Research on the Development and Application of Lightweight Automotive Materials

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Abstract—With the continuous improvement of people's living standards, mobility tools have also evolved from walking and cycling to today's private cars. The rapid increase in the number of private cars has caused China's energy consumption to increase. China does not have sufficient energy resources. In order to alleviate the pressure on energy, the energy conservation and emission reduction of automobiles must be paid attention to. There are many ways to save energy and reduce emissions of automobiles. One of them is to reduce the weight of the car. Once the weight of the car is reduced, the amount of energy consumed will be reduced, thereby achieving the goal of energy conservation. Based on this, this article focuses on the use of lightweight materials in current automotive materials, and introduces a variety of lightweight materials in detail to help cars reduce weight, reduce energy consumption, and achieve sustainable development in the automotive industry.

1. INTRODUCTION
Cars have become a necessary means of travel from house to house, and some families even have two to three private cars. The increase in the number of domestic cars reflects that the improvement of the national economy is considerable. However, it also means that pollution will be more serious and the problem of energy shortage will be more severe. Automotive lightweighting is the development trend of the scientific development concept and the corresponding national call for energy conservation and environmental protection, that is, replacing traditional automotive materials with lighter materials to reduce the overall weight of the vehicle and thus reduce energy consumption. The development of automobiles mainly depends on the renewal and iteration of automotive materials. To realize the lightweight of automobiles, the key is to apply lightweight automotive materials.

2. COMMON AUTOMOTIVE MATERIALS
In general, common automotive materials are mainly glass, plastic, steel and aluminum alloys, and most of the weight of automobiles also comes from these materials. Among them, the weight of steel accounts for about 70% of the entire car, and aluminum alloy and other materials account for about 10%. It can be seen that in order to truly realize the weight reduction of automobiles, special materials must be used instead of steel materials. The automotive industry has a long history of development. Lightweight automotive materials are also widely used. Under the condition of ensuring the performance of automobiles, the great use of lightweight automotive materials can better achieve the scientific development of the automotive industry. This will be the focus of this article.
3. THE PRACTICAL SIGNIFICANCE OF LIGHTWEIGHT AUTOMOTIVE MATERIALS

3.1. Effective energy saving and emission reduction
According to scientific statistics, the quality of a car is closely related to its fuel consumption. When the quality is reduced by 10%, the fuel consumption will be reduced by 6 to 8%, and the emission of polluting gases will also be reduced by about 4%. Therefore, the most direct way to reduce the weight of automobiles is to save energy and reduce emissions. Since the reform and opening up, China's comprehensive national strength has been continuously rising, and the national economic level has also shown a considerable upward trend[1]. As people's incomes increase, so does their natural consumption capacity. The car is a very convenient, at the same time it's a proof of identity, and one of the necessary tools under the current view of marriage. From 137 million cars in 2013 to 457 million in 2018, the number of cars has grown extremely rapidly. However, relevant authorities have proposed that the current average fuel consumption of automobiles in China is 8.06L / 100km, and each liter of gasoline burned will produce 10m3 of exhaust gas (about 12.9kg). The number of cars is increasing, fuel resources are being consumed, and the pollution of the atmosphere is also intensifying. Therefore, only by reducing the fuel rate and fuel consumption can we truly fit our overall strategy of scientific development concept[2]. The lightweight application of automotive materials has significantly reduced the fuel consumption of automobiles, which in turn has reduced the emission of polluting gases and the consumption of fuel resources.

3.2. Research on automobile lightweight is the need to save energy
As we all know, cars rely mainly on gasoline and diesel to create power, and both gasoline and diesel are derived from petroleum[3]. At this stage in China, petroleum resources are very scarce, and in the face of the increasing number of cars, it is clear that there is a shortage of demand. So China's oil resources are more dependent on imports. According to customs data, as early as 2005, China's dependence on oil imports was less than 30%, and by 2011, the dependence had climbed to more than 50%, and in recent years it had exceeded 60%. Excessive dependence on imports will also undermine the sustainable development of China's energy industry. For this reason, energy conservation is an urgent task, and strengthening research on lightweight vehicles can provide guidance and reference for energy conservation and create more opportunities for China's current refining technology innovation[4].

4. USE OF LIGHTWEIGHT AUTOMOTIVE MATERIALS
According to the development history of the automotive industry, the currently common lightweight automotive materials are mainly high-strength steel, titanium alloy materials, magnesium alloy materials, aluminum and aluminum alloy materials, and plastics and composite materials[5]. The weight reduction of these materials is shown in Table 1.

| Automotive materials          | Reduce weight | Application scenario                                                                 | Disadvantage                                      |
|------------------------------|---------------|---------------------------------------------------------------------------------------|---------------------------------------------------|
| High strength steel          | 35%-45%       | Auto body, chassis and other components                                                | Poor corrosion resistance and weather resistance  |
| Aluminum and aluminum alloy | 30%-40%       | Bumpers, hoods, brakes, etc.                                                          | The bearing capacity is relatively weak, and the processing of aluminum is relatively difficult |
| Magnesium alloy material     | 40%-55%       | Engine part cylinder block, fan, etc., clutch and transmission housing on the chassis, steering wheel and hub, etc. | Flammable and poor corrosion resistance            |
| Titanium alloy material      | 15%-20%       | Automotive engine valves, valve springs, valve seats and connecting rods, etc.          | High cost and difficult processing                |
35% 高强度钢

4.1. Application of high strength steel

High-strength steel will be the main material of automobile quality for a period of time due to its good processability, safety, low cost and other factors. Through the treatment of carbonized and alloyed steel, the strength of alloy steel will be greatly improved, and the weight will be significantly reduced compared to before. This high-strength steel is mainly an essential material for automobile housings or certain parts of the chassis. Not only can it save costs, but it also meets the requirements for the development of lightweight materials, but the material also has some defects, such as poor corrosion resistance and weather resistance. This will also affect the life of the car. Therefore, in terms of light weight and durability, high-strength steel also needs to be weighed[6].

4.2. Application of aluminum and aluminum alloy materials

The strength of aluminum is relatively low. The new material aluminum alloy has a proportion of about 1/3 of that of steel. Reasonable use of aluminum and aluminum alloy can effectively reduce the overall quality of the car. The research and development of new aluminum alloy materials for automobiles is mainly concentrated on three aspects: one is the whole body or large aluminum materials; the other is the all-aluminumization of some structural parts such as doors; If aluminum is used instead of steel in automobile parts, the weight of automobile parts can be reduced by 30% to 50%, and the aluminization of the automobile structure can reduce the mass of the entire automobile to 30% to 40%. However, there are still many immature uses of aluminum as the main material of automobiles[7]. The biggest disadvantages are the relatively weak resistance of aluminum and the relatively difficult processing of aluminum.

4.3. Application of magnesium alloy materials

Magnesium alloy is lighter than aluminum alloy. Its specific gravity is about 33% lighter than aluminum alloy and 77% lighter than steel. It is currently the lightest material in industrial metal structural materials[8]. At present, the application of magnesium alloys in automobiles mainly includes engine gas, crankcase, gasoline and air filter housings, intake manifolds, oil pump distributors, fans, etc.; clutch and transmission housings and frames on chassis As well as steering wheels, steering gear, wheels, etc., and according to related reports, the magnesium alloy for bicycles has increased from 9.3kg to 40kg. Compared with aluminum, magnesium alloy can reduce the weight of the material of the same structure by 21%, compared with gray cast iron, it can reduce 50%.

4.4. Application of titanium alloy materials

Titanium alloy is mainly used to reduce the quality of automobiles. It is mainly used in automobile connecting rods, engine valves, titanium alloy springs, etc. The main disadvantages of titanium and titanium alloys in application are high cost, difficult processing, and difficulty in refining. Therefore, currently titanium alloy parts are only used in racing cars or high-end cars.

4.5. Application of plastics and composite materials

Various plastics and composite materials are also widely used in the structure of automobiles. The use of plastic and non-metal composite materials can generally reduce the weight of parts by about 35%. For example, the front and rear bumpers of automobiles, but currently plastics are mainly used in the interior and exterior of automobiles, such as lights, armrests, and instrument panels. At present, some high-strength plastics are increasingly used in automobile bodies and engines. The composite materials currently used in automobiles can be divided into the following three types: the first is glass fiber reinforced materials, which are gradually increasing in application due to their specific characteristics,
and are currently mainly used to manufacture exterior parts of car bodies; etc. The second is a carbon fiber reinforced material, which has high strength and elasticity, and has been well applied in some developed countries. It is mainly used to manufacture the body of a racing car or a concept car. The third is an organic synthetic fiber composite material. This material is currently being developed in various countries around the world, and some countries have also used specific models, but due to its higher cost, it is less used in automotive lightweight design.

5. CONCLUSION
In summary, automobile materials are the key to determining the development of automobiles. In order to alleviate the energy shortage situation in China, it is very necessary to apply lightweight automotive materials reasonably. At present, under the general trend, the entire automotive industry is trying to apply lightweight materials, which is a very scientific reform and innovation. Through research and analysis, the author also introduces and analyzes lightweight materials such as high-strength steel, aluminum and aluminum alloy materials, plastics and composite materials. In general, lightweight automotive materials will be a top priority in the future automotive manufacturing field. It is also hoped that the popularity of this situation will truly promote China's sustainable development.

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