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Status of Composite Materials in Automobile Sector

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ABSTRACT

Composite materials may someday have big advantages over steel in automobile manufacturing. Composites are being considered to make lighter, safer and more fuel-efficient vehicles. A composite is composed of a high-performance fiber (such as carbon or glass) in a matrix material (epoxy polymer) that when combined provides enhanced properties compared with the individual materials by themselves. Carbon-fiber composites weigh about one-fifth as much as steel, but are as good or better in terms of stiffness and strength. They also do not rust or corrode like steel or aluminum, and they could significantly increase vehicle fuel economy by reducing vehicle weight by as much as 60 percent.

Keywords: composite materials, corrosion resistance, electrical resistance

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INTRODUCTION

A composite is a homogenous mixture created by the synthetic assembly of two materials of which one is a reinforcing material called fiber and the other Is binding material called matrix.

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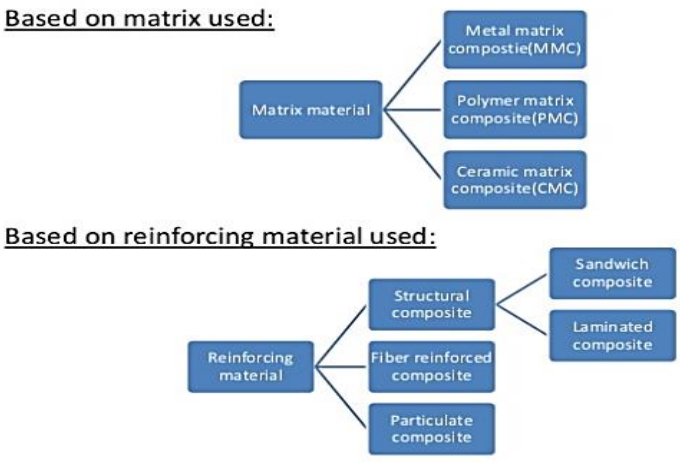
Characteristics of Composite Materials

- Rigid with high strength to weight ratio.
- Good Electrical resistance.
- Resistance to chemical and weather is high.
- Good stiffness.
- Good corrosion resistance.

Classification of Composite Materials



History of composite in Automobile industry

In 1930, Henry Ford attempted to use Soya oil to produce a Phenolic resin and thence to produce a Wood filled composite material for car bodies. 1940 – Flax – a flax reinforced spitfire fuselage was made at Duxford, Cambridge shire. In the 1950, when glass fiber reinforcement material and cold setting polyester resins commercially available, this put the manufacture of compound curved streamlined automobile bodies into reach of low volume, low capital companies. The first uses composite by a high volume manufacturer are was probably the 1954. In 1960s low volume and high value specialists' sports car were manufactured.

Example: The Reliant Scimitar - In the late 1990s,Rover group (moving later into a BMW group phase) was working very closely with researches at the Warwick Manufacturing Group at the University of Warwick. The collaboration and then SALVO (Structurally Advanced Lightweight Vehicle Objective) had aim of providing on new materials, manufacturing technologies and facilitating the integration of such materials and technologies into volume automotive manufacturing in the new millennium.

Necessity of Composite materials

- To improve fuel efficiency by reducing mass of the vehicle.
- To improve safety and crashworthiness.
- To enhance styling and part consolidation.
- To provide aerodynamic design -Effect of reduction in weight (using composite) on the cost manufacture and fuel efficiency of vehicle - Automobile- 5-7 $/kg, Aeronautical- 500-700$/kg, Space- 5000 to 7000$/kg.

The table below shows the values of fuel consumption and fuel efficiency for different types and vehicles weight.

Design/Engine type	Vehicle Weight	Fuel Consumption (lit. per 100 km) and mgh	Fuel efficiency increase
State of the art	500 kg	10 (23.5)	0%
High strength steel plus structural bonding	350 kg (30%)	9.58 (24.6)	4.20%
Carbon fiber composite for structure and closures	270 kg (42%)	9.31 (25.3)	7%
Diesel engine		7 (33.6)	30%
Full Hybrid (Otto)		6.5 (36.2)	35%
Full hybrid (Diesel)		5.5 (42.8)	45%

Composite to improve Safety and crush worthiness

The crashworthiness design fundamental includes the below points:

- Maintain occupant survivable volume or occupant space.
- Restrain occupants (within the space) ¬ Limit occupants deceleration within tolerable levels
- Minimize post-crash hazards

Specific Energy of Absorption-

Materials is said to have good crashworthiness or safe if it has absorption of energy resulting out of crash.

$$SEA = W/V*P$$

W= Total energy absorption V= Volume of crushed materials P= Density of the materials

The below graph compares the SEA for metals and composite From the graph it shows that composite is 6 to 8 times safer than a structure built with metals.

Styling and Part consolidation

The use of composites (PMCs) in styling of interiors of a vehicle has resulted In enhancing the aesthetic look and also in consolidating the parts to fit into Small

available space inside the vehicle. Some examples are given below:

Fig. 1*. CERP Inner deck lid for FORD GT*

Here the consolidation of 4 parts into one is possible due to ability to create Complex curvatures.

Fig. 2. *LGF PP for Polo front end carrier*

Fig. 3. *SMC (Sheet moulding Compound) for GM/Ford pickup truck*

Fig. 4. *Glass/ Epoxy top sleeper*

Effect of using composite on Aerodynamic design

Use in aerodynamic design of the body of Automobile to reduce air drag. The table below shows the energy losses due to various resistances to the movement of the vehicle.

Expended energy	City	Highway
Tire resistance	25%	33%
Aerodynamic drag	18%	51%
Inertia (linear and rotational)	57%	16%

Studies shows that every 2% increase in Cd (avg. drag coefficient) is expected to enhance fuel economy by 1.4mpg (.6%).

Scope of Composite in Modern Auto Industries

The automotive companies in today's modern world are forced to look for new ways and innovations in manufacturing cars/trucks due to fierce competition. The cars today should have all the comforts needed by the customer at low cost which led to the use of composite materials in the construction of body, interiors, chassis, hoods, electrical components etc (Fig 5 & 6).

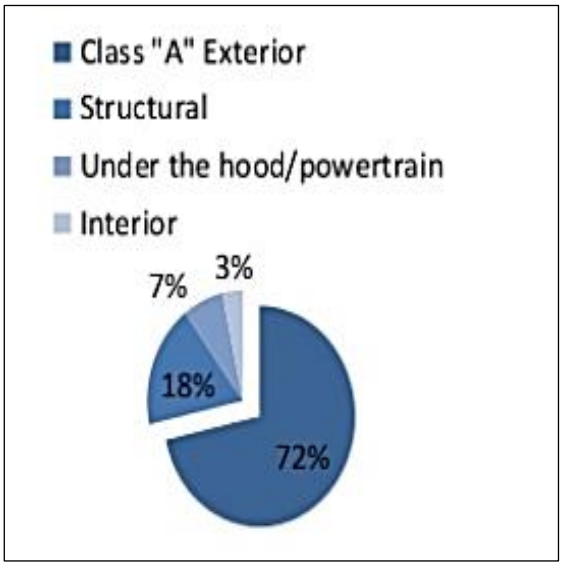


Fig. 5. *The Pie chart below shows the use of composites in an automobile.*

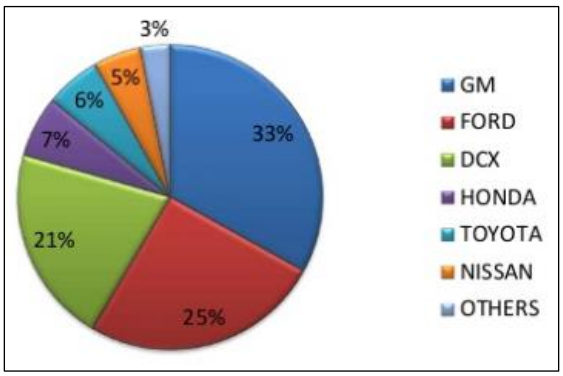


Fig. 6. *The Pie chart below shows the use of composites in an automobile company.*

Problems need to overcome to build a composite car

- Volume manufacture
- Tooling assumption (soft tooling)
- Design complexity
- Design for energy absorption
- Computer aided engineering (CAE) capability
- Component quality
- Performance level
- Fit and finishing
- Robust supply chain
- Recycling
- Risk

THE FUTURE OF COMPOSITE MATERIALS

In most cases polymer matrix composites (PMC) are in competition against existing metal components. In the case of automotive applications this means steel and Aluminium. Composite use on our current vehicles looks set to increase substantially (market trends Suggest up to 10% growth per year in automotive markets) and the use of such components will give the OEM a customer benefit that will be hard to ignore. The successful exploitation of composite materials may well give motor manufacturers the edge they require to stay ahead of the marketplace and it is up to each OEM to ensure they remain at the forefront of this technology.

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