Carbon Composites are becoming Competitive and Cost Effective for Automobile Industry

Automotive Mega Trends USA
Dearborn, Michigan, Mar 17, 2015

Shama Rao N., Simha T.G.A., Rao K.P., Ravi Kumar G. V. V.
Engineering Services,
Infosys Limited
www.infosys.com
## Contents

- Executive Summary
- Composites in Industry
- Carbon Composites in Automotive
- Advantages of Carbon Composites
- Challenges for Automotive Composites
- Drivers to reduce the Composite Costs
- Recent Advances in Polymer Matrix Composites (PMCs)
- Technological Advances to reduce costs in Automotive Composites
- Cost Analysis
- Conclusions
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.

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

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

Composites saved 30%

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