Molding Technology to Realize Resinification of Automobile Parts

Mitsubishi Heavy Industries
Plastic Technology Co., Ltd.
Sales Department

In parallel with the development of eco-friendly cars such as hybrid vehicles and EV (electric vehicles), there has recently been a growing need for weight saving technologies to improve fuel efficiency in the automobile industry, with it contributing to environmental conservation and the establishment of a sustainable society. In addition, the simultaneous attainment of the improvement of market competitiveness is required, and as a result the fulfillment of cost reduction and flexible design, which are incompatible with weight saving, is an issue.

A vehicle body consists of modules such as the front end module and the back door module, and exterior parts including a panorama roof. One effective vehicle weight saving method is resinification, but it has a problem with the fulfillment of the following requirements.

(1) The front end carrier and back door inner require high rigidity and strength.

(2) The back door outer and exterior parts have a decisive influence on the vehicle design, and therefore require forming flexibility, a surface shape that causes no defective coating and flexural rigidity.

(3) Outer panels with a large projected area such as panorama roofs use injection compression molding that can be performed with lower clamping force because they require very high clamping force if normal injection molding is used. Injection compression molding has a problem with the occurrence of bias resin pressure in the mold, which causes unparallel mold parting line and results in an inaccurate thickness. Therefore an injection compression molding method that can maintain parallelism of mold parting line is required.

To fulfill the above requirements, Mitsubishi Heavy Industries Plastic Technology Co., Ltd. has developed the following three technologies.

(1) Long fiber reinforced thermoplastics (LFT) plasticization technology that can ensure effective fiber length without breaking long fibers as much as possible for the resinification of parts requiring high rigidity and strength.

(2) Highly dispersible, high kneading uniform melting technology that disperses the pigment master batch and talc master batch for the improvement of rigidity and reduction of linear expansion coefficient, prevents surface defects, has high formability and can perform high cycle molding.

(3) Four-axis parallel injection compression molding that independently controls the positions of the four tie bar axes of a two-platen clamping device.

This report presents the advantages and application examples of these technologies.

1. Plasticization technology (dedicated screw)

Figure 1 shows molding technologies that enable the resinification of automobile parts.

1.1 LFT plasticization technology

A normal screw breaks during plasticization and shortens the fiber length of LFT. On the other hand, a low compression ratio screw that hardly breaks the fibers results in insufficient fiber opening/diffusion antinomically. We researched screw designs, including the screw lead, through many experiments and developed a screw dedicated to long fibers that can ensure both effective

fiber length (prevention of fiber breakage) and good fiber opening/diffusion characteristics (patented).

As shown in Figure 1 (a), this plasticization technology consists of the dedicated screw design, the antiwear screw cylinder, the large flow path check ring and the large-diameter nozzle.

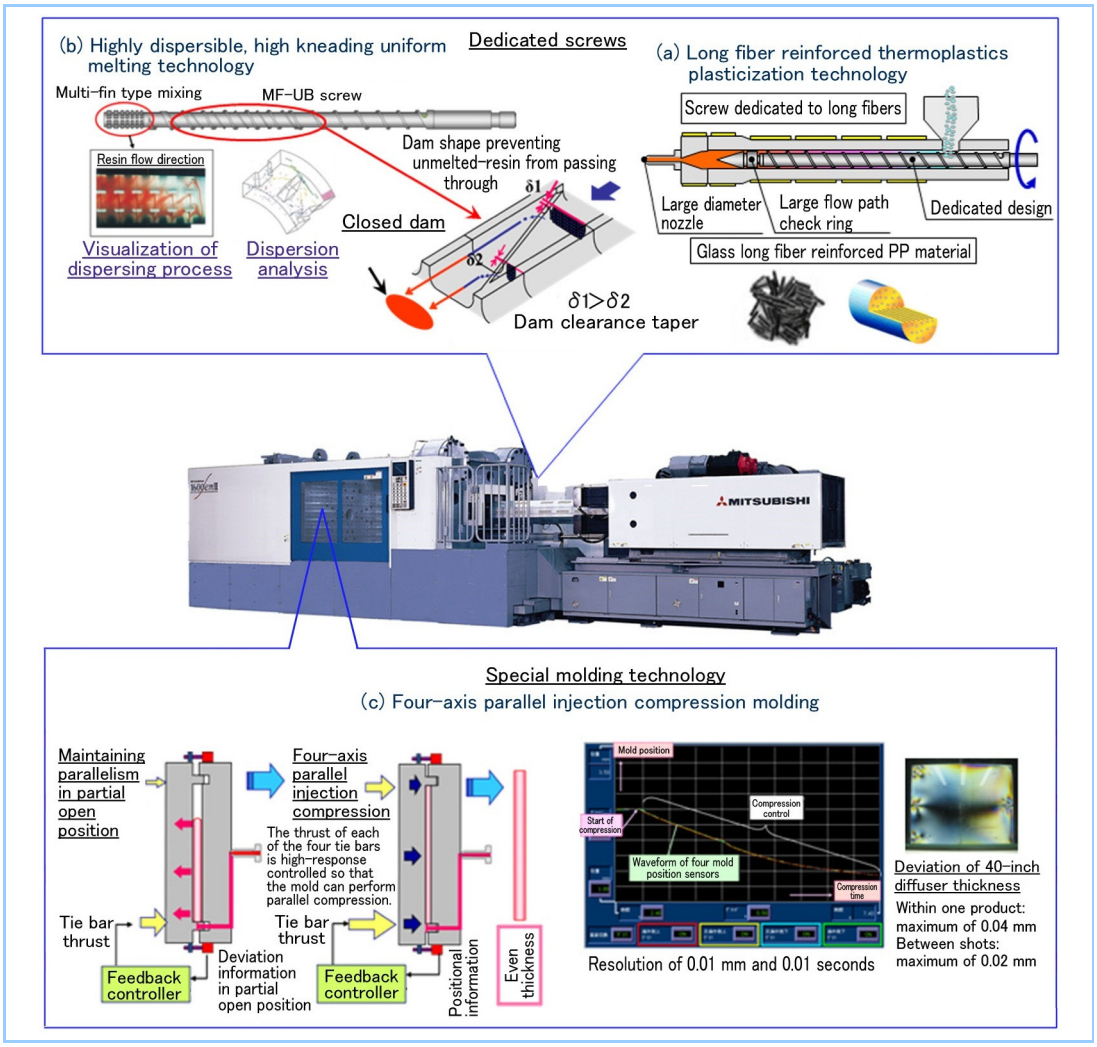

Figure 1 Molding technologies that enable the resinification of automobile parts

1.2 Highly dispersible, high kneading uniform melting technology <MF-UB screw>

The double flight (long barrier) type UB screw, which we utilized ahead of our competitors, prevents breakup to prevent unmelted resin from passing through due to the closed dam with a dam clearance taper (patented), and is gaining a good reputation for the advantage that no surface defects caused by unmelted resin occur.

Recently, there has been growing need for “high dispersion” that kneads and plasticizes the master pellet (master batch) containing recycled materials such as sprues or runners, which is are molded items that do not become products, and fillers such as pigment or talc in high concentration, in order to reduce resin material cost. For this reason, a mixing nozzle is used, but it has problems of difficulty in color change and an increase in electric power consumption because of the very large pressure loss during injection. Therefore the MF-UB screw, which is a UB screw equipped with a high-dispersion, multi-fin type mixer on its top, is available optionally in the catalog as shown in Figure 1 (b).

A multi-fin type mixer has an optimum fin shape designed through an analysis of the dispersion process of molten resin and a visualization experiment for comparison and evaluation of the shape obtained by the dispersion analysis, and improves stirring effects of laminar fluid.

Improvement in dispersion performance has made the mixing nozzle unnecessary, and the MF-UB screw contributes to a reduction of loss in color change and material cost cutting, in addition to energy saving due to the lower injection pressure.

2. Four-axis parallel injection compression molding

Injection compression molding of a tabular item having a large projected area with lower clamping force uses a side gate that injects resin from the side of the molded item to prevent the formation of weld lines. However, such injection compression with a side gate has the problem that uneven loading may occur on the movable platen resulting in an inclined mold and uneven thickness of the molded item.

As shown in Figure 1 (c), four mold position sensors are placed at the four corners of the mold parting line to directly detect the mold position, and then the four tie bar axes are controlled using positional feedback compensation by the high-response hydraulic servo valves and our proprietary feed forward compensation so that the mold can be clamped in parallel.

Consequently, the thickness deviation of the molded 40-inch diffuser was no more than 0.04 mm within one single product and no more than 0.02 mm between molding shots. In this way, even thickness of molded items and a subsequent reduction of optical distortion can be attained. As shown in the chart in Figure 1, when four-axis parallel injection compression molding is used, the wave forms of the four mold position sensors conform to each other even in injection compression molding with a side gate, which demonstrates that the parallelism of the mold parting line is always maintained and parallel compression between molds is realized.

3. Resinification examples of automobile parts

Figure 2 shows resinification examples of automobile parts and their technologies.

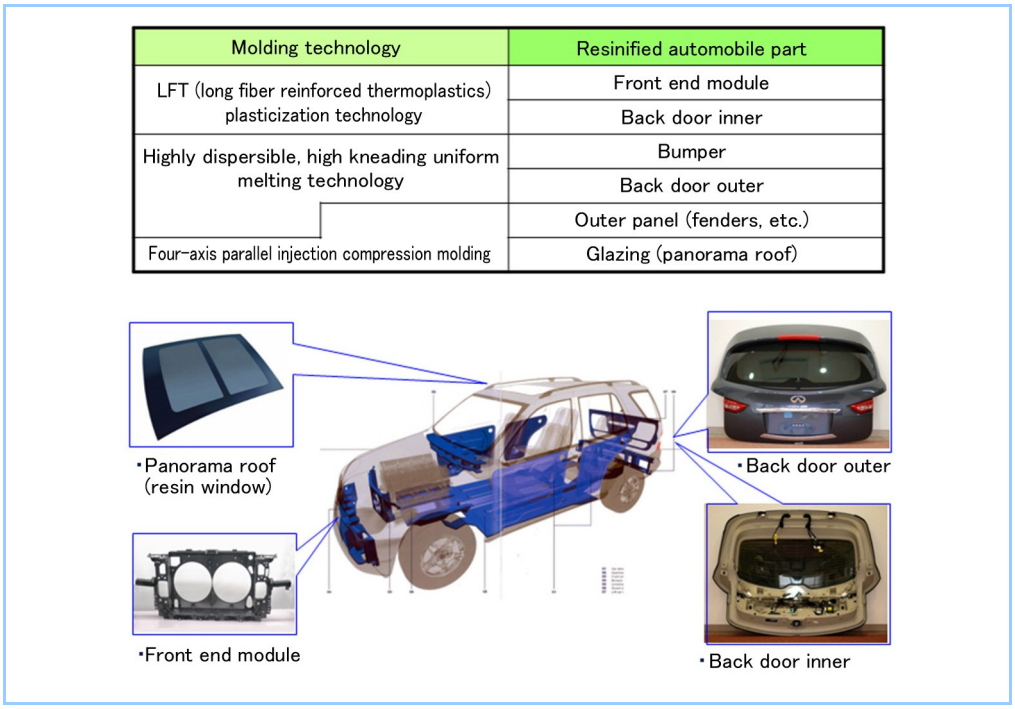

Figure 2 Resinification examples of automobile parts and their molding technologies

3.1 Application example for automobile modules

The manufacture of automobiles has proceeded with modularization, and therefore a vehicle consists of a front end module, a back door module, etc. Among such modules, the front end carrier, door module components, and back door inner require not only weight saving, but also high rigidity and strength. For these applications, LFT such as PP-LGF (polypropylene containing glass fibers) and PP-LCF (polypropylene containing carbon fibers) is used. However, it is indispensable for the fulfillment of product specifications to leave long fibers. Therefore a screw dedicated to long fibers is employed.

Outer panels including back door outers, bumpers, and fenders have a decisive influence on the vehicle design, and therefore require a high-quality appearance and forming flexibility. For this application, a highly dispersible and high kneading MF-UB screw is employed for dealing with fillers such as pigment and talc used for the reduction of resin material cost. Basically a standard

injection molding machine with a clamping force of 1600 to 3500 tonf and a screw diameter of 120 to 200 mm is used for this application, and in principle a dedicated screw for dealing with the resin to be used is also added.

3.2 Application example for panorama roof

Panorama roofs are manufactured by molding transparent PC (polycarbonate) using a four-axis parallel injection compression molding method and then molding black PC alloy into the frame. A panorama roof with surface area of 1.5 m^2 achieves weight reduction to approximately 10 kg, half of a glass roof having the same surface area.

As described above, this report presented molding technologies for the resinification of automobile parts. It is expected that resin parts will continue to further increase in the future because they are low-cost and have high design flexibility. We are willing to continue the development of molding technologies for the promotion of the resinification of automobile parts to meet the expectations of our customers.