Hitachi Chemical
Working On Wonders

Automobile Related Products for Environmental Conservation and Energy Saving

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Environmental problems such as global warming and air pollution are becoming serious, and regulations on automobiles are increasing. Although the electrification of automobiles as an environmental countermeasure has been growing against the background of governmental preferences, internal combustion engines and hybrids are dominant for the time being. We are proactively developing auto parts and materials to realize environmental conservation and energy saving. This report refers to an overview of our R&D and manufacturing efforts on these issues.

1 Introduction

The automobile industry is undergoing a once-in-100 year major reform with the shift to electric vehicles (EV). The factors promoting this reform include legal regulations and preferential treatment systems in response to environmental problems such as air pollution and global warming. Laws and regulations that obligate the introduction of environmentally-friendly vehicles, such as ZEV (Zero Emission Vehicle) regulations in California, USA; and NEV (New Energy Vehicle) regulations in China, directly drive the EV shift. Other standards, such as CO_2 and emission regulations, set criterion and indirectly promote the introduction of environmentally-friendly vehicles as a means to meet the target. Europe has the most stringent CO_2 regulations, and the 2021 criterion (95 g/km) requires a reduction of about 30% from the 2015 level. (The criteria in the US, Japan, and China are 113 g/km, 114 g/km, and 116 g/km, respectively.) These laws and regulations give preferential treatment to EV shift, and the rate of adoption of EV is predicted to be 8% in 2030 (1% in 2017)[1) to 3)]. However, the movement toward Life Cycle Assessment (LCA), which evaluates CO_2 emissions over the vehicle life cycle, has recently become active. If the method of measuring CO_2 emissions is changed to LCA, the CO_2 emissions of hybrid vehicles (HEV) become equivalent to or lower than those of EVs, depending on the technological progress. With the current regulations that target CO_2 emissions, EV is overwhelmingly superior, as CO_2 emissions when driving can be regarded as zero. In the case of LCA, however, EV CO_2 emissions are likely to exceed HEV when CO_2 emissions from power generation and battery production are added. The rate of adoption of EVs may fluctuate significantly depending on the situation, and we are closely monitoring trends[4)]. In this way, the environmental friendliness of automobiles is progressing in various forms, but some shared technologies are required for (1) energy saving, (2) electrification, and (3) air pollution reduction. In this report, we introduce our company's efforts to apply these technologies to automobile parts.

2 Energy Savings

2.1 Weight reductions[5)]

To improve fuel efficiency with the aim of reducing CO_2 emissions, there are increasing demands for weight reductions, that are effective for any drivetrain. Reducing the weight by 100 kg is said to improve fuel efficiency by 1 km/L and reduce CO_2 emissions by 15 g/km. Methods to reduce weight are (1) moving to resins, (2) downsizing functional parts, and (3) thinner walls by using high-strength materials. Resins, of which CFRP (Carbon Fiber Reinforced Plastics) is a typical example, are lighter than steel and the other metals that are mainly used at present. In the automobile field, they are increasingly used for frames and structural parts and their use is expected to grow to the same scale as aircraft applications on a volume basis by 2030. Furthermore, due to their lightness and moldability, other plastics such as polypropylene and polycarbonate are being used for an increasingly wide range of automobile structural parts, electrical components, engine compartment parts, and fuel pumps. Hitachi Chemical products that are used include adhesives to connect components and parts, interior instrument panels and console boxes, exterior resin back doors[6)] and bumpers, resin gears in engine compartments, and housings for inverter power circuits as electronics system products. We are now working on developments to achieve further weight reductions in terms of materials and shapes. The resin back door uses polypropylene (PP), glass fiber (GF), and our adhesive to achieve weight reductions of 30%

or more compared to the conventional steel type. It uses 55% fewer parts, which improves productivity (**Figure 1**) (**Figure 2**). We are promoting the application of foam molding technology to various exterior parts to achieve further weight reductions in future. Resin gears also reduce the weight by 46% compared to steel gears and 58% weight reduction is achieved in the balancer system (**Figure 3**) (**Figure 4**). In the future, the company intends to expand their application by further increasing the strength.

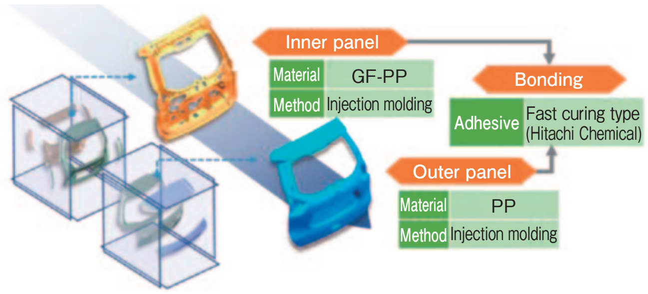
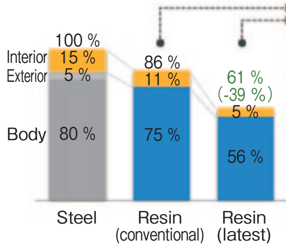


Figure 1 Structure of Back Door



Light-weight design

Item	Improvement over conventional product
Outer panel	Thinner wall "-10 %"
Inner panel	Thinner wall "-10 %"
Adhesive	Thinner wall "-50 %"
Other	Smaller metal parts

Figure 2 Weight Reduction Effect of Back Door Resinification

Gears

	Steel gear	Resin gear
NO.1 gear	1.0 (steel)	0.2 (resin)
NO.2 gear		0.3 (steel)
NO.3 gear	0.3 (steel)	0.1 (resin)
Total	1.3	0.6

46 %reduction

Figure 3 Weight Reduction Effect of Resin Gears

Balancer system (kgf)

	Units	Steel	Resin
Number of journals	Qty	3	2
Journal diameter	mm	OD29	OD23
Shaft length	Mm	265	185
Shaft mass	kgf	6.2	3.6

58 %reduction

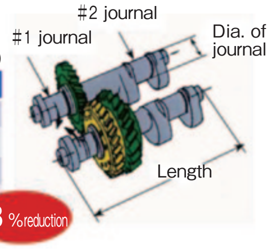


Figure 4 Weight Reduction Effect of Balancer System

2.2 Improving fuel consumption of internal combustion engines[7]

Although the EV shift is predicted to continue until 2030, it is expected that approximately 90% of vehicles (mainly HEV) will have an engine, so that improving the fuel efficiency of internal combustion engines is an important development topic. **Figure 5** shows the development trends to improve the fuel efficiency of internal combustion engine parts. Hitachi Chemical mass-produces high-strength gears through a combination of powder metallurgy and densification technology and mass-produces turbocharger parts[8] with improved heat and wear resistance due to the precipitation of fine carbides. In the future, we intend to launch products that can improve fuel efficiency through weight reduction and downsizing.

	2015	2020	2025	Key technology
Trends in engine technology development	Lean burn			High strength (surface pressure resistance)
	Idle stop			Low friction
	Compact and lightweight			High strength
	Downsizing + turbo			Heat and wear resistance

Figure 5 Technical Road Map of Engine

3 Electrification[9]

Electrification is an important technology that contributes to energy saving and the environment. The necessary functions are batteries, motors, and inverters. As products to support these functions, Hitachi Chemical mass-produces negative electrode materials [10, 11] for lithium-ion batteries that have maintained top market share for more than 15 years based on high-capacity artificial graphite, high-power carbon-coated graphite, and high-capacity SiO; low VOC, high productivity impregnated varnish[12] for motors; IPM (Intelligent Power Module) housings (**Figure 6**) using Al bus bars for inverters, and reactor cores that reduce core loss thanks to our original material technologies. Electrification is about to bring about significant technological innovations such as lighter batteries, and we intend to proceed with development work to establish the appropriate technologies.

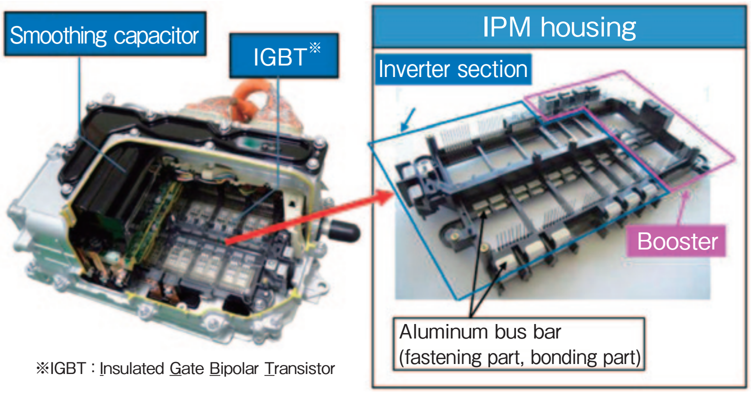


Figure 6 Structure of IPM System

4 Air Pollution Reduction

Air pollution is a problem that has a serious impact on the ecosystem, including harm to humans and the death of forests due to the release and movement of environmentally hazardous substances into the atmosphere. Environmentally hazardous substances include sulfur dioxide, nitrogen oxides, suspended particulate matter, carbon monoxide, hydrocarbons, and heavy metals, which need to be reduced or eliminated. We pioneered the industry by creating asbestos-free brake pads. Restrictions on the use of copper began in North America due to concerns that copper contained in the brake dust emitted from brake pads would contaminate rivers. Products sold in North America after 2025 are planned to be copper-free and their use will also be expanded overseas. We quantitatively investigated the effects of copper and achieved copper-free products by supplementing the functions with multiple metal and inorganic materials[14]. In addition, we are focusing on eliminating solvent from the above-mentioned impregnation varnish, eliminating the use of heavy metals such as chromium, and mass-producing plated exterior sheets that do not require plating solution. In the future, we intend to proceed with developments to reduce and eliminate environmentally hazardous substances.

5 Conclusions

In this paper we introduced our environmental conservation and energy-saving initiatives. However, we are also actively expanding applications of light control film for heat management and RFIDs to improve the convenience of distribution. The automotive industry is undergoing further changes in car usage patterns known as “sharing” and is promoting autonomous driving and connected cars combined with electrification in a revolution known as CASE (Connected, Autonomous, Shared & Service, Electric). In particular, autonomous driving is achieved by linking many main technologies such as sensors, actuators, hardware, software, control, communication, image processing, and recognition. It is also necessary to link the automobile parts. Based on our core technologies, we will create new products that support CASE to make a contribution to society.

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