

DEVELOPMENT OF HYBRID TECHNOLOGY FOR AUTOMOTIVE INTERIOR PARTS

T. Hirota ^{1,2}, A. Uotani ¹, Y. Ohmura ¹, N. Usui ¹, and J. Nambu ¹

¹ *Plastics Technical Center, Sumitomo Chemical Co.,*

2-1 Kitasode Sodegaura City, Chiba Pref., 299-0295, Japan

² *Corresponding author's Email: hirotat@sc.sumitomo-chem.co.jp*

SUMMARY: In this paper, we introduce three hybrid technologies for processing plastic parts that can realize more improvement about cost and weight reduction. The first one is SPM (Sumitomo Press Molding) that is a molding process combining the advantages of both injection molding and press molding. And this molding is possible with a low mold clamping force of 1/3-1/6th compared to that of injection molding. The second one is BM (Back Molding), which is the hybrid technology of vacuum forming and injection molding. By using BM, the functional properties of polypropylene foam sheets can be improved. The plastic parts made by this technology can realize both weight reduction and functional properties needed for automotive parts. The third one is FEM (Foam Expansive Molding) that can produce parts made of polypropylene foam sheets with high expansion ratio and large thickness. Using this technology, polypropylene foam sheets can be both lighter and more rigid than solid sheets.

KEYWORDS: polypropylene foam sheet, vacuum forming, weight reduction, low pressure molding

INTRODUCTION

Recently, the mileage improvement of the automotive is needed from the view of social demands such as, the rise of the oil price or the reduction of the carbon dioxide discharge. The weight reduction of the automotive parts is one of the effective ways for the mileage improvement. By the way, plastic products are popular as automotive parts, because they are superior to realize low costs, complex shapes, and weight reduction. And many processes, such as injection molding, blow molding and vacuum forming, are used for producing plastic parts. In this paper, we show three hybrid technologies for processing plastic parts that can realize more improvement about low-pressure molding and weight reduction.

SPM (SUMITOMO PRESS MOLDING)

SPM is a molding process developed by Sumitomo chemical Co., Ltd., combining the advantages of both injection molding and press molding, adaptable to an abundance of universal applications and capable of a broad diversity of uses. Its unique features are especially evident in the field of in-mold lamination molding. Basic process of SPM is shown as Fig. 1. In SPM, resin is injected in a cavity of the mold that is opened a little. After that, the resin is compressed and formed to the shape of the part.

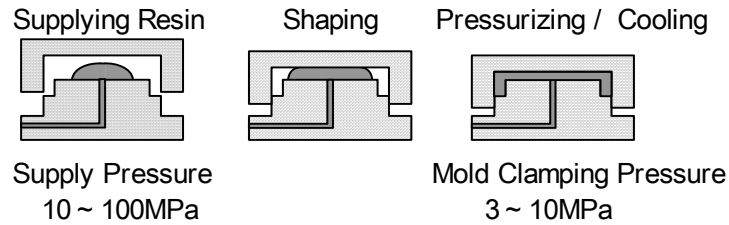


Fig. 1 Basic schematic of SPM process.

SPM is possible with a low supply pressure of 1/2-1/10th and mold clamping force of 1/3-1/6th compared to that of injection molding. In injection molding, the visco-elasticity of resin makes a large pressure gradient between gate point and edge of cavity. The lower pressure gradient provides the lower deformation or warpage.

In the process of SPM, a virtually uniform pressure is exerted over the entire surface of the product. This feature is effective at in-mold lamination molding, because uniform low pressure can avoid wrinkles of upholstery of in-mold lamination molding. In-mold lamination molding process of SPM is shown as Fig. 2.

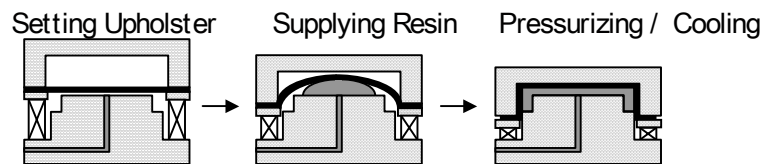


Fig. 2 In-mold lamination molding process.

Examples of SPM products are shown in Fig. 3. SPM is a good process for interior parts, which is decorated by upholstery. SPM is also a process well suited for large plastics parts because of the low deformation feature.



Fig. 3 Examples of SPM products.

SUMICELLER® (POLYPROPYLENE FOAM SHEET)

Polypropylene foam sheet is one of the solutions that realize weight reduction of recyclable automotive parts. We market polypropylene foam sheets under the trade name of Sumiceller®, that is produced with using form extruding process. Main lineups of Sumiceller® are of two basic grades. First one of them is used for construction material, such as a protection sheet of wall and floor. Second one is used for casing material, such as a box, a partition board and an impact energy absorber. And we are trying to apply them to new application in automotive field like door trims. Cross sections of three PP foam sheets are shown as Fig. 4. Expansion ratios of all sheets are 3.0, and thicknesses of all sheets are 3.0 mm. Main differences between Sumiceller® and other products are cell size and numbers of cells. Properties of melted resin and methods for foaming are regarded as the reasons of these differences. Uniform sized micro-cells of Sumiceller® present large advantages in view not only of the quality of foam sheets, but also in terms of easy processing by vacuum forming.

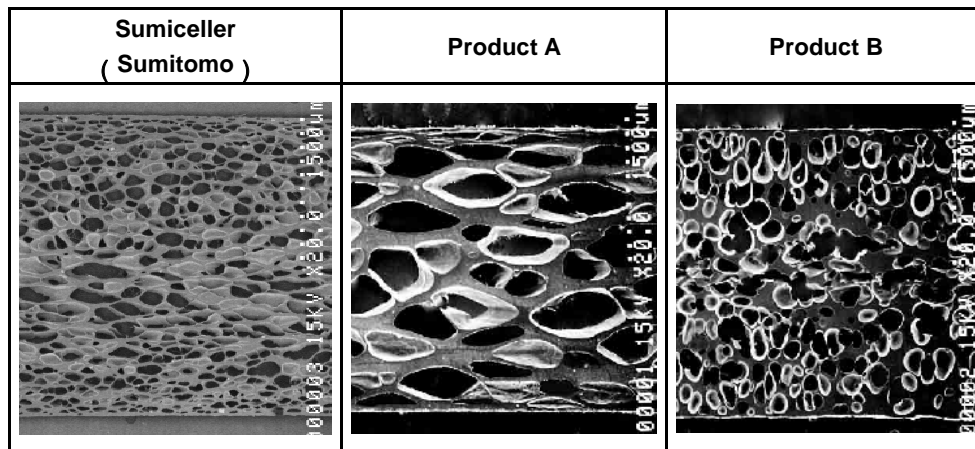


Fig. 4 Cross-sections of PP foam sheets.

BM (BACK MOLDING)

Vacuum forming with using Sumiceller® is superior to expansive ratio in comparison with the foam injection molding, of which expansive ratio is 2.0-3.0. And the foam injection molding cannot control expansive ratio in the direction transverse to the draw direction, in which product is ejected. By the way, vacuum forming with Sumiceller® cannot give additional structures, such as ribs or hooks to plastics parts. BM process is additional function technology and supplies solution to improve the automotive parts properties.

The schematic of BM process is shown in Fig. 5. In the BM process, firstly Sumiceller® sheet is heated and the heated sheet supply into the adequate cavity clearance. Then sheet is vacuumed and shaped. In order to put the additional functional structures on the backside of the automotive parts, core-mold with injection machine is set on Sumiceller® molding products. The molten resin is supplied in mold parts, and various functional structures can be attached on Sumiceller® vacuum forming products.

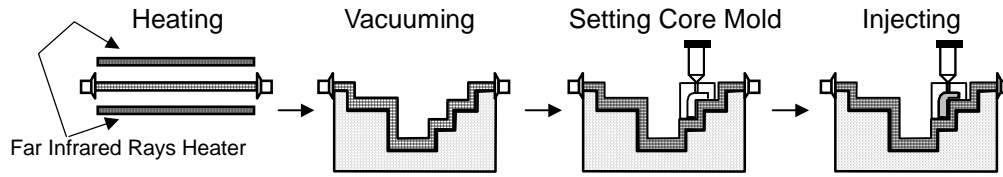


Fig. 5 Schematic of the BM process.

Examples of BM products are shown in Fig. 6. Clip base is need for automotive interior parts. Rib structures are attached at armrest part where strength for load is needed. So BM can increase the functional performances of vacuum formed parts.



Fig. 6 Example of BM product.

FEM (FOAM EXPANSIVE MOLDING)

FEM process can supply functionalized Somiceller[®] products. The targets of FEM are the products that have excellent features about rigidity, weight reduction, cushion, sound absorbance and insulation. The FEM process is shown as Fig. 7. First, Somiceller[®] sheet is heated. Then upper and lower mold is shut in each side edge of Somiceller[®] sheet and vacuuming action is achieved from upper and lower mold. By applying both side vacuum forming process to Somiceller[®], we can make Somiceller[®] to advanced form that has high expansive ratio and large thickness.

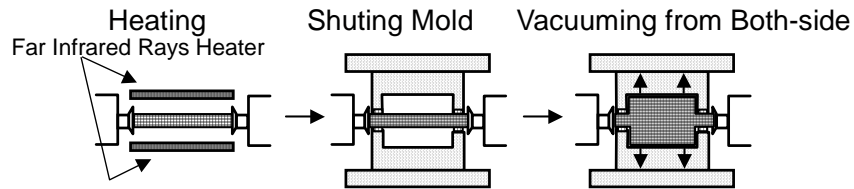


Fig. 7 FEM process.

Flexural rigidity of foam sheet is larger than that of solid sheet. Comparison of flexural rigidity of specimen, of which width is 1 cm, is shown as Fig. 8. The flexural rigidity of the solid sheet, of which thickness is 2.3 mm, is 119 N·cm². And its weight per the area of the solid sheet is 2070 g/m². The flexural rigidity of Somiceller[®] 3025, of which thickness is 2.5 mm and expansive ratio is 3.0, is 45.1 N·cm². And its weight per the area is 750 g/m².

By using the FEM technology, we can increase expansion ratio of Somiceller[®] while keeping the same weight per unit area of the sheet. For example, by increasing the thickness to 4.2 mm, the flexural rigidity of Somiceller[®], the weight per unit area of which is less than half of that

of 2.3 mm solid sheets, becomes the same as that of 2.3 mm solid sheets. By increasing the thickness to 5.0mm, the flexural rigidity of Sumiceller[®] becomes 1.5 times that of 2.3 mm solid sheet.

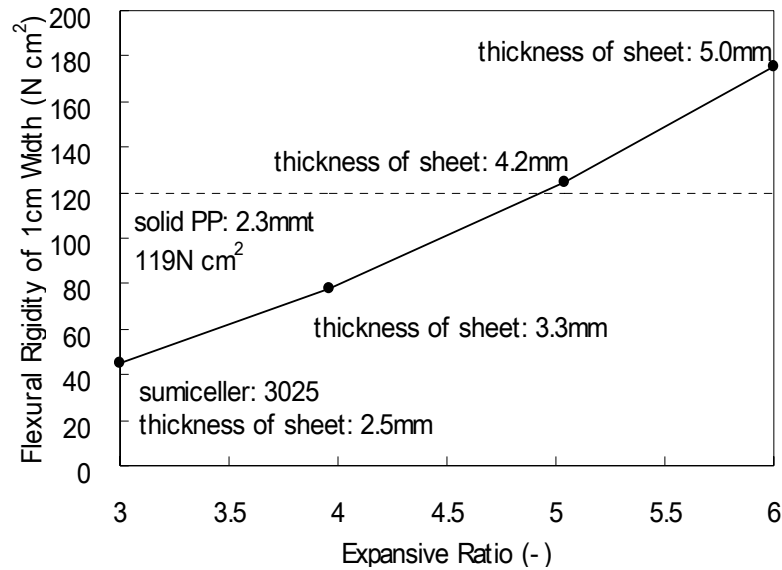


Fig. 8 Comparison of flexural rigidity.

CONCLUSION

We introduced three hybrid technologies (SPM, BM, FEM), which are available especially for large size plastics molded parts. Using these technologies, complicated plastic parts with high geometrical accuracy and low deformation can be produced. These technologies can be used to produce light weight, low deformation and low cost automotive parts, such as a door trim, a trunk side trim and a package tray.

REFERENCES

1. Sumitomo Chem. U. S. Patent 6565795, 2000