

# Carbon Composites are becoming Competitive and Cost Effective for Automobile Industry

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# Executive Summary

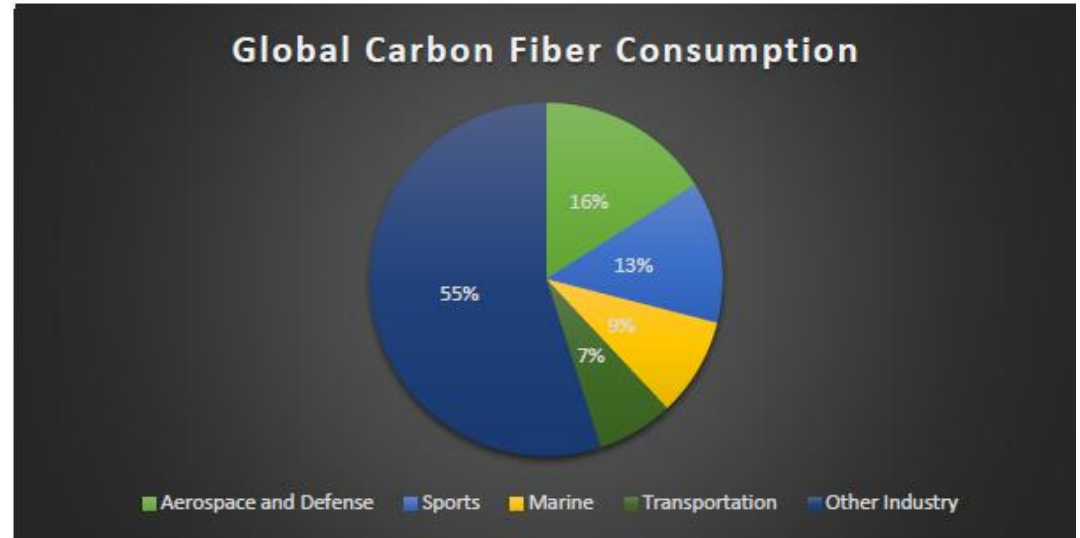
- Carbon composites are becoming competitive and cost effective compared to metals.
- Many advances in raw materials, manufacturing technologies, assembly techniques are influencing directly the cost of composites design & development.
- Advanced technologies will help reducing the cost of composites substantially which will spur the demand for composites exponentially in coming years.
- Composite design, analysis, manufacturing tools will help in reducing the engineering cycle time, reduce the costs and improve the quality while maintaining repeatability of parts being manufactured.
- Composites will play important role in future automotive industry





# Composites in Industry

- Global composites materials market 28Bn USD in 2014 and is growing 15-20% year
- Composites have been widely used across industries – Aerospace, Wind, Automotive, Industrial, Marine, Oil & Gas etc.



Global Carbon Composite Consumption - 2012

**Need for Fuel Efficiency, Regulatory Requirements, Performance and Reduced Life Cycle Cost will drive the future of Composites across Auto-Industry**

# Carbon Composites in Automotive

- Suspension components for passenger cars
- Chassis Frames
- Power Train Elements
- Brakes & Wheels
- Seat Structures
- Roof sections
- Bumpers
- Exterior Body panels
- Under body Floor
- Truck Roofs
- Engine support subframe
- Car Roofs
- A/B/C Pillar
- Rear Floor
- Body side wedge
- Screen Surround

BMW i3 – Body and internal structure is made of CFRP

Chevrolet Corvette Stingray – CFRP hood and roof assemblies

# Carbon Composites has un-paralled potential for

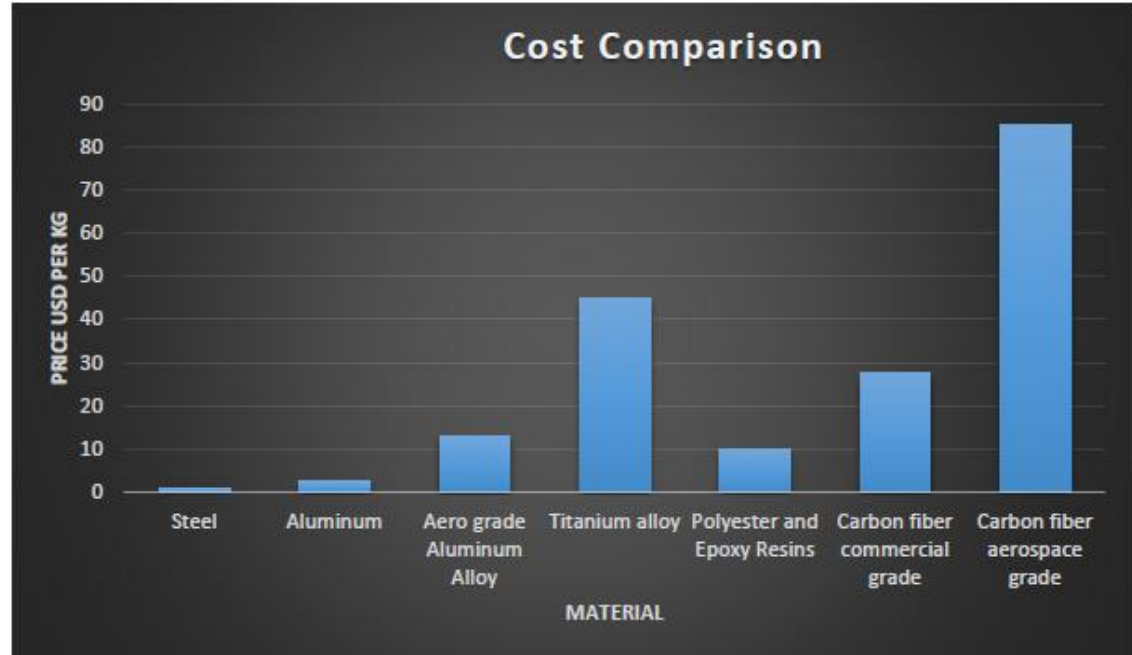
Composites saved **30%**

Weight and cost compared to steel in floor system for long reefer trailers

- Light weight Construction
- Durability
- Safety
- Simplified part production
- Part consolidation
- Less expensive tooling
- Direct and indirect cost saving
- Long useful life
- Corrosion Resistance

# Challenges of Carbon composites

- Material cost
- Impact performance
- Manufacturing cycle time
- Joining methods
- Manufacturing infrastructure
- Volume production
- Repair and recycling issues
- Need for energy efficient processes for fiber production

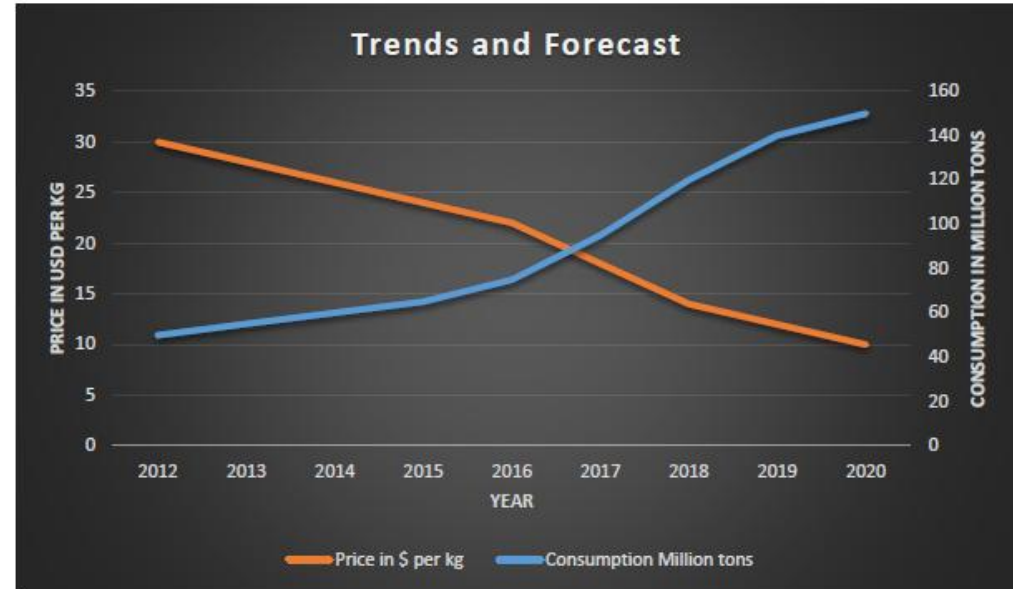


Cost Comparison of Various Raw Materials

# Drivers to Reduce Costs of Automotive Composites

## Drivers to reduce costs of automotive composites

- Reduction in cost of carbon fiber
- Availability of high performance resins meeting production automation requirements
- Cost effective product forms
- Cost effective production methods and automation
- Availability of design and environment data
- High volume processing



Trends and Forecast of Carbon Fiber



# Recent Advances in Composites

## Raw Material

- Cost effective and high yield precursors
- Chopped carbon fiber/epoxy prepregs in SMC form for structural application with minutes of processing time.
- Development of highly moldable fast cycle prepregs, uni-directionally arrayed chopped strand prepregs
- Development of highly reactive resins to reduce cycle time
- Combined fibers to create hybrids and weaving forms, re-use of waste fibers by combining and consolidating dry fibers into a mat
- Development in preform technology: multi-ply curved complex preforms

## Production Technologies

- Fast cycle manufacturing techniques
- Automated Layup
- Automated Braiding (3D), preform making and forming
- RTM and RI technology
- Utilization of fluid based pressure/heating/cooling systems
- High Speed Compression Molding
- High pressure molding process
- Rapid cure resin technology combined with RTM curing in 10 min.

## Advance Software Tools

- Advances in CAD, CAE and manufacturing simulation tools
- Knowledge Based Engineering Tools
- Design for part integration and Co-Cure methods
- Design Integrated virtual manufacturing software systems
- Cost modeling software

# Advanced Technologies influencing the cost of Automotive Composites

## Raw Materials and Material Forms

- Cost effective fiber precursors: Polymers, natural fibers
- Novel Carbonization techniques
- Multi-material system and hybrids-carbon and glass
- Carbon/Epoxy SMCs
- New and faster curing resins
- Combined fibers: chopped fibers with continuous fibers
- Stronger and durable adhesives

## Design

- Advances in CAE
- Change in mind set of designers
- Design guidelines
- Material and property database
- Education and training

## Manufacturing Processes

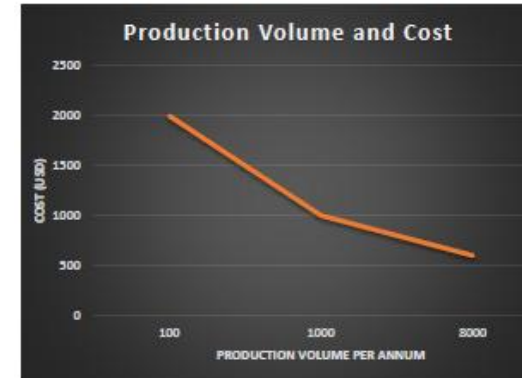
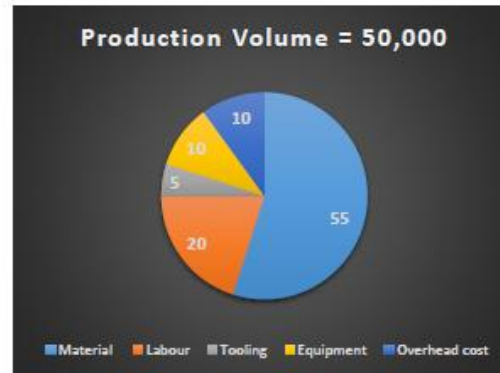
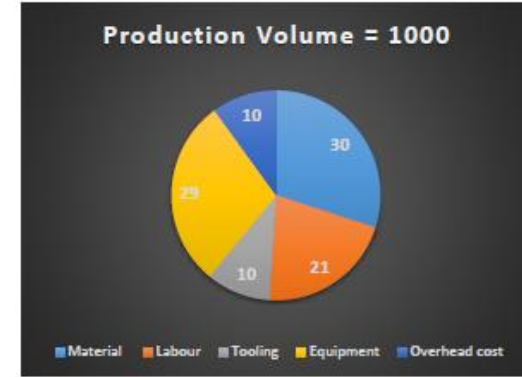
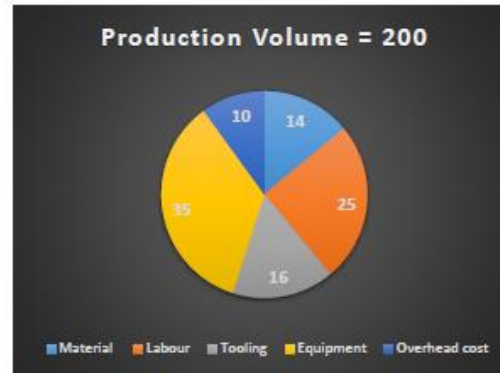
- High speed compression molding
- Compression molding of pre-pregs
- High speed resin transfer molding
- Reactive injection molding
- Resin spray transfer molding
- Fully automated production lines
- Reproduceable manufacturing process
- Use of thermoplastics in RTM
- Multi-functional processing methods

## Joining and Bonding

- Design criteria
- Better integration of methods with metals
- Design methodologies
- Tailoring of adhesives
- Mechanical fasteners to suit PMCs
- Repair and assembly

# Influence of Production Volume on Cost

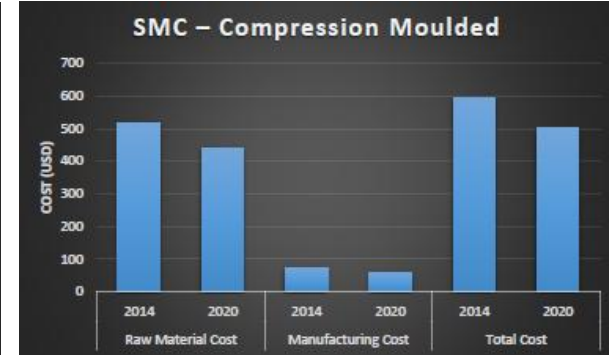
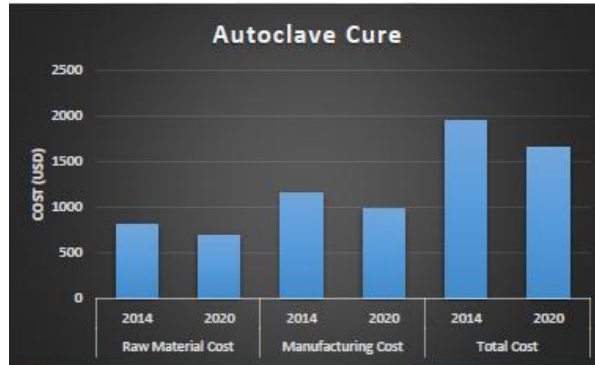
Influence of production volume on various costs for a stiffened panel made out of hand layup autoclave process



Influence of production volume on Cost

# Cost Analysis of various Manufacturing Processes

A stiffened panel is made out of 3 manufacturing processes (Autoclave, RTM and SMC) and their associated costs. Current and 2020 predictions are shown below



Cost Estimation for a medium sized Carbon Composite component

# Conclusions

- Carbon Composites (CFC) are becoming competitive and cost effective
- At the current rates, CFC components are costlier compared to metal components
- Many advances in raw materials, manufacturing technologies, assembly techniques are influencing directly the cost of composites design & development
- Advanced technologies will help reducing the cost of composites substantially
- Advanced technologies will spur the demand for composites exponentially in coming years
- Automotive industry will embrace carbon composites in big way in coming years



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