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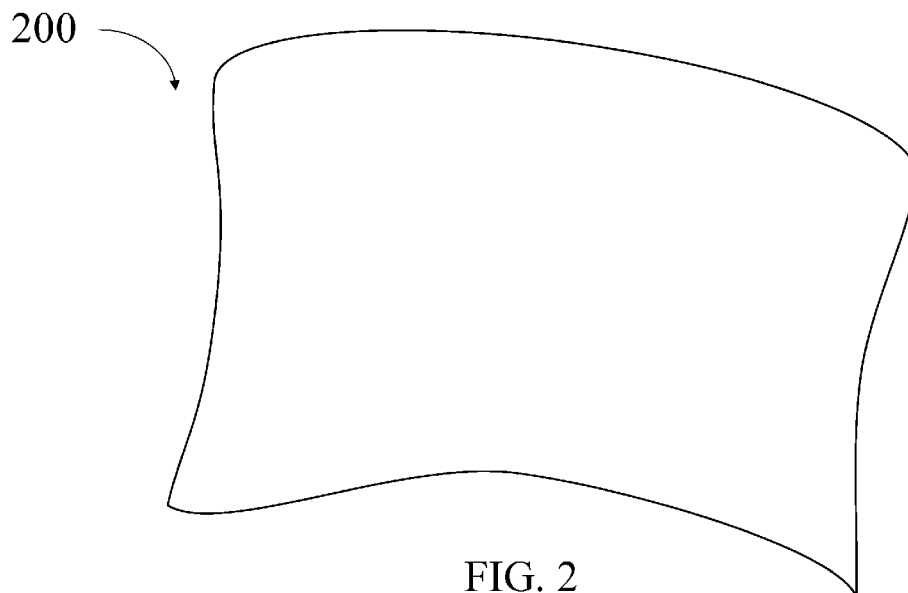
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(54) Title: PREFORMED WINDOW FILM AND METHODS OF MAKING AND USING



(57) Abstract: Preformed window films are described. In particular, preformed window films that include window film layers, pressure sensitive adhesives, and liners are described. The preformed window films are stretched such that they a) do not lay flat on a planar surface without wrinkling, and b) when taut, have a shape having a curvature in at least two perpendicular directions.



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Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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PREFORMED WINDOW FILM AND METHODS OF MAKING AND USING

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Background

Certain window films are used in automotive and building applications to provide physical protection and/or desired optical performance. For example, some window films may block a portion of infrared, ultraviolet, and/or visible light from passing through those windows. For building windows, the window surfaces are typically flat. However, for certain building windows, and many automotive windows, the surfaces are curved. Application of window film to these curved surfaces requires a highly skilled installation and a lot of time.

Summary

In one aspect, the present description relates to a preformed window film. The preformed window film includes a window film layer, the window film including at least one visible or infrared absorbing or reflecting material, a pressure sensitive adhesive layer in contact with the window film layer, and a liner in contact with the pressure sensitive adhesive layer. The preformed window film is stretched such that it a) does not lay flat on a planar surface without wrinkling, and b) when taut, has a shape having a curvature in at least two perpendicular directions.

In another aspect, the present description relates to a method of applying a preformed window film, including the steps of, in order, providing a preformed window film including a window film layer, the window film layer including at least one visible or infrared absorbing or reflecting material, a pressure sensitive adhesive layer in contact with the window film layer, and a liner in contact with the pressure sensitive adhesive layer, where the preformed window film is stretched such that it a) does not lay flat on a planar surface without wrinkling, and b) when taut, has a shape having a curvature in at least two perpendicular directions, and then removing the liner from the preformed window film, and then applying the preformed window film to a window having a curvature in at least two perpendicular directions.

In yet another aspect, the present description relates to a method of preforming a window film, comprising the steps of, in order, providing a window film segment, the window film segment including a window film layer, the window film layer including at least one visible or infrared absorbing or reflecting material, a pressure sensitive adhesive layer in

contact with the window film layer, and a liner in contact with the pressure sensitive adhesive layer, and then stretching the window film segment over a tool, and then removing the window film from the tool to produce a preformed window film, the preformed window film having a deformation through stretching such that it a) does not lay flat on a planar surface without wrinkling, and b) when taut, has a shape having a curvature in at least two perpendicular directions.

Brief Description of the Drawings

FIG. 1 is a schematic side elevation cross section of a conventional window film segment.

FIG. 2 is a schematic top perspective view of a preformed window film.

FIG. 3A and 3B are schematic illustrations of a steps of a method of forming a preformed window film.

FIG. 4 is a schematic illustration of a method of applying a preformed window film.

Detailed Description

FIG. 1 is a schematic side elevation cross section of a conventional window film segment. Window film segment **10** includes window film layer **12**, pressure sensitive adhesive **14**, and liner **16**. Typically, window film is conventionally sold, transported, and stored by the roll, and cut to the particular window it is intended to be installed on. A conventional window film may have any suitable shape and size, but it lies flat (without wrinkling) and is generally planar.

Conventionally, a window film includes a window film layer **12** primarily responsible for the optical performance of the window film. In some embodiments, the window film layer may include a multilayer optical film. Multilayer optical films include repeating patterns of optical microlayers that, through constructive interference between adjacent microlayers having different indices of refractions, efficiently reflect one or both polarizations of light. The reflected wavelengths are dependent on the physical thickness and the index of refraction of the layers (i.e., the optical thickness). Multilayer optical films are known as components in commercially available films, that reflect primarily visible light, such as Enhanced Specular Reflector (available from 3M Company, St. Paul, Minn.), and films that reflect primarily infrared light, such as the Automotive Window Film Crystalline Series window film (available from 3M Company, St. Paul, Minn.).

In order to be attached to the desired substrate or surface (typically a glass or plastic window or other transparent surface), conventional window film also includes a pressure sensitive adhesive **12** to easily adhere the window film layer without the need for sophisticated adhesive coating, drying, and/or curing equipment. This is useful when the installation is to be done at a job site or an automotive tint shop, where such equipment is unlikely to be available.

Liner **14** is provided on the otherwise exposed surface of the window film in order to allow the window film to be transported in a roll and to prevent undesired adhesion and debris accumulation when handling, converting, measuring, or cutting. Typically, the liner is a removable release liner, which may be removed manually or as part of a continuous process without an excessively high required peel strength. The liner is typically paper or plastic, including an optional release coating layer, which may be silicone or another low surface energy material for easy release from the adhesive.

The challenge in installing conventional window film is that it requires particular skills, specialized training, and a lot of time. Conventionally, window film, particularly window film intended to be installed on a complex curved surface (i.e., a surface having curvature in both of two perpendicular directions), is cut or provided as an oversized piece, and then shrunk down to fit through the application of heat. Often “fingers” of excess film has to be heat shrunk in order to provide a good and smoothed fit. Such a finicky installation process can add considerably to the cost of labor and the volume of installations a shop can perform. Further, such an installation process becomes exceedingly difficult for windows with a high degree of curvature.

FIG. 2 is a schematic top perspective view of a preformed window film. Preformed window film **200** is a discrete section of window film. In some embodiments, preformed window film **200** may be sized to fit on a particular selected window or other target surface. In some embodiments, preformed window film **200** may be roughly rectangular, although any suitable shape is possible.

Preformed window film **200** includes the same key components as a conventional window film: including a window film layer, a pressure sensitive adhesive layer, and a liner. However, the preformed window film is distinct in that it has been stretched or deformed. The preformed window film has been stretched or deformed so that it does not lay flat on a planar surface without wrinkling. While the rigidity of the window film may not be sufficient to maintain a fully three dimensional shape, the deformation causes the window film to wrinkle when pressed or laid flat. However, its native shape, or its shape that it holds when

taut, includes curvature in at least two perpendicular directions. In others, its stretched or implied shape is one that includes curvature in at least two perpendicular directions.

The stretching may cause slight physical thinning in certain places. For example, a caliper thickness of the film at the edge may be thinner than a caliper thickness of the same film near the center. In some embodiments, the caliper thickness of the film at the center may be thinner than the caliper thickness of the same film near the edge.

The stretched shape of the preformed window film allows for much simpler installation on complex curved surfaces. In some embodiments, this shape allows the installation of the preformed window film without the application of heat.

In some embodiments, preformed window film **200** includes a window film layer that includes a light absorbing pigment, such as carbon black or a ceramic pigment. In some embodiments, preformed window film **200** includes a window film layer that includes a reflective multilayer optical film. In some embodiments, preformed window film **200** includes a tacky pressure sensitive adhesive.

In some embodiments, preformed window film **200** includes a window film layer and a liner that stretch at the same or approximately (within 20%, within 10%, within 5%, or even within 1%) the same extent and rate. In some embodiments, this means that the window film layer stretched with the liner does not cause the liner to delaminate from the pressure sensitive adhesive layer, and allows the liner to remain in intimate contact with the pressure sensitive adhesive layer. In some embodiments, this means that there is no air gap or delamination between the liner and the pressure sensitive adhesive layer.

FIG. 3A and 3B are schematic illustrations of a steps of a method of forming a preformed window film. Generally, window film segment **310** is pressed or contacted to tool **320** in order to deform or stretch the window film segment such that it is permanently altered.

In some embodiments, window film segment **310** is contacted with tool **320** in a thermoforming process. In some embodiments window film segment **310** is contacted with tool **320** in the presence of a partial vacuum. Any suitable thermoforming process (and/or device) may be used. In some embodiments, the window film segment and/or the tool is heated. In some embodiments, the heat applied increases the temperature of one or more of the layers of the window film segment beyond its glass transition temperature. In some embodiments, one or more of the window film layer, the pressure sensitive adhesive value, and the liner may have difference shrinkage values.

In some embodiments, tool **320** is glass. In some embodiments, tool **320** is a replica or identical part to the window that will ultimately have the window film segment installed on it.

In some embodiments, tool **320** is intended and used as a positive tool (convex). In some embodiments, tool **320** is intended and used as a negative tool (concave). In some embodiments, window film segment **310** is first contacted to tool **320** such that the liner of the window film segment is in contact with tool **320**. This may serve as a protective layer for the optically functional (in other words, since the liner is discarded, scratches or other defects acquired through thermoforming and/or handling are inconsequential to final installed quality).

In some embodiments, window film segment **310** is a portion of a continuous roll (i.e., the window film has not yet been converted at the time it is thermoformed or otherwise molded against the tool). In the case of stretching a continuous roll, nips or other mechanisms to isolate the portion being stretched or formed from the other portions may be used as appropriate. In such cases, the window film may be trimmed separated either before transportation (e.g., converted window film pieces being shipped stacked as sheets), at the installation site, or at a converter or specialized distributor in between molding and installation. Because the liner is intact and attached through thermoforming, there is greater flexibility regarding handling and transportation of the stretched film. In other words, it is not deformed and adhered in the same step.

After forming, and the window film is removed from the tool, it produces a preformed window film. The preformed window film now has a deformation through stretching such that it a) does not lay flat on a planar surface without wrinkling, and b) when taut, has a shape having a curvature in at least two perpendicular directions. The window film may be converted and/or trimmed into the desired size and shape.

FIG. 4 is a schematic illustration of a method of applying a preformed window film. FIG. 4 depicts adhering a window film segment **410**, its liner removed, to a surface of a window **420** having a curvature in two perpendicular directions. The window film is stretched such that it a) does not lay flat on a planar surface without wrinkling, and b) when taut, has a shape having a curvature in at least two perpendicular directions. In some embodiments, this curvature corresponds to the curvature of the window. Window **420** may be any suitable window or windshield. In some embodiments, window **420** may be the side window or the front or rear windshield of a transportation vehicle such as an automobile, a truck, a train, an airplane or a bus. In some embodiments, window **420** may be a building or architectural window.

In some embodiments, additional drying or curing processes can be applied to remove trapped air bubbles from the film or help the pressure sensitive adhesive create a lasting bond.

Appropriate cleaning procedures to prepare the window may also be conducted. In some embodiments, heat need not be applied in order to shrink the window film to fit.

In some embodiments, the preformed window film is applied to the interior surface (concave) surface of a curved window. In some embodiments, although not specifically

5 illustrated in FIG. 4, the preformed window film is applied to the exterior (convex) surface of a curved window.

Descriptions for elements in figures should be understood to apply equally to corresponding elements in other figures, unless indicated otherwise. The present invention

10 should not be considered limited to the particular examples and embodiments described above, as such embodiments are described in detail in order to facilitate explanation of various aspects of the invention. Rather, the present invention should be understood to cover all aspects of the invention, including various modifications, equivalent processes, and alternative devices falling within the scope of the invention as defined by the appended claims and their equivalents.

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What is claimed is:

1. A preformed window film, comprising:
a window film layer, the window film layer including at least one visible or infrared
5 absorbing or reflecting material;
a pressure sensitive adhesive layer in contact with the window film layer; and
a liner in contact with the pressure sensitive adhesive layer;
wherein the preformed window film is stretched such that it a) does not lay flat on a
planar surface without wrinkling, and b) when taut, has a shape having a curvature in at least
10 two perpendicular directions.
2. The preformed window film of claim 1, wherein the window film layer includes a
reflective multilayer optical film.
- 15 3. The preformed window film of claim 1, wherein the window film layer includes
carbon black.
4. The preformed window film of claim 1, wherein the window film layer includes a
ceramic pigment.
- 20 5. The preformed window film of claim 1, wherein the liner is a removable release liner.
6. The preformed window film of claim 1, wherein the liner stretches at approximately
the same rate and extent as the window film layer.
- 25 7. The preformed window film layer of claim 1, wherein the liner is in intimate contact
with the pressure sensitive adhesive layer.
8. The preformed window film of claim 1, wherein the pressure sensitive layer is tacky.
- 30 9. A method of applying a preformed window film, comprising the steps of, in order:
 - i. providing a preformed window film including a window film layer, the
window film layer including at least one visible or infrared absorbing
material, a pressure sensitive adhesive layer in contact with the

- 5 window film layer, and a liner in contact with the pressure sensitive adhesive layer, wherein the preformed window film is stretched such that it a) does not lay flat on a planar surface without wrinkling, and b) when taut, has a shape having a curvature in at least two perpendicular directions;
- ii. removing the liner from the preformed window film;
- iii. applying the preformed window film to a window having a curvature in at least two perpendicular directions.
- 10 10. The method of claim 9, wherein applying the preformed window film to a window does not require the application of heat.
11. The method of claim 9, wherein applying the preformed window film to a window uses the application of heat.
- 15 12. The method of claim 9, wherein the window is a front or rear windshield of a transportation vehicle.
13. The method of claim 9, wherein the window is a side window of a transportation vehicle.
- 20 14. The method of claim 9, wherein the preformed window film is applied to an interior surface of the window.
- 25 15. The method of claim 9, wherein the preformed window film is applied to the exterior surface of the window.
16. The method of claim 9, wherein the preformed window film is applied to a convex surface of the window.
- 30 17. The method of claim 9, wherein the preformed window film is applied to a concave surface of the window.
18. A method of preforming a window film, comprising the steps of, in order:

i. providing a window film segment, the window film segment including a window film layer, the window film layer including at least one visible or infrared absorbing material, a pressure sensitive adhesive layer in contact with the window film layer, and a liner in contact with the pressure sensitive adhesive layer;

5 ii. stretching the window film segment over a tool;

iii. removing the window film from the tool to produce a preformed window film; the preformed window film having a deformation through stretching such that it a) does not lay flat on a planar surface without wrinkling, and b) when taut, has a shape having a curvature in at least two perpendicular directions.

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19. The method of claim 18, wherein the tool is a positive tool.

20. The method of claim 18, wherein the tool is a negative tool.

15 21. The method of claim 18, wherein the tool includes glass.

22. The method of claim 18, wherein the tool is a vehicle window or windshield.

20 23. The method of claim 18, wherein stretching the window film over a tool includes a thermoforming process.

24. The method of claim 18, wherein stretching the window film over a tool includes placing the liner side of the window film segment in contact with the tool.

25 25. The method of claim 18, wherein stretching the window film over a tool includes the application of heat.

26. The method of claim 18, further comprising the step of applying the preformed window film to a window.

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27. The method of claim 18, wherein the window is the same shape and size as the tool.

28. The method of claim 18, wherein the application of the preformed window film to the window does not require the application of heat.

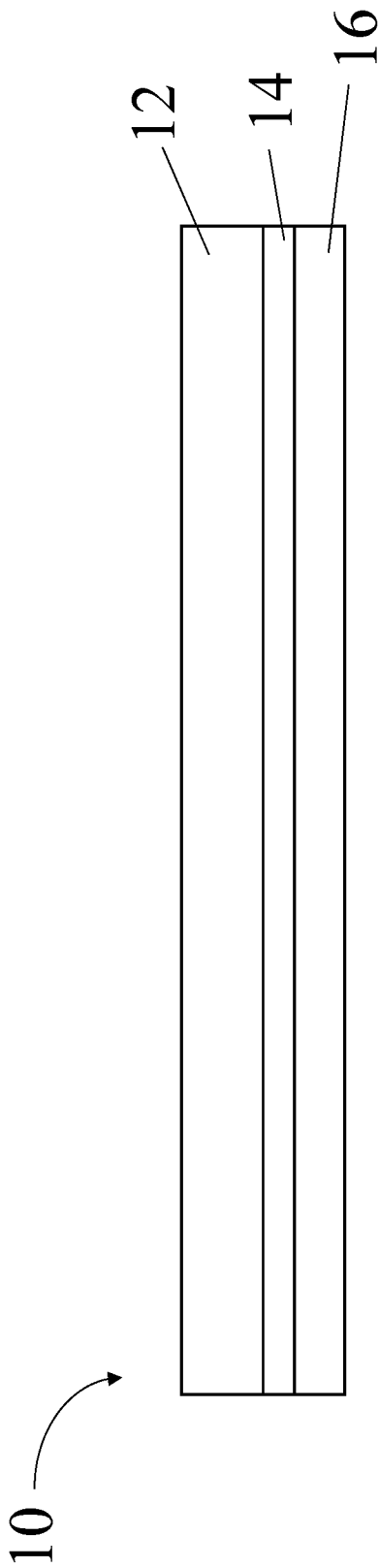
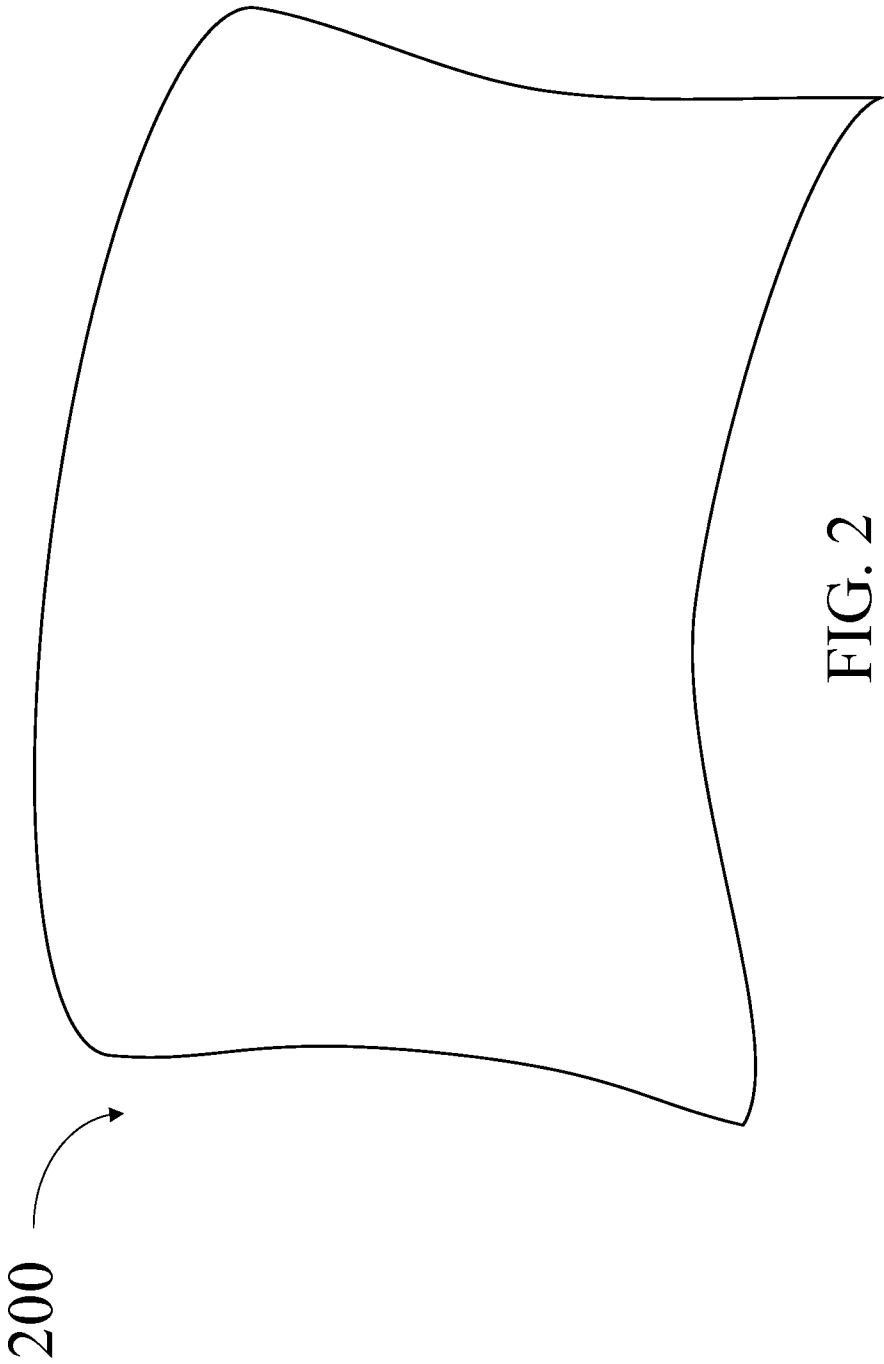


FIG. 1



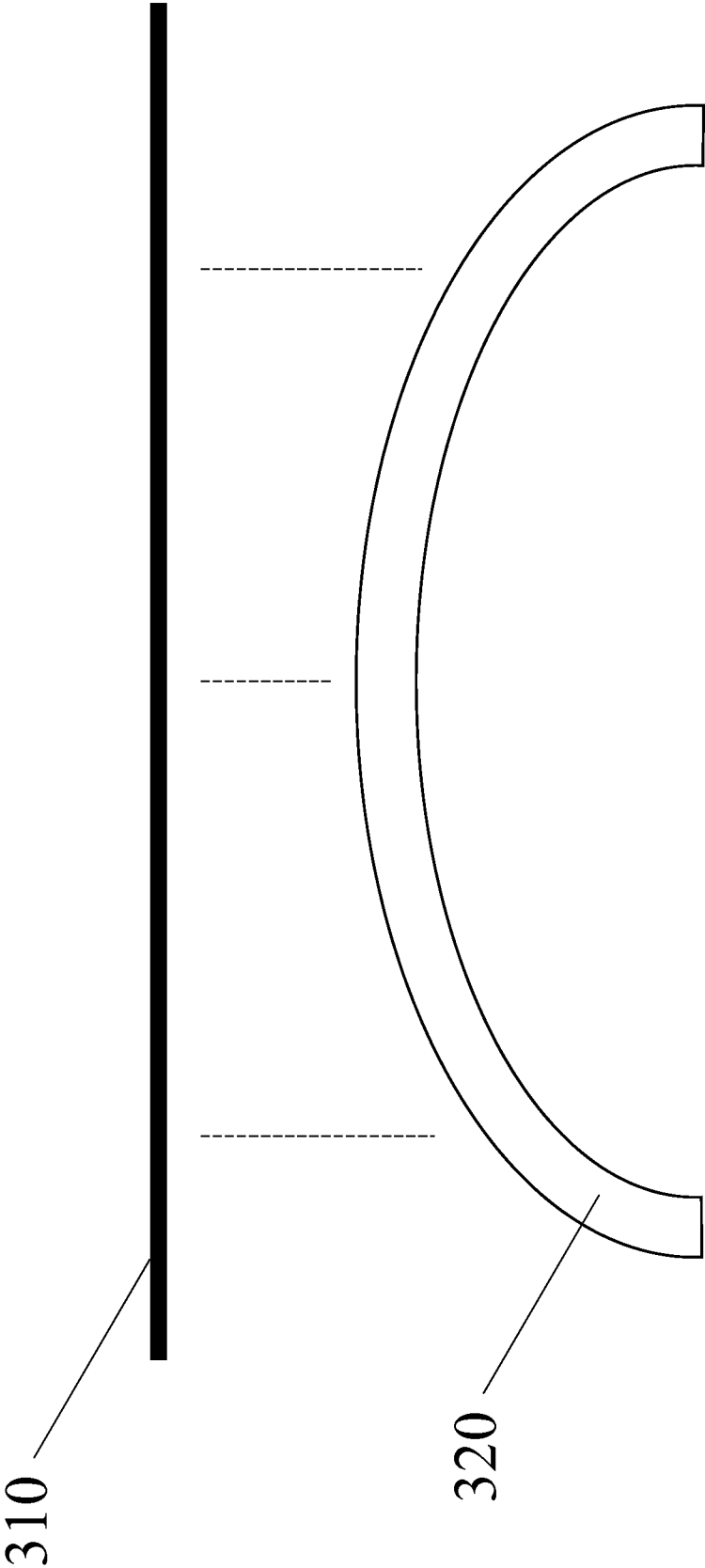


FIG. 3A

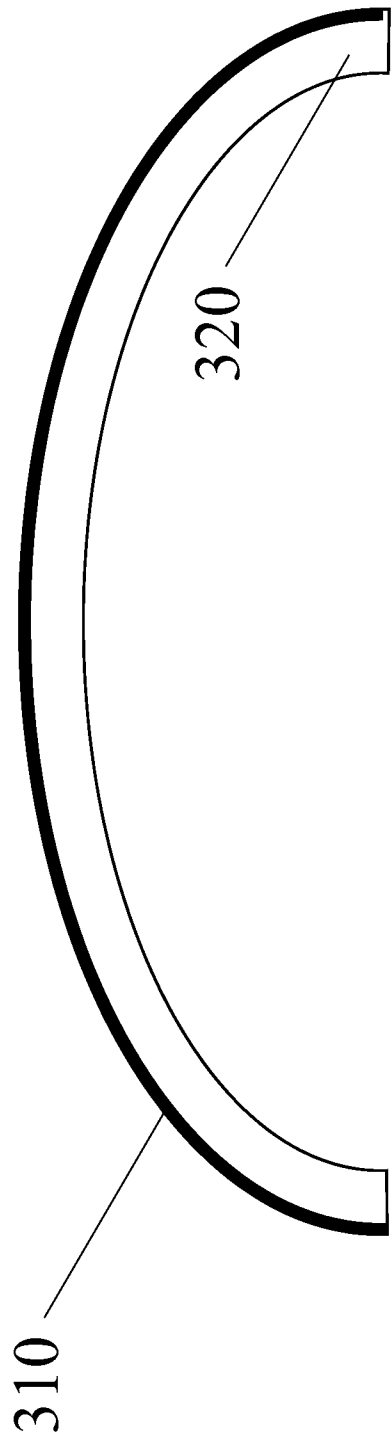
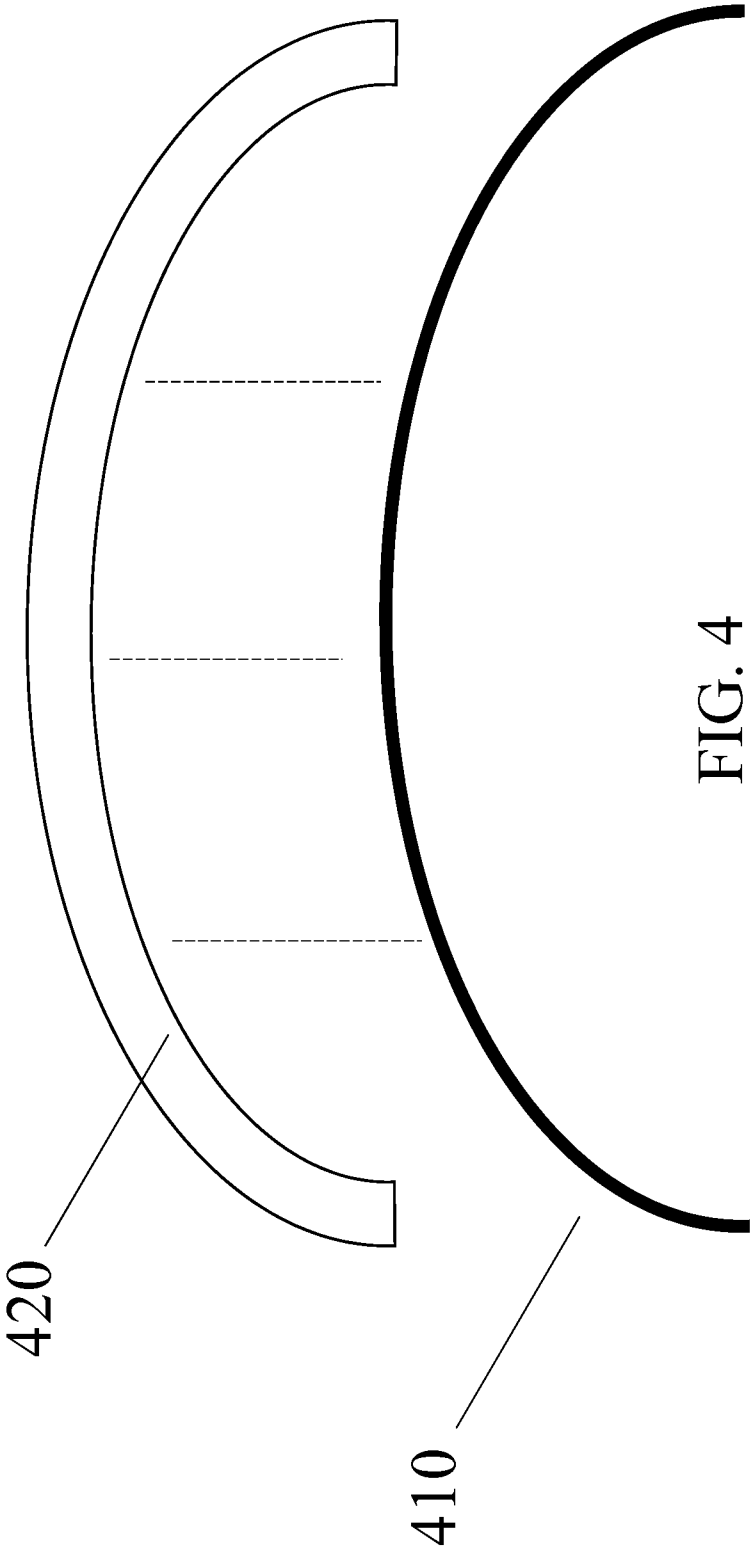


FIG. 3B



INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER

C09J 7/38(2018.01)i; **C09J 7/20**(2018.01)i; **C08J 5/18**(2006.01)i; **B32B 7/023**(2019.01)i; **B32B 7/06**(2006.01)i;
B32B 27/20(2006.01)i; **C08K 3/04**(2006.01)i; **C08K 3/013**(2018.01)i

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)

C09J 7/38(2018.01); B29C 51/14(2006.01); B32B 27/00(2006.01); B32B 27/28(2006.01); B32B 3/00(2006.01);
B32B 7/02(2006.01); C03C 17/32(2006.01); C08K 5/00(2006.01)

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

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: preformed window film, window film layer, pressure sensitive adhesive layer, liner, curvature, tool, stretching, thermoforming

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2011-0256368 A1 (MCCORMICK, C. et al.) 20 October 2011 (2011-10-20) abstract; paragraphs [0030], [0048], [0056], [0064], [0074], [0078], [0084]; claim 33; figure 3A	1-28
Y	US 2020-0024186 A1 (3M INNOVATIVE PROPERTIES COMPANY) 23 January 2020 (2020-01-23) abstract; claims 1, 8-11	1-28
A	US 5294272 A (PETERSON, C. A. et al.) 15 March 1994 (1994-03-15) column 5, lines 3-52; claim 1; figures 2A-2E, 3	1-28
A	JP 2012-224009 A (BRIDGESTONE CORP.) 15 November 2012 (2012-11-15) the whole document	1-28
A	WO 2009-026147 A2 (3M INNOVATIVE PROPERTIES COMPANY) 26 February 2009 (2009-02-26) the whole document	1-28



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

07 June 2021

Date of mailing of the international search report

07 June 2021

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/IB2021/051741

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