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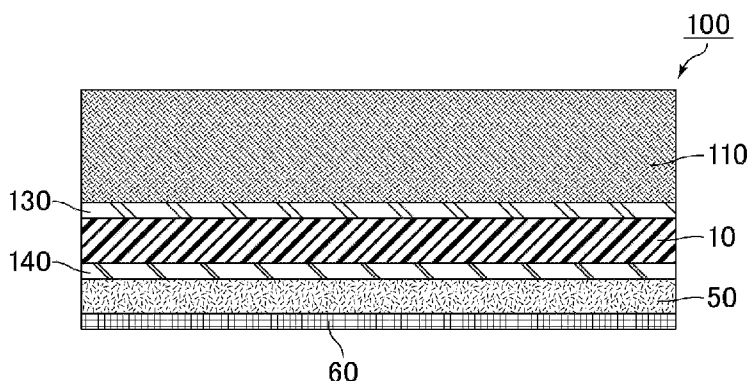
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WO 2022/266478 A1

(54) Title: GLASS PRODUCT AND METHOD OF PRODUCING GLASS PRODUCT

FIG. 1



(57) Abstract: A glass product includes a glass piece, a first adhesive layer, a switchable film having variable light transmission adhered to the glass piece via the first adhesive layer, a second adhesive layer, and a protective layer on the switchable film, wherein the protective layer includes a low-emissivity coating.

GLASS PRODUCT AND METHOD OF PRODUCING GLASS PRODUCT

Cross Reference to Related Application

[0001] This application claims priority to U.S. Provisional Application No. 63/211,692, filed on June 17, 2021, entitled "Glass Product," the entire contents of which are incorporated by reference herein in their entirety.

Technical Field

[0002] The present disclosure is generally related to a glass product having a switchable film, a protective layer over the switchable film, and a low-emissivity coating on the protective layer. The present disclosure is also generally related to a method of producing the glass product.

Background

[0003] Switchable films, functionally changing in light transmission under electrical power, may be used in automotive glazings to provide variably transparent windows. The switchable films may be laminated in a glazing between two glass sheets, which may include deairing and autoclaving the switchable film between glass sheets. The glass sheets may include a complex curvature shape. The laminated process may be complex with a laminated functional film which may wrinkle when laminated between the glass sheets having complex curvature and may require electrical connections to be formed within the glazing. The difficulty in producing such parts may lead to unacceptable parts being produced, which may be scrapped as unusable. An alternative method for providing a switchable glazing may be needed to improve on these difficulties, among others.

Summary

[0004] Disclosed herein includes a glass product, including a glass piece; a first adhesive layer; a switchable film having variable light transmission adhered to the glass piece via the first adhesive

layer; a second adhesive layer; a protective layer over the switchable film via the second adhesive layer; and includes low-emissivity characteristics.

[0005] In some embodiments of the present disclosure, the low-emissivity characteristics may be due to a low-emissivity coating, which may include indium tin oxide.

[0006] In some embodiments of the present disclosure, the protective layer may include a polymer film. The polymer film may have a hard coating thereon.

[0007] In some embodiments of the present disclosure, the protective layer may include a glass sheet.

[0008] In some embodiments of the present disclosure, the glass product may be a sunroof.

[0009] In some embodiments of the present disclosure, the protective layer may include an area for capacitive switching of the switchable film.

[0010] In some embodiments of the present disclosure, the protective layer may have a thickness of 1.0 mm or less.

[0011] In some embodiments of the present disclosure, at least one of the first and the second adhesive layers may be a coating. In some embodiments of the present disclosure, at least one of the first and the second adhesive layers may include a pressure-sensitive adhesive, or a cured material of a photocurable, reaction-curable, or moisture-curable adhesive.

[0012] In some embodiments of the present disclosure, a sealant may be provided at an edge of the switchable film and the protective layer.

[0013] In another aspect of the present disclosure, a method of producing the glass product of the present disclosure includes: forming the low-emissivity coating on the protective layer; adhering the protective layer to the switchable film via the second adhesive layer; and adhering the switchable film to the glass piece via the first adhesive layer.

[0014] In some embodiments of the present disclosure, the glass piece may have a curved shape, and the switchable film with the protective layer adhered thereto may be shaped prior to adhering to the glass piece.

[0015] In some embodiments of the present disclosure, at least one of the first and the second adhesive layers may include a photocurable, reaction-curable, moisture-curable, or pressure-sensitive adhesive, and the adhering at least one of the protective layer and the adhering the switchable film may be carried out at an ambient temperature.

Brief Description of the Drawings

[0016] The accompanying drawings, which are incorporated into and constitute a part of this specification, illustrate one or more example aspects of the present disclosure and, together with the detailed description, serve to explain their principles and implementations.

[0017] FIG. 1 is a cross section illustrating a glass product, according to an exemplary embodiment of the present disclosure.

[0018] FIG. 2 is a cross section illustrating a glass product, according to an exemplary embodiment of the present disclosure.

[0019] FIGs. 3A, 3B, and 3C illustrate steps of producing a glass product, according to an exemplary embodiment of the present disclosure.

[0020] FIG. 4A illustrates a step of producing a glass product, according to an exemplary embodiment of the present disclosure.

[0021] FIG. 4B is a cross section illustrating a glass product, according to an exemplary embodiment of the present disclosure.

Detailed Description

[0022] In the following description, for purposes of explanation, specific details are set forth in order to promote a thorough understanding of one or more aspects of the disclosure. It may be evident in some or all instances, however, that any aspects described below can be practiced without adopting the specific design details described below.

[0023] This disclosure relates generally to a glass product, including: a glass piece; a first adhesive layer on the glass piece; a switchable film having variable light transmission adhered to the glass piece via the first adhesive layer; a second adhesive layer on the switchable film; a protective layer adhered to the switchable film via the second adhesive layer, wherein the protective layer has a low-emissivity characteristic. The protective layer may include a low-emissivity coating to provide the low-emissivity characteristics. This disclosure also relates generally to a method of producing the glass product, including: forming the low-emissivity coating on the protective layer; adhering the protective layer to the switchable film via the second adhesive layer; and adhering the switchable film to the glass piece via the first adhesive layer.

[0024] Where a switchable film is laminated between interlayers in a laminated glazing, the relatively soft interlayers may allow for change in shape of the switchable film, including wrinkling of the film. Applying the film instead to a harder glass surface may allow for prevention or limitation of such wrinkling even where the glass has a complex curvature shape.

[0025] Glass products described herein may include laminated or non-laminated glazings. Such glazings may be used, for example, in automotive vehicles as windows, such as windshields, sunroofs, back windows, or side windows. The glass product may include a glass piece which may include a single glass sheet or a laminated glazing. The glass pieces may be bent to a desired shape. A conventional laminated glazing may include a first glass sheet, an interlayer, and a second glass

sheet laminated together. The glass sheets may be bent to a desired shape prior to lamination with an interlayer therebetween. Preferably, the glass sheets may be a soda-lime silica glass. Glass bending may preferably occur by heat treatment from 550°C to 700°C, more preferably from 580°C to 660°C. The interlayer may include an adhesive polymer sheet, which may include polyvinyl butyral (PVB) or ethylene vinyl acetate (EVA). An interlayer may include an ionomer sheet in some glazings. An inner glass sheet of the glazing faces a vehicle interior when installed, and an outer glass sheet faces a vehicle exterior when installed. The glass product may be a sunroof.

[0026] A switchable film as used herein includes a functional layer for changing in transparency due to a connection to an electrical power source. Switchable films may include, for example, a liquid crystal film, such as polymer dispersed liquid crystal (PDLC), polymer network liquid crystal (PNLC), or other liquid crystal films, a nanoparticle film, such as a suspended particle device (SPD), or electrochromic films. A switchable film may include, for example, a first base layer, a first electrode on the first base layer, a functional layer, a second electrode, and a second base layer. The second electrode may be formed on the second base layer. The first and second electrodes may preferably include a metal oxide, such as indium tin oxide and may be the same or different material. The first and second base layers may preferably include polymer films, such as polyethylene terephthalate (PET) and may be the same or different from each other. The first and second electrodes may be independently connected to a power source. Some switchable films may be segmented so that the segments formed may be controlled independently of each other. Segments may be formed by creating electrically isolated portions on one or both of the first and second electrodes. The segments may each require electrical connection via a busbar. The switchable film may connect to a power source via busbars formed on the electrodes. The

functional layer may include any suitable material and may include, for example, liquid crystal for PDLC or PNLC or nanoparticles for SPD. When the switchable film is connected to an electric power source, the switchable film may switch from a dark or opaque state to a clear state, or vice versa.

[0027] As disclosed herein, a switchable film may be adhered to a glass piece, or glazing. Particularly the switchable film may be adhered to the glass piece on an inner surface facing a vehicle interior when installed. The switchable film may be adhered by an adhesive layer which may include, or be formed by, a hot-melt, thermosetting, photocurable, reaction-curable, moisture-curable, or pressure-sensitive adhesive. The adhesive may include compounds based on acrylate, urethane, urethane acrylate, epoxy, epoxy acrylate, acryl, silicone, isocyanate, polyolefin, modified olefin, polypropylene, ethylene vinyl alcohol, vinyl chloride, chloroprene rubber, cyanoacrylate, polyamide, polyimide, polystyrene, polyvinyl butyral, ethylene vinyl acetate, or the like. The preferable adhesive may be selected for suitable workability and adhesion properties, as well as for providing suitable optical transparency.

[0028] It may be desirable to cover such a switchable film with a protective layer so as to protect it from an environment in the vehicle. The protective layer may be applied over the switchable film with an adhesive that may be the same or different from the adhesive used to adhere the switchable film to the glass piece. The protective layer may preferably have a thickness of 1 mm or less, more preferably 0.7 mm or less. The protective layer may include a polymer layer or a glass layer. For example, the protective layer may include a polymer film, such as a polyethylene terephthalate (PET) film, a polycarbonate film, or an acrylic film, and the polymer film may have a hard coating, such as an acrylic coating, thereon. A hard coating may strengthen the film against physical and chemical damage. The adhesive and protective layer may have a suitable optical

appearance to be applied to a glass piece, which may preferably include a sunroof. Where the protective layer is a glass layer, the glass layer may be thin and flexible. The glass layer may preferably have a thickness of 1.0 mm or less, more preferably 0.7 mm or less, and may be chemically strengthened. In some embodiments, the protective layer may be larger in size than the switchable film so as to extend past the switchable film and completely cover it. Where all or part of the protective layer does not extend past the edge of the switchable film, the edges of the switchable film and the protective layer may be covered with a sealant. Where the protective layer does extend past the edge of the switchable film, the protective layer and the second adhesive may seal the edge of the switchable film. An additional sealant may be used in combination with the second adhesive. The protective layer may have flexibility to conform to the shape of the glass piece and the switchable film on the glass piece.

[0029] The protective layer may have physical and chemical protective qualities. Particularly, the protective layer may have a haze value of less than 2% after the Taber test, as described in ECE R43 (updated May 2019). Further, the protective layer may have a chemical resistance which may pass the chemical resistance test as defined in ECE R43 (updated May 2019).

[0030] The glass product disclosed herein may preferably further include a low-emissivity (low-e) coating. Particularly, it may be beneficial to provide a low-e coating on a surface of the glass product facing a vehicle interior when installed. Such placement may maximize the effectiveness of the low-e coating and prevent heat dissipating from the glass product to the vehicle interior. The low-e coating may preferably include a metal oxide, such as indium tin oxide. The low-e coating may be formed by any suitable means, including vapor deposition processes. The low-e coating may have an emissivity, which means a normal level of emission at 283 K according to the standard EN 12898, of 0.3 or less, preferably 0.2 or less.

[0031] The protective layer may further include an area for capacitive switching of the switchable film, which may be connected to the switchable film. For example, the protective layer may have a multi-layer structure in this area which has a dielectric layer sandwiched by two conductive layers or a single layer structure which may include a laser-deleted portion of the low-e coating or a printed pattern on the protective layer. A protective layer with such a structure may provide capacitive switching, or a touch panel. An electrical connection from a power source to the capacitive switching may be formed in this area. This area may be marked to indicate the position of the capacitive switching.

[0032] Each of FIGs. 1 and 2 illustrates a glass product 100, 101, according to an exemplary embodiment of the present disclosure. The glass product 100 includes a glass piece 110; a first adhesive layer 130 on the glass piece 110; a switchable film 10 having variable light transmission adhered to the glass piece 110 via the first adhesive layer 130; a second adhesive layer 140 on the switchable film 10; a protective layer 50, 51 adhered to the switchable film 10 via the second adhesive layer 140; and a low-e coating 60 on the protective layer 50, 51. The protective layer 51 in the glass product 101 shown in FIG. 2 includes a polymer film 51a and a hard coating 51b on the polymer film 51a.

[0033] The glass product 100, 101 may be produced by a method including: forming the low-e coating 60 on the protective layer 50, 51; adhering the protective layer 50, 51 to the switchable film 10 via the second adhesive layer 140; and adhering the switchable film 10 to the glass piece 110 via the first adhesive layer 130.

[0034] FIGs. 3A, 3B, and 3C illustrate steps of producing the glass product 100, according to an exemplary embodiment of the present disclosure. A low-e coating 60 may be formed on a protective layer 50, as shown in FIG. 3A. The protective layer 50 with the low-e coating 60 may

then be adhered to a switchable film 10 via a second adhesive layer 140, as shown in FIG. 3B. The switchable film 10 with the protective layer 50 may then be adhered to a glass piece 110 via a first adhesive layer 130, as shown in FIG. 3C. In order to produce the glass product 101 shown in FIG. 2, a hard coating 51b may be formed on a polymer film 51a to obtain the protective layer 51 prior to forming the low-e coating 60.

[0035] As shown in FIG. 4A, the glass piece 111 may have a curved shape. After adhering the protective layer 50, 51 to the switchable film 10 via the second adhesive layer 140, the switchable film 10 may be bent or curved prior to adhering to the glass piece 111.

[0036] FIG. 4A illustrates a step of producing the glass product 102 shown in FIG. 4B, according to an exemplary embodiment of the present disclosure. When a glass piece 111 has a curved shape, the switchable film 10 with the protective layer 50 may be bent or curved prior to adhering to the glass piece 111.

[0037] Adhering the switchable film 10 with the protective layer 50, 51 to the glass piece 110, 111 may be carried out by laminating the switchable film 10 and the glass piece 110, 111 with the first adhesive layer 130 therebetween, which may include laminating them via a vacuum, such as a vacuum bag degassing, or physically pressing them with a roller. The adhering may preferably be processed in a vacuum or double-vacuum thermoforming process such that the first contact of adhesive layer 130 and the glass piece 110, 111 will be under vacuum, which may avoid air bubbles in the interface between the glass piece 110 and the adhesive layer 130.

[0038] At least one of the first and the second adhesive layers 130, 140 may be a coating. In other words, at least one of these adhesive layers 130, 140 may be formed by coating an adhesive. The adhering may be carried out at an ambient temperature, *i.e.*, about 10 to 40°C, when the first and the second adhesive layers 130, 140 include, or are formed by, a photocurable, reaction-curable,

moisture-curable, or pressure-sensitive adhesive. Adhering at an ambient temperature may be preferable since it can avoid a damage of the switchable film 10 caused by heating.

[0039] The above description of the disclosure is provided to enable a person skilled in the art to make or use the disclosure. Various modifications to the disclosure will be readily apparent to those skilled in the art, and the common principles defined herein may be applied to other variations without departing from the spirit or scope of the disclosure. Further, the above description in connection with the drawings describes examples and does not represent the only examples that may be implemented or that are within the scope of the claims.

[0040] Furthermore, although elements of the described aspects and/or embodiments may be described or claimed in the singular, the plural is contemplated unless limitation to the singular is explicitly stated. Additionally, all or a portion of any aspect and/or embodiment may be utilized with all or a portion of any other aspect and/or embodiment, unless stated otherwise. Thus, the disclosure is not to be limited to the examples and designs described herein, but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

Claims

1. A glass product, comprising:
 - a glass piece;
 - a first adhesive layer;
 - a switchable film having variable light transmission adhered to the glass piece via the first adhesive layer;
 - a second adhesive layer; and
 - a protective layer over the switchable film via the second adhesive layer;wherein the protective layer includes a low-emissivity characteristics.
2. The glass product according to claim 1, wherein the protective layer includes a low-emissivity coating.
3. The glass product according to claim 2, wherein the low-emissivity coating includes indium tin oxide.
4. The glass product according to any of claims 1 to 3, wherein the protective layer includes a polymer film.
5. The glass product according to claim 4, wherein the polymer film has a hard coating thereon.

6. The glass product according to any one of claims 1 to 3, wherein the protective layer includes a glass sheet.
7. The glass product according to any one of claims 1 to 6, wherein the glass product is a sunroof.
8. The glass product according to any one of claims 1 to 7, wherein the protective layer includes an area for capacitive switching of the switchable film.
9. The glass product according to any one of claims 1 to 8, wherein the protective layer has a thickness of 1.0 mm or less.
10. The glass product according to any one of claims 1 to 9, wherein at least one of the first and the second adhesive layers is a coating.
11. The glass product according to any one of claims 1 to 10, wherein at least one of the first and the second adhesive layers include a pressure-sensitive adhesive, or a cured material of a photocurable, reaction-curable, or moisture-curable adhesive.
12. The glass product according to any one of claims 1 to 11, further comprising a sealant at an edge of the switchable film and the protective layer.

13. A method of producing the glass product according to any one of claims 4 to 12, comprising:

forming the low-emissivity coating on the polymer film or the glass sheet;
adhering the protective layer to the switchable film via the second adhesive layer; and
adhering the switchable film to the glass piece via the first adhesive layer.

14. The method according to claim 13, wherein the glass piece has a curved shape, and the switchable film with the protective layer adhered thereto is shaped prior to adhering to the glass piece.

15. The method according to claim 13 or 14, wherein at least one of the first and the second adhesive layers includes a photocurable, reaction-curable, moisture-curable, or pressure-sensitive adhesive, and at least one of the adhering the protective layer and the adhering the switchable film is carried out at an ambient temperature.

FIG. 1

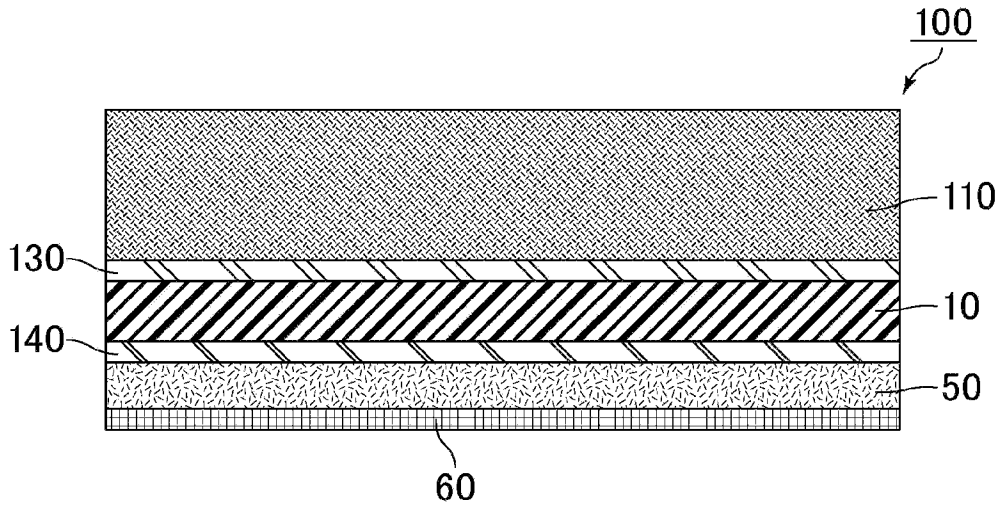


FIG. 2

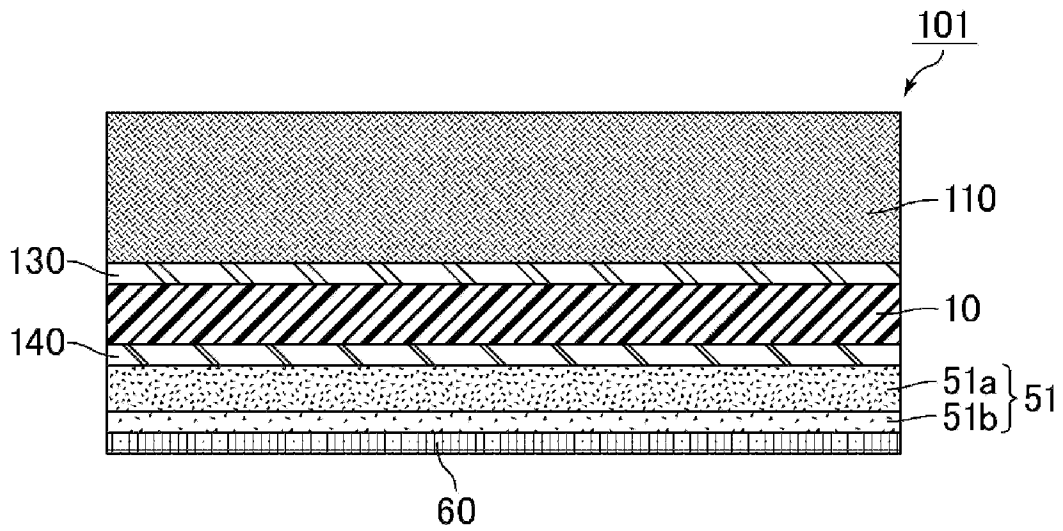
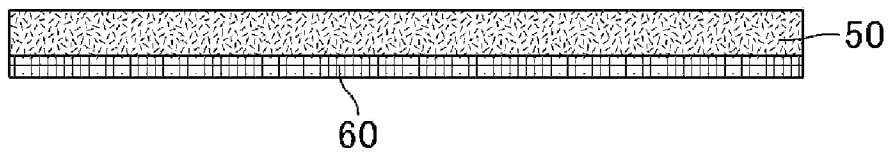


FIG. 3A



2/3

FIG. 3B

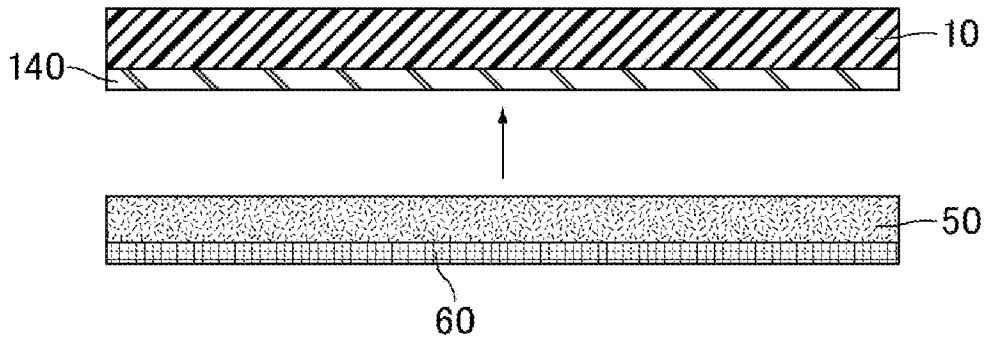


FIG. 3C

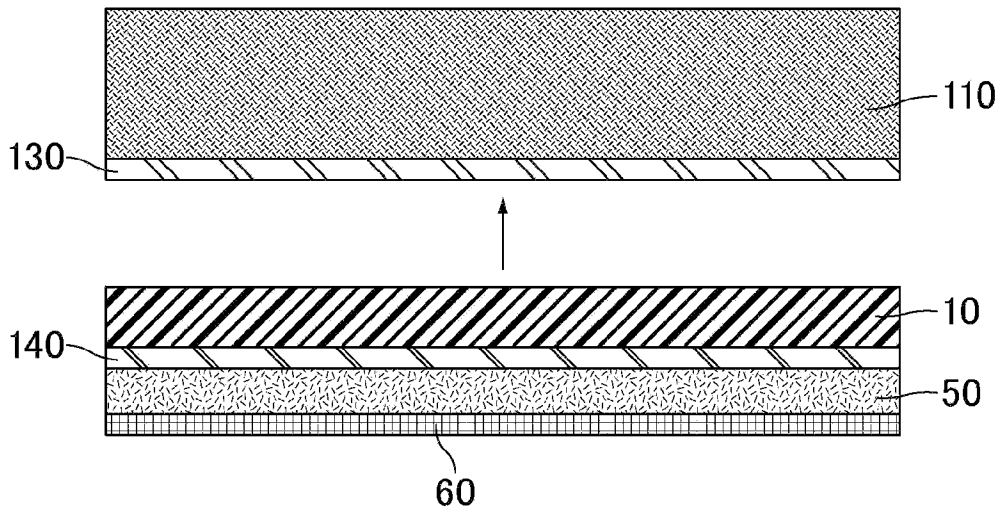


FIG.4A

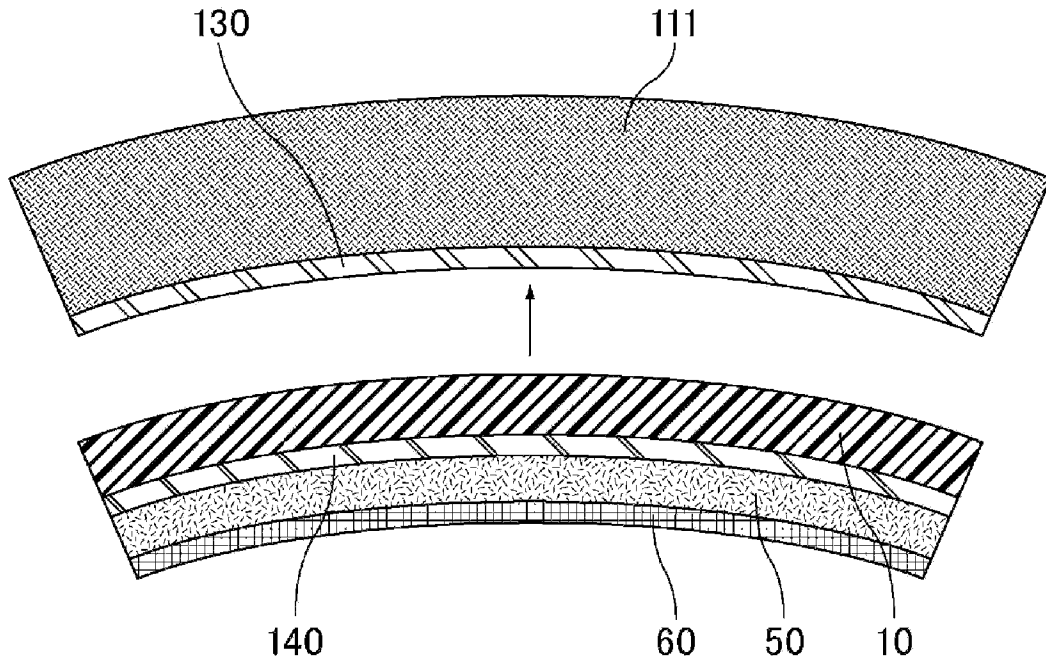
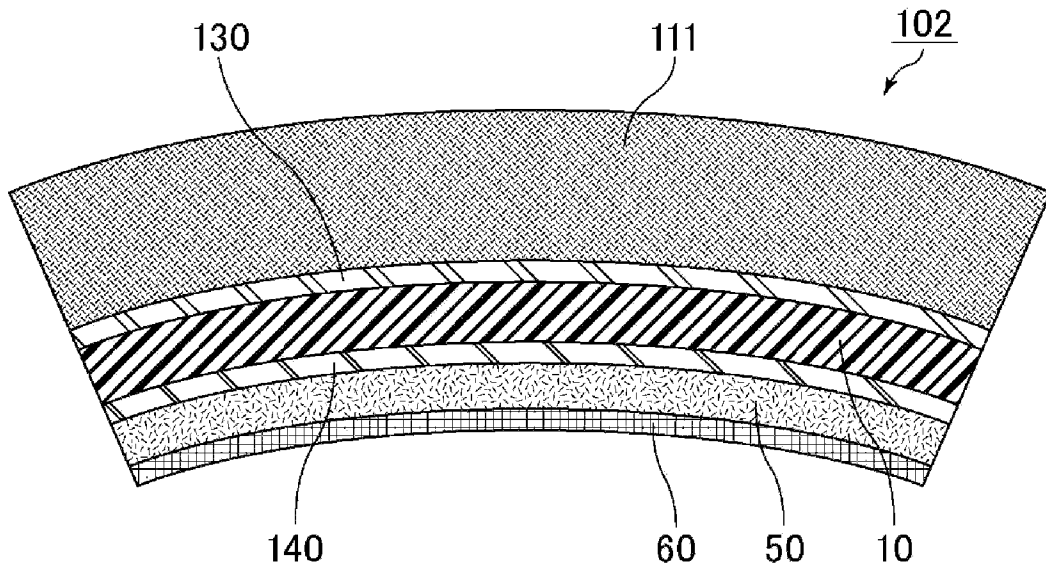


FIG.4B



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2022/034049

A. CLASSIFICATION OF SUBJECT MATTER
INV. B32B7/12 B32B17/10
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/170170 A1 (BOOTE JOSEPH JEREMY [GB]) 14 July 2011 (2011-07-14) figure 8 claims 1-18 paragraph [0036] - paragraph [0081] -----	1-15
X	WO 2009/004385 A1 (PILKINGTON GROUP LTD [GB]; PILKINGTON AUTOMOTIVE D GMBH [DE] ET AL.) 8 January 2009 (2009-01-08) figures 1, 7 claims 1-25 page 1, paragraph 4 page 9, paragraph 3 - page 10, paragraph 3 -----	1-15

Further documents are listed in the continuation of Box C.

See patent family annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2022/034049

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