A gas barrier for a vacuum insulated structure of a refrigerator is provided. The gas barrier includes a plastic trim breaker; a metal outer panel a metal inner panel and insulation between the outer and inner metal panels. The gas barrier for a vacuum insulated structure further includes a PVD metal coating applied to the an inside surface of the plastic trim breaker to provide a barrier layer to the plastic trim breaker, wherein the PVD coating on the inside of the plastic trim breaker contacts the inner and outer metal outer panels to prevent heat or gas from entering the insulated structure and decreasing the effectiveness of the insulation over time.
GAS BARRIER FOR VACUUM INSULATION

FIELD OF THE DISCLOSURE

[0001] This application relates to a panel or cabinet for refrigeration. In particular, the present disclosure relates to a barrier layer of aluminum or another suitable barrier layer for an interior surface of three-dimensional, shaped (3D) vacuum structure or to provide a barrier layer for a thermal breaker between a metal outer cabinet and a metal inner liner or panel.

BACKGROUND

[0002] Various types of insulated cabinet and insulated door structures have been developed for refrigerators, freezers, and other such appliances. Insulated appliance door and cabinet structures may include polyurethane foam, polystyrene or other insulating material that is positioned between an outer door skin or wrap and an inner door liner. However, known insulated appliance structures may suffer from various drawbacks.

[0003] Vacuum panels provide superior insulation properties over traditional polyurethane (PU) foam. In order to maintain the vacuum inside the panel, the enclosure of the panel must contain a barrier material to prevent gas from entering the panel and losing vacuum inside the panel over time. When considering a vacuum insulated structure, the walls of the structure must have a barrier layer to prevent gas(es) from entering the structure. Plastics do not typically have good barrier properties, while metals typically do have good barrier properties. Vacuum panels traditionally use aluminum foil or a metalized film to provide barrier properties. However, a foil or film is difficult to match to a 3D shape. Another method is to use ethylene vinyl alcohol (EVOH) or other polymeric material barriers that can be co-extruded or laminated with (High Impact Polystyrene (HIPS)). This sheet can then be thermoformed into a part such as a door or cabinet liner. The drawback is that this is limited to thermoforming. If a more complex part, such as one that is made by injection molding, is desired, these solutions do not work.

SUMMARY

[0004] An aspect of the present disclosure is to use Physical Vapor Deposition (PVD) to create a thin layer of aluminum or other barrier material on a part, often a shaped and structured three-dimensional part. One application is to apply it on the internal side of the plastic door liner (FIGS. 1 & 2). The interior of the plastic door liner would be coated with aluminum to provide good barrier properties and could be assembled with a metal outer panel and filled with a filler material (fiberglass or foamed silica) appropriate for building a vacuum insulated door. One advantage of using PVD to cover the inside surface of the liner with a barrier layer is that the inside of the liner does not need to be flat. It could have a shape to match the outside of the liner or could have additional features such as ribs for strength or bosses for attachment. If both sides of the door are plastic, the internal sides of both panels would be treated with PVD.

[0005] Another application is to apply a thermal breaker between a metal outer cabinet and a metal inner liner. A cabinet with metal walls will provide good barrier properties, but it will also conduct heat around the flange. A solution to the heat bridge is to use a plastic breaker strip to provide a barrier to the heat conduction. However, this plastic breaker strip does not have good vapor (gas) barrier properties and will allow gas to accumulate in the vacuum structure and reduce insulation performance over time. A barrier layer of metal can be applied to the interior surface of the breaker strip to give the breaker strip good barrier performance. By being on the inside surface, the PVD barrier layer typically will not be visible to consumers. The thickness of the barrier layer is quite thin, from approximately 0.001 mm to about 0.015 mm and it will not transfer heat into the cabinet as much as a thicker material such as the wall.

[0006] An aspect of the present disclosure is generally directed toward a gas barrier for a vacuum insulated structure or liner of a refrigerator, the gas barrier for the gas insulated structure of a refrigerator includes a plastic trim breaker; a metal outer panel; a metal inner panel; insulation between the outer and inner metal panels; and a PVD metal coating applied to the inside surface of the plastic trim breaker to provide a barrier layer to the plastic trim breaker. The PVD coating on the inside of the plastic trim breaker abuts the outer surfaces of the inner and outer metal outer panels to prevent gasses from entering the insulated structure and decreasing the effectiveness of the insulation over time.

[0007] Another application is to provide a 3D vacuum insulated refrigerator structure. The 3D refrigerator liner includes an interior 3D liner having an internal side facing to the interior of the refrigerator structural component, such as a door or wall, and a visible side which is visible to a consumer viewing the inside of the refrigerator; and a metal coating applied by PVD to the internal side of the interior 3D liner to form a barrier layer on the interior panel, wherein the barrier layer prevents gas from permeating easily through the 3D liner.

[0008] Another application is to provide a refrigerator including a plastic trim breaker; a 3D liner; a wrapper which surrounds the liner; a back plate secured to the back of the 3D liner. Insulation is provided between the 3D liner and the wrapper, and a PVD metal coating applied to the inside surface of the plastic trim breaker to provide a barrier layer to the plastic trim breaker, wherein a portion of the barrier layer abuts at least a portion of both the 3D liner and wrapper and contacts at least a portion of the plastic trim breaker that contacts the 3D liner and wrapper, to prevent heat from entering the structure.

[0009] These and other features, advantages, and objects of the present disclosure will be further understood and appreciated by those skilled in the art by reference to the following specification, claims, and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The foregoing summary, as well as the following detailed description of the disclosure, will be better understood when read in conjunction with the appended drawings. For the purpose of illustration, there are shown in the drawings, certain embodiment(s) which are presently preferred. It should be understood, however, that the disclosure is not limited to the precise arrangements and instrumentalities shown. Drawings are not necessary to scale. Certain features may be exaggerated in scale or shown in schematic form in the interest of clarity and conciseness.

[0011] FIG. 1A is a perspective view of a visible side of an interior door panel or liner, according to an exemplary embodiment;

[0012] FIG. 1B is a perspective view of the interior side of an interior door panel or liner of FIG. 1A;
FIG. 2A is a perspective view of a standard panel or liner material;

0014 FIG. 2B is a perspective view of an interior view of an interior door panel or liner having an aluminum layer or similar barrier layer which is applied through PVD, according to an exemplary embodiment of the present disclosure;

0015 FIG. 3 is a cross-sectional view of an exemplary embodiment having a plastic trim breaker with a metal interior coating creating a barrier layer, which provides a thermal break between two metal panels;

0016 FIG. 4 is an exploded view of FIG. 3;

0017 FIG. 5 is a frontal view of the structure of FIG. 4;

0018 FIG. 6A is a cross-sectional view of FIG. 5 taken along lines 6-6;

0019 FIGS. 6B and 6C are alternate exemplary embodiments of the plastic trim breaker of FIG. 3 and the inner and outer metal panels of FIG. 3;

0020 FIG. 7A is a perspective view of a HIPPS panel or liner having reinforcing ribs;

0021 FIG. 7B is a partial perspective view of a HIPPS panel or liner having reinforcing ribs and a boss;

0022 FIG. 8 is a perspective view of a HIPPS panel or liner having no ribs or bosses;

0023 FIG. 9 is a perspective view of a freezer door; and

0024 FIG. 10 is a cross-sectional view of FIG. 9 taken along lines 10-10 of FIG. 9.

DETAILED DESCRIPTION OF THE PRESENT DISCLOSURE

0025 It is to be understood that the present disclosure is not limited to the particular description below, as many variations of the present disclosure may be made and still fall within the scope of the appended claims. It is also to be understood that the terminology employed is for the purpose of describing present disclosure, and is not intended to be limiting in any manner.

0026 In this specification and the appended claims, the singular forms “a,” “an” and “the” include plural reference unless the context clearly dictates otherwise. The present disclosure is generally directed toward a 3D vacuum insulated appliance structural component.

0027 For purposes of description herein, The terms “upper,” “lower,” “right,” “left,” “rear,” “front,” “vertical,” “horizontal,” “top,” “bottom,” “left,” “right” and derivatives thereof shall relate to the disclosure as oriented in FIGS. 1A-1B. However, it is to be understood that the disclosure may assume various alternative orientations, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification are simply present disclosure of the inventive concepts defined in the appended claims. Hence, specific dimensions and other physical characteristics relating to the present disclosure disclosed herein are not to be considered as limiting, unless the claims expressly state otherwise.

0028 FIG. 1A is a perspective view of a 3D interior door or cabinet liner 10. The door or cabinet liner is generally formed of high-impact polystyrene (HIPPS), but is not limited to such material. FIG. 1A shows the visible side of the interior door or cabinet liner. The visible side is visible to a user of the refrigerator, who has opened the door of the refrigerator and is looking into the refrigerator door or cabinet. The interior door or cabinet liner may be used as an interior liner of a refrigerator door or refrigerator cabinet. In addition, the interior liner may be used for an under counter refrigerator, as well as a refrigerator of any other shape, as would be understood by those of ordinary skill in the art.

0029 FIG. 1B is a rear perspective view of the 3D HIPPS door or cabinet liner of FIG. 1A. FIG. 1B shows the side of the door or cabinet liner 20 that is the side facing the interior of the refrigerator cabinet structure between the line and the exterior of the appliance cabinet, and is not visible to a user. In FIG. 1B, a coating of aluminum or other barrier material is applied to the interior surface through a physical vapor deposition (PVD) process. The applied coating forms a barrier layer that prevents gases from entering the structure over time, and reduces the effectiveness of the insulation of the refrigerator.

0030 FIG. 2A is a perspective view of a cutaway portion of an interior door or cabinet liner 30. The interior door or cabinet liner 30 is formed of HIPPS and is a standard liner made from HIPPS. The door or cabinet liner 30 of FIG. 2A does not have the coating applied by a PVD process using aluminum or another barrier layer. Thus, the drawback of FIG. 2 is that gases can easily permeate through the HIPPS material through the liner, as shown by the arrows in the Figure.

0031 FIG. 2B is a perspective view of a cutaway portion of the HIPPS door or cabinet liner of FIG. 2A. The exception is that this Figure shows the door or cabinet liner 40 having the layer of aluminum or similar barrier material that is applied by PVD to produce a barrier layer. As shown by arrows in the figure, gases reaching the door or cabinet liner from the side that is visible to the user do not easily permeate through the aluminum or other barrier material layer coated on the HIPPS liner through the PVD process, and reflects backwardly towards the visible portion of the cabinet or door of the refrigerator. This exemplary embodiment can also be applied to a freezer associated with a refrigerator or to a stand-alone freezer.

0032 FIG. 3 is directed to another exemplary embodiment. FIG. 3 is directed to an embodiment having a plastic trim breaker. The plastic trim breaker provides a thermal break between two metal plates. The embodiment is generally represented by lead line 50. Plastic trim breaker 51 provides a thermal break between metal outer panel 52 and metal inner panel 54. Between the metal outer panel 52 and the metal inner panel 54 is an insulation layer 55, which is generally formed of fumed silica or fiberglass, but is not limited thereto. Above the insulation and also abutting the metal outer panel 52 and the metal inner panel 54 is a seal 53. The seal is made of a gasket material, as would be understood by one of ordinary skill in the art. Because the seal is well known to artisans, it is not further described herein. The upper portions of the outer metal panel 52 and the inner metal panel 52 have inwardly extending flanges, unlabeled, which extend inwardly toward each other but leave a gap between the flanges. Although the flanges are shown in FIG. 3 as being thin and extending inwardly toward each other with a large gap there between, this is exemplary only and the exemplary embodiments are not limited thereto. In addition, coated on the inside of the plastic trim breaker 51 is a coating of aluminum or other suitable barrier layer material 56. The aluminum or other suitable barrier layer material is coated onto the inside of the plastic trim breaker 51 by a PVD process. The coated layer serves as a barrier material. The barrier layer 56 serves to prevent heat or gas from entering the area between the flanges and typically extends between and across the space between the flanges. A cabinet door or with metal walls
will conduct heat in the area between the flanges if no barrier layer 56 is provided. To prevent heat or gas from entering through the plastic trim 1 in the area between the flanges, the barrier layer is provided.

[0033] FIG. 4 is an exploded view of FIG. 3. In FIG. 4, the insulation and gasket are not shown. FIG. 4 shows plastic trim 51, inner metal panel 54, and outer wrapper 52. The outer wrapper is an outer metal panel that surrounds inner metal panel 54. Attached to the back of wrapper 52 is a back plate 58.

[0034] FIG. 5 is a front view of FIG. 4 and illustrates plastic trim breaker 51.

[0035] FIG. 6A is a cross-sectional view of FIG. 6 taken along lines 6-6 of FIG. 5. FIG. 6A shows the relationship between inner metal panel 54 and outer metal panel 52.

[0036] FIG. 6B is an exemplary embodiment of an exploded view of a portion of FIG. 6A, as shown in FIG. 6A, by dot and dash lines. FIG. 6B shows plastic trim breaker 51 having recesses 59 therein for receiving edges of outer metal panel 52 and inner metal panel 54. Metal panels 52 and 54 are secured to recesses 59 in the plastic trim breaker 51 by glue or other suitable connection, typically an adhesive connection.

[0037] Barrier layer 56, which may be aluminum, is formed by a PVD process. The barrier layer 56 typically has a thickness of from about 0.001 mm to about 0.015 mm.

[0038] FIG. 6C is another exemplary embodiment, which represents a different structure for the plastic trim breaker 51. In this exemplary embodiment, as shown in FIG. 6C, the plastic trim breaker 51 has a recess facing inwardly toward a front surface of the plastic trim breaker. In contrast, in FIG. 6B, the recess faces in an opposite direction.

[0039] FIG. 7A is a perspective view of a HIPS liner, similar to FIG. 2B, but having ribs for strengthening the structure. FIG. 7A is an interior view of an interior door panel or liner.

[0040] FIG. 7B is an exploded view of a portion of FIG. 7A, taken from the dot-dash line labeled FIG. 7B in FIG. 7A. FIG. 7B shows ribs 70-73. In addition, FIG. 7B shows boss 74 for connection of the HIPS liner or panel to another part of the refrigerator structure.

[0041] FIG. 8 is a perspective view of an interior HIPS panel or liner. FIG. 8 is a view facing internally into the interior structure of the refrigerator or freezer.

[0042] FIG. 9 is a perspective view of an entire door of a freezer compartment of a French door bottom mount configuration refrigerator or freezer. This exemplary embodiment is not limited to a freezer door and can be configured for a refrigerator door, cabinet wall, or for a pantry door of an appliance. FIG. 9 shows door 80.

[0043] FIG. 10 is a cross-sectional view of FIG. 9 taken along line 10-10 of FIG. 9. FIG. 10 illustrates door 80. In this exemplary embodiment, the entire freezer door is made from 3D HIPS liners. In FIG. 10, reference numeral 82 represents the connection between two liners. In addition, 83 is an aluminum coating or similar barrier layer that is coated on the inside of both HIPS liners; i.e., the entire inside is coated with the aluminum or similar barrier layer. The coating is formed by a PVD process. Coating 83 prevents gas from entering the liner and getting into the interior of the door structure. Although a door structure is shown in this exemplary embodiment, the inventive concept is not limited thereto and can be applied to any refrigerator or freezer cabinet structural component as well.

[0044] Although the above description has described and illustrated various aspects of the present disclosure, the various aspects are merely exemplary by nature and are not to be construed as limiting of the inventive concept. Rather, the inventive concept of the disclosed present disclosure is defined by the claimed subject matter.

1. A vacuum insulated structural component of a refrigerator with a gas barrier comprising:
   a. a plastic trim breaker;
   b. a metal outer panel;
   c. a metal inner panel;
   d. insulation between the outer and inner metal panels; and
   e. a physical vapor deposited metal coating applied to an inside surface of the plastic trim breaker to provide a barrier layer to the plastic trim breaker,

   wherein the physical vapor deposited coating on the inside of the plastic trim breaker has a thickness of at least about 0.015 mm and abuts or is adjacent to surfaces of the inner and outer metal panels to prevent heat or gas from entering the insulated structure between the inner and outer metal panels.

2. The vacuum insulated structural component of a refrigerator of claim 1, further comprising a cabinet seal surrounded by the insulation, the outer and inner metal panels and the barrier layer on the inside of the plastic trim breaker.

3. The vacuum insulated structural component of a refrigerator of claim 1, further comprising a flange extending inwardly from at least one of the outer and inner metal panels toward the other of the outer and inner metal panels.

4. The vacuum insulated structural component of a refrigerator of claim 3, further comprising a flange extending from each of the outer and inner metal panels.

5. The vacuum insulated structural component of a refrigerator of claim 4, wherein the flanges generally extend in a direction toward each other.

6. The vacuum insulated structural component of a refrigerator of claim 5, wherein the barrier layer substantially prevents heat from entering the structure between the flanges.

7. The vacuum insulated structural component of a refrigerator of claim 3, wherein the barrier layer prevents the space between the inner and outer metal panels from conducting heat or gas.

8. The vacuum insulated structural component of a refrigerator of claim 1, wherein the insulation is formed from the group consisting of fumed silica, fiberglass, precipitated silica, glass microspheres or open cell polyurethane foam.

9. The vacuum insulated structural component of a refrigerator of claim 1, wherein the barrier layer is formed of aluminum or other barrier material and the vacuum insulated structural component is a wall of the refrigerator or a door of a compartment of the refrigerator and wherein an interior of the door comprises recessed dyke walls.

10. A three-dimensional vacuum insulated refrigerator liner, the three-dimensional refrigerator liner comprising:
   a. an interior three-dimensional liner having an internal side facing toward the interior of the refrigerator structure and a visible side which is visible to a consumer viewing the inside of the refrigerator; and
   b. a metal coating applied by physical vapor deposition to the internal side or the visible side of the interior three-dimensional liner to form a barrier layer on the interior panel,

   wherein the barrier layer prevents gas from permeating easily through the three-dimensional liner.
11. The vacuum insulated three-dimensional refrigerator liner of claim 10, wherein the three-dimensional interior liner is constructed of HIPS or another high impact liner material.

12. The vacuum insulated three-dimensional refrigerator liner of claim 10, wherein the liner is part of a refrigerator door.

13. The vacuum insulated three-dimensional refrigerator liner of claim 10, wherein the three-dimensional liner is part of a refrigerator cabinet.

14. The vacuum insulated three-dimensional refrigerator liner of claim 10, wherein the three-dimensional refrigerator liner is part of an under counter refrigerator.

15. The vacuum insulated three-dimensional refrigerator liner of claim 10, wherein the barrier layer is formed of aluminum or other barrier material.

16. The vacuum insulated three-dimensional refrigerator liner of claim 10, wherein the interior liner comprises bosses to provide attachment to the three-dimensional interior liner.

17. The vacuum insulated three-dimensional refrigerator liner of claim 10, wherein the three-dimensional interior liner has ribs to provide enhanced strength to the three-dimensional interior liner.

18. A refrigerator, the refrigerator comprising:
   a plastic trim breaker;
   a three-dimensional liner;
   a wrapper which surrounds the liner;
   a back plate secured to the back of the three-dimensional liner;
   insulation between the three-dimensional liner and the wrapper, and
   a physical vapor deposition metal coating applied to the inside surface of the plastic trim breaker to provide a barrier layer to the plastic trim breaker,
   wherein a portion of the barrier layer contacts a portion of both the three-dimensional liner and wrapper to prevent heat or gas from entering the interior of the refrigerator restructure.

19. The refrigerator of claim 18, wherein the barrier layer is formed of aluminum.

20. The refrigerator of claim 18, wherein the trim breaker includes recesses to receive the inner three-dimensional liner and the wrapper.