

DESCRIPTION

Metallic Decorative Plate with Sublimation-Transfer Pattern, Heat-Insulating
Panel and Outer Wall for Refrigerator both Employing the Same, and
5 Processes for Producing These

TECHNICAL FIELD

The present invention relates to a metallic decorative plate with a
sublimation-transfer pattern appropriate to an outer plate of a heat insulating
10 panel formed integrally with foamed heat insulating material, a heat insulating
panel using the metallic decorative plate, an outer wall for a refrigerator using
the heat insulating panel, and methods of manufacturing them.

BACKGROUND ART

15 Recent years are called an individuality era, and the variety of individual
sense of values is increased. Especially, the needs for a favorite color and
pattern of an article become extremely various and strong. On the other hand,
home electrical appliances such as refrigerators are mass-produced at low cost,
and, for this purpose, a coated steel plate or a laminated metal plate is used
20 where a steel plate and a surface treated layer capable of being post-processed
are integrated. In a manufacturing process of the coated steel plates or the
laminated metal plates, plates having the same color and pattern are usually
produced in large quantity, because it is difficult to frequently alter the
specification after the color and pattern of the surface treated layers are decided.
25 Therefore, response to various needs for an individual color and pattern is not
usually performed because the response reduces production efficiency and
delays the delivery.

However, sublimation-transfer technology using sublimation coloring agents has recently developed, and a method of directly printing a pattern on the laminated metal plate or the coated steel plate is commercialized. For example, Japanese Patent Unexamined Publication No. 2001-329474 discloses
5 a method of printing a sharp print pattern having no color shading on a printed matter by thermally transferring the printed matter and a transfer sheet in an adhered state using vacuuming. In this method, the transfer print sheet coated with a coloring composition containing the sublimation coloring agents by ink jet or the like is superimposed on the printed matter, and is inserted
10 between a hot plate and a rubber sheet. The clearance between the hot plate and the rubber sheet is vacuumed by a vacuum pump, thereby the transfer print sheet is attached firmly to the printed matter. Further, using thermal energy supplied from the hot plate, the sublimation coloring agents are thermally transferred from the transfer print sheet to the printed matter.

15 In this method, even when a large coated steel plate is used as a printed matter, the whole surface of the printed matter can be homogeneously pressurized and a printed matter having no color shading can be formed.

For printing a pattern on a metal plate such as a steel plate, a transparent or translucent resin film excellent in dye-affinity is previously
20 formed on the surface layer.

An employed steel plate is disclosed in Japanese Patent No. 2957864, for example. This steel plate is a metallic decorative plate, and has an opaque resin layer disposed on a basis material made of a metallic plate. The steel plate further has a plurality of transparent resin layers that are laminated on
25 the opaque resin layer and have a colored pattern formed of a sublimation coloring agent infiltrating into each of the layers.

In the metal decorative plate, a pattern is formed directly by sublimation

transfer on the laminated metal plate to which a transparent film is previously adhered. Therefore, when a small number of metallic decorative plates having a pattern are manufactured, time for manufacturing is shortened. The lamination of a plurality of layers allows quality and depth to be provided on a
5 finished pattern surface, and makes roughness of the pattern inconspicuous even in a closed view. Further, colored patterns are formed on all surfaces of a metallic decorative panel.

However, when general polyvinyl chloride film, polyethylene film, or polyester film is used on the laminated layer formed of the plurality of layers, a
10 print line of the colored pattern becomes blurred due to the plurality of laminated layers. They are very poor in thermal resistance and weather resistance. Especially, when heat of 50°C or higher is supplied, the sublimation coloring agent causes a re-sublimation phenomenon in the laminated layer, and hence the initially finished pattern is apt to break over time.

15 When the metallic decorative plate is used in a heat insulating panel formed of urethane integral foaming in a refrigerator door or the like, the layer receives heat due to urethane foaming and color shading occurs during the process. When a memo pad or the like is adhered to the refrigerator door in actual use, also, color migration can occur.

20 A metallic decorative plate having a sublimation transfer pattern excellent in weather resistance is disclosed in Japanese Patent Unexamined Publication No. 2002-59078, for example. In this publication, top coat is formed of thermosetting polyester resin having specified molecular weight, glass transition temperature (T_g), and melamine content, thereby providing a
25 metallic decorative plate having a pattern excellent in weather resistance.

In other words, the metallic decorative plate is formed of clear coating mainly containing the thermosetting polyester resin where average molecular

weight is 1000 to 10000, Tg is 20 to 60°C, and ratio of melamine to 100 parts by mass of solid content of resin is 20 to 150 parts by mass. In this metallic decorative plate, the top coat on which the colored pattern is formed by infiltration of the sublimation coloring agent is disposed on a substrate metal plate directly or through a base coat layer or a primer layer.

Since the clear coating mainly contains thermosetting polyester resin having specified molecular weight and glass transition temperature, the weather resistance and re-sublimation property in a laminated metal plate are improved.

In a sublimation transfer pattern printing method using either the laminated metal plate or the coated steel plate, the pattern drawn with the sublimation coloring agent during the clear coating of the outer film is infiltrated, thereby producing a pattern arbitrarily. Therefore, a color and pattern can be arbitrarily printed on the coated steel plate or a pre-coated steel plate in a post-process, and the method can respond to various needs.

However, the conventional metallic decorative plate having a sublimation transfer pattern has not sufficient long-time reliability. Even a metallic decorative plate having a pattern sublimated and transferred on a coated steel plate coated with thermosetting polyester resin cannot perfectly solve the re-transfer. Moreover, the coating is cracked by pressing or bending in the post-processing since the thermosetting resin is used.

Especially, when the metallic decorative plate is used in a refrigerator door having a heat-insulation property, temperature rises to 60°C or higher when manufacturing a urethane foaming insulating panel unitarily, so that a re-sublimation phenomenon occurs and the sublimation transfer pattern becomes blurred. Moreover, when the metallic decorative plate is used in a refrigerator door and a memo pad or the like is attached to the door with a

magnet or the like, a coloring agent is migrated by re-sublimation.

As a result, it is difficult to keep a stable color and pattern on a conventional treated steel plate of an article that is exposed in or out of a room for a long time.

SUMMARY OF THE INVENTION

A metallic decorative plate having a sublimation transfer pattern of the present invention may have an outer film resin layer disposed on the metal plate surface via an outer film adhering layer. The outer film resin layer may be formed of light transmitting resin of which glass transition temperature is not lower than a temperature at which a sublimation coloring agent re-sublimates to blur the pattern and is lower than a temperature at which the sublimation coloring agent is transferred. A sublimation coloring agent may be infiltrated into at least one of the outer film adhering layer and outer film resin layer, thereby forming a colored pattern. The metallic decorative plate may be applied and suitable to a heat insulating panel using resin foam, and the heat insulating panel is applied and suitable to an outer wall of a refrigerator. A manufacturing method of the metallic decorative plate of the example embodiments has the following steps:

(A) superimposing a laminated metal plate on a transfer print sheet so as to bring an outer film resin layer of the laminated metal plate into contact with a surface including a colored pattern of the transfer print sheet, the outer film resin layer being adhered to a first surface via an outer film adhering layer in the laminated metal plate, and the transfer print sheet having a surface provided with the colored pattern with the sublimation coloring agent; and

(B) heating and crimping the outer film resin layer and the surface including the colored pattern brought into contact with each other at a temperature for making the temperature of the outer film resin layer higher

than glass transition temperature.

The sublimation coloring agent may thus be infiltrated into at least one of the outer film resin layer and the outer film adhering layer. When the metallic decorative plate is used for the heat insulating panel, the outer film resin layer may be formed of a material having a glass transition temperature higher than a temperature achieved in a process of foaming a foam heat insulating material.

In accordance with a first aspect of the present invention, there is provided a metallic decorative plate with a sublimation transfer pattern comprising a metal plate; a first adhesive layer formed on a first surface of the metal plate; and a light transmitting first resin layer formed on the first surface of the metal plate via the first adhesive layer, wherein a sublimation coloring agent is infiltrated into at least one of the first resin layer and the first adhesive layer to form a colored pattern, and glass transition temperature of the first resin layer is not lower than a temperature where the sublimation coloring agent re-sublimates to blur the pattern and is lower than a temperature where the sublimation coloring agent is transferred.

In accordance with a second aspect of the present invention, there is provided a heat insulating panel comprising: the metallic decorative plate with a sublimation transfer pattern of the above; an inner surface member disposed on a second surface side facing a first surface of the metal plate and foaming thermal-insulating material foamed and filled into a space formed of the metallic decorative plate and the inner surface member.

In accordance with a third aspect of the present invention, there is provided an outer wall for a refrigerator, wherein the outer wall is formed of the

heat insulating panel of the above, the metallic decorative plate forms a front surface of the refrigerator, and the inner surface member forms a part of a storage room in the refrigerator.

In accordance with a fourth aspect of the present invention, there is provided a manufacturing method of a metallic decorative plate comprising: (A) superimposing a laminated metal plate on a transfer print sheet so as to bring a light transmitting first resin layer of the laminated metal plate into contact with a surface provided with a colored pattern with a sublimation coloring agent of the transfer print sheet, the first resin layer being applied to a first surface of the laminated metal plate via a first adhering layer and glass transition temperature thereof being not lower than a temperature at which a sublimation coloring agent re-sublimates to blur the pattern and being lower than a temperature at which the sublimation coloring agent is transferred; and (B) heating and crimping the first resin layer and the surface including the colored pattern brought into contact with each other in step (A) while the temperature of the first resin layer is higher than glass transition temperature of the first resin layer, wherein the sublimation coloring agent is infiltrated into at least one of the first resin layer and the first adhering layer.

In accordance with a fifth aspect of the present invention, there is provided a manufacturing method of a heat insulating panel comprising: manufacturing the metallic decorative plate of the above; (D) disposing an inner surface member on a second surface side facing the first surface of the laminated metal plate having the colored pattern; (E) injecting foaming resin into a space formed of the laminated metal plate and the inner surface member; and (F) forming a foaming insulating material by foaming the foaming resin in the space and integrating the laminated metal plate and the foaming insulating material, wherein the manufacturing method of the heat

insulating panel satisfies one of the following conditions: (1) glass transition temperature of resin forming the first resin layer is higher than a temperature to which the first resin layer is heated in step (F) and is lower than a temperature to which the first resin layer is heated in step (B); and (2) a temperature to which the first resin layer is heated in step (F) is lower than the glass transition temperature of the first resin layer.

In accordance with a sixth aspect of the present invention, there is provided a manufacturing method of an outer wall for a refrigerator comprising: manufacturing the metal decorative plate of the above; (G) processing the laminated metal plate having the colored pattern into a shape of the outer wall for the refrigerator; (H) disposing an inner surface member on a second surface side facing the first surface of the laminated metal plate on the outer wall; and (J) injecting foaming resin into a space formed of the outer wall and the inner surface member, (K) forming a foaming insulating material by foaming the foaming resin in the space and integrating the outer surface plate and the foaming insulating material, wherein the manufacturing method of the outer wall satisfies one of the following conditions: (1) glass transition temperature of resin forming the first resin layer is higher than a temperature to which the first resin layer is heated in step (K) and is lower than a temperature to which the first resin layer is heated in step (B); and (2) a temperature to which the first resin layer is heated in step (K) is lower than the glass transition temperature of the first resin layer.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of a metallic decorative plate having a sublimation transfer pattern in accordance with a first exemplary embodiment

of the present invention.

Fig. 2 is a sectional view of a laminated metal plate used for the metallic decorative plate of Fig. 1.

Fig. 3 is a sectional view showing a stacked state of the laminated metal plate and a transfer print sheet in a sublimation transfer process in accordance with the first exemplary embodiment of the present invention.

Fig. 4 is a process chart showing manufacturing methods of the metallic decorative plate and a heat insulating panel using it in accordance with the first exemplary embodiment of the present invention.

Fig. 5 is a sectional view showing an installed state of the transfer print sheet and the laminated metal plate in a sublimation transfer device used for manufacturing the metallic decorative plate in accordance with the first exemplary embodiment of the present invention.

Fig. 6 is a sectional view showing a state where a lifting device of the sublimation transfer device is operated to crimp a driving chamber onto a lower surface of an upper chamber of Fig. 5.

Fig. 7 is a sectional view showing a crimped state of the transfer print

sheet and the laminated metal plate by decompression by operating a vacuum pump of the sublimation transfer device of Fig. 5.

Fig. 8 is an assembling perspective view showing a configuration state of a heat insulating panel by combining the bent metallic decorative plate and an
5 inner surface member in accordance with the first exemplary embodiment of the present invention.

Fig. 9 is a sectional view showing an urethane foaming process of the heat insulating panel in accordance with the first exemplary embodiment of the present invention.

10 Fig. 10 is a sectional view showing a stacked state of the laminated metal plate and the transfer print sheet via a backup member in a sublimation transfer process in accordance with a second exemplary embodiment of the present invention.

Fig. 11 is a sectional view showing a stacked state of the laminated metal
15 plate and the transfer print sheet in a sublimation transfer process in accordance with a third exemplary embodiment of the present invention.

Fig. 12 is a schematic sectional view showing a heat treating process after sublimation transfer in accordance with a fourth exemplary embodiment of the present invention.

20 Fig. 13 is a schematic sectional view showing a heat treating process after sublimation transfer in accordance with a fifth exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

25 A metal decorative plate having a sublimation transfer pattern, a heat insulating panel using it, and a refrigerator door formed of the heat insulating panel of exemplary embodiments of the present invention are described with

reference to the following drawings. In each embodiment, elements similar to the previous embodiment are denoted with the same reference numbers, and the descriptions of those elements are omitted.

5 FIRST EXEMPLARY EMBODIMENT

Fig. 1 is a sectional view of a metallic decorative plate having a sublimation transfer pattern in accordance with the first exemplary embodiment of the present invention. Fig. 2 is a sectional view of a laminated metal plate used for the metallic decorative plate. Fig. 3 is a sectional view showing a stacked state of the laminated metal plate and a transfer print sheet in a sublimation transfer process. In metallic decorative plate (hereinafter referred to as "decorative plate") 1 having a sublimation transfer pattern, colored pattern (hereinafter "pattern") 15A on transfer print sheet (hereinafter "sheet") 2 is sublimated and transferred to laminated metal plate (hereinafter "plate") 3.

Plate 3 sequentially has substrate adhesive layer (second adhesive layer) 9, intermediate thermoplastic resin layer (second resin layer) 10, outer film adhesive layer (first adhesive layer) 11, ink layer 12, and outer film resin layer (first resin layer) 13 on a front surface side of metal plate 8.

In metal plate 8, plated layers 5 and 5A are formed on both surfaces of metal plate basis material (hereinafter "basis material") 4 formed of a steel plate by composite electro-galvanizing of zinc. Chemical treated layers 6 and 6A are formed on plated layers 5 and 5A by phosphoric acid, and anti-rust paint layer 7 is formed of epoxy resin on chemical treated layer 6A. Film-like opaque second resin layer 10 made of vinyl chloride resin via second adhesive layer 9 is laminated on chemical treated layer 6 on a first surface side.

First resin layer 13 is laminated on second resin layer 10 via first

adhesive layer 11 and ink layer 12. First adhesive layer 11 is formed of hot melt film of saturated copolymer polyester resin at melting point of 114°C. First resin layer 13 is formed of transparent or translucent film of polyethylene terephthalate, namely polyester resin having glass transition temperature of 74°C and crystallinity of 35%. In other word, first resin layer 13 is in a light transmission state.

Sublimation coloring agent (hereinafter "coloring agent") 14 is infiltrated into first resin layer 13, ink layer 12, and first adhesive layer 11. Coloring agent 14 is transferred from sheet 2 to plate 3 by a sublimation transfer process of attaching plate 3 firmly to sheet 2 and heating and crimping them. Pattern 15 is thus formed. In a part having no pattern 15, ink layer 12 or a coloring layer of opaque second resin layer 10 brings color.

In the present embodiment, plated layers 5 and 5A are disposed on both surfaces of metal plate 8, chemical treated layers 6 and 6A are further disposed on plated layers 5 and 5A, and anti-rust paint layer 7 is disposed on the second surface side. This structure is required for improving rust prevention of decorative plate 1, but is not absolutely necessary.

A manufacturing method of decorative plate 1 of the present embodiment and a manufacturing method of metallic decorative heat-insulating panel (hereinafter "panel") 20 using decorative plate 1 are described hereinafter.

Fig. 4 is a process chart showing the manufacturing methods of decorative plate 1 and panel 20 of the present embodiment. Fig. 5 is a sectional view showing an installed state of sheet 2 and plate 3 in sublimation transfer device 17 in accordance with the present embodiment. Fig. 6 is a sectional view showing a pressed and crimped state of the same in sublimation transfer device 17. Fig. 7 is a sectional view showing a decompressed state in sublimation transfer device 17. Fig. 8 is a perspective view showing a

combined and engaged state of bent decorative plate 1 and inner surface member 18. Fig. 9 is a sectional view of panel 20 in urethane jig 19.

First, in a rust proofing process (A process) of a steel plate of basis material 4, plated layers 5 and 5A are formed on both surfaces by composite
 5 electro-galvanizing of zinc, and chemical treated layers 6 and 6A are formed on both surfaces by phosphoric acid. Next, in an adhering process (B process) of an intermediate thermoplastic resin layer, second resin layer 10 of opaque polyvinyl chloride having second adhesive layer 9 made of an acrylic adhesive is applied to a first surface side of metal plate 8.

10 In an adhering process (C process) of an outer film resin layer, first resin layer 13 is applied to second resin layer 10 through first adhesive layer 11 having ink layer 12 to manufacture plate 3 as shown in Fig. 2. Ink layer 12 is previously metallically finished. First adhesive layer 11 is formed of hot melt film of saturated copolymer polyester resin having melting point of 114°C.
 15 First resin layer 13 is formed of transparent film of polyethylene terephthalate, namely polyester resin having glass transition temperature of 74°C and crystallinity of 35%.

In a pattern printing process (D process) of Fig. 4, pattern 15A of an original form by coloring agent 14 is printed on transfer paper 21 using an ink
 20 jet printer, thereby manufacturing sheet 2.

In sublimation transfer device 17 for producing decorative plate 1 shown in Fig. 5 to Fig. 7, lifting device 23 is fixed to base disk 22, and upper chamber 25 is fixed to base disk 22 via guide pins 24 on four sides. Upper chamber 25 has decompressing chamber 27 having built-in heater 26 as a heating source.
 25 The inside of decompressing chamber 27 is decompressed by vacuum pump 28 via decompressing pipe 29 and decompression regulating valve 30.

Lifting device 23 is connected to driving chamber 31 liftable along guide

pins 24. Drawer type transfer vessel 32 is installed in driving chamber 31. Crimp sheet 33 made of heat-resistant polytetrafluoro-ethylene or silicon rubber is laid on the entire inner surface of transfer vessel 32. Packing 34 made of polytetrafluoro-ethylene rubber or silicon rubber is disposed on the
5 outer periphery of transfer vessel 32.

Transfer vessel 32 can be drawn forward along drawing guide 35 via bearing 36. In the drawn state of transfer vessel 32, lower surface heat resistant sheet (hereinafter "sheet") 37 having air-permeability, sheet 2, plate 3, and upper surface heat resistant sheet (hereinafter "sheet") 38 are sequentially
10 installed on crimp sheet 33 in transfer vessel 32.

Decompressing chamber 27 has decompression hole 39 communicating with transfer vessel 32 and leak valve 40 communicating with the outside air.

As crimp sheet 33, a soft elastic material made of rubber or the like that is produced by co-polymerizing sulfur or 2,3-dichloro-1,3-butadiene to silicon
15 rubber, fluoro-rubber, butyl rubber, chloroprene can be employed. Heat transfer is repeated intermittently at a temperature not lower than 150°C, so that silicon rubber or fluoro-rubber having high heat resistance is especially preferable.

When a pattern is transferred or printed on plate 3 with sublimation dye
20 using sublimation transfer device 17, air between plate 3 and sheet 2 does not escape because plate 3 has no air permeability. Water vapor coming from moisture contained in sheet 2 is apt to retain between plate 3 and sheet 2. The residual air or residual moisture causes concentration irregularity in pattern 15 to be added to plate 3. Therefore, sandwiching plate 3 and sheet 2 between
25 air-permeable sheet 37 and sheet 38 improves the contacting state.

As sheets 37 and 38, cotton cloth, polyester cloth, heat resistant felt made of aromatic polyamide fiber, or silicon rubber sponge mat or fluororubber

sponge mat with continuous holes can be employed. Sheets 37 and 38 are preferably made of material that has heat resistance at 150°C or higher and easily restores in shape after thermo compression.

A primer-treated steel plate is employed as a sublimated transfer article
5 in the present embodiment; however, not only the steel plate but also stainless steel or aluminum plate may be employed as basis material 4.

As light transmitting first resin layer 13, polyester resin, especially polyethylene terephthalate resin, is most easily selected in grade and preferable. First resin layer 13 may be made of resin that easily passes coloring agent 14
10 migrated from sheet 2 at a sublimation transfer time and hardly passes it at normal temperature or 70°C or lower. In other words, resin where glass transition temperature is 70 to 120°C and crystallinity is 20 to 50% is simply required.

It is preferable that first resin layer 13 does not extremely soften at
15 heating temperature of 150 to 200°C at a transfer time. When first resin layer 13 is made simply of polyethylene terephthalate of polyester resin, the melting point is about 250°C and hence a significant problem does not arise. Further, when resin into which polyethylene naphthalate is melted and blended is employed, heat resistance and glass transition temperature further increase.
20 When first resin layer 13 is formed of such a material, surface gloss of plate 3 is suppressed from decreasing after a print pattern is thermally transferred.

As sheet 2, a sheet on which coloring agent 14 is printed and applied by gravure printing, offset printing, or screen printing is employed. For small lot printing, sublimation dye can be printed and applied by an electro-photographic
25 method using computer graphics requiring no plate-making process, an electrostatic recording method, an ink jet method, or a thermal transfer method. The sublimation dye is transferred by sublimation or volatilization when being

heated. Dispersed dye such as a quinophthalone derivative, an anthraquinone derivative, or azo dyestuff is suitably employed, for example. Conventional dye used for sublimation heat transfer or sublimation transfer printing can be used especially without limit.

5 As material of first adhesive layer 11, use of an acrylic-resin-based adhesive excellent in weathering resistance is preferable for certainly constraining coloring agent 14 coming through first resin layer 13 at high temperature of 170°C in the sublimation transfer process. Saturated copolymer polyester resin having melting point of 100 to 180°C sufficiently
10 constraints coloring agent 14 and is optimal. Not only hot melt film of saturated copolymer polyester resin having melting point of 114°C but also that having melting point of 140°C can be employed.

The sublimation transfer process (E process) is described hereinafter with reference to Fig. 5 to Fig. 7. Transfer vessel 32 is drawn, sheet 37, sheet 2,
15 plate 3, and sheet 38 are stacked sequentially on crimp sheet 33, and transfer vessel 32 is installed on driving chamber 31.

Lifting device 23 is then operated, and driving chamber 31 is lifted up until packing 34 is crimped to the lower surface of upper chamber 25 as shown in Fig. 6.

20 Vacuum pump 28 is then operated and decompression regulating valve 30 is opened. Transfer vessel 32 is sealed by upper chamber 25 and crimp sheet 33 by lifting up of driving chamber 31, and the inside of transfer vessel 32 is decompressed through decompressing pipe 29 and decompression hole 39. By decompression to about 0.05 MPa, crimp sheet 33 is pulled to the lower
25 surface of upper chamber 25. The stacked sheet 37, sheet 2, plate 3, and sheet 38 are crimped by force of crimp sheet 33 as shown in Fig. 7.

When the inside of transfer vessel 32 is heated to 150 to 200°C by heater

26 in a crimped state of sheet 2 and plate 3, coloring agent 14 of pattern 15A printed on sheet 2 sublimates.

When the heating is performed in the contact state of sheet 2 and plate 3 as shown in Fig. 7, sublimating coloring agent 14 infiltrates into first resin
5 layer 13 in plate 3 in the thickness direction. Pattern 15 is transferred to not only first resin layer 13 but also ink layer 12 and first adhesive layer 11 by infiltration of coloring agent 14.

In the sublimation transfer process (E process) of about six minutes, the inside of the chamber may be kept at 0.02 MPa for initial one minute, the
10 pressure may be increased to 0.08 MPa by decompression regulating valve 30 for the ensuing five minutes. Thus, adhesion is completed before first adhesive layer 11 and second resin layer 10 reach softening points or higher. When the temperature increases to a temperature range for sublimation transfer, the sublimation transfer is promoted without applying required pressure or higher.
15 Surface smoothness is therefore kept. The transfer rate and clarity of a sublimation transfer phenomenon are determined based on the temperature, time, and the distance between a transferred matter and coloring agent 14, but are not affected by the pressure.

When a heating and crimping process has a primary crimping process
20 and a secondary crimping process, it is preferable to perform heating and crimping while the pressure in the secondary crimping process is lower than that in the primary crimping process. In other words, at a time when first adhesive layer 11 and second resin layer 10 are not yet softened by heating, first resin layer 13 is tightly attached to the surface including pattern 15A.
25 The pressure is then decreased with increment in temperature. Thus, a cloth trace of sheet 2 or a backup member does not remain.

In the E process, it is preferable that a stainless-steel-made spacer (not

shown) having substantially the same thickness as that of plate 3 is laid around plate 3 to prevent crimp sheet 33 from directly contacting with an end surface of plate 3. The spacer prevents a trouble that the end portion of plate 3 is pressed to crimp sheet 33 and resin softened by heat protrudes from the end
5 portion to damage appearance.

In the present embodiment, first resin layer 13 is formed of resin having glass transition temperature of 73°C, and lies in a rubber elastic region at 170°C. At this temperature, a polymeric structure is amorphous and has extremely many spaces, and first resin layer 13 is apt to pass coloring agent 14
10 that is put into a molecular state by heat. However, saturated copolymer polyester resin having melting point of 114°C is used in first adhesive layer 11, so that melted coloring agent 14 having a low-molecular structure is not passed and constrained by first adhesive layer 11.

After the E process, decompression regulating valve 30 is closed and leak
15 valve 40 is opened to return air pressure in transfer vessel 32 to atmospheric pressure, and lifting device 23 is operated to lift down driving chamber 31. Cooling time is provided as required, decorative plate 1 having colored plate 3 is extracted from transfer vessel 32.

When first resin layer 13 is cooled to glass transition temperature of 73°C
20 or lower, first resin layer 13 comes into a glass state and crystallization progresses to crystallinity of 35%. In this state, polymer chains become dense and hence coloring agent 14 cannot pass through the layer. First adhesive layer 11 having melting point of 114°C solidifies at that temperature, so that coloring agent 14 is fixed completely.

25 Since material having glass transition temperature of 70°C or higher is employed as first resin layer 13, re-sublimation hardly occurs at temperature lower than 70°C. When first adhesive layer 11 having melting point of 100°C

or higher is employed, re-sublimation does not occur in a living temperature range. When the melting point is 180°C or higher, however, adhesion of the film is difficult and constraint of coloring agent 14 at the sublimation transfer time is insufficient. Thus, first adhesive layer 11 is preferably made of
5 material having melting point that exceeds a temperature at which coloring agent 14 re-sublimates to blur the pattern and lies in a temperature range where first adhesive layer 11 has adhesiveness. The clarity increases at lower crystallinity of first resin layer 13. However, a re-sublimation phenomenon occurs at about 70°C when the crystallinity is 20% or lower, and the clarity
10 extremely decreases to unclear the sublimation pattern when the crystallinity is 50% or higher.

Thus, a required pattern can be easily provided if necessary in the present embodiment, so that a colored pattern can be arbitrarily printed on plate 3 and plate 3 becomes an available steel plate even in a mass-produced
15 home electrical appliance.

In the F process, corner parts of a completed decorative plate 1 are cut. In the G process, decorative plate 1 is bent.

In the H process, side caps 41 and 42 are engaged with inner surface member 18 such as a door back as shown in Fig. 8, thereby forming space 45 of
20 which outer surface is first resin layer 13 surface of decorative plate 1. In the J process, as shown in Fig. 9, the engaged product in the H process is disposed in urethane jig 19 and urethane resin is injected into space 45, thereby providing panel 20 as an integral foam of decorative plate 1 and inner surface member 18.

Here, in the urethane foaming process, foaming increases the
25 temperature to 60°C or higher. However, since first resin layer 13 is formed of resin film having glass transition temperature of 70°C or higher, the layer does not re-sublimate and the pattern does not become blurred. Since resin having

high crystallinity is employed, coloring agent 14 hardly passes through it to prevent color shading.

Decorative plate 1 of the present embodiment is formed of plate 3 having light-transmitting first resin layer 13 disposed on the metal plate 8 surface through first adhesive layer 11. The glass transition temperature of the resin forming first resin layer 13 is not lower than the temperature at which coloring agent 14 re-sublimates to blur pattern 15 and is lower than the temperature at which coloring agent 14 is transferred. Coloring agent 14 is infiltrated into at least one of first resin layer 13 and first adhesive layer 11 to form pattern 15. Since first resin layer 13 is made of material of which glass transition temperature is lower than the temperature at which coloring agent 14 is transferred, pattern 15 can be transferred to first resin layer 13 and first adhesive layer 11 by superimposing sheet 2 on plate 3 and sublimating coloring agent 14.

Temperature achieved in the urethane foaming process or in a living environment is generally lower than 70°C, so that coloring agent 14 does not re-sublimate when the glass transition temperature of first resin layer 13 is 70°C or higher. Since the glass transition temperature of first resin layer 13 is not lower than the temperature at which coloring agent 14 re-sublimates to blur pattern 15, long-time weather resistance and heat resistance are kept. Coloring agent 14 is transferred at 150 to 200°C, so that the glass transition temperature of first resin layer 13 is preferably 120°C or lower.

An ultraviolet absorber may be mixed to first resin layer 13. When the ultraviolet absorber is mixed into first resin layer 13, the ultraviolet absorber can increase weather resistance of sublimation transfer ink (pattern 15 by coloring agent 14) that has relatively low weather resistance.

In decorative plate 1 of the present embodiment, first resin layer 13 is

formed of polyester resin film. Using a characteristic of polyester resin having a moderate glass transition temperature range and moderate crystallinity increases sublimation transfer property and suppresses re-sublimation. As the polyester resin film, polyethylene terephthalate resin is employed. In such a structure, the glass transition temperature region is easily set at 80 to 120°C, and moderate crystallinity is easily selected. As the polyethylene terephthalate resin, resin having crystallinity between 20% and 50% at a temperature not lower than the using temperature of decorative plate 1 and lower than the temperature at which coloring agent 14 re-sublimates to blur the pattern is employed. In this configuration, high crystallinity makes the molecular structure dense, so that re-sublimation after the sublimation transfer is suppressed.

First resin layer 13 may be formed of mat-toned film of polyethylene terephthalate resin mixed with melted micro silica. Thanks to this configuration, appearance failure such as pressure mark occurring at the sublimation transfer time is not conspicuous, a wall surface such as grain having no gloss (brightness) can be easily formed of decorative plate 1 provided by sublimation transfer.

As the polyester resin film, melted and blended resin of polyethylene terephthalate resin and polyethylene naphthalate resin may be employed. In this case, the glass transition temperature of first resin layer 13 can be easily controlled in response to mixing ratio of the polyethylene terephthalate resin having glass transition temperature of about 75°C to the polyethylene naphthalate resin having glass transition temperature of about 121°C. The polyethylene naphthalate resin has higher heat resistance than that of the polyethylene terephthalate resin, so that the heat resistance of first resin layer 13 increases. Therefore, reduction of surface brightness after the sublimation

transfer process is suppressed, and appearance state is kept sufficient.

Pearl material may be mixed into first adhesive layer 11. Decorative plate 1 having such a structure has excellent appearance and high degree of freedom of exterior design, and can be applied to similar products of a panel material and a wall material of a system kitchen.

In decorative plate 1 of the present embodiment, first adhesive layer 11 is formed of saturated copolymer polyester resin having melting point of 100 to 180°C. Such first adhesive layer 11 does not peel at the temperature in the urethane foaming process (J process) or in a usual living temperature range. First adhesive layer 11 softens near the melting point during heating in the sublimation transfer process (E process), has viscosity, does not pass coloring agent 14, constrains coloring agent 14, and suppresses re-sublimation.

In decorative plate 1 of the present embodiment, second resin layer 10 is disposed between the first surface of metal plate 8 and first adhesive layer 11. Second resin layer 10 provides flexibility, so that decorative plate 1 is easily bent or pressed, and can be post-processed.

In decorative plate 1 of the present embodiment, polyvinyl chloride resin film or polypropylene resin film is employed as second resin layer 10. Employing the flexible polyvinyl chloride resin film or polypropylene resin film as second resin layer 10 moderates irregularity of metal plate 8 and extremely improves pressing property and bending property of decorative plate 1.

As second resin layer 10, polyethylene terephthalate resin film may be employed. The polyethylene terephthalate resin film has relatively high heat resistance, so that appearance of decorative plate 1 is kept stable and pressing property, bending property, and adhesiveness are improved.

In decorative plate 1 of the present embodiment, colored ink layer 12 is disposed between first adhesive layer 11 and first resin layer 13. Ink layer 12

covers first adhesive layer 11 having insufficient appearance and base color is changed in ink layer 12, thereby providing the sublimation transfer pattern with variation, depth feeling, and new design property.

Heat insulating panel 20 of the present embodiment has decorative plate 1, inner surface member 18 disposed on the second surface side of metal plate 8, and urethane foaming thermal-insulating material. Urethane foaming thermal-insulating material is filled into space 45 formed of decorative plate 1 and inner surface member 18 and foamed. In panel 20, as first resin layer 13 disposed on the first surface of metal plate 8 via first adhesive layer 11, material having glass transition temperature of 70 to 120°C is employed. In other words, the temperature to which first resin layer 13 is heated in the urethane foaming process is lower than glass transition temperature of the resin forming first resin layer 13. Therefore, even when first resin layer 13 is heated to about 60°C in the J process, the sublimation transfer pattern does not re-sublimate, and color shading or color migration to the inner wall of the urethane jig does not occur.

A refrigerator door of the present embodiment has panel 20, decorative plate 1 forms the front surface of the refrigerator, and inner surface member 18 forms a part of the storage room in the refrigerator cooled by refrigeration cycle. A door having such a structure can respond to individual request for various colors and patterns. Even when a memo pad or the like is attached to the surface of the door, color migration does not occur, and discoloration or fading is extremely suppressed in usual living environment.

Urethane is employed as the foaming thermal-insulating material in the present embodiment; however, resin foam such as phenol foam or styrene foam may be employed. In this case, the achieved temperature in the foaming process varies, so that material having the corresponding glass transition

temperature is employed as the first resin layer.

The decorative plate is applied to the refrigerator door in the present embodiment; however, the decorative plate may be applied to the outer wall such as the front panel when a sliding vegetable compartment or the like is
5 disposed.

SECOND EXEMPLARY EMBODIMENT

Fig. 10 is a sectional view showing a stacked state of a laminated metal plate and a transfer print sheet via a backup member in a sublimation transfer
10 process in accordance with the second exemplary embodiment of the present invention.

In the manufacturing method of a metallic decorative plate of the present exemplary embodiment, a surface including pattern 15A of transfer print sheet 2 with backup member 50 is superimposed on outer film resin layer (first resin
15 layer) 13 of laminated metal plate 3, and they are heated and crimped. An irregular part or a striped pattern is disposed on the surface of backup member 50. Thus, three-dimensional delustering-type pattern 15 is formed on plate 3, semi-gloss (semi-bright) type appearance is obtained, or three-dimensional part such as a vertical stripe or a lateral stripe is easily formed. Providing such a
20 metallic decorative plate with a sublimation transfer pattern increases degree of freedom of design used when a metallic decorative plate similar to panel material or wall material of a system kitchen is manufactured.

THIRD EXEMPLARY EMBODIMENT

25 Fig. 11 is a sectional view showing a stacked state of a laminated metal plate and a transfer print sheet in a sublimation transfer process in accordance with the third exemplary embodiment of the present invention.

In the manufacturing method of a metallic decorative plate of the present exemplary embodiment, transfer print sheet 51 having irregularity or a striped pattern on its surface is employed. Outer film resin layer (first resin layer) 13 of laminated metal plate 3 is superimposed on and contacted with the surface including pattern 15A of sheet 51, and they are heated and crimped. Thus, a three-dimensional delustering-type colored pattern is formed on plate 3. In other words, transfer print sheet 51 has the function of backup member 50 of the second embodiment. Thus, the advantage of the second embodiment is produced, and a metallic decorative plate with a sublimation transfer pattern that is of semi-gloss (semi-bright) type or has a three-dimensional part such as a vertical stripe or a lateral stripe can be easily and stably obtained.

FOURTH EXEMPLARY EMBODIMENT

Fig. 12 is a schematic sectional view showing a heat-treating process after sublimation transfer in accordance with the fourth exemplary embodiment of the present invention.

Decorative plate 1 employing an extremely-sharp bright film as outer film resin layer (first resin layer) 13 is conveyed by first and second conveyers 52 and 53 with the surface having colored pattern 15 (first resin layer 13) directed upward. In the conveying process, first resin layer 13 of laminated metal plate 3 is previously heated by a heater of previously heating vessel 54 faced to conveyer 52. Heating roller 55 that is disposed between conveyer 52 and conveyer 53 and has an outer peripheral surface formed of a smooth metal surface heats and crimps first resin layer 13 of plate 3 at about 200°C for about one minute. First resin layer 13 of plate 3 is then cooled by cold air sprayed from cooling nozzle 56A of cooling unit 56 faced to conveyer 53.

In a manufacturing method of a metallic decorative plate of the present

embodiment, the extremely-sharp bright film is employed as first resin layer 13. First resin layer 13 is superimposed on and contacted with the surface including pattern 15A of transfer print sheet 2, and they are heated and crimped, thereby printing pattern 15 on plate 3. After the sublimation transfer process, first resin layer 13 is thermally treated under a temperature and time condition where sublimation coloring agent (coloring agent) 14 infiltrating into plate 3 does not re-sublimate. In this heat-treating process, the extremely-sharp brightness of first resin layer 13 is returned to a state before the sublimation transfer process.

When first resin layer 13 formed of the extremely-sharp bright film is superimposed on sheet 2 and heated and crimped, the extremely-sharp brightness of first resin layer 13 decreases. Since first resin layer 13 is thermally treated under the temperature and time condition where coloring agent 14 infiltrating into plate 3 does not re-sublimate, the extremely-sharp brightness of first resin layer 13 can be returned to the state before the sublimation transfer process. Therefore, decorative plate 1 having extremely-sharp brightness is provided, and degree of freedom of design increases when metallic decorative plate 1 similar to panel material and wall material of a system kitchen is produced.

In the heat-treating process of the present embodiment, the heated smooth metal surface is crimped to first resin layer 13 of plate 3. Since the smooth metal surface to which coloring agent 14 is not sublimated or transferred is crimped to first resin layer 13, coloring agent 14 as a transferred object is suppressed from re-sublimating from first resin layer 13, and an extremely sharp appearance without stripping is obtained.

In the heat-treating process of the present embodiment, heated heating roller 55 of which outer peripheral surface is the smooth metal surface is faced

to first resin layer 13, and heating roller 55 rolls and presses plate 3. Plate 3 is thus pressed by the roller without using a flat plate, so that the extremely-sharp brightness of first resin layer 13 of plate 3 can be restored inexpensively and efficiently.

5

FIFTH EXEMPLARY EMBODIMENT

Fig. 13 is a schematic sectional view showing a heat-treating process after sublimation transfer in accordance with the fifth exemplary embodiment of the present invention.

10 Metallic decorative plate 1 with a sublimation transfer pattern employing an extremely-sharp bright film as outer film resin layer (first resin layer) 13 is conveyed by resin-made conveyer 57 with the surface having colored pattern 15 (first resin layer 13) directed upward. In the conveying process, first resin layer 13 of laminated metal plate 3 is heated by electromagnetic
15 induction heating by electromagnetic induction heating unit 58 disposed on the upstream side in the internal conveyance of conveyer 57. At this time, the upper part of plate 3 is covered with heat insulating cover 59, so that plate 3 is hardly cooled by ambient air and efficiently heated by electromagnetic induction heating unit 58.

20 First resin layer 13 is then cooled by cold air sprayed from cooling nozzle 56A of cooling unit 56.

In the heat-treating process of the present embodiment, plate 3 is heated by electromagnetic induction. First resin layer 13 that is made of thermoplastic resin and is bonded to the first surface side of metal plate 8 is
25 heated efficiently in a short time, so that the extremely-sharp brightness of first resin layer 13 can be restored efficiently in a short time.

In a manufacturing process of metallic decorative plates in accordance

with the first to fifth exemplary embodiments, based on a sample of panel material of a system kitchen that is specified by a prospective buyer of a refrigerator for the system kitchen, a metallic decorative plate of which appearance is remarkably similar to the panel material of the system kitchen
5 can be manufactured. Thus, the refrigerator model is not limited to a model dedicated to the system kitchen, but a refrigerator for the system kitchen that is in extremely harmony with the system kitchen can be made-to-order.

INDUSTRIAL APPLICABILITY

10 In a metallic decorative plate with a sublimation transfer pattern of the present invention, a sublimated, transferred, and printed pattern does not re-sublimate due to heat in an urethane foaming process or in a living temperature range, and weather resistance and heat resistance are kept for a long time. Therefore, urethane foaming insulating material is filled into a
15 space formed of the metallic decorative plate and an inner surface member, and the metallic decorative plate can be applied to a refrigerator door or the like forming the front surface of the refrigerator.

CLAIMS

1. A metallic decorative plate with a sublimation transfer pattern comprising:

5 a metal plate;
 a first adhesive layer formed on a first surface of the metal plate; and
 a light transmitting first resin layer formed on the first surface of the metal plate via the first adhesive layer,

 wherein

10 a sublimation coloring agent is infiltrated into at least one of the first resin layer and the first adhesive layer to form a colored pattern, and

 glass transition temperature of the first resin layer is not lower than a temperature where the sublimation coloring agent re-sublimates to blur the pattern and is lower than a temperature where the sublimation coloring
15 agent is transferred.

2. The metallic decorative plate according to claim 1,

 wherein the first resin layer has crystallinity of at least 20% and at most 50% at a temperature not lower than a using temperature of the metallic
20 decorative plate and lower than the temperature at which the coloring agent re-sublimates to blur the pattern.

3. The metallic decorative plate according to claim 1,

 wherein the glass transition temperature of the first resin layer is at
25 least 70°C and at most 120°C.

4. The metallic decorative plate according to claim 1,

wherein the first resin layer contains an ultraviolet absorber.

5. The metallic decorative plate according to claim 1,

wherein the first resin layer is formed of a polyester resin film.

5

6. The metallic decorative plate according to claim 5,

wherein the polyester resin film is formed of polyethylene terephthalate resin.

10

7. The metallic decorative plate according to claim 5,

wherein the polyester resin film is made of mat-toned polyethylene terephthalate resin into which micro silica is melted and mixed.

8. The metallic decorative plate according to claim 5,

15

wherein the polyester resin film is made of melted and blended resin of polyethylene terephthalate resin and polyethylene naphthalate resin.

9. The metallic decorative plate according to claim 5, wherein,

the glass transition temperature of the polyester resin film is at least

20 70°C and at most 120°C, and

crystallinity of the polyester resin film at a temperature of 70 to 120°C is at least 20% and at most 50%.

10. The metallic decorative plate according to claim 1,

25

wherein the first resin layer includes pearl material.

11. The metallic decorative plate according to claim 1,

wherein melting point of the first resin layer exceeds a temperature at which the sublimation coloring agent re-sublimates to blur the pattern and lies in a temperature range where the first adhesive layer has adhesiveness.

5 12. The metallic decorative plate according to claim 11,

 wherein the first resin layer is made of saturated copolymer polyester resin of which melting point is a temperature of at least 100°C and at most 180°C.

10 13. The metallic decorative plate according to claim 1, further comprising a second resin layer between the metal plate and the first adhesive layer.

 14. The metallic decorative plate according to claim 13,

 wherein the second resin layer is made of one of vinyl chloride resin
15 film and polypropylene resin film.

 15. The metallic decorative plate according to claim 13,

 wherein the second resin layer is made of polyethylene terephthalate resin film.

20

 16. The metallic decorative plate according to claim 1, further comprising a colored ink layer between the first adhesive layer and the first resin layer.

 17. A heat insulating panel comprising:

25 the metallic decorative plate with a sublimation transfer pattern according to claim 1;

 an inner surface member disposed on a second surface side facing a

first surface of the metal plate; and

foaming thermal-insulating material foamed and filled into a space formed of the metallic decorative plate and the inner surface member.

5 18. An outer wall for a refrigerator, wherein
the outer wall is formed of the heat insulating panel according to
claim 17,

the metallic decorative plate forms a front surface of the refrigerator,
and

10 the inner surface member forms a part of a storage room in the
refrigerator.

19. A manufacturing method of a metallic decorative plate comprising:

(A) superimposing a laminated metal plate on a transfer print sheet
15 so as to bring a light transmitting first resin layer of the laminated metal plate
into contact with a surface provided with a colored pattern with a sublimation
coloring agent of the transfer print sheet, the first resin layer being applied to a
first surface of the laminated metal plate via a first adhering layer and glass
transition temperature thereof being not lower than a temperature at which a
20 sublimation coloring agent re-sublimates to blur the pattern and being lower
than a temperature at which the sublimation coloring agent is transferred; and

(B) heating and crimping the first resin layer and the surface
including the colored pattern brought into contact with each other in step (A)
while the temperature of the first resin layer is higher than glass transition
25 temperature of the first resin layer ,

wherein the sublimation coloring agent is infiltrated into at least one
of the first resin layer and the first adhering layer.

20. The manufacturing method of the metallic decorative plate according to claim 19, wherein

in step (A), the surface including the colored pattern is superimposed
5 on the first resin layer by a backup member having one of irregularity and a striped pattern on a surface thereof, and

in step (B), the surface including the colored pattern is crimped to the first resin layer by the backup member.

10 21. The manufacturing method of the metallic decorative plate according to claim 19, wherein

one of irregularity and a striped pattern is disposed on a surface of the transfer print sheet.

15 22. The manufacturing method of the metallic decorative plate according to claim 19, further comprising

(C) thermally treating the first resin layer in a condition where the sublimation coloring agent having infiltrated into the laminated metal plate does not re-sublimate,

20 wherein the first resin layer includes a sharp bright film.

23. The manufacturing method of the metallic decorative plate according to claim 22,

wherein a heated smooth metal surface is crimped to the first resin layer in step (C).

25

24. The manufacturing method of the metallic decorative plate according to claim 22,

wherein a heated roller of which outer peripheral surface is a smooth metal surface is faced to the first resin layer, and the laminated metal plate is rolled and pressed using the roller in step (C).

5 25. The manufacturing method of the metallic decorative plate according to claim 22,

 wherein the laminated metal plate is heated by electromagnetic induction in step (C).

10 26. A manufacturing method of a heat insulating panel comprising:

 manufacturing the metallic decorative plate according to claim 19;

 (D) disposing an inner surface member on a second surface side facing the first surface of the laminated metal plate having the colored pattern;

 (E) injecting foaming resin into a space formed of the laminated
15 metal plate and the inner surface member; and

 (F) forming a foaming insulating material by foaming the foaming resin in the space and integrating the laminated metal plate and the foaming insulating material,

 wherein the manufacturing method of the heat insulating panel
20 satisfies one of the following conditions:

 (1) glass transition temperature of resin forming the first resin layer is higher than a temperature to which the first resin layer is heated in step (F) and is lower than a temperature to which the first resin layer is heated in step (B); and

25 (2) a temperature to which the first resin layer is heated in step (F) is lower than the glass transition temperature of the first resin layer.

27. The manufacturing method of the heat insulating panel according to claim 26,

wherein the first resin layer contains resin that does not peel at the temperature in step (F), softens at heat and crimp time in step (B), has viscosity,
5 and constraints the sublimation coloring agent.

28. A manufacturing method of an outer wall for a refrigerator comprising:

manufacturing the metal decorative plate according to claim 19;

10 (G) processing the laminated metal plate having the colored pattern into a shape of the outer wall for the refrigerator;

(H) disposing an inner surface member on a second surface side facing the first surface of the laminated metal plate on the outer wall; and

(J) injecting foaming resin into a space formed of the outer wall and
15 the inner surface member,

(K) forming a foaming insulating material by foaming the foaming resin in the space and integrating the outer surface plate and the foaming insulating material,

wherein the manufacturing method of the outer wall satisfies one of
20 the following conditions:

(1) glass transition temperature of resin forming the first resin layer is higher than a temperature to which the first resin layer is heated in step (K) and is lower than a temperature to which the first resin layer is heated in step (B); and

25 (2) a temperature to which the first resin layer is heated in step (K) is lower than the glass transition temperature of the first resin layer.

29. The manufacturing method of the outer wall for the refrigerator for a system kitchen according to claim 28;

wherein the metallic decorative plate of which appearance is similar to panel material of the system kitchen is manufactured based on a sample of
5 the panel material in the manufacturing process of the metallic decorative plate according to claim 16.