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# Why Carbon Fibers Over Any Other Metal.

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## Abstract

*The main purpose of writing this paper is to know that, whether carbon fiber is really proving its worth of cost in manufacturing industries or not? Carbon fiber is the combination of the less weight and the best mechanical properties we can ever get together. This paper is an attempt towards the study of the advantages of the carbon fiber and how it's been helping us all over the automobile manufacturing sectors. The advanced researches and surveys regarding the carbon fibers are mentioned in this paper. The development of this fiber is mentioned with its uses and how it can affect the fuel economy of the country by using it on large scale.*

**Key words:** Less weight, Best mechanical properties, Manufacturing sector, Fuel economy.

## Introduction :

The carbon composites had been came forth in the field of automotive, like never before. The main objective is to reduce the $CO_2$ emission from the commercial as well as passenger vehicles, to make less use of fossil fuels by making them more fuel efficient as possible. Now one of the ways to reduce $CO_2$ emission is to reduce weight. Because lesser the weight of the cars greater will be the mileage and less will the need of the oil, further more there will be no need of the heavy engines (with more cc and less mileage) in the car anymore. The carbon fiber reinforced polymer is proven to be lighter and stronger than the steel. There are some studies that had proved carbon fiber polymer more use full than the steel. In the practical test it is found that if we take the rods of same diameter one of steel and other of carbon fibers the steel rod can only bear up to 1376 Nm torque but on other hand the carbon fiber can withstand up to 4728 Nm torque, till the Necking in the rods [1].Though there are lots of factors in consideration, the strength to its weight ratio is the crucial point to keep in mind by the design engineers. The carbon fiber was earlier used for the modification and stylish purpose but the facts and the need had changed the point of view in the market. Now the world leading cars

manufacturing companies are trying to make everything of carbon fiber to attain the quality and strength without being compromised with the safety of the passengers. The solution is provided with the listed problems below.

## 1. EMISSION OF HARMFUL GASES.

Earlier in the pursuit of making the expensive and speedy cars some companies were using carbon fibers, but now indirectly it is leisurely being compulsory to use, because the government is more focusing on the P2 (Pollution Protection) law. As per the survey of 2017 the capital of India (Delhi) is the 2nd most polluted city in the world. The carbon composites had been came forth in the field of automotive, like never before. The main objective is to reduce the $CO_2$ emission from the commercial as well as passenger vehicles, to make them more fuel efficient. Now one of the ways to reduce $CO_2$ emission is to reduce weight. In U.S.A, the environment protection agency created an air quality trends across the country. These estimates are based on the actual monitored readings and the engineering calculations. These also based on the industrial activities, technology development, and fuel consumption by the vehicles. The data of the Air Quality is shown by the graph below [2].

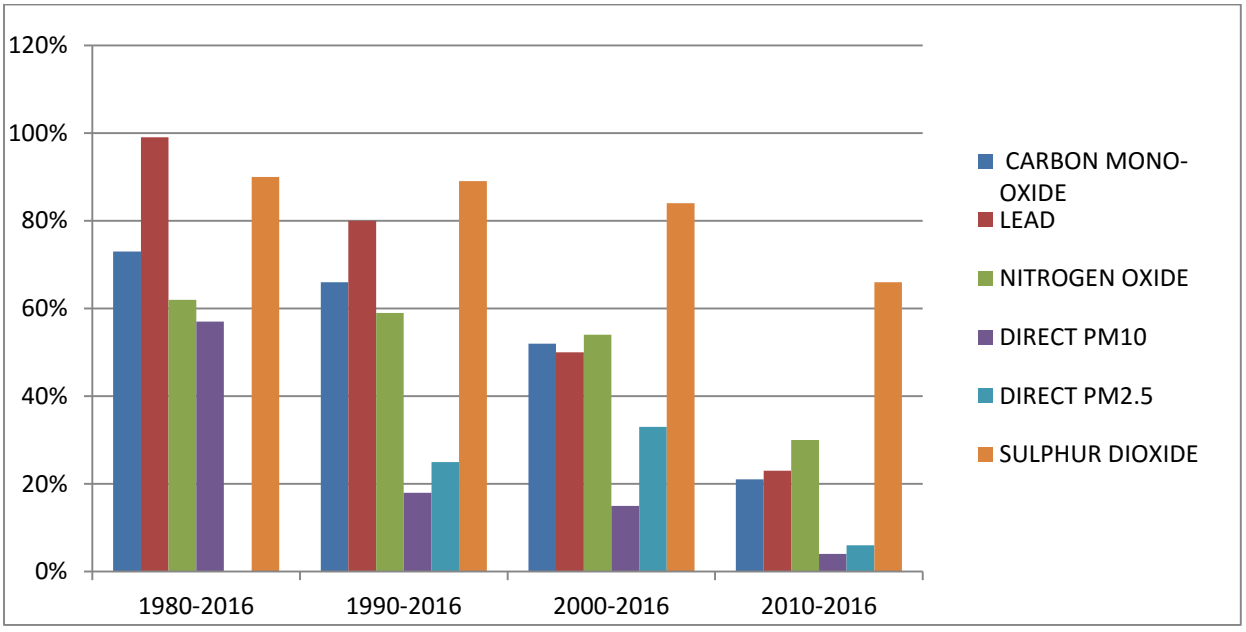


**Fig1. PERCENTAGE CHANGE IN EMISSION.**

As shown from the Fig1, the percentage emission from the air is continuously decreasing from 1980 to 2016. The usage of carbon fibers in the automobiles helped them approximately 12% to achieve this data and the improvement in the Air Quality in the U.S.A these years.

By Jeff Bennett:- Till these days the U.S consumers like to buy heavy vehicles that tends to increase the mileage problems in the cars. This makes the engineers to sums up that why the auto companies are trying their best to reduce weight by using any material they can put their hands on just to increase the fuel efficiency and reducing the carbon emission for better of the environment. For every 4.5 kg weight they reduce from the cars they can decrease up to 7 kg of $co_2$ from the emission every year. Though some companies are still using the steel for manufacturing the cars but they also found their way of reducing the weight by applying different heating and cooling processes that can cut out few kg's without compromising the strength of steel.

Muhammad Pervaiz1, et al.:- On light weighting of automobiles by novel composites. They stated that 'The greenhouse gas emission (GHG) associated with road transport vehicles are responsible for 27% of the total combined pollution in the U.S.A and since it is known that 95% of the transports energy is derived from fossil fuels like diesel and gasoline. This made the researchers to put their all focus to curb the emission from the vehicles. Obama's administration said in November 2014 that by, 2025 they will cut the nation's pollution by 26-28%.Then the National Highway Safety Administration (NHSA) in combination to Environmental Protection Agency (EPA) together aimed to reduce the emission from the heavy duty vehicles. At last they found that the major effect will be from the reducing of the vehicle weight that will reduce emission by 16-24%. The data [3] of material responsible for the most of the percentage of the mass reduction is shown below.

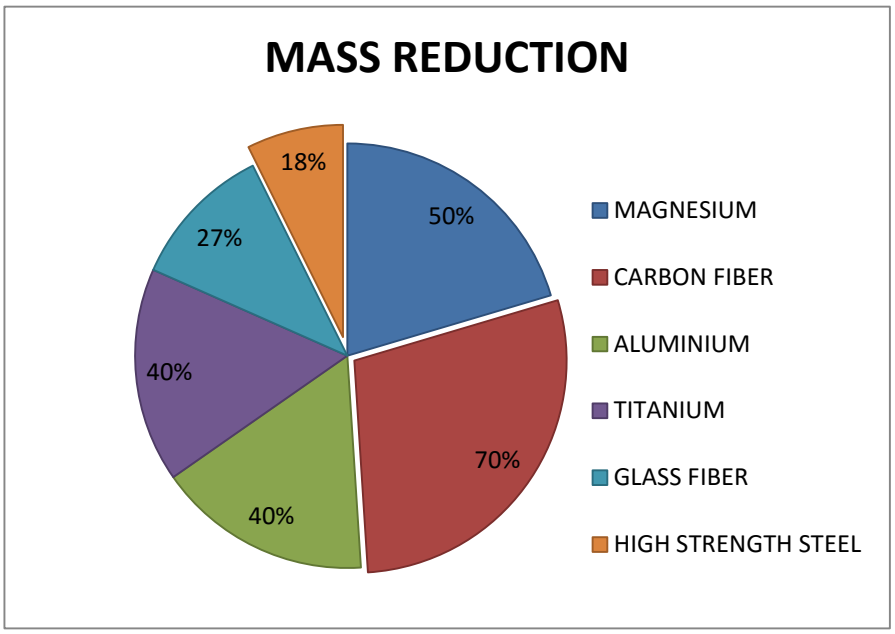


**Fig2. Materials responsible for weight reduction in automotive.**

## 2. FUEL ECONOMY.

On the other hand the energy crisis is on its peak and expanding globally. This had the concern of the researchers to make energy efficient vehicles. So it is indeed had become the matter of concern for the governments of all around the world. That's why the Indian government is giving subsidy to the 13 cities of electric buses and taxies. The battery is being used in them and to make more efficient use of the technology and natural resources. Where we can't use the battery vehicles the engines with the better efficiency are being used. Recently it is found that for every 100 kg reduction the fuel consumption can decrease to 0.3L/100Km for the cars and 0.4L/100Km for the light trucks [4]. Here in the table 1 we can see the statistics [5] for the fuel cost saving over 200,000km.

| Weight reduction (kg) | Estimated fuel cost saving in cars ($) | Estimated fuel cost saving in light trucks ($) |
|---|---|---|
| 10 | 65 | 87 |
| 25 | 164 | 218 |
| 50 | 327 | 436 |

| | | |
|---|---|---|
| 100 | 654 | 872 |
| 200 | 1308 | 1744 |
| 400 | 2616 | 3488 |
| 1000 | 6540 | 8720 |

**Table 1: Stats on fuel cost saving via weight reduction.**

Making the cars more fuel efficient without even changing the engine is the best possible way; it can also save us way more time, money and research. As talked earlier we can do that by reducing the car weight by substituting the heavy metal components of the car with the much lighter carbon fiber. As the matter of fact by doing so we can reduce the car weight by 60% and reducing this much of weight of the car can save us about 30% of the fuel. This huge saving is done without even changing the car engines. The mileage will sure increase and the less fossil fuel will be consumed. This way it really can help in changing the economy of the fuel in many developing countries.

## 3. COST OF CARBON FIBER.

The little disadvantage of using the carbon fiber in the production line is that it is bit costlier than the all of its substitutes though little cost is compensated by saving the fuel cost after using the light weight carbon fiber and increasing the mileage. But in a more realistic and economic world, our target is to substitute only large and heavier panels. The other problem is the time taken in the processing of the fiber and molding it, then heating it, so the researchers are doing their best in reducing the cost of the carbon fiber by reducing the manufacturing time by using the infrared rays for it, reducing the manufacturing time up to the one-fifth of it, the other technique is by using the low viscosity resins that can be settled at faster rate than the normal resins. Sooner or later the demand of carbon fiber is going to increase globally and the cost will decrease automatically. The demand of composites in automotive sectors is increasing by 0.92% annually. The reason of choosing the carbon fiber is that they have the highest strength to weight ratio comparing to all other materials and metals. As the matter of fact ten years ago the price of carbon fibers were 9500 rupees per half kg, but these days it been 650 rupees per half kg. It's all due to the demand and more advantages of it than any other metal or alloy. The carbon fibers are way more durable, so these are becoming more than just the stylish and modifying symbol.

## 4. SAFETY.

Safety is the major concern of the people these days, they hardly bother about the performance, power, and weight of the car. The worst thing for the people will be a car with the best mileage, but can't survive a little crash. So as per the requirements of the people these days the cars should get passed in all the safety measures of the roads. Now on the basis of the mechanical properties the carbon fiber is almost same as the steel. The table of stiffness and ultimate strength is given below in comparison of both steel and aluminum[6].

| | Aluminum | Steel | One direction carbon fiber- common modulus | One direction carbon fiber- improved modulus | One direction carbon fiber- highest modulus |
|---|---|---|---|---|---|
| Stiffness against weight ($10^6$ $m^2$ $s^{-2}$) | 26 | 25 | 113 | 166 | 240 |
| Resistance to damages (kN*m/kg) | 214 | 254 | 785 | 423 | 252 |

**TABLE 2:- Comparison of the steel, aluminum and carbon fiber (one-direction).**

## 5. CONCLUSION.

Implementation of the carbon fiber rather than any other metal is useful in improving vehicles efficiency. The main advantage of carbon fiber is, though being lightest among others and proving better strength and safety towards collisions to the passengers. So being the lightest it also helps in attaining the better speed of the cars, now the power of the engine is not wasted in carrying the weight of the car.

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