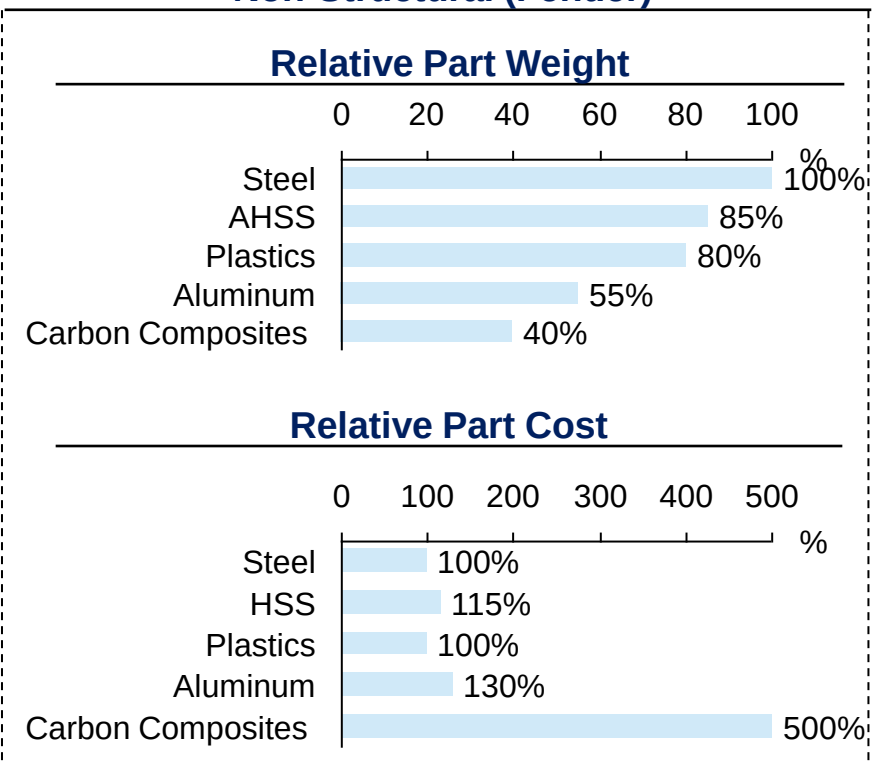
Role of Composite Materials in Addressing Automotive Industry Problems

Composite materials offer advantage of lightweight with higher strength. It is suitable in both structural and non-structural applications

Structural (Chassis)



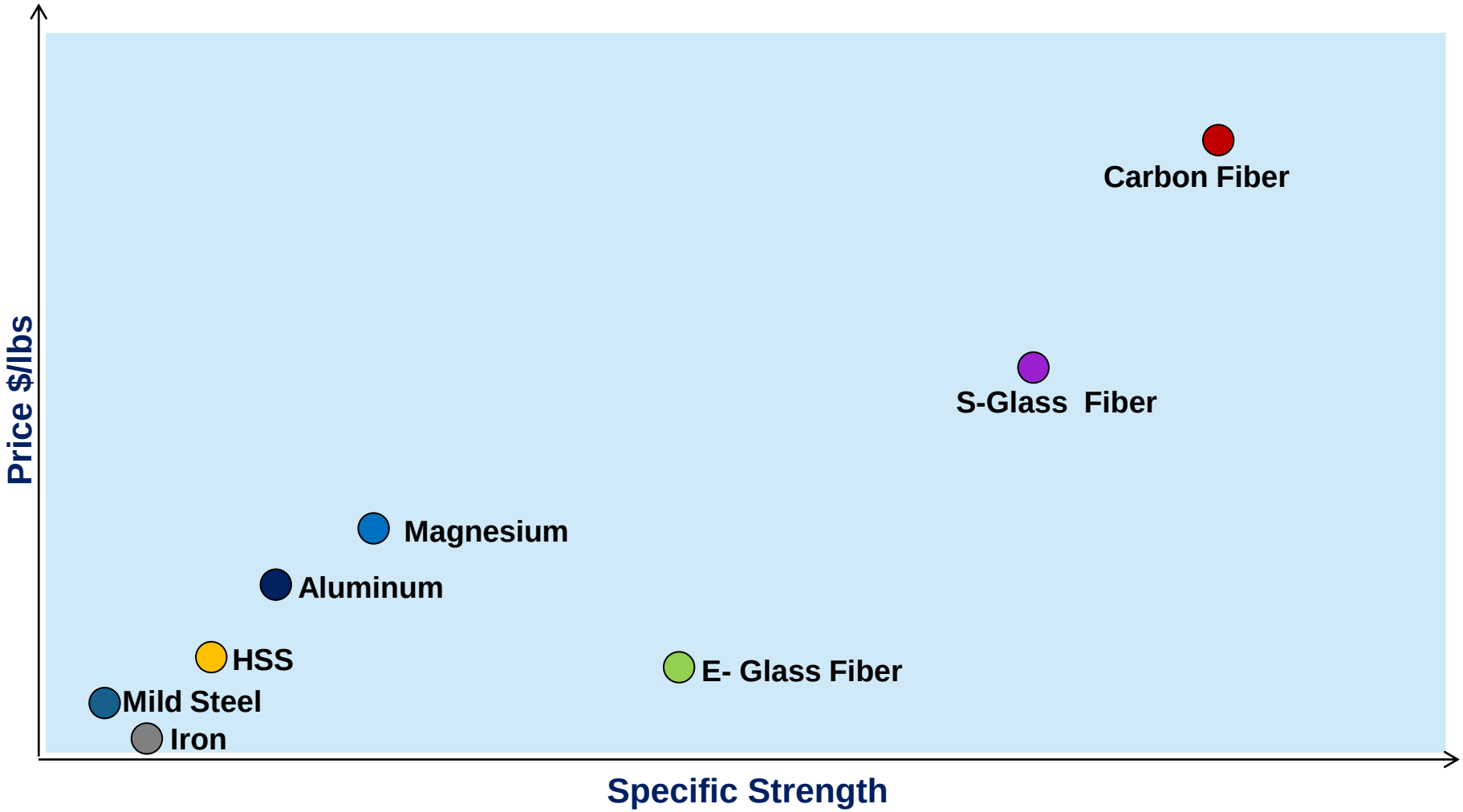
Non-Structural (Fender)



Drivers

- CAFÉ Requirement
- CO_2 Emission
- Safety

Carbon Fiber Has Excellent Property than Other Materials but Price is Very High



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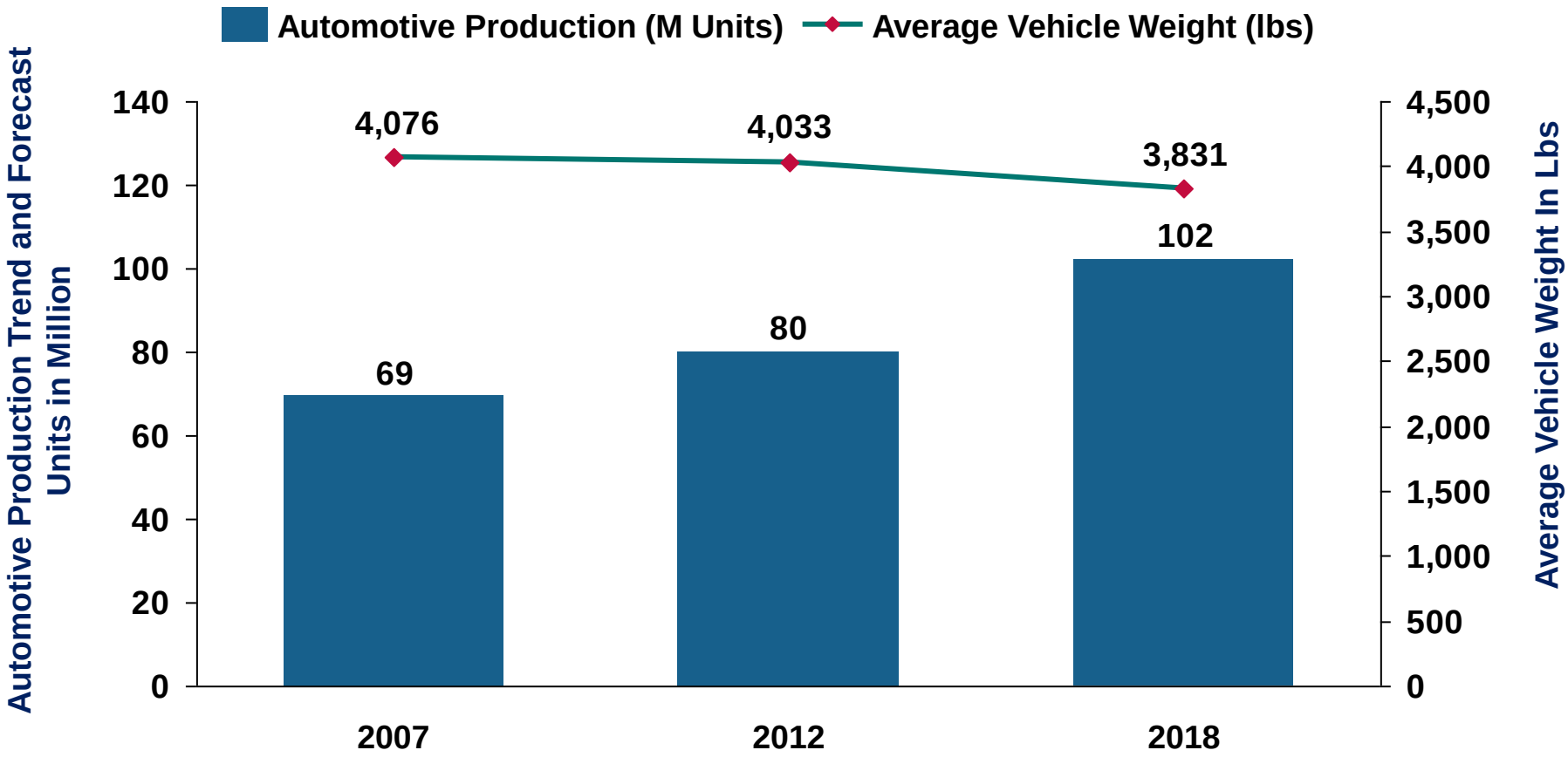
Global Annual Automotive Production is Likely to Reach 102 million Units in 2018. Average Vehicle Weight is Expected to Decline by 5%

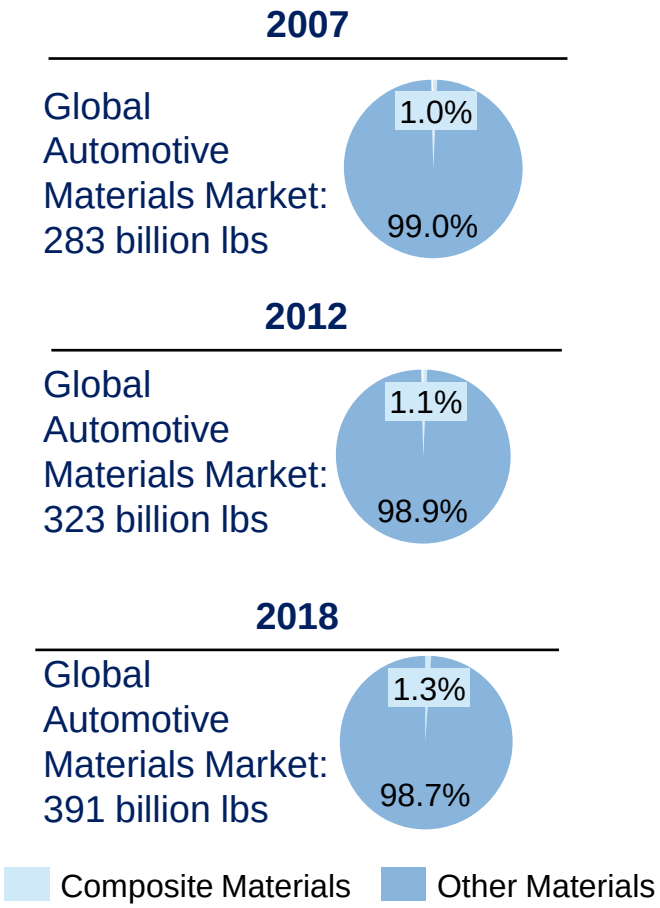
Trend and Forecast of Global Automotive Production and Average Vehicle Weight (2007-2018)



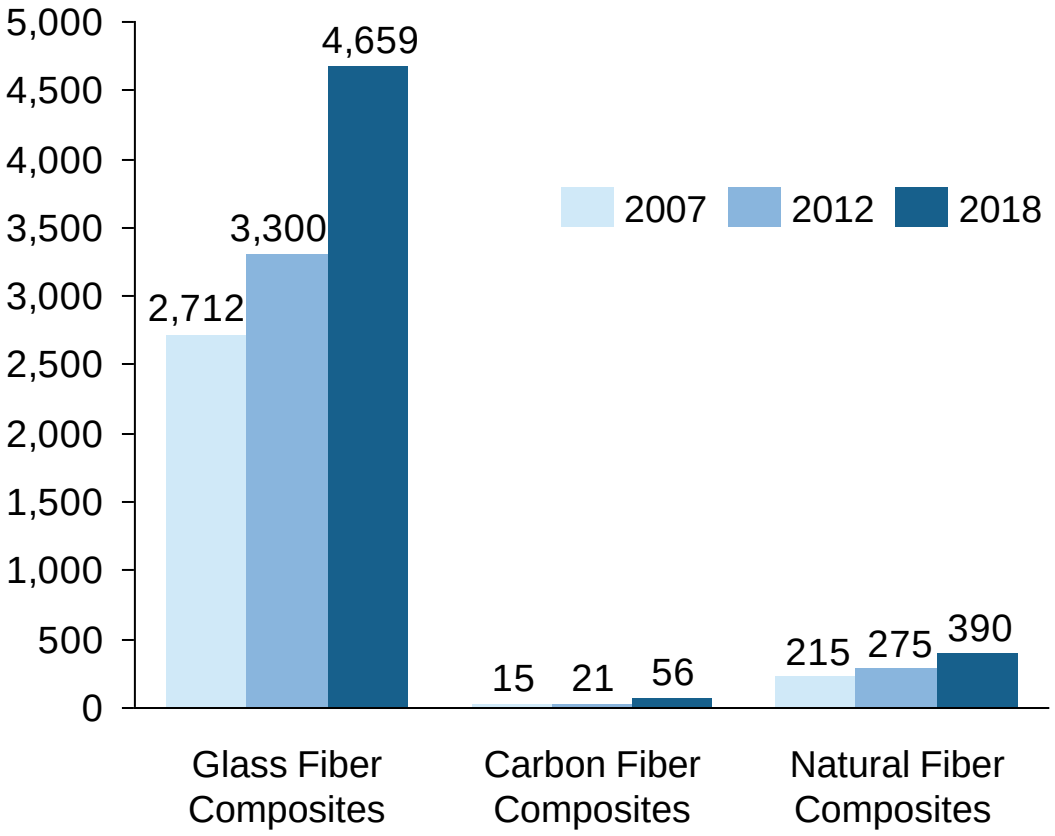
Note: Automotive includes Passenger Cars & Light Trucks

Composite Materials are Estimated to Account for 1.3% of Global Automotive Materials Market in 2018 with a total Demand of 5.1 billion lbs

Share of Composite Materials in Global Automotive Materials Market



Trend and Forecast of Composite Materials Market In Automotive Industry in Million lbs



Major Applications of Various Types of Composite Materials

1. Glass Fiber Composites


Interior Headliner


Underbody System

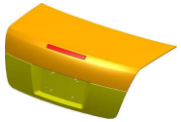

Air Intake Manifold


Instrument Panel


Bumper Beam


Air Cleaner Housing


Load Floor


Deck Lid


Air Duct


Airbag Housing


Front End Module

Engine Cover

2. Carbon Fiber Composites

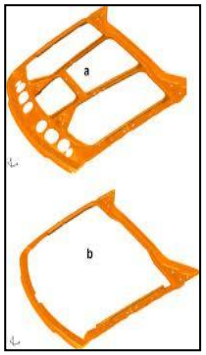

Chassis/ Monocoque


Roof


Tailgate


Hood


Floor Panel



Hood Frame


Side Panels


Trunk Lid


Fender


Rear Spoiler


Bumper

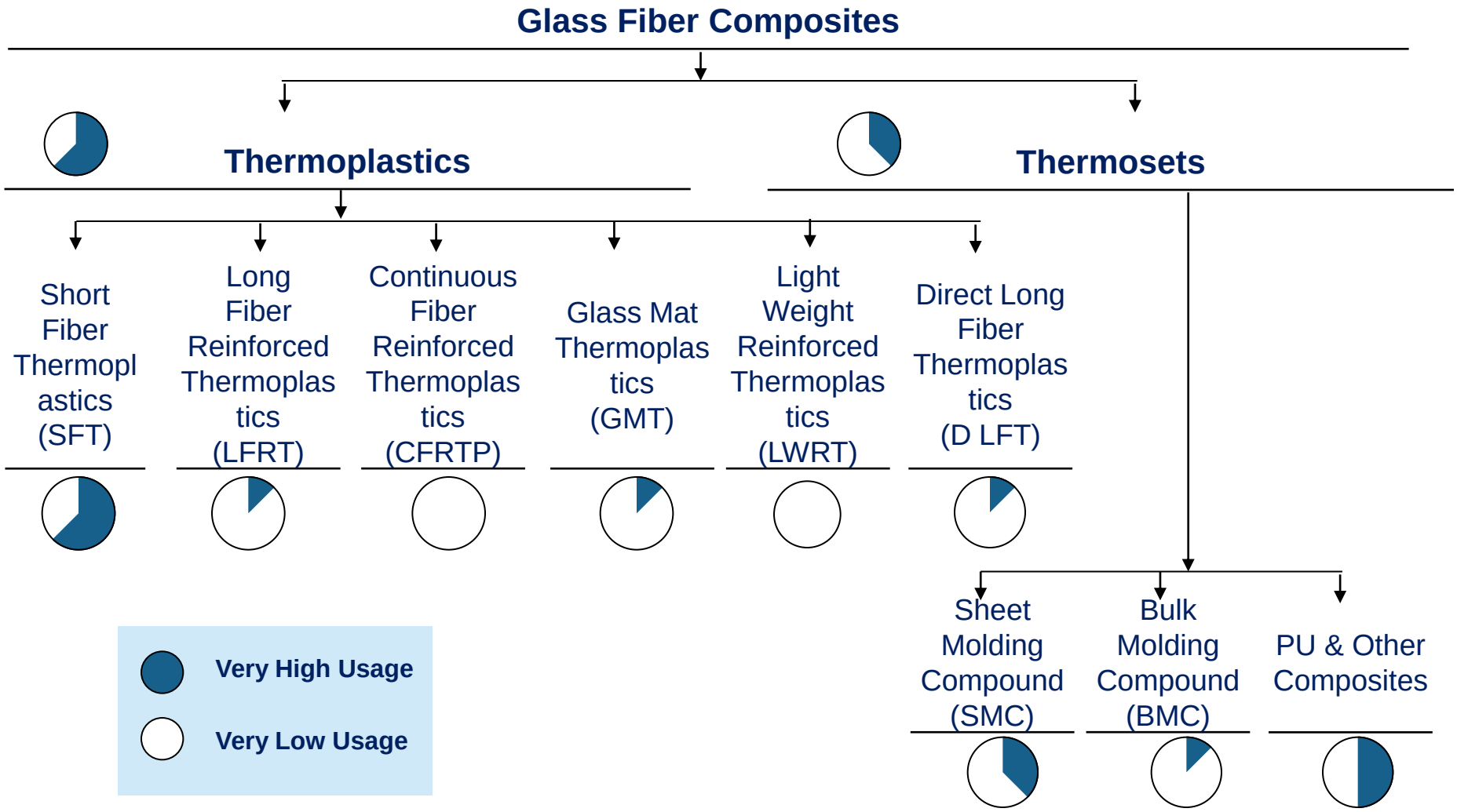
3. Natural Fiber Composites


Door Panels

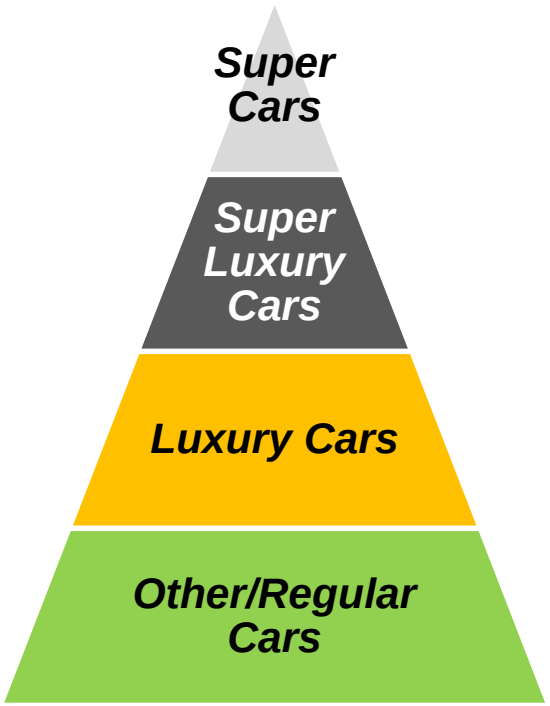

Seat backs


Load Floor

1. Types of Glass Fiber Composites Used in Automotive Industry



Carbon Fiber Potential: Significant Opportunity from High-End Cars to High-Volume Cars with the Production of Low-Cost Carbon Fiber



Global Automotive Production Forecast by Car Type in 2018		Expected Demand of CF @ Current Price in 2018			Expected Demand of CF @ $5/lb in 2018		
		CF Usage in % of cars	Demand in Mlbs	Demand in $M	CF Usage	Demand in Mlbs	Demand in $M
Super Cars	6,500	100%	1.43	17.2	100%	1.43	7.2
Super Luxury Cars	650,000	10%	14.3	172.0	25%	35.8	179.0
Luxury Cars	5 Million	10%	110.0	1,320.0	25%	275.0	1,375.0
Other/Regular Cars	96 Million	5%	1,056.0	12,672.0	10%	2212.0	10,560.0
Global Automotive Production in 2018	102 Million		1,182	14,181		2424	12,121

Assumption: Per vehicle CF consumption is 220 lbs

3. Natural Fiber Composites: Dominance By Fiber Type, By Resin Type, and By Manufacturing Process

By Fiber Type

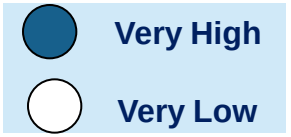
- Flax
- Kenaf
- Hemp
- Jute
- Others

By Resin Type

- Polypropylene
- Polyethylene
- Others

By Manufacturing Process

- Compression Molding
- Injection Molding
- Others



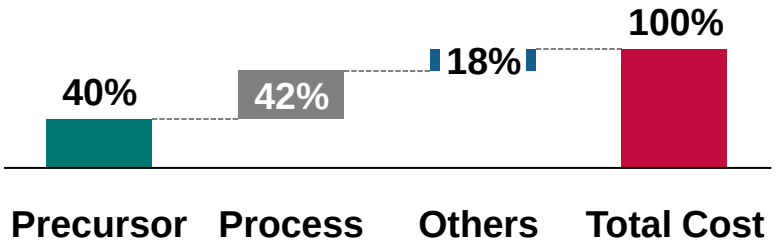
Strategic Alliances between OEMs and Carbon Fiber Suppliers in Automotive Industry

BMW & SGL GROUP THE CARBON COMPANY	GM & Toho Tenax Toho Tenax America, Inc.	DAIMLER 'TORAY'	Ford & DOWAKSA	JAGUAR LAND-ROVER & CYTEC
Production of carbon fibers and carbon fiber fabrics for the upcoming BMW i-series electric vehicles for its passenger cell	To develop advanced carbon fiber thermoplastic composite technologies for high volume applications in GM cars, trucks, and crossovers	To develop, manufacturing and marketing of carbon fiber automotive components by utilizing High Cycle Resin Transfer Molding (RTM) developed by Toray	To develop cost-effective ways of using carbon fiber in high volume cars and trucks. By 2020, Ford aims to cut between 250 pounds and 750 pounds from its new cars and trucks	To develop use carbon fiber-based structural composite materials for high-volume serial automotive vehicles

Industry is Putting Efforts on Alternative Precursors and Improvisation in Manufacturing Process to Reach Desired Level of $5-$6/lbs

Current Price: $10-$12/lbs

Carbon Fiber Precursor Cost	40%
Manufacturing Process	42%
Others	18%



Current carbon fiber price is very high. Industry is looking for price in the range of $5-$6/lbs

Major Areas of Carbon Fiber Cost Reduction

Alternative Precursors

- Commercial grade PAN
- Textile grade PAN
- Lignin based
- Polyolefin based

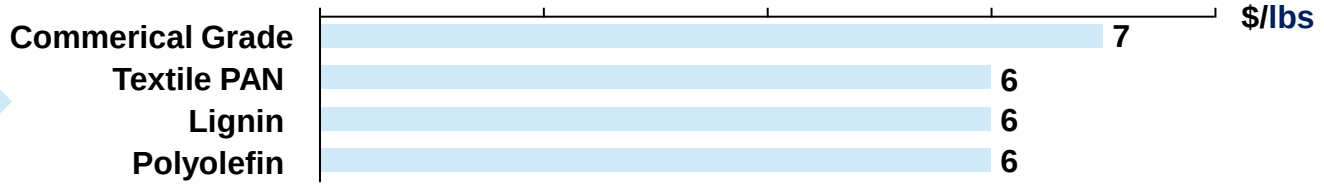
Cost Reduction Potential 20%-30%

Manufacturing Process

- Advanced Oxidative Stabilization
- MAP Carbonization
- Advanced Surface Treatment & Sizing
- Tow Splitting

Cost Reduction Potential 40%-60%

Low Cost Alternative Carbon Fiber Expected Future Price $/lbs



Cycle Time Challenge: Auto OEMs are Looking for Part Manufacturing Process with Cycle Time in the Range of One to Two Minutes

Current Usage

Limited to	• Super Cars	• High Segment Cars	• Electric Cars
Manufacturing Process	Prepreg Layup	Resin Transfer Molding	Pressure Press
Cycle Time	2-4 Hours	0.05-1 Hour	17 Minutes

Current part fabrication process is good enough for low volume cars but for use in mass produced vehicle, there is need for process improvisation

Target Part Cycle Time

Carbon Fiber Part Cycle Time: One-Two Minute

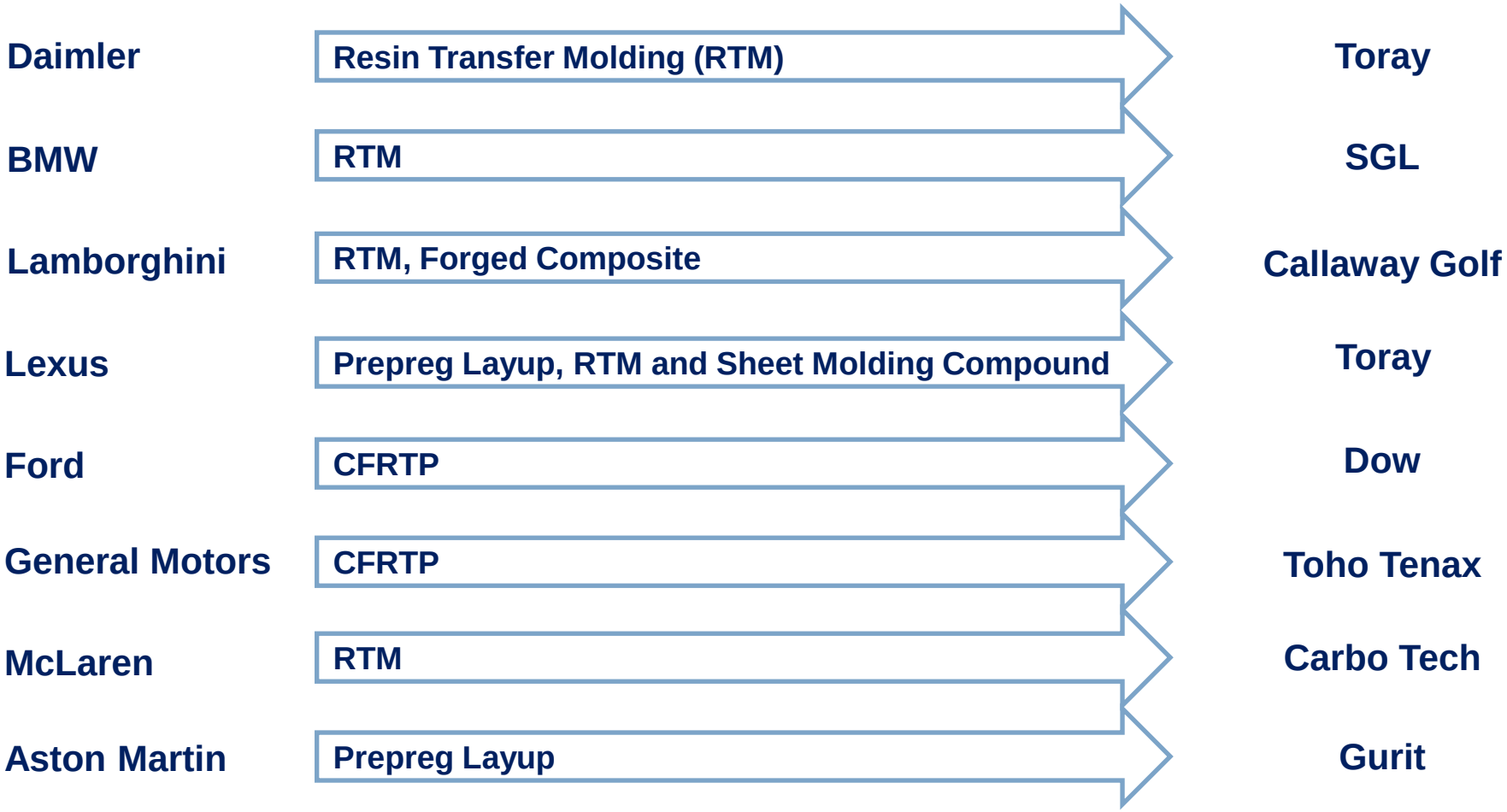
Target Car Segment

- Sports cars
- Luxury cars
- Electric cars
- Regular cars

Area of Focus

- Technology improvement (HP RTM and CFRTP)
- Spreading carbon fiber tow
- Low viscose epoxy resin

Industry is Heavily Targeting Resin Transfer Molding (RTM) and CFRTP Processes for Fabricating Carbon Composites Parts

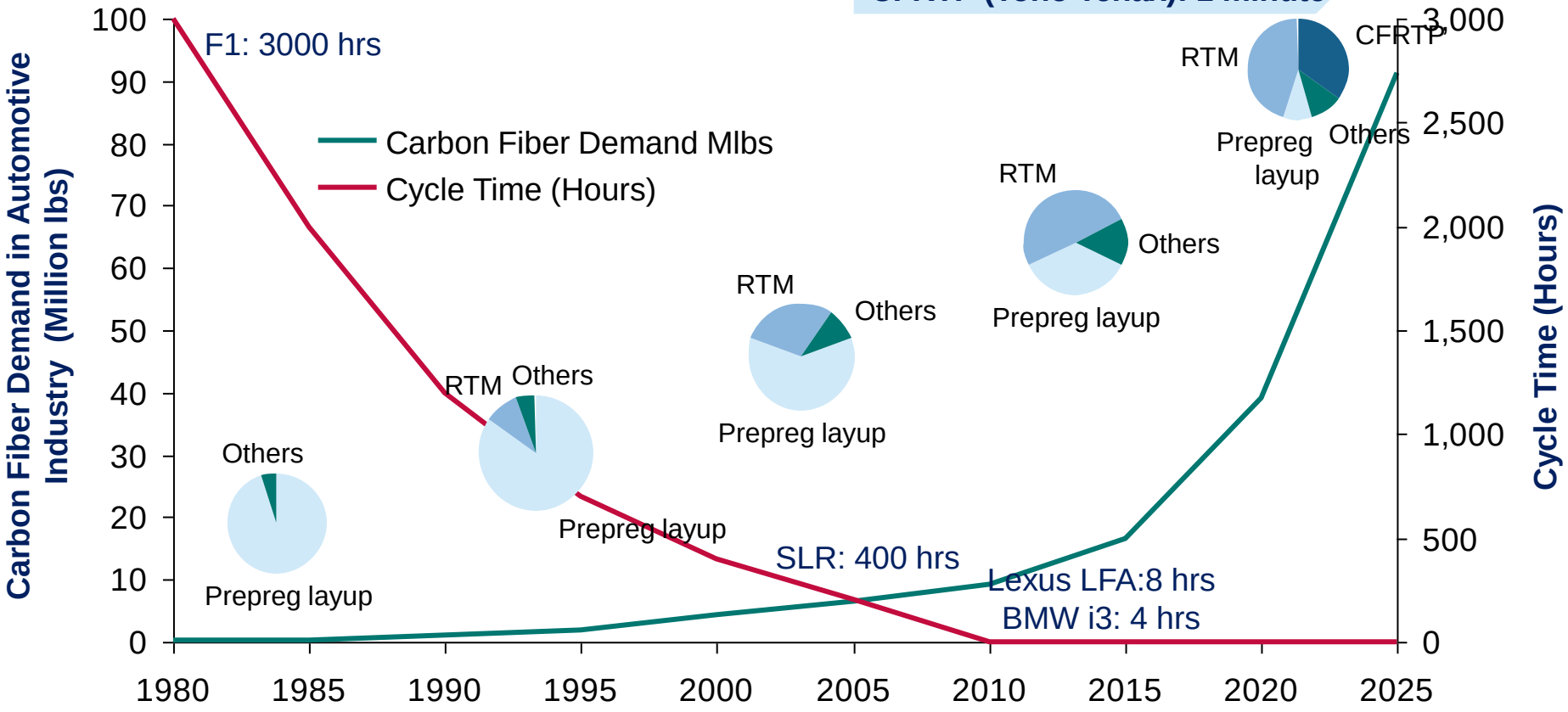


Industry is on the Way of Achieving the Targeted Cycle Time

Prepreg layup: 3000 hrs

Prepreg layup: 400 hrs

Prepreg Layup: >90 minutes
Pressure Press: 17 minutes
Forged Composite: 8.5 minutes
HPRTM: 3-4 minutes
CFRTP (Toho Tenax): 1 minute



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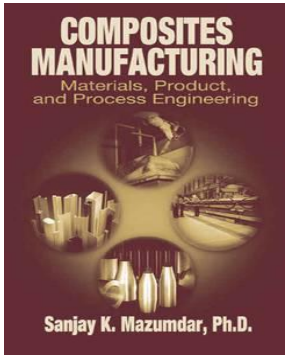
About Speaker

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

- With a global consulting experience spanning over 14 years, Dr. Sanjay Mazumdar has been leading Lucintel since 1998 on projects as diverse as growth consulting, due diligence, value chain assessments and opportunity analysis providing actionable and cost-effective market intelligence, consulting and insights, to over 700 global customers. Some highlights:
  - Provided advisory services (M & A, market entry) to hundreds of clients.
  - Subject matter expert in chemical & advanced materials & authored a book titled "Composites Manufacturing: Materials, Product & Process Engineering".
  - Panelist at conferences with industry leaders such as Airbus, B/E Aerospace, Boeing, Core Molding, Ershigs, Owens Corning, and more.
  - Speaker at various conferences & published more than 25 papers.
  - Worked for General Motors in ultra-lightweight product development project and received 2 Record of Inventions.
  - Two Society of Plastics Engineers Awards and one DuPont Plunkett Award.
  - Ph.D. in Mechanical Engineering from Concordia University, Montreal and has additional training in Strategic Management from MIT, Boston.
  - Thought leadership on nature inspired innovations and launched video describing 5 innovation mega trends. Click to benefit from innovation ideas.



About Lucintel

Vision:

- Passion for data and insights. Empower companies develop better products and growth platform

History

- Founded in 1998
- Over 120 full time analysts / consultants. Global presence

Industry Leadership

- Over 1000 clients – Fortune 500 companies
- Fifteen years of proven management consulting & market research experience
- Panelists and key note speakers at leading conferences
- Subject matter expertise in composites, adhesives, chemicals, automotive, aerospace, energy and construction markets.

Lucintel Ensures Strategic Insights for the Right Market Entry

"*Lucintel has its finger on the pulse of the market and drives deep Strategic Insight*"

- Andy Schmidt, MacQuarie Partners, Managing Partner

- Lucintel has performed hundreds of consulting projects in the area of M & A, market entry strategy, opportunity screening, competitive benchmarking, value chain analysis, unmet needs analysis and others in a variety of markets for last 14 years.

- Lucintel with its profound business success knowledge, has driven strategic success across the value chain from material suppliers to component makers to OEM's to Investors seeking sustainable winning strategies.

- Access to vital, hard to find insights through detailed primary and secondary research and analysis. Incomparable data accuracy and integrity

- Lucintel has over 30,000 contacts in its database for conducting primary research

- Lucintel has +500 market reports on various market segments:

  - No Learning Curve - Deep industry knowledge and insight. Quality, Accuracy & Depth

Over thousand clients around 70 countries value our service

. . . with Project Teams with an Appropriate Mix between Technical and Business Expertise for Results that Drive the Bottom Line.

- Senior level consultants and analysts
- PhDs and MBAs
- Masters level engineers
- Scientists and Industry experts
- Past projects ranging from start up to multi-national Fortune 500 companies.
- Over 120 full time analysts / consultants

Lucintel has published +500 multi-client market reports & conducted hundreds of consulting projects across multiple markets

Market Reports


Aerospace


Transportation


Marine


Construction


Renewable Energy

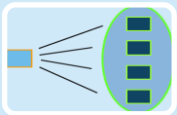

Recreational


Composite Materials

Consulting


Strategic Growth Consulting

Benchmarking


Opportunity Screening


Partner Search and Evaluation


Due Diligence and M&A


Market Entry Strategy

Lucintel's Experience in Market & Strategic Analysis

- Lucintel has over thousand customers in 70 countries. It has worked with a variety of global companies, including (but not limited to) 3M, Audi, Carlyle, Credit Swiss, Cytec, DSM, Eastman, GE, Gurit, Sverica International, Sumitomo, etc. and has good experience in dealing with due diligence, M & A, market entry strategy, target screening and strategic growth consulting.
- Lucintel provides accurate data since we triangulate data using various means. During the project, Lucintel talks to suppliers, buyers and users to drive insights about the project. We have more than 30,000 contacts from more than 70 countries across different industries.
- Lucintel has performed a significant number of projects in market assessment, M & A, due diligence, investment thesis and winning strategy formulation. Below are comments from our satisfied clients in the area of M & A, market assessment, and Due Diligence, demonstrating our capabilities in management consulting and timely delivery.
  - "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 International.
  - "Lucintel has its finger on the pulse of the market and drives deep strategic insights." Andy Schmidt, Managing Partner, MacQuarie Partners

Thank You!