

The Use of "KP SHEET" in Automobile Interiors and "KP BOARD" as a Wood Substitute*

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1 Introduction

"KP SHEET" and "KP BOARD" are stampable sheets made of polypropylene (PP) powder and chopped glass fiber (GF) by a paper making process of the K-Plasheet Corp.

This paper describes the manufacturing process and characteristics of KP SHEET used in automobile interiors and KP BOARD used as a wood substitute.

2 Manufacturing Process of KP SHEET

The manufacturing process of KP SHEET is called a paper making method, which is based on technology developed by Arjo Wiggings Corp. in England^{1,2)}.

In the first step, non-woven material, which is a mixture of PP and GF, is produced by a paper making method, and is called a web. The web is an intermediate material that looks like a blanket, and it has an uniform distribution of the GF/PP and porous structure. In the next step, the web is heated and pressed using a hot press to achieve sufficient impregnation of melted PP into GF, subsequently cooled and cold pressed. This produces dense consolidated KP SHEET of high strength.

3 Characteristics of Expansion Molding Process

When KP SHEET is heated to a temperature above the melting temperature of PP, the sheet expands by releasing the residual stresses that are held in GF in the consolidation stage. This is called spring back.

This expansivity, which is an outstanding characteristic of KP SHEET, can be used to produce light and stiff-molded articles. This molding process is called expansion molding.

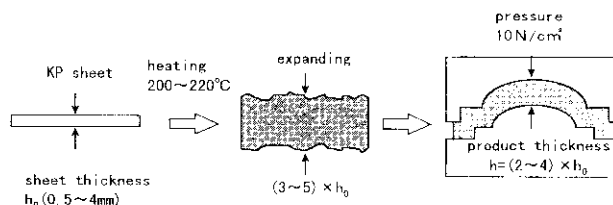


Fig. 1 Schematic diagram of expansion molding

sion molding. A schematic diagram is shown in Fig. 1. KP SHEET expanded by heating is compressed in a mold and cooled down to produce molded articles which are 2–4 times thicker than the original thickness. Due to the low molding pressure of this process (less than 2–3 kgf/cm²), it is possible to reduce the die cost.

For automobile interiors, the surface texture is often laminated on the surface of the molded articles in order to improve their handling and beauty. One great advantage of KP SHEET is that lamination of surface texture and trimming can be done simultaneously during the molding process.

KP BOARD³⁾ are produced by expansion molding in the hot press/the cold press process as flat boards which are sold.

4 Mechanical Properties and Structure of KP SHEET and KP BOARD

Mechanical properties of expansion molded panels prepared from KP SHEET are shown in Table 1. Elastic slope is defined as the slope of load-deflection curves at the early stage. The values of maximum load and elastic slope, which are used as the parameters of mechanical properties of molded parts, are increased with an increase in the expansion ratio.

A weight comparison of various materials with the same rigidity KP BOARD is shown in Fig. 2. KP BOARD has almost the same resistance to bending at same unit weight as plywood.

A SEM photograph of expansion-molded KP SHEET is shown in Photo 1. Here we can clearly see tight bonding of GF at their contact points by PP in porous KP

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Table 1 The mechanical properties of expansion molded panel prepared from KP SHEET

Expansion ratio	Thickness (mm)	Flexural strength (N/mm ²)	Flexural modulus (N/mm ²)	Maximum load (N)	Elastic slope (N/mm)
Consolidated sheet	0.96	24	3100	7.5	0.4
2	1.88	9.2	1020	11	1.4
2.5	2.5	6.3	850	13	2.6

Unit weight: 1.0 kg/m²

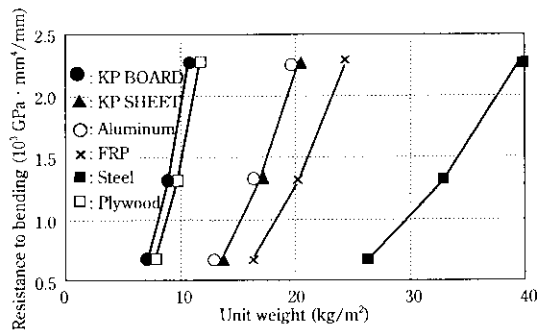


Fig. 2 Weight comparison of various materials with same rigidity

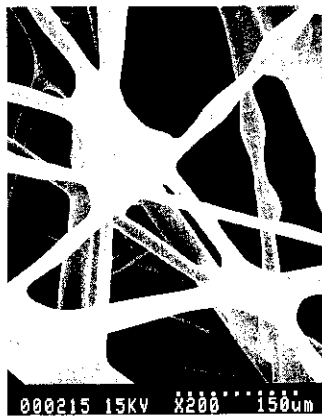


Photo 1 Structure of KP SHEET (expansion molding)

SHEET. This SEM photograph suggests that the light weight and excellent mechanical properties of porous KP SHEET are enhanced by this tight bonding. Due to their structure, KP SHEET is defined as shape retainable glass fiber material rather than fiber reinforced plastic sheet.

Since KP BOARD is mainly used as a substitute for wood, there is no lamination process of surface texture. However, multi-layered KP BOARD can be produced in order to enhance the mechanical strength and ensure the abrasion resistance of this board.

For an example, **Photo 2** shows one grade of KP BOARD, which consists of three layers, *i.e.*, an ex-

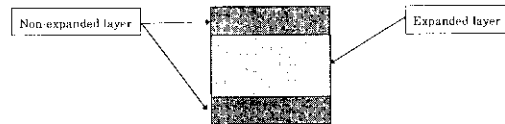
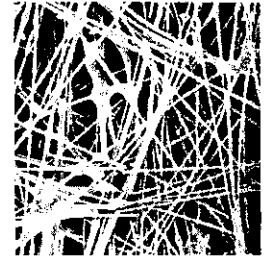
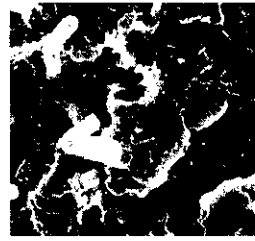


Photo 2 Structure of KP BOARD

panded layer in the middle sandwiched between two non-expanded layers.

It is the introductory period to advance the further applications of KP SHEET used in automobile interiors and KP BOARD as wood substitute.

5 “KP SHEET” Used in Automobile Interiors

Specifications besides light weight and high stiffness of the materials used in automobile interiors are as follows.

- (1) Good moldability (freedom of design)
- (2) Dimensional consistency (thermal stability in molding and using) and shape retentivity
- (3) Recyclability

Recent materials used for the Headliner are resin felt, wooden boards, cardboard, and urethane for hot press molding, and thermoplastic foam, thermoplastic-urethane and PP cardboard for cold press molding. The ability of these materials and KP SHEET to meet the above specifications is summarized in **Table 2**. Resin felt, wooden boards, cardboard, urethane, and thermoplastic-urethane are not recyclable, while thermoplastic foam is inferior in dimensional consistency. Moreover the design of wooden boards and cardboard is restricted by their poor moldability and they are easily warped by humidity. On the other hand, KP SHEET meets all these specifications extremely well, and can thus satisfy the customers' requirements.

Since KP SHEET can be molded in a wide range of stiffnesses, weights, and thicknesses to meet the customers' needs, KP SHEET has been supplied to customers with different standards and different automobile types. Examples of the applications of expansion molded KP SHEET in an automobile interior, *i.e.*, the headliner and the rearpackage, are shown in **Photos 3** and **4**, respectively. Because both the headliner and the rearpackage are large parts, they should be light and of high stiffness, so in these applications, the characteristic of expansion molded KP SHEET are utilized very suitably. Besides these applications, expansion molded KP

Table 2 Performance comparison of various materials used for automobile's interior

Material Property	Moldability	Dimension's consistency	Recycle
Resin felt	○	○	×
Wooden board	×	×	×
Card board	×	×	×
Urethane	○	○	×
Thermoplastic foam	○	×	○
Thermo-urethane	○	○	×
PP Card board	×	○	○
KP SHEET	○	○	○

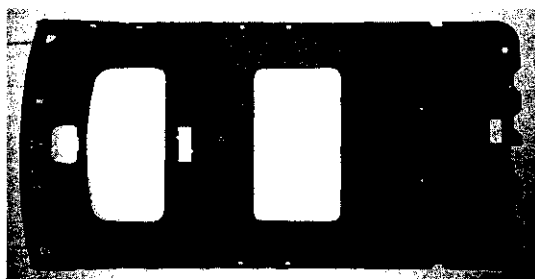


Photo 3 Headliner



Photo 4 Rearpackage

SHEET has been applied to other types of interior trim.

6 "KP BOARD" as a Wood Substitute

The characteristics of KP BOARD are as follows.

- (1) The specific gravity can be designed in the range from 0.2 to 1.2
- (2) It is possible to add various functions by lamination
- (3) It can be sawed, nailed, riveted, etc., as easily as wood
- (4) Low heat conductivity
- (5) Excellent resistance to water, corrosion and chemical agents
- (6) Recyclability

Photo 5 shows an example of KP BOARD. As described in section 4, since it is possible to laminate different types of materials to KP BOARD, KP BOARD



Photo 5 KP BOARD

can satisfy a wide range of customers' requirements.

KP BOARD is currently being used as concrete frameboards, truck floorboards, and other material in many fields. However, new usage as wood substitutes are constantly being developed.

7 Concluding Remarks

KP SHEET manufacturing equipment was installed at Kawasaki Steel's Chiba Works in 1991 and has been operating smoothly. K-Plasheet Corp. has been supplying KP SHEET as a unique composite material which is produced by distinctive processes such as a paper making method. K-Plasheet Corp. has succeeded in the development of KP SHEET used in automobile interiors for moldable glass fiber reinforced material, and expansion molded KP BOARD is also produced on KP SHEET manufacturing line. K-Plasheet Corp. plans to continue developing of new products, applications and molding processes to meet customers' needs in the future.

References

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- 3) K. Ono and Y. Sato: *Reinforced Plastics*, **43**(1997)4, 147

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