Title: SOFT COATED GLASS PANE REFRIGERATOR DOOR CONSTRUCTION AND METHOD OF MAKING THE SAME.

Abstract: A door for a refrigerator display case is provided. The door includes a glass panel having a surface coated with a low-emissivity soft coating. A refrigerator display case is also provided. The display case has a refrigerated enclosure and a door with three glass panels. The middle glass panel is coated with a low-emissivity soft coating.
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Soft Coated Glass Pane Refrigerator Door Construction and
Method of Making the Same

Field of the Invention

The present invention relates generally to door constructions, and in particular, those used for refrigerated display cases.

Background of the Invention

Commercial refrigerators and refrigerated display cases (coolers and freezers) are used in markets, food vending operations, liquor stores and the like for preserving freshness and attractively displaying products to the consumer. Typically, such display cases have a refrigerated enclosure and an opening that is sealed by a door that the consumer can open to retrieve the desired product.

The energy required to operate refrigerated display cases can be substantial. Thus, it is generally desirable to improve the thermal performance of the display case by reducing the amount of heat transferred from the surroundings to the refrigerated enclosure. However, in addition to insulating the refrigerated enclosure from ambient conditions, the display case doors provide a customer with a means of viewing the refrigerated products. Thus, it is desirable for the doors to allow as much visible light as possible to pass from inside the enclosure to the customer, while preventing the transmission of non-visible light from the surroundings to inside the enclosure.

In addition, because the interior space of the refrigerated enclosure is typically maintained at a temperature well below the dew point of the ambient air, condensation frequently occurs on the glass panes of the doors. Such condensation can drip onto
the floor, potentially causing a slipping hazard. It can also cause the glass panes to fog up, thereby impairing the customers' ability to view the products in the display case. Display cases have been developed which use heated glass panes or heated display case frames to reduce condensation. However, this approach also affects the thermal performance of the display case by increasing the energy required to operate it.

To address the foregoing issues, three-pack display cases (i.e., display cases with three glass panes) with low emissivity hard coated surfaces have been developed, as described in U.S. Patent No. 6,606,832. However, such door constructions require hard coating two of the three panes in order to achieve the desired thermal performance. As a result, the use of such hard coated constructions is costly. Accordingly, a need has developed for an improved door construction.

**Summary of the Preferred Embodiments**

In accordance with a first aspect of the present invention, a door for a refrigerated display case is provided. The door comprises a glass panel having first and second surfaces, wherein the first surface is coated with a low emissivity soft coating. In describing the glass panels, the surface closest to the customer, i.e. the outside, is referred to as the first surface, and the inner surface is referred to as the second surface. The coated surface preferably has an emissivity of not more than about 0.1. An emissivity of not more than about 0.05 is more preferable and an emissivity of not more than about 0.03 is especially preferred.

In accordance with a second aspect of the present invention, a refrigerated display case having three glass panels is provided. Each panel has first and second surfaces, and one of the surfaces is coated with a low-emissivity soft coating. The coated surface preferably has an emissivity of not more than about 0.1. An emissivity of not more than about 0.05 is more
preferable and an emissivity of not more than about 0.03 is especially preferred.

In a preferred embodiment, the three panels comprise first, second and third glass panels, wherein the first glass panel is located nearest the customer. In additional preferred embodiments, the first surface of the second panel is coated with a low emissivity soft coating. In other preferred embodiments, the first and second surfaces of the second glass panel are coated with a low-emissivity soft coating.

In accordance with another aspect of the present invention, a refrigerated display case is provided. The display case comprises a refrigerated enclosure having an interior space and an opening. A door is connected to the refrigerated enclosure and is movable from a closed position to an open position. The door comprises a first glass panel, a second glass panel, and a third glass panel. The second panel comprises first and second surfaces, and the first surface is coated with a low emissivity soft coating, wherein the first surface has an emissivity of not more than about 0.1. An emissivity of not more than about 0.05 is more preferable and an emissivity of not more than about 0.03 is especially preferred. In a preferred embodiment, the first surface of the second panel has an uncoated perimeter portion.

In accordance with yet another aspect of the present invention, a method of assembling a display case having a refrigerated enclosure and an opening is provided. The method comprises providing a door comprising a glass panel that has a surface coated with a low emissivity soft coating and movably covering the opening with the door.

In accordance with another aspect of the present invention, a method of assembling a display case having a refrigerated enclosure and an opening is provided. The method comprises providing a door having three glass panels, each of which has first and second surfaces. One of the surfaces is coated with a
low emissivity soft coating. The method further comprises movably covering the opening with the door. In a preferred embodiment, the second panel is located between the first and third panels and the coated surface is the first surface of the second glass panel.

**Brief Description of the Drawings**

The invention may be more readily understood by referring to the accompanying drawings in which:

FIG. 1 is a perspective view of a portion of a refrigerated display case used to illustrate the present invention.

FIG. 2 is a top plan view of a portion of a refrigerator door in accordance with a preferred embodiment of the present invention.

Like numerals refer to like parts throughout the several views of the drawings.

**Detailed Description of the Preferred Embodiments**

FIG. 1 depicts one-half of a refrigerated display case incorporating two display case doors in accordance with a preferred embodiment of the present invention. Display case 20 includes doors 30, mounted in surrounding frame 40 that defines an opening in display case 20. Doors 30 have glass panels, generally depicted as 100. Glass panels 100 are designed to allow someone, such as a supermarket customer, to view display items 60 on shelves 70. Items 60 may or may not be refrigerated items, such as frozen foods.

Using handles 48, doors 30 can be swung or slid open or closed to alternately seal or unseal the interior space of display case 20. Typical display cases include numerous other structures for attaching doors 30 to display case 20, as well as features for housing wiring, which are described in U.S. Patent
No. 6,606,832, the disclosure of which is incorporated by reference herein.

Referring to Figure 2, a top plan view of a preferred embodiment of a refrigerator door is provided. Door 30 comprises three glass panels, depicted as 120, 140 and 160. Door 30 is typically mounted in a frame having a door rail that supports and surrounds a glazing channel (not shown). The glazing channel may be provided to support the glass panels and protect the edges thereof. Instead of a glazing channel, a tape may be applied to the door rail to protect the glass panes. The tape may be a foam or other polymeric tape, and may be, for example, a film supported polyolefin film tape or similar material.

Each glass panel has two surfaces, depicted as 121, 122, 123, 124, 125 and 126. In the embodiment of Figure 2, surface 121 faces the customer and surface 126 faces the interior space of display case 20. In a triple panel display case configuration, such as the one shown in FIG. 2, the overall thickness of the glass pack is preferably at least 1 1/4 inches, with the panels preferably being 1/8 inch thick and the spaces between the panels preferably being 7/16 inch.

Glass panels 120, 140 and 160 are preferably designed to maximize visible light transmission from inside the case to the customer, thereby improving the ability of customers to view display items 60. However, it is also desirable to minimize the transmission of non-visible light (i.e., ultraviolet and infrared light) through glass panels 120, 140 and 160 from outside to inside the case in order to improve thermal performance. In addition, capturing the transmission of such non-visible wavelengths by the glass panels beneficially generates heat within door 30 which can drive off or prevent condensation on surfaces 121-126, further improving product visibility. Coolers are a type of refrigerated display case which operate at a temperature of approximately 38°F. Freezers are another type of refrigerated display case which operate below 0°F. When the
glass panels of such display cases come into contact with ambient air, the relatively colder glass panels can cause moisture in the air to condense on the surfaces of the glass panels. Thus, it is desirable to use the non-visible wavelengths of light to heat the glass panels, thus reducing or preventing condensation.

It is preferred that door 30 have an energy consumption that is reduced or entirely eliminated. Known doors for refrigerated display cases frequently use heated door frames or glass panels to reduce condensation. While atmospheric conditions in certain geographic locations may make heated door frames or glass desirable, the present invention eliminates or reduces the energy consumed by such heated doors, while still reducing the accumulation of condensation on glass panels 120, 140 and 160.

Prior techniques for improving thermal performance and reducing condensation (or reducing the heating needed to avoid condensation) involved the use of low emissivity hard coated glass panes. However, in order to achieve the desired performance, such hard coatings had to be applied to two of the six surfaces of glass panels 120, 140 and 160. The present invention results from the surprising discovery that when used in a triple panel refrigerator door construction, a single glass panel coated with a low emissivity soft coating can achieve the same performance as two panels coated with a low emissivity hard coating.

As is well known to those of ordinary skill in the art, hard coatings are those coatings that are applied during the glass manufacturing process using chemical vapor deposition techniques. The coating is applied when the glass pane is in its molten stage. As a result, the coating fuses to the glass, becomes part of it, and thus becomes hard. The present invention involves the use of soft coatings. In contrast to hard coatings, soft coatings are typically applied to the glass panel after it has solidified and do not fuse to the glass. As used herein, the
term "soft coating" means a coating that is not diffused into the glass pane to which it is applied.

As used herein the term "low emissivity" means an emissivity of less than 0.2. Soft coated glass panes generally have lower emissivities than hard coatings. However, they also suffer from certain drawbacks. First, because they are not fused to the glass, soft coatings are more vulnerable to physical damage, such as 'scratching,' than are hard coatings. Thus, soft coated glass must be handled more carefully than hard coated glass. Second, the processes used to temper glass panes are more costly and difficult to perform when soft coatings are used. Industry standards for display cases such as the one depicted in FIGS. 1 and 2 require panels 120 and 160 to be tempered in order to minimize the likelihood of breakage by and injury to consumers or employees. Many soft coatings cannot undergo such tempering without degrading or becoming damaged by the tempering process. While some soft coatings can undergo tempering, soft coated panels typically must be tempered more slowly than hard coated panels, increasing processing costs. Even when such safeguards are implemented, however, soft coated panels tend to have higher scrap rates than hard coated panels.

To address the foregoing, low emissivity soft coating 240 is preferably applied to surface 123 and/or 124 of glass panel 140, as depicted in FIG. 2. It is especially preferable to apply soft coating 240 to surface 123 only, as shown in FIG. 2. It is preferred to apply soft coating 240 to inner panel 140 because unlike panels 120 and 160, industry standards do not require panel 140 to be tempered. Preferably, the emissivity of coated surface 123 is not more than about 0.1. However, an emissivity of not more than about 0.05 is more preferred and an emissivity of not more than about 0.03 is especially preferred. Preferably, glass panels 120, 140 and 160 provide a visible light transmission through door 30 which is greater than about 0.6. However, a visible light transmission of greater than about 0.7
is more preferred, and a visible light transmission of greater than about 0.75 is especially preferred.

Typical soft coatings comprise multiple layers of metal oxides, and a variety of known soft coatings can be used with the present invention, including SOLARBAN® 60, a product of PPG Industries, Inc. and ACCLIMATE RLE 71/38, a product of Guardian Industries Corporation.

Glass panels 120 and 140 are separated by spacing 125, and glass panels 140 and 160 are separated by spacing 135. Spacings 125 and 135 can be filled with an inert gas to better insulate door 30 and improve its thermal performance.

A variety of inert gases can be used. However, Krypton, Xenon, Argon or a mixture of 12% Air, 22% Argon and 66% Krypton are preferred. The use of 100% Argon gas is especially preferred.

As shown in FIG. 2, spacings 125 and 135 can also be maintained by spacer assemblies 180, which are preferably positioned around the perimeter of glass panels 120, 140 and 160. Spacer assemblies 180 may be conventional spacers, such as the "comfort seal" manufactured by TruSeal Technologies, Inc., but warm edge spacer assemblies are preferred, as described in greater detail below. Conventional sealant may be placed about the spacers to a level flush with the outward facing perimeter edges 200, 204 and 206 of glass panels 120, 140, and 160 or even over those surfaces if desired.

Referring again to Figure 2, spacer assemblies 180 preferably use warm edge technology. As used herein, the term "warm edge technology" refers to a spacer that has dessicant embedded, surrounded or incorporated in a polymeric-based seal material. Spacers incorporating warm edge technology may or may not incorporate metal structures, metal foils or other inorganic materials, but often do include such materials.

Spacer assemblies 180 preferably include an interior body portion 340 formed of a dessicant matrix extending the width of
the spacing between adjacent glass panes. An outer-most edge of interior body portion 340 is adjacent on each side thereof to polyisobutylene sealant beads 360 which contact each adjacent glass panel to form a seal therewith.

Spacer assemblies 180 also preferably comprise a vapor barrier film 320 which may be a metal, Mylar, or other vapor-impervious film extending the width of the spacer between adjacent glass panels. The film 320 may be supported at its ends by polyisobutylene sealant bead 360, as depicted in FIG. 2. The depth of each bead 360 into the spacer from the adjacent glass panel is preferably between 10 and 20 percent of the width of spacings 125 and 135. Sealant beads 360 help to seal between metal foil 320 and adjacent surfaces of glass panels 120, 140 and 160, and contribute to reducing vapor flow between the inside and outside of the glass unit. In an especially preferred embodiment, there is little or no structural metal (e.g., from the frame or door rails) in spacer assembly 180.

Hot melt sealant 280, which is preferably hot melt butyl, surrounds beads 360, film 320 and the outwardly facing portion of interior body portion 340 to form a seal between adjacent glass panels. Hot melt sealant 280 preferably extends from metal foil 320 to the outer most portion of spacer assembly 180. Sealant 280 extends on both the inside and outside surfaces of metal foil 320, and width-wise from the surface of one glass panel to the surface of the adjacent glass panel to seal them. Sealant 280 surrounds a polymeric core 300 centered in the hot melt between the glass panels. Polymeric core 300 preferably takes up about 60-80 percent of each of the width-wise spacings 125 and 135 between adjacent panels, with the hot melt separating the core from each of the adjacent panels. Polymeric core 300 preferably extends from the plane of outer peripheral edges 200, 204, and 206 approximately two-thirds of the way into the hot melt. Polymeric core 300 is preferably formed from a relatively firm thermoplastic or thermosetting material, and may be formed from
EPDM or other suitable material. The core can also be completely surrounded by hot melt 280. Such a warm edge technology spacer can be used between each of adjacent glass panels 120, 140 and 160, or alternatively, can be used between one pair of adjacent glass panels, with a different type of spacer being used between the other pair of panels.

As mentioned previously, soft coatings tend to be vulnerable to oxidation. Such oxidation can also degrade the seal provided by sealant 280. As a result, it is preferred to "edge-delete" the coating from the glass to reduce the likelihood of oxidation. In the embodiment of Figure 2, coating 240 is not applied to surface 123 in the region adjacent to exposed edge 204 of glass panel 140. As shown in the figure, it is especially preferred to apply coating 240 inward of spacer assembly 180 to further reduce the likelihood of oxidation-induced degradation of the coating 240 and sealant 280.

Another example of a warm edge technology spacer is a spacer such as that shown and described in U.S. Pat. No. 5,851,609, incorporated herein by reference, and describing what is commonly known as SWIGGLE® spacer by TruSeal technologies. However, in the embodiments described herein for a refrigerator display case door, the spacer element forming the undulating portion preferably has a wave or peak amplitude, or spacing from the trough of one part to the peak of the adjacent portion of the undulation, greater than approximately 0.1 inch, and preferably in the range of 0.1 to 0.125 inch or more, to withstand the compressive forces that may develop in a swing door under normal operating conditions, for example, from opening and closing, racking or twisting as a result of the door size and movement during normal operating and from the application of the door frame itself about the edges of the glass unit. One preferred amplitude may be in the range of about 0.125-0.2 inch with a possible thickness of about 0.160 to 0.170 inch. Alternatively or additionally, the wall thickness of the metal or other
material of the spacer element can be made thicker to further withstand the compressive forces in the glass unit, even though doing so would increase the cross sectional area for thermal flow from one glass panel to the adjacent glass panel, thereby tending to decrease the insulating properties of the glass unit. However the integrity of the glass unit within the door frame would be enhanced.

As mentioned earlier, it is desirable to increase the transmission of visible light through glass panels 120, 140 and 160 of door 30 in order to improve the consumers' ability to view display items 60. One of the known drawbacks of soft coatings is their relatively poorer visible light transmission in comparison to hard coatings. However, as mentioned previously, it has surprisingly been discovered that the use of a single, soft coated glass panel can achieve the same thermal performance as two hard coated panels in a refrigerated display case. More preferably, when used with a refrigerated case temperature of -12 °F and a room temperature of 75°F, a three-pack refrigerator door (i.e., a refrigerator door with three glass panels) with a single soft coated panel in accordance with the present invention will protect against condensation on the glass panels when the relative humidity of the room exceeds 55%. By reducing the number of coated glass panels, it has been found that a soft coated construction can achieve an overall visible light transmission that is at least equal to certain hard coated constructions wherein two of the glass panels are coated.

The embodiments described above are exemplary embodiments of the present invention. Those skilled in the art may now make numerous uses of, and departures from, the above-described embodiments without departing from the inventive concepts disclosed herein. Accordingly, the present invention is to be defined solely by the scope of the following claims.
Claims

What is claimed is:

1. A door for a refrigerated display case, said glass door comprising a glass panel having a surface coated with a low-emissivity soft coating.

2. The door of claim 1, wherein the emissivity of said coated surface is not more than about 0.1.

3. The door of claim 1, wherein the emissivity of said coated surface is not more than about 0.05.

4. The door of claim 1, wherein the emissivity of said coated surface is not more than about 0.03.

5. The door of claim 1, wherein said glass panel is untempered.

6. The door of claim 1, wherein said door has a visible light transmission greater than about 0.6.

7. The door of claim 1, wherein said door has a visible light transmission of greater than about 0.7.

8. The door of claim 1, wherein said door has a visible light transmission of greater than about 0.75.

9. The door of claim 1, wherein said surface has an uncoated perimeter portion.

10. The door of claim 1, wherein said uncoated perimeter portion is substantially the entire perimeter of the glass panel.

11. The door of claim 1, wherein said glass panel is untempered.
12. A door for a refrigerated display case, comprising three glass panels, each said panel having first and second surfaces, wherein one of said surfaces of one of said panels is coated with a low-emissivity soft coating.

13. The door of claim 12, wherein said three glass panels comprise a first glass panel, a second glass panel and a third glass panel, and wherein said second glass panel is located between said first glass panel and said third glass panel.

14. The door of claim 13, wherein said first surface of said second glass panel is coated with a low-emissivity soft coating.

15. The door of claim 13, wherein said first surface of said second panel and said second surface of said second panel are coated with a low-emissivity soft coating.

16. The door of claim 12, wherein said emissivity of said coated surface is not more than about 0.1.

17. The door of claim 12, wherein said emissivity of said coated surface is not more than about 0.05.

18. The door of claim 12, wherein said emissivity of said coated surface is not more than about 0.03.

19. The door of claim 12, wherein the glass panel having the coated surface is untempered.

20. The door of claim 12, wherein said door has a visible light transmission greater than about 0.6.

21. The door of claim 12, wherein said door has a visible light transmission of greater than about 0.7.

22. The door of claim 12, wherein said door has a visible light transmission of greater than about 0.75.
23. The door of claim 12, wherein said coated surface has an uncoated perimeter portion.

24. The door of claim 23, wherein said uncoated perimeter portion is substantially the entire perimeter of the glass panel having the coated surface.

25. The door of claim 12, wherein the glass panel having a coated surface is untempered.

26. A refrigerated display case, comprising:
   a. a refrigerated enclosure having an interior space and an opening;
   b. a door connected to said refrigerated enclosure and movable from a closed position to an open position, said door comprising a first glass panel, a second glass panel, and a third glass panel, wherein said first glass panel is distal from said interior space, said third panel is proximate said interior space, and said second panel is located between said first panel and said second panel, said second panel further comprising first and second surfaces, wherein said first surface faces said first panel, said first surface is coated with a soft coating, and said coated first surface has an emissivity of not more than about 0.1.

27. The refrigerated display case of claim 26, wherein said coated first surface has an emissivity of not more than about 0.05.

28. The refrigerated display case of claim 26, wherein said coated first surface has an emissivity of not more than about 0.03.
29. The refrigerated display case of claim 26, wherein said coated first surface has an uncoated perimeter portion.

30. The refrigerated display case of claim 29, wherein the uncoated perimeter portion is substantially the entire perimeter of the second glass panel.

31. The refrigerated display case of claim 26, wherein said door further comprises a spacer assembly between said first glass panel and said second glass panel.

32. The refrigerated display case of claim 31, wherein said spacer assembly comprises warm edge technology.

33. The refrigerated display case of claim 31, wherein said spacer assembly abuttingly contacts said first surface, thereby defining a contact location on said first surface.

34. The refrigerated display case of claim 33, wherein said contact location of said first surface is not coated with said low-emissivity soft coating.

35. The refrigerated display case of claim 31, wherein said spacer assembly comprises a sealant adapted to form a seal between said first glass panel and said second glass panel.

36. The refrigerated display case of claim 26, wherein the door has a visible light transmission of greater than about 0.6.

37. The refrigerated display case of claim 26, wherein the door has a visible light transmission of greater than about 0.7.

38. The refrigerated display case of claim 26, wherein the door has a visible light transmission of greater than about 0.75.

39. A method of assembling a display case having a refrigerated enclosure and an opening, the method comprising:
a. providing a door, said door comprising a glass panel having a surface, said surface being coated with a low-emissivity soft coating.

b. movably covering said opening with said door.

40. A method of assembling a display case having a refrigerated enclosure and an opening, the method comprising:

a. providing a door comprising three glass panels, each said panel having first and second surfaces, wherein one of said surfaces is coated with a low emissivity soft coating;

b. movably covering said opening with said door.

41. The method of claim 40, wherein said three glass panels comprise a first glass panel, a second glass panel and a third glass panel, and wherein said second glass panel is located between said first glass panel and said third glass panel.

42. The door of claim 41, wherein said coated surface is said first surface of said second glass panel.

43. The door of claim 41, wherein said coated surface is said first surface of said second glass panel and said second surface of said second glass panel is coated with a low-emissivity soft coating.

44. The door of claim 40, wherein said emissivity of said coated surface is not more than about 0.1.

45. The door of claim 40, wherein said emissivity of said coated surface is not more than about 0.05.

46. The door of claim 40, wherein said emissivity of said coated surface is not more than about 0.03.
47. The door of claim 40, wherein the glass panel having said coated surface is untempered.