

Polymer Application in Automotive Industry

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ABSTRACT

As you know, the reliability of the car, its durability, comfort and traffic safety can only be ensured if polymeric materials are used - plastics, rubbers, varnishes and paints, and others.

In context, they are often referred to as the materials of the future due to their light weight, strength and ease of molding. However, modern plastics offer many more advantages.

The article analyzes the prospects for the use of polymeric materials in the automotive industry.

As you know, plastics and cars are inventions of the same era, the 19th century. Today, they are increasingly used in the design of modern cars. In context, they are often referred to as the materials of the future due to their light weight, strength and ease of molding. However, modern plastics offer many more advantages. At present, there is practically no plastic that would not find application in the automotive industry, whether it be thermoplastics, polyurethanes, resins, synthetic rubber, coating raw materials, chemical fibers, dyes and glass fibers, adhesives and corrosion inhibitors. The use of modern polymeric materials instead of traditional ones can significantly reduce the weight of the part, in some cases up to 50% [1].

The first plastic was invented in 1855 by the British metallurgist and inventor Alexander Parkes. When he decided to find a cheap substitute for expensive ivory, from which billiard balls were made at that time, he could not even imagine what an important discovery for mankind he managed to make. The ingredients of the first plastic were nitrocellulose, alcohol and camphor. The mixture of these components was heated to a fluid state, and then poured into a mold and solidified at normal temperature. This is how the founder of modern plastics, parkesin, was invented.

The key advantage of plastics over metal is lightness: on average, plastic parts weigh 25-30% less than steel ones. And reducing the weight of the car reduces fuel consumption. Not least an important advantage of plastic is its corrosion resistance, which is an order of magnitude higher than that of metal. The tendency to abandon metal can also be seen in the example of the use of plastics in the automotive industry.

Since the 1970s, the proportion of metal parts in a car has been steadily declining: if previously an ordinary car was 79% steel, then today the share of metal in a car is about 55%. Plastics, by

contrast, are showing steady growth, from 6% in the early 1970s to 18% by 2020, and rubber from 2% to 7%. At first it may seem that plastics are used only in interior trim, but they can be found in the body, in the suspension and even in the engine of the car.

According to experts, the global demand for engineering plastics for automotive applications will grow by 7% per year in the near future. [2].

It's safe to say that the car of the future will contain many more polymers than it does now.

Formula 1 race cars consist mainly of plastic and composite materials, and it is the use of plastics that can significantly reduce weight by 25-70%, improve dynamic performance and increase the speed of racing cars. Less gasoline consumption, in turn, makes cars using plastic composites more environmentally friendly.

The number of polymers is growing not only in cars, but in other cars there are also more and more plastic parts.

At present, the range of application of plastics is very wide: from body parts, engine and chassis parts, control systems to finishing and decorative elements and plain bearings. The surface of finishing details can imitate metal, wood, leather, fabric. Body parts, such as bumpers, grilles, moldings, headlight housings, are made of black painted polyurethane with a matte surface, which gives the model a modern look. Количественное использование пластмасс в изготовлении легковых автомобилей примерно таково: в автомобилях малого класса собственной массой до 800 кг на пластмассы приходится 105 кг, что составляет около 13%; в моделях среднего класса используется 140 кг пластмасс, или 11% от полной массы автомобиля; в моделях большого класса — 180 кг или 9,5%.

Calculations carried out by Volkswagen (Germany) on the basis of experimental data showed that the maximum use of plastics in the Golf model will reduce its weight by 15% compared to the weight of the traditional model. With the maximum use of aluminum, the weight reduction will be 22%. In the total mass of materials used, plastics accounted for 22%, and aluminum - 10%, while the weight reduction of the model was 17% [3].

In the 1960 technological advances made it possible to use polymers in the production of the most important automotive components. Model Renault 5, produced since 1972, was the first mass-produced car with a plastic bumper, which became widespread in the following decade. This was a turning point in the history of the automotive industry, because, in addition to having a decisive influence on the appearance of vehicles, plastic bumpers contributed to a significant reduction in the weight of the car and became the basis for improving safety. Volkswagen was the first brand to introduce a "seamless" plastic radiator and fuel tanks; BMW - front and rear spoiler; Renault - protective side panels; a General Motors - oil separator. As R&D departments have improved the thermoplastic properties, impact energy absorption capacity and anti-corrosion performance of the material, the design possibilities have also expanded, and individual brands have been able to expand the use of new materials in the automotive industry, including components such as: mudguards, reflectors, body, hood and rear doors, headlight covers. К началу 21-го века автомобильные аксессуары и рабочие характеристики были уже усовершенствованы, а регламенты по охране окружающей среды требовали снижения выбросов и более активного участия в переработке и повторном использовании компонентов.

Thus, the challenge is to reduce the weight of vehicles and find 100% recyclable materials that can replace the materials currently used, including for car body components.

To solve energy saving issues and achieve greater traffic safety, it is important to use plastics that would not only replace other materials (often expensive) and reduce the weight of the car, but would also suggest new engineering solutions. Modern methods and technology for the

production of plastic products make it possible to integrate structures - to combine individual elements into one part.

For example, the so-called bumper system combines the actual bumper, radiator grille, signaling and lighting equipment. The latest technology makes it possible to manufacture the listed parts in the form of one part of a modern form. At the same time, the number of assembly operations is reduced, production costs are reduced. [4].

In the 1960 new discoveries in polymers enabled the development of thermosetting polymers such as polypropylene, a type of plastic widely used in modern vehicles. Its mechanical properties, light weight and the fact that it is 100% recyclable contribute to the fact that polypropylene currently accounts for 40% of all plastics used in the automotive industry. In the middle of the 20th century, research and experimentation with plastics led to the creation of new materials, which gradually began to be used in the automotive industry. For example, the excellent insulating properties of Bakelite, invented by Leo X. Baekeland in 1907, have made it an ideal material for making plugs, sockets, handles, switches, and cabinet parts for modern office equipment.

The American company General Electric Plastics in 1979 for the first time on the Lincoln Continental model of Ford made headlights from plastic - Lexan polycarbonate.

Currently, three French firms are engaged in the manufacture of headlights from Lexan polycarbonate and Noril thermoplastic resin.

Cibie also manufactures the headlight for the Citroen Visa. Here, a piece of Lexan 141 is used that combines the base and body, it is attached to the glass of the headlight and the metal mirror.

Ducellier (France) chose Noril PX 1155 from General Electric Plastics for the manufacture of headlights for Peugeot 505 models. This high-quality thermoplastic is used to make the stand for the adjustment mechanism.

Due to the high surface quality of Noryl parts, it is not difficult to apply a metalized coating in a vacuum without pre-treatment of the surface. Of interest is the modern way of designing the instrument panel. Reinforced translucent tinted LT macrofoil sheets fiberglass, having a matte front surface, are glued to the instrument panel using an adhesive layer applied on the reverse side.

Colored signs can be applied to them, they are not deformed under the influence of temperature, they can be cut. Due to the natural dark color of the plates, the colored marks printed on the reverse side of the plates only appear when illuminated. This effect is used in the manufacture of pilot lamps. [5].

It should be noted that the higher cost compared to steel, aluminum, etc., hinders the widespread use of new materials. In particular, this applies to graphite fiber, which is used to reinforce resins when creating composite materials. However, low energy costs in the production of plastic parts using modern technology make it possible to compensate for the high cost of materials. For example, the so-called RRIM process of reaction injection molding with simultaneous reinforcement makes it possible to obtain lightweight, durable body parts from composite materials, the cost of which is lower than steel ones.

The day is not far off when a significant part of the components and parts of machines and devices will be made of various kinds of plastics.

Already today, the world's first car, 90% made of various types of plastics, was presented in Japan. Due to the use of various types of plastics, the weight of the car is 40% lighter than usual. Lighter weight saves energy and opens up new prospects for the development of electric vehicles [6].

The new 90% plastic concept car was developed as part of a government innovation technology program and is the result of collaboration between scientists at the University of Tokyo and automakers.

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