Research on Properties and Applications of New Lightweight Aluminum Alloy Materials

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Abstract. The burgeoning demands of contemporary industry have necessitated a huge shift in the selection and utilization of materials, steering focus towards those that embody enhanced properties and environmental sustainability. Lightweight aluminum alloys have emerged as frontrunners in this transition owing to their low density, high strength, ease of processing, and environmental compatibility. These attributes have propelled aluminum alloys to a position of prominence, often superseding steel as the preferred choice in various industrial domains. In the transportation sector, the merits of these alloys are particularly conspicuous. They have become instrumental in automobile manufacturing, facilitating a reduction in vehicle weight, which in turn augments fuel efficiency and bolsters endurance. This trajectory is anticipated to persist, with high-strength aluminum alloys poised to become quintessential structural materials in future automotive manufacturing endeavors. These new materials, characterized by superior strength and enhanced corrosion resistance, are expected to be crafted utilizing emergent technologies such as 3D printing, heralding a transformative era in the automotive industry. This study delineates the escalating significance of lightweight aluminum alloys in modern industry, with a special emphasis on their transformative potential in revolutionizing automotive manufacturing through advancements in material science and technology. It underscores the pivotal role these alloys are set to play in shaping a sustainable and efficient future for the automotive industry.

Keywords: Aluminum alloy, lightweight materials, modern industry, material properties.

1. Introduction

In recent years, the transportation industry has been arguably one of the most active fields of application in materials science. As the demand for transportation continues to grow, so do the property requirements of materials. In terms of strength and stiffness, since vehicles, aircraft, and other kinds of transportation need to have sufficient strength to withstand high-speed motion and vibration, materials must be able to resist these stresses and maintain the structure shape. For example, aluminum alloys and high-strength steel are the most popular automotive materials. In terms of corrosion resistance, vehicles need to be exposed to various environmental conditions for a long time, such as high temperature, low temperature, humidity and salt spray. In order to ensure its stability and safety, it is necessary to choose materials with good corrosion resistance, such as stainless steel, titanium alloys and ceramic materials. In addition, lightweight is becoming a new trend in modern transportation. In order to reduce weight and improve energy efficiency, the transportation industry has been studying lightweight materials. Among lightweight materials, carbon fiber composite is a very popular one, which is lighter than traditional metal materials but at the same time has higher strength and toughness. But due to its higher price, it is not suitable for family cars. At present, the most suitable for automobile production is lightweight aluminum alloy. Moreover, recyclability and environmental protection indicators have always been the basic requirements for modern industry. To meet the performance conditions under the premise of recyclability, it is very important to develop new kinds of environmentally friendly materials. So, developing more advanced and efficient materials to meet changing needs has big potential in modern industry.

In this situation, the development process of vehicles always comes with the replacement of materials. Ford first carried out assembly line production of automobiles, and the independence of each module of the car made material replacement more convenient. If a car wants to increase its speed without the same original power system, the most effective way is to reduce the body mass. Since the 70s of the 20th century, aluminum alloy materials have begun to appear in large quantities in cars, and the total proportion of aluminum alloy in some cars has reached 15%, and some German brands have reached as high as 25% [1]. While in the railage industry, different series of aluminum alloys have already been heavily used in elements of railway vehicles due to their superb lightweight properties and corrosion resistance [2]. Because of these cases, the research on the properties and application of new lightweight aluminum alloy materials has attracted much attention in recent years. With the continuous advancement of science and technology, people have put forward higher requirements and expectations for the strength, corrosion resistance and machinability of aluminum alloys.

2. The Characteristics and Composition of Lightweight Aluminum Alloys

2.1. Alloying Elements and Composition Design

Common aluminum alloys include industrial pure aluminum, cast aluminum alloy and deformed aluminum alloy. Among them, cast aluminum alloys contain Si, Mg, Cu and other elements in addition to aluminum elements; Deformed aluminum alloys usually contain Zn, Mn, Cr and other metal elements. In the field of vehicle engineering, for example, there is an aluminum alloy composition for vehicle exterior panels as follows: the composition ratio of Ti, B and Mg is about 1: (2.0~2.5): (5.0~6.0). Among them, the weight of B accounts for about 1.1%~2.5% of the total weight of aluminum alloy composition, Mg accounts for about 0.5%~5%, and Ti accounts for about 0.55%~1.0%. Its microstructure also includes the AlB2 phase and the TiB2 phase as the strengthening phase. It improves its stiffness and NVH properties by maximizing the formation of boride complexes in internal tissues, thereby improving its elasticity, formability and dent resistance [3]. Another Al-Cu-Li alloy product with good fatigue properties, its composition: 2.0~6.0 Cu, 0.5~2.0 Li, 0~1.0 Mg, 0~0.7 Ag, 0~1.0 Zn, and at least one element selected from Zr, Mn, Cr, Sc, Hf and Ti. The content of the selected elements is 0.05~0.20 Zr, 0.05~0.8 Mn, 0.05~0.3 Cr, 0.05~0.3 Sc, 0.05~0.5 Hf and 0.01~0.15 Ti, Si $\leq$ 0.1, Fe$\leq$ 0.1 in the alloy, and the content of each other element $\leq$ 0.05 and the total amount $\leq$ 0.15. The average logarithmic fatigue measured by the smooth specimen of the alloy in the aging state is 242 MPa at the maximum stress amplitude, frequency of 50 Hz, and at least 250 000 cycles under the test condition of stress ratio R = 0.1 [3].

There are many series of commonly used aluminum alloys, of which the 6000 series contains more magnesium and silicon, with Mg_2Si as the main strengthening phase. 6063, 6061, 6005A are now the most widely used and promising aluminum alloys; And 5052 aluminum plate reinforced phase is Al-Mg, magnesium content in its alloying elements is the highest, is the most widely used anti-rust aluminum, his strength can meet the basic requirements of building materials, but also has high fatigue strength, its plasticity and corrosion resistance is also very high, but cannot be further strengthened by heat treatment, in general, this material is often used for top covers and door panels and other components; While 6063 aluminum alloy is a medium-strength heat-treatable reinforced alloy, Mg and Si are the main strengthening elements, and structural parts such as columns are its main application fields.

2.2. Structure and Phase Evolution

2.2.1 Macrostructure

The color of pure aluminum is usually silvery-white, but its color may change when other elements are added to the aluminum alloy. For example, adding copper will make the aluminum alloy appear light yellow or brown, adding magnesium will make the aluminum alloy appear light gray or light brown, and adding zinc will make the aluminum alloy appear light yellow or light gray. In addition, the color of aluminum alloys is also affected by its heat treatment process. For example, solution-treated and quenched aluminum alloys typically exhibit a bright silver or metallic luster, while tempered aluminum alloys exhibit a dark silver or matt luster. Various shapes: aluminum alloys can be made into various shapes through various processing processes, such as plates, bars, pipes, profiles, etc., which are widely used in various fields.

Aluminum alloy has good dimensional stability and high-precision parts can be obtained through precision machining. At the same time, aluminum alloy has higher strength and toughness than pure aluminum and has better impact resistance and fatigue resistance. In addition, lightweight is another major structural feature of aluminum alloys, which have less density than steel and copper and have the advantage of manufacturing transportation tools. Aluminum alloy also has good corrosion resistance and can be used for a long time in the atmospheric environment without serious corrosion.

2.2.2 Microstructure

For the microstructure composition of aluminum alloys, their grain size is usually small due to heat treatment, which helps to improve their strength and toughness. The lattice structure of aluminum alloy is generally a face-centered cubic lattice, which makes it have good plasticity and toughness. At the same time, its atomic arrangement order is usually irregular, which helps to improve the complexity of its microstructure, thereby improving the comprehensive performance. Dislocations in aluminum alloys are similar to those in steel, including blade dislocations, screw dislocations, folding dislocations, and hybrid dislocations. Most dislocations affect the mechanical properties of aluminum alloys, but in general, the presence of mixed dislocations can improve the strength and toughness of aluminum alloys.

However, compared with steel, aluminum alloys are more prone to segregation of alloying elements, which greatly reduces their mechanical properties. This is because Mg, Cu, Zn and other elements are often added to aluminum alloys, and the solubility of these elements in the crystal lattice is low, while it is easy to form an enrichment area in the crystal lattice, which results in segregation. In addition, the heat treatment process of aluminum alloy is more complex than that of steel, resulting in a complex, segregated structure. For example, solution treatment and quenching treatment will change the lattice structure of aluminum alloys, thus affecting the distribution of Cu and Zn. Therefore, controlling the process to adjust the microstructure of the aluminum alloy is the main research object of the modern aluminum alloy industry.

In modern times, the influence of the new process on the microstructure of aluminum alloy is very significant. For example, Bi et al. found that the grain size of aluminum alloys under the cold metal transition + pulse (CMT+P) process will continue to decrease from top to bottom. The bottom grain does not have time to grow to form fine equiaxed crystals and columnar crystals. In contrast, the middle and upper grains form larger equiaxed crystals and columnar crystals due to the heat accumulation effect, which will gradually reduce the tensile strength of the aluminum alloy for overlay welding from bottom to top [4], which will make the material as a whole vulnerable area and affect product performance. Zhu found that in cast aluminum alloys, the morphology and size of α-Al and the second phase and the morphology, size and length-diameter ratio of eutectic Si are extremely important for their microstructure, and the morphology and size of the second phase in the alloy are also closely related to the microstructure regulation of the alloy and its application fields. That is, if in situ nanocrystals are generated in aluminum alloys through special processes, they can self-regulate the distribution of other major phases, improve the segregation of other alloying elements, and thus improve the overall mechanical properties of aluminum alloys [5].

3. The Performance of Lightweight Aluminum Alloys

3.1. Comprehensive Properties Evaluation

Lightweight aluminum alloys have many characteristics. First of all, its density is low, the specific gravity is small, and the density of light aluminum alloy is usually lower than that of pure aluminum, which can reduce the weight of the product, thereby reducing material costs and transportation costs. Smaller proportions also mean less raw material costs, lower energy consumption and higher transportation efficiency, which can lead to the reduction of related industrial energy consumption and emissions so that it can meet environmental protection requirements. In addition, the strength of aluminum alloy is very high, which can meet the needs of many application scenarios, such as automobiles, aircraft, ships, etc. At the same time, it has good corrosion resistance and can provide high-quality structural materials for large-scale industrial equipment that have been used for a long time. Finally, the aluminum alloy also has the advantages of easy machinability and good heat treatment performance. Aluminum alloy can withstand forging, rolling, extrusion and other processes of plastic processing to obtain a variety of complex shapes of parts. Its microstructure and properties can also be improved by processes such as solution treatment, quenching and tempering.

3.2. Mechanical Properties

The specific data of strength, hardness, plasticity, toughness and fatigue strength of lightweight aluminum alloy will vary depending on the alloying elements. Taking 6000 series aluminum alloy as an example, under normal circumstances, its tensile strength is usually between 200~500MPa, and the shear strength is usually between 100-300MPa. Its hardness is usually between HB 100-300, its ductility is usually between 40%~80%, and its flexural strength is usually between 200~400MPa. Its impact resistance is usually between 10~100 J/m. Its fatigue resistance is usually between 10^6~10^7 times/mm, and its fatigue strength is usually 100~300MPa.

3.3. Physical Properties

Generally, the density of lightweight aluminum alloy is usually between 2.7~2.8 g/cm^3, the melting point is usually between 660~670°C, the thermal conductivity is usually between 200~300W/m·K, and the magnetism is usually non-magnetic. Compared with steel, the density of aluminum alloy is only 1/3, which brings a significant improvement in specific strength.

3.4. Chemical Properties

6000 series aluminum alloys generally have high corrosion resistance and chemical stability, while 7000 series aluminum alloys and 2000 series aluminum alloys have relatively poor corrosion resistance and chemical stability. In addition, the corrosion resistance and chemical stability of lightweight aluminum alloys are also affected by factors such as atmospheric environment, temperature, humidity, pH and so on. Therefore, when using lightweight aluminum alloys, it is necessary to select the appropriate alloying elements and heat treatment processes according to specific application scenarios and requirements to improve their corrosion resistance and chemical stability.

3.5. Process Properties

The casting performance, cutting performance and heat treatment performance of lightweight aluminum alloy are relatively good, which is determined by its special physical properties and chemical composition. Among them, the casting performance is because of its low melting point, good fluidity, and easy-to-form high-quality castings. In addition, the tensile strength and ductility of lightweight aluminum alloys are also relatively high, and they can withstand large pressures and tensile forces, thereby improving the stability and strength of castings. The cutting performance is because its hardness and strength are relatively high, and it can withstand large cutting forces and cutting speeds. In addition, because the heat treatment performance of lightweight aluminum alloy is also relatively good, it can improve the microstructure and performance through the heat treatment process, thereby further improving the cutting performance.

3.6. Manufacturing Process

There are many manufacturing processes and strengthening methods for aluminum alloys, and the common strengthening methods are solution treatment, quenching and tempering, cold working and adding Mg, Si, Zn, Cu and other alloying elements. Choosing a different manufacturing process will bring a significant difference in the performance of aluminum alloys. Husaini et al. found that the cast wheel rims can withstand a load of 3 tons (30000 N), and the value of rim tension can be accepted until the fracture is 45.84MPa. Meanwhile, spoke wheel rims can withstand smaller compressive loads than cast wheel rims, which are 2 tons (20000 N), and the rims can accept the stress of 66.04MPa until they break [6]. Casting wheels are made by pouring molten metal into a mold and then allowing it to cool and solidify. Therefore, the processing technology of casting wheels mainly includes mold making, metal melting, pouring, cooling post-treatment and other steps. In mold manufacturing, techniques such as precision machining and surface treatment are often required to ensure the accuracy and quality of the mold. Once the mold with sufficient precision can be obtained, the casting wheel can be mechanically manufactured in the form of a whole to ensure the unity of the mechanical properties of each part. The spoke wheel is made by connecting the spokes to the hub, and the specific process includes cold working, welding and other steps. As mentioned above, some processes will cause differences in mechanical properties at the weld, resulting in local mechanical properties that are not up to standard and may cause the overall failure of the spokes when encountering large external forces.

In addition, the performance of aluminum alloys can be greatly improved on the basis of the original manufacturing process. Chakravarty et al. found that the cutting force of 7075 aluminum alloy is significantly smaller than without cryogenic treatment after cryogenic treatment; the cutting force of T6-state alloy is 1.25 times as much as the T6I4-state alloy [7]. Under the same cutting parameters, cryogenically treated 7075-T6I4 aluminum alloy has a smaller grain size and contains more precipitates in the aluminum matrix, which are η-$MgZn_2$. The precipitated phase size of T6 is about 80 nm, about 2.5 times that of T6I4. After T6 and T6I4-state samples are cryogenically treated, the alloy precipitate size is about the same as or slightly smaller than the grain size of the alloy without cryogenic treatment, but the precipitates are denser and discontinuous. After T6 and T6I4 heat treatment, a distinctive stacking fault arises in the machined surface. After cryogenic treatment, the stacking fault is greatly improved [7].

Wei deeply studied the effect of solution-quenching-cryogenic on the properties of aluminum alloys and found that the deformation of samples treated with solution-quenching-aging (SA) and solution-quenching-aging-cryogenic (SAC) treatment was small. The samples treated with solution-quenching-cryogenic-aging (SCA) and solution-quenching-uphill quenching (SUQ) treatments have the largest fluctuation of deformation and deformation within a certain time. The solution-quenching-aging-cryogenic-aging (SACA) specimen has relatively small deformation and change amplitude, and the dimensional stability of the specimen after milling is relatively the best [8]. That is to say, in addition to choosing the appropriate processing technology, the impact of the process sequence on the performance of aluminum alloy is also very huge.

4. Fabrication Techniques

4.1. Casting Methods

Sand casting is a traditional casting process in which the metal is melted and poured into a sand mold for cooling and forming. Sand molds are made of sand, binders and other auxiliary materials that can simulate the shape and size of metals. The advantage of sand casting is that it can quickly produce a large number of parts suitable for parts of various shapes and sizes. However, the disadvantage of sand casting is that the accuracy is low, defects such as shrinkage holes and pores are easy to occur, and processes such as post-treatment and surface treatment are required to improve the quality. Die casting is a newer casting process in which metal is melted and poured into a mold to cool and form. Molds are usually made of materials with high hardness and wear resistance, such as ceramics, metals or polymer materials. The advantage of die casting is that high precision and surface quality can be obtained, which can reduce the time and cost of processes such as post-treatment and surface treatment. However, the disadvantages of die casting are that the equipment and tools are relatively complex, the maintenance cost is high, and the production efficiency is relatively low.

For the modern automotive industry, lightweight aluminum alloys are more likely to use the die-casting method because it can achieve high precision and surface quality, thereby reducing the time and cost of post-processing and surface treatment processes. Therefore, die casting is more suitable for the production of lightweight aluminum alloy parts for automobiles, such as engine blocks, cylinder heads, gearbox housings, etc. The precision and surface quality requirements of these parts are high and need to be obtained by die casting.

4.2. Wrought Techniques

Extrusion molding is the process of extruding an aluminum alloy blank through the mold of an extruder. During the extrusion process, the aluminum alloy blank is plastically deformed by the extrusion force and friction of the mold to form the desired shape and size. The advantage of extrusion molding is that high precision and surface quality can be obtained, which can reduce the time and cost of processes such as post-processing and surface treatment. However, the disadvantages of extrusion molding are that the equipment and tools are relatively complex, the maintenance cost is high, and the production efficiency is relatively low.

Rolling is the process of pressing an aluminum alloy blank through the rolls of a rolling mill. During the rolling process, the aluminum alloy blank is plastically deformed by the pressure and friction of the roll to form the desired shape and size. The advantage of rolling is that a large number of parts can be produced quickly, suitable for parts of various shapes and sizes. However, the disadvantage of rolling is that the accuracy is low, defects such as shrinkage holes and pores are easy to occur, and processes such as post-treatment and surface treatment are required to improve quality. Similarly, because extrusion molding has better precision, it is generally used to produce aluminum alloy engine blocks, cylinder heads, gearbox housings, etc. Of course, for parts that are produced in large quantities, such as doors, bodies, and wheels, we can also improve production efficiency by rolling.

4.3. Powder Metallurgy and Additive Manufacturing

The powder-forming process of an aluminum alloy mainly includes powder metallurgy, investment casting method and pressure sintering method. The powder metallurgy method is a method of making parts of aluminum alloy powder through mixing, pressing, sintering and other processes. This method can obtain high precision and surface quality, which can reduce the time and cost of processes such as post-treatment and surface treatment. However, the disadvantages of the powder metallurgy method are that the equipment and tools are relatively complex, the maintenance cost is high, and the production efficiency is relatively low. The investment casting method is a method of making parts of aluminum alloy powder through melting, mold molding, sintering and other processes. This method can obtain high precision and surface quality, which can reduce the time and cost of processes such as post-treatment and surface treatment. However, the disadvantages of the investment casting method are that the equipment and tools are relatively complex, the maintenance cost is high, and the production efficiency is relatively low. The pressure sintering method is a method of making parts of aluminum alloy powder through pressing, sintering and other processes. This method can obtain high precision and surface quality, which can reduce the time and cost of processes such as post-treatment and surface treatment. However, the disadvantages of the pressure sintering method are that the equipment and tools are relatively complex, the maintenance cost is high, and the production efficiency is relatively low.

Additive manufacturing of aluminum alloys refers to a manufacturing technique that manufactures parts by adding materials layer by layer, also known as 3D printing. The advantages of additive manufacturing are obvious. For example, additive manufacturing can produce parts quickly, especially for complex parts, which can greatly shorten the production cycle. There is also additive manufacturing that can achieve precise dimensional control and complex structural design to meet the requirements of high precision. In addition, additive manufacturing can quickly adjust the design and production of parts and can quickly respond to changes in market demand. Additive manufacturing can reduce the waste of materials, use materials more efficiently, and meet the requirements of contemporary society for industrial environmental protection. However, additive manufacturing also has many disadvantages. First of all, it is expensive. Equipment for additive manufacturing is very high, especially for high-volume production, and the cost will be higher. Second, additive manufacturing makes it difficult to control the accuracy of large-size parts. Additively manufactured parts require complex post-processing, including cleaning, sintering, heat treatment, etc., which will greatly increase the cost of mass production. Finally, additive manufacturing has limited material options, especially for aluminum alloys with high strength and hardness.

5. Applications in Modern Industry

The new aluminum alloy material has good corrosion resistance. For example, magnesium matrix composite is an aluminum alloy material with magnesium as the main component, which has not only excellent mechanical properties but also has good anti-rust ability and high-temperature stability. Therefore, magnesium matrix composites are widely used in shipbuilding, marine engineering and other fields. In addition, the new aluminum alloy material can also improve its oxidation resistance and wear resistance by adding other elements to meet the needs of different fields. At the same time, in order to meet the lightweight requirements of transportation, the research and development of new lightweight aluminum alloy materials is one of the hot spots in materials research in recent years. The aluminum alloy with outstanding performance is ultra-high-strength aluminum alloy, which is a new type of aluminum alloy material with extremely high specific strength, and its specific strength can reach 10,000~25,000kg/mm^3. This high-strength aluminum alloy can be used in aerospace and other fields, such as aircraft structural parts, engine housings, etc. In addition, they can be used in the automotive industry to manufacture body frames and chassis components, among other things.

To make the new aluminum alloy material widely used, the processability of the material is a key factor. At present, various advanced processing technologies and technical means have been applied to the production of new aluminum alloy materials, including powder metallurgy, laser melting deposition, electron beam welding, etc. By adopting these advanced technologies, efficient production processes and reduced costs can be achieved. Moreover, lightweight transportation has gradually become mainstream in the past decade. The lightweight of the car was first proposed by developed countries, from the Indians first made of aluminum alloy as a material to make a car crankcase, to 1999 Audi's first mass production of all-aluminum cars, aluminum alloy with its low density, high specific strength and specific stiffness, good elasticity and impact resistance and high recyclability, high regeneration rate and a series of advantages, the application in automobiles has been vigorously developed (Li et al., 2010). In 2015, the proportion of aluminum alloys in automotive applications reached more than 35%. As early as 2009, some scholars found that aluminum alloy can not only reduce the weight of the car to reduce fuel consumption but also reduce the moment of inertia of parts and improve the performance of the axle structure of the car [9].

On freight trains, aluminum alloys can bring more significant transportation efficiency improvements. In the van container, the parts of the steel replaced by aluminum alloy are not only outside the container itself but also fenders, rear protection, side guardrails, door bar locks and door hinges. The edges and other sides can be lightweight by aluminum alloy. Synthesis can bring 30%~40% weight gains [10]. However, it should be noted that for fuel vehicles, the reduction of the overall weight of the car is not necessarily reasonable because when the weight of the car is lower than a certain proportion, the car needs to reduce the height to achieve the effect of body stability, which is a loss to the comprehensive performance of the car [11]. While car lightweight has great prospects in electric energy vehicles, when the quality of the whole vehicle is reduced, electric vehicles can balance the total weight by increasing the battery pack, which not only ensures the balance and safety of the body but also improves the endurance of the vehicle. Therefore, in the modern and near future, the lightweight aluminum alloy frame electric vehicle industry is one of the important research objects.

Also, with the alienization rate of the car body increasing, it is necessary to increase the aluminum alloy forming process, maintenance and other aspects [12].

6. Conclusion

Due to its low density, high strength, easy processing and environmental protection, lightweight aluminum alloy has gradually increased its status in modern industry, surpassing steel in many fields to become the first choice for engineering materials. In the field of transportation, the advantages of lightweight aluminum alloys are very prominent, and they are widely used in automobile manufacturing to reduce vehicle weight and improve fuel efficiency and performance. In the body structure, the low density of aluminum alloy greatly improves transportation efficiency. In the suspension system, aluminum alloy can manufacture high-precision suspension arms and steering knuckles to improve handling performance. In the power system, aluminum alloy can reduce the weight of the engine and does not provide an upper limit for the installation of the battery of the electric vehicle, which greatly strengthens the endurance of the vehicle. In terms of wheels, aluminum alloy wheels have become the first choice of many automakers because of their beauty and corrosion resistance.

In the future, this trend will continue. Because of the increasing demand for lightweight in the automotive industry, high-strength aluminum alloys will become one of the core structural materials for future automobile manufacturing. These high-strength aluminum alloys offer higher strength and better corrosion resistance, allowing them to replace bulky steel components further. Moreover, the new requirements for environmental protection will also greatly affect the development of aluminum alloys. With the extension of the service life of automobiles and the increase in the number of end-of-life cars, aluminum alloy recycling will become an important field. By recycling aluminum alloys, the cost of automobile manufacturing can be reduced while reducing the need for raw materials. Finally, 3D printing technology will gradually be popular in automobile manufacturing, which can bring new opportunities for the manufacture of lightweight aluminum alloys.

Of course, lightweight aluminum alloys also have shortcomings such as high prices, unstable strength of different series, and poor welding performance, which will also become one of the problems that the material industry needs to solve in the future. In short, the application of lightweight aluminum alloys in the automotive industry has achieved remarkable results and will continue to play an important role in the future. With the development of high-strength aluminum alloy, aluminum alloy recycling, 3D printing technology and lightweight design, the application prospect of lightweight aluminum alloy in the automotive industry will be broader.

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