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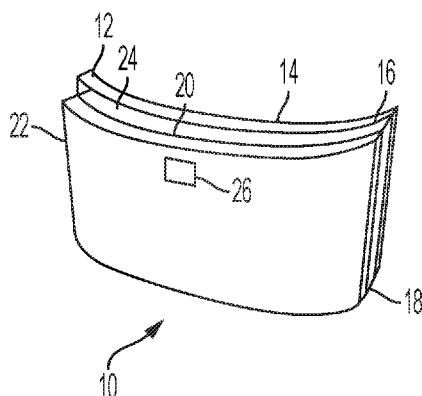


FIG. 1

(57) Abstract: A laminate (10) is disclosed comprising two decorated or non-decorated glass substrates (12,18) and at least one adhesive interlayer (24) located between the two decorated or non-decorated glass substrates (12,18). The total thickness of the laminate (10) is less than 5 mm (e.g., less than 4.5 mm and less than 4 mm). The laminates described herein are suitable for use in automotive applications, including as automotive windshields and roofs. The laminates described herein comprise at least one locally strengthened region (26) that is suitable for attaching windshield interior attachments including a rearview mirror, camera brackets, rain sensors, and telephone holders.



LOCAL GLASS STRENGTHENING TO IMPROVE AUTO GLAZING INTERIOR ATTACHMENT RELIABILITY PERFORMANCE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority under 35 U.S.C. § 119 of U.S. Provisional Application Serial No. 62/834,672 filed on April 16, 2019 the content of which is relied upon and incorporated herein by reference in its entirety.

BACKGROUND

[0002] In modern automobiles, it is commonplace to attach devices to the inside of the windshield. The most common of these devices is the rearview mirror. But other devices are also attached to the windshield, including camera brackets, rain sensors, and telephone holders. Some of these devices are attached to the windshield and other glass surfaces in an automobile via a button—a mirror button, when the attachment is a rearview mirror. A mirror button is a metal “puck” that is adhered to the windshield, to which a rear view mirror can mechanically attached. It is important that this mirror button is attached securely to the glass and the glass is robust enough for common use and adjustment of the rear view mirror. Auto manufacturers have specifications around the robustness of the windshield/mirror button attachment to ensure limited field failures.

[0003] Because glass commonly fails when a surface flaw is put under tension, this becomes a likely failure mode. As the industry moves to thinner laminate windshields, these tensile stresses on the surfaces will become greater. This is result of the reduced bending stiffness and increased deflections of these thinner laminates. Methods are therefore needed for strengthening the region where a device is attached to an automotive glass surface, especially for thinner laminates.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIGS. 1-3 are perspective views of example laminates that can be prepared according to the disclosure.

[0005] FIG. 4 is a schematic of a peel test set up.

[0006] In the drawings, which are not necessarily drawn to scale, like numerals describe substantially similar components throughout the several views. Like numerals having different letter suffixes represent different instances of substantially similar components. The drawings illustrate generally, by way of example, but not by way of limitation, various embodiments discussed in the present document.

DESCRIPTION

[0007] To address the risk of surface tension and potential glass failure due to loading on windshield interior attachments, a glass ply (e.g., soda lime glass, also known as “SLG”) in a laminate can be strengthened locally around the point of attachment of interior attachments

(e.g., a rearview mirror, camera brackets, rain sensors, and telephone holders) to the laminate—although the materials and methods described herein could also be tailored to locally strengthening around the point of attachment of attachments on a laminate's exterior surfaces. This can be achieved by any suitable means, including chemically (e.g., by ion exchange) or through thermal heat strengthening. The local strengthening results in a surface compression that bending stresses will have to overcome before the glass surface experiences tension leading to glass breakage.

[0008] FIG. 1 illustrates a laminate of the disclosure, the laminate 10 comprising:

a decorated or non-decorated chemically strengthened glass substrate 12 having first and second major surfaces 14,16 and a first thickness (T^1);

a first decorated or non-decorated conventional glass substrate 18 having third and fourth major surfaces 20,22 and a second thickness (T^2); and

at least one adhesive interlayer 24 located between the chemically strengthened glass substrate second major surface 16 and the conventional glass substrate third major surface 20, the adhesive interlayer 24 having a third thickness (T^3).

[0009] As used herein, the term “conventional glass” generally refers to a glass that has not been chemically (e.g., by ion exchange processes) or thermally strengthened.

[0010] In some embodiments, $T^1 + T^2 + T^3$ is less than about 5 mm (e.g., less than about 4.5 mm and less than about 4 mm); $T^1 < T^2$; at least one of the third and fourth major surfaces 20,22 of the first conventional glass substrate comprising at least one locally strengthened region 26; and the at least one locally strengthened region coincides with the footprint of a point of attachment of at least one interior attachment attached to the laminate.

[0011] FIG. 2 illustrates a laminate of the disclosure, the laminate 40 comprising:

a second decorated or non-decorated conventional glass substrate 42 having first and second major surfaces 44,46 and a fourth thickness (T^4);

a third decorated or non-decorated conventional glass substrate 48 having third and fourth major surfaces 50,52 and a fifth thickness (T^5); and

at least one adhesive interlayer 54 located between the second conventional glass substrate second major surface 46 and the third conventional glass substrate third major surface 50, the adhesive interlayer 54 having a sixth thickness (T^6).

In some embodiments, $T^4 + T^5 + T^6$ is less than about 5 mm (e.g., less than about 4.5 mm and less than about 4 mm); $T^4 < T^5$; and at least one of: at least one of the third and fourth major surfaces 50,52 of the third conventional glass substrate comprising at least one locally strengthened region 56; at least one of the third and fourth major surfaces of the third conventional glass substrate comprising at least one locally strengthened region; and the at least one locally strengthened region coincides with the footprint of a point of attachment of at least one interior attachment attached to the laminate. In some instances, in addition, at least

one of the first and second major surfaces 44,46 of the second conventional glass substrate comprises at least one additional locally strengthened region 58. See FIG. 3. Further, in some instances, only the third and fourth major surfaces of the third conventional glass substrate comprises at least one locally strengthened region.

[0012] The laminates described herein are suitable for use in automotive applications, including as automotive windshields and roofs. The laminates described herein comprise at least one locally strengthened region that is suitable for attaching windshield interior attachments including a rearview mirror, camera brackets, rain sensors, and telephone holders either directly, in direct contact with the laminate or indirectly, via a “puck” or “button” that is attached to the laminate. The interior attachments are then attached to the “puck” or “button,” either of which can have any suitable shape (e.g., triangular, round, oblong, or parallelogram).

[0013] The locally strengthened regions 26, 56, and 58 can coincide with the “footprint” of the point of attachment of interior attachments (e.g., a rearview mirror, camera brackets, rain sensors, and telephone holders) to the laminate. In some cases, the “footprint” of the point of attachment of interior attachments can be smaller than the locally strengthened regions 26, 56, and 58. But in other cases, the “footprint” of the point of attachment of interior attachments can be larger than the locally strengthened regions 26, 56, and 58. In still other cases, the “footprint” of the point of attachment of interior attachments can substantially match the locally strengthened regions 26, 56, and 58.

[0014] The locally strengthened regions 26, 56, and 58 can have any suitable dimensions. For example, the locally strengthened regions 26, 56, and 58 can have a length (L) and a width (W), wherein L and W can each, independently, be from about 0.5 cm to about 5 cm; about 1 cm to about 3 cm; about 2 cm to about 5 cm; or about 1 cm to about 2 cm.

[0015] The number of locally strengthened regions 26, 56, and 58 can be any suitable number, depending on the number of interior attachments that will be attached to the windshield that will be formed from the laminates described herein. For example, the number of locally strengthened regions 26, 56, and 58 can be one, two, three, four or five; from two to five; one to three; one to two; or, in any event, less than ten.

[0016] T^1 and T^4 can each be, independently, about 1.5 mm or less. For example, T^1 and T^4 can each independently be in a range from about 0.1 mm to about 1.5 mm, 0.2 mm to about 1.5 mm, 0.3 mm to about 1.5 mm, 0.4 mm to about 1.5 mm, 0.5 mm to about 1.5 mm, 0.6 mm to about 1.5 mm, 0.7 mm to about 1.5 mm, 0.8 mm to about 1.5 mm, 0.9 mm to about 1.5 mm, 0.1 mm to about 1.5 mm, from about 0.15 mm to about 1.5 mm, from about 0.2 mm to about 1.5 mm, from about 0.25 mm to about 1.5 mm, from about 0.3 mm to about 1.5 mm, from about 0.35 mm to about 1.5 mm, from about 0.4 mm to about 1.5 mm, from about 0.45 mm to about 1.5 mm, from about 0.5 mm to about 1.5 mm, from about 0.55 mm to about 1.5 mm,

from about 0.6 mm to about 1.5 mm, from about 0.65 mm to about 1.5 mm, from about 0.7 mm to about 1.5 mm, from about 0.1 mm to about 1.3 mm, from about 0.1 mm to about 1.2 mm, from about 0.1 mm to about 1.1 mm, from about 0.1 mm to about 1.05 mm, from about 0.1 mm to about 1 mm, from about 0.1 mm to about 0.95 mm, from about 0.1 mm to about 0.9 mm, from about 0.1 mm to about 0.85 mm, from about 0.1 mm to about 0.8 mm, from about 0.1 mm to about 0.75 mm, from about 0.1 mm to about 0.7 mm, from about 0.1 mm to about 0.65 mm, from about 0.1 mm to about 0.8 mm, from about 0.4 mm to about 0.8 mm, from about 0.5 mm to about 0.8 mm, from about 0.3 mm to about 0.7 mm, or from about 0.3 mm to about 0.7 mm, and all ranges and sub-ranges therebetween.

[0017] T^2 and T^5 can each be, independently, about 2.5 mm or less. For example, T^2 and T^5 can each independently be in a range from about 0.5 mm to about 2.5 mm, 0.6 mm to about 2.5 mm, 0.7 mm to about 2.5 mm, 0.8 mm to about 2.5 mm, 0.9 mm to about 2.5 mm, 1 mm to about 2.5 mm, 1.1 mm to about 2.5 mm, 1.2 mm to about 2.5 mm, 1.5 mm to about 2.5 mm, 1.9 mm to about 2.5 mm, from about 2.0 mm to about 2.5 mm, from about 0.5 mm to about 2.0 mm, from about 0.6 mm to about 2.0 mm, from about 0.7 mm to about 2.0 mm, from about 0.9 mm to about 2.0 mm, from about 1.0 mm to about 2.0 mm, from about 1.2 mm to about 2.0 mm, from about 1.5 mm to about 2.0 mm, from about 0.8 mm to about 2.1 mm, from about 1.0 mm to about 2.1 mm, from about 1.2 mm to about 2.1 mm, from about 1.4 mm to about 2.1 mm, from about 1.6 mm to about 2.1 mm, from about 1.8 mm to about 2.1 mm, or from about 1.9 mm to about 2.1 mm, and all ranges and sub-ranges therebetween.

[0018] T^3 and T^6 can each be, independently, about 1.5 mm or less. For example, T^3 and T^6 can each independently be in a range from about 0.1 mm to about 1.5 mm, 0.2 mm to about 1.5 mm, 0.3 mm to about 1.5 mm, 0.4 mm to about 1.5 mm, 0.5 mm to about 1.5 mm, 0.6 mm to about 1.5 mm, 0.7 mm to about 1.5 mm, 0.8 mm to about 1.5 mm, 0.9 mm to about 1.5 mm, 0.1 mm to about 1.5 mm, from about 0.15 mm to about 1.5 mm, from about 0.2 mm to about 1.5 mm, from about 0.25 mm to about 1.5 mm, from about 0.3 mm to about 1.5 mm, from about 0.35 mm to about 1.5 mm, from about 0.4 mm to about 1.5 mm, from about 0.45 mm to about 1.5 mm, from about 0.5 mm to about 1.5 mm, from about 0.55 mm to about 1.5 mm, from about 0.6 mm to about 1.5 mm, from about 0.65 mm to about 1.5 mm, from about 0.7 mm to about 1.5 mm, from about 0.1 mm to about 1.3 mm, from about 0.1 mm to about 1.2 mm, from about 0.1 mm to about 1.1 mm, from about 0.1 mm to about 1.05 mm, from about 0.1 mm to about 1 mm, from about 0.1 mm to about 0.95 mm, from about 0.1 mm to about 0.9 mm, from about 0.1 mm to about 0.85 mm, from about 0.1 mm to about 0.8 mm, from about 0.1 mm to about 0.75 mm, from about 0.1 mm to about 0.7 mm, from about 0.1 mm to about 0.65 mm, from about 0.1 mm to about 0.8 mm, from about 0.4 mm to about 0.8 mm, from about 0.5 mm to about 0.8 mm, from about 0.3 mm to about 0.7 mm, or from about 0.3 mm to about 0.7 mm, and all ranges and sub-ranges therebetween.

[0019] Any number of glass compositions can be employed as the decorated or non-decorated chemically strengthened glass substrate, including ion-exchangeable glasses such as alkali aluminosilicate glasses or alkali aluminoborosilicate glasses, though other glass compositions are contemplated. As used herein, "ion exchangeable" means that a glass is capable of exchanging cations located at or near the surface of the glass with cations of the same valence that are either larger or smaller in size.

[0020] For example, a suitable glass composition comprises SiO_2 , B_2O_3 and Na_2O , where $(\text{SiO}_2 + \text{B}_2\text{O}_3) \geq 66$ mol.%, and $\text{Na}_2\text{O} \geq 9$ mol.%. In an embodiment, the glass sheets include at least 6 wt.% aluminum oxide. In a further embodiment, a glass sheet includes one or more alkaline earth oxides, such that a content of alkaline earth oxides is at least 5 wt.%. Suitable glass compositions, in some embodiments, further comprise at least one of K_2O , MgO , and CaO . In a particular embodiment, the glass can comprise 61-75 mol.% SiO_2 ; 7-15 mol.% Al_2O_3 ; 0-12 mol.% B_2O_3 ; 9-21 mol.% Na_2O ; 0-4 mol.% K_2O ; 0-7 mol.% MgO ; and 0-3 mol.% CaO .

[0021] A further example glass composition suitable for forming hybrid glass laminates comprises: 60-70 mol.% SiO_2 ; 6-14 mol.% Al_2O_3 ; 0-15 mol.% B_2O_3 ; 0-15 mol.% Li_2O ; 0-20 mol.% Na_2O ; 0-10 mol.% K_2O ; 0-8 mol.% MgO ; 0-10 mol.% CaO ; 0-5 mol.% ZrO_2 ; 0-1 mol.% SnO_2 ; 0-1 mol.% CeO_2 ; less than 50 ppm As_2O_3 ; and less than 50 ppm Sb_2O_3 ; where $12 \text{ mol.}\% \leq (\text{Li}_2\text{O} + \text{Na}_2\text{O} + \text{K}_2\text{O}) \leq 20 \text{ mol.}\%$ and $0 \text{ mol.}\% \leq (\text{MgO} + \text{CaO}) \leq 10 \text{ mol.}\%$.

[0022] A still further example glass composition comprises: 63.5-66.5 mol.% SiO_2 ; 8-12 mol.% Al_2O_3 ; 0-3 mol.% B_2O_3 ; 0-5 mol.% Li_2O ; 8-18 mol.% Na_2O ; 0-5 mol.% K_2O ; 1-7 mol.% MgO ; 0-2.5 mol.% CaO ; 0-3 mol.% ZrO_2 ; 0.05-0.25 mol.% SnO_2 ; 0.05-0.5 mol.% CeO_2 ; less than 50 ppm As_2O_3 ; and less than 50 ppm Sb_2O_3 ; where $14 \text{ mol.}\% \leq (\text{Li}_2\text{O} + \text{Na}_2\text{O} + \text{K}_2\text{O}) \leq 18 \text{ mol.}\%$ and $2 \text{ mol.}\% \leq (\text{MgO} + \text{CaO}) \leq 7 \text{ mol.}\%$.

[0023] In another embodiment, an alkali aluminosilicate glass comprises, consists essentially of, or consists of: 61-75 mol.% SiO_2 ; 7-15 mol.% Al_2O_3 ; 0-12 mol.% B_2O_3 ; 9-21 mol.% Na_2O ; 0-4 mol.% K_2O ; 0-7 mol.% MgO ; and 0-3 mol.% CaO .

[0024] In a particular embodiment, an alkali aluminosilicate glass comprises alumina, at least one alkali metal and, in some embodiments, greater than 50 mol.% SiO_2 , in other embodiments at least 58 mol.% SiO_2 , and in still other embodiments at least 60 mol.% SiO_2 , wherein the ratio:

$$(\text{Al}_2\text{O}_3 + \text{B}_2\text{O}_3)/\Sigma \text{ modifiers} > 1$$

wherein the ratio the components are expressed in mol.% and the modifiers are alkali metal oxides. This glass, in particular embodiments, comprises, consists essentially of, or consists of: 58-72 mol.% SiO_2 ; 9-17 mol.% Al_2O_3 ; 2-12 mol.% B_2O_3 ; 8-16 mol.% Na_2O ; and 0-4 mol.% K_2O , wherein the ratio:

$$(\text{Al}_2\text{O}_3 + \text{B}_2\text{O}_3)/\Sigma \text{ modifiers} > 1$$

[0025] In yet another embodiment, an alkali aluminosilicate glass substrate comprises, consists essentially of, or consists of: 60-70 mol.% SiO₂; 6-14 mol.% Al₂O₃; 0-15 mol.% B₂O₃; 0-15 mol.% Li₂O; 0-20 mol.% Na₂O; 0-10 mol.% K₂O; 0-8 mol.% MgO; 0-10 mol.% CaO; 0-5 mol.% ZrO₂; 0-1 mol.% SnO₂; 0-1 mol.% CeO₂; less than 50 ppm As₂O₃; and less than 50 ppm Sb₂O₃; wherein $12 \text{ mol.\%} \leq \text{Li}_2\text{O} + \text{Na}_2\text{O} + \text{K}_2\text{O} \leq 20 \text{ mol.\%}$ and $0 \text{ mol.\%} \leq \text{MgO} + \text{CaO} \leq 10 \text{ mol.\%}$.

[0026] In still another embodiment, an alkali aluminosilicate glass comprises, consists essentially of, or consists of: 64-68 mol.% SiO₂; 12-16 mol.% Na₂O; 8-12 mol.% Al₂O₃; 0-3 mol.% B₂O₃; 2-5 mol.% K₂O; 4-6 mol.% MgO; and 0-5 mol.% CaO, wherein: $66 \text{ mol.\%} \leq \text{SiO}_2 + \text{B}_2\text{O}_3 + \text{CaO} \leq 69 \text{ mol.\%}$; $\text{Na}_2\text{O} + \text{K}_2\text{O} + \text{B}_2\text{O}_3 + \text{MgO} + \text{CaO} + \text{SrO} > 10 \text{ mol.\%}$; $5 \text{ mol.\%} \leq \text{MgO} + \text{CaO} + \text{SrO} \leq 8 \text{ mol.\%}$; $(\text{Na}_2\text{O} + \text{B}_2\text{O}_3) \leq \text{Al}_2\text{O}_3 \leq 2 \text{ mol.\%}$; $2 \text{ mol.\%} \leq \text{Na}_2\text{O} \leq \text{Al}_2\text{O}_3 \leq 6 \text{ mol.\%}$; and $4 \text{ mol.\%} \leq (\text{Na}_2\text{O} + \text{K}_2\text{O}) \leq \text{Al}_2\text{O}_3 \leq 10 \text{ mol.\%}$. Additional examples for generating ion exchangeable glass structures are described in Published U.S. Appl. No. US 2014-0087193 A1 and U.S. Patent No. 9,387,651 the entirety of each being incorporated herein by reference.

[0027] Any number of glass compositions can be employed as the first, second, and third decorated or non-decorated conventional glass substrates, including conventional soda lime glass (SLG), annealed glass, or the like.

[0028] Any number of materials can be employed as the at least one adhesive interlayer, including one or more polymer interlayers comprising poly vinyl butyral (PVB), polycarbonate, acoustic PVB, ethylene vinyl acetate (EVA), thermoplastic polyurethane (TPU), ionomer, a thermoplastic material, and combinations thereof. Suitable materials that can be employed as the at least one adhesive interlayer include for example, polyurethanes (e.g., DP604NS available from 3M®, Saint Paul, MN, as well as Betamate 73100/002, 73100/005, 73100/010, Betaseal X2500, and Betalink K2, from Dupont®, Wilmington, DE), polysiloxanes and silane-modified polymers (e.g., TEROSON RB IX, also known as TEROSTAT MS 9399 and TEROSON MS 647, available from Loctite®), and epoxies (e.g., Scotch-Weld™ Epoxy Adhesive DP125 and DP105 available from 3M®, Saint Paul, MN).

[0029] Additional materials that can be employed as the at least one adhesive interlayer include, but not limited to, materials selected from one of more of the categories: (a) Toughened Epoxy (for example, Masterbond EP21TDCHT-LO, 3M Scotch Weld Epoxy DP460 Off-white); (b) Flexible Epoxy (for example, Masterbond EP21TDC-2LO, 3M Scotch Weld Epoxy 2216); (c) Acrylics and/or Toughened Acrylics (for example, LORD Adhesive 403, 406 or 410 Acrylic adhesives with LORD Accelerator 19 or 19GB w/ LORD AP 134 primer, LORD Adhesive 850 or 852/LORD Accelerator 25GB, Loctite HF8000, Loctite AA4800); (d) Polyurethanes (for example, 3M Scotch Weld Urethane DP640 Brown, SikaForce 7570 L03, SikaForce 7550 L15, Sikaflex 552 and Polyurethane (PUR) Hot Melt adhesives such as,

Technomelt PUR 9622-02 UVNA, Loctite HHD 3542, Loctite HHD 3580, 3M Hotmelt adhesives 3764 and 3748); and (e) Silicones (Dow Corning 995, Dow Corning 3-0500 Silicone Assembly adhesive, Dow Corning 7091, SikaSil-GP). In some cases, structural adhesives available as sheets or films (for example, but not limited to, 3M Structural adhesive films AF126-2, AF 163-2M, SBT 9263 and 9214, Masterbond FLM36-LO) may be utilized.

[0030] The interlayer may be applied in a variety of ways. In one embodiment, the interlayer is applied manually using, for example, a roller, a brush, a doctor blade or a draw down bar.

[0031] The decorated or non-decorated chemically strengthened glass substrate and the decorated or non-decorated first, second, and third conventional glass substrates can have any suitable compressive stress at the glass surface (CS) and depth of compressive layer (DOL). For example, the decorated or non-decorated chemically strengthened glass substrate can possess a surface compression or compressive stress of approximately 300 MPa and a DOL of greater than about 60 microns; a residual surface CS level of between about 250 MPa to about 350 MPa with a DOL of greater than 60 microns; or a CS level of about 300 MPa. In addition, or alternatively, the decorated or non-decorated first, second, and third conventional glass substrates can each independently have a residual surface CS level of between about 250 MPa to about 350 MPa with a DOL of greater than 60 microns; or a CS level of about 300 MPa.

[0032] As mentioned herein, the first decorated or non-decorated conventional glass substrate 18 has third and fourth major surfaces 20,22, wherein at least one of the third and fourth major surfaces 20,22 of the first conventional glass substrate comprises at least one locally strengthened region 26. A region 26 on one or both of the third and fourth major surfaces 20,22 of the first conventional glass substrate can be strengthened by any suitable means including thermally or chemically, before or after the decorated or non-decorated first conventional glass substrate is manipulated further (e.g., bent or otherwise cold formed).

[0033] For example, one or both of the third and fourth major surfaces 20,22 of the first conventional glass substrate can be strengthened chemically by contacting one or more regions of one or both of the third and fourth major surfaces 20,22 of the first conventional glass substrate with a localizable ion exchange solution (e.g., localized using a local containment device to hold the solution in a given area of at least one of the third and fourth major surfaces) comprising alkali metal ions that are larger than the ions in the glass or an ion exchange paste comprising an inorganic substance doped with alkali metal ions that are larger than the ions in the glass. An example of an ion exchange paste is a potassium nitrate-containing clay. The ion exchange paste is applied to one or more regions of one or both of the third and fourth major surfaces 20,22 of the first conventional glass substrate. The paste on the first conventional glass substrate is then heated at a suitable temperature (e.g., 350-500 °C) for a suitable period of time (e.g., about 1-24 hours). During the heating, the larger

ions in the paste exchange with the smaller ions in the glass surface. After cooling, compressive stress is induced in the area(s) where the paste is applied because the larger ions are now in a small site near the surface of the glass. The paste is cleaned off one or both of the third and fourth major surfaces after the local chemical strengthening is complete.

[0034] In one example, after the first conventional glass substrate is manipulated further (e.g., bent), the third and fourth major surfaces 20,22 can be strengthened chemically by contacting one or more regions of both of the third and fourth major surfaces 20,22 of the first conventional glass substrate with an ion exchange paste, followed by heating of the paste at a suitable temperature, then cooling. In another example, after the first conventional glass substrate is manipulated further (e.g., bent), the third and fourth major surfaces 20,22 can be strengthened chemically by contacting one or more regions of only the third major surface 20 of the first conventional glass substrate with an ion exchange paste, followed by heating of the paste at a suitable temperature, then cooling.

[0035] In another example, after the first conventional glass substrate is manipulated further (e.g., bent), the third and fourth major surfaces 20,22 can be strengthened chemically by contacting one or more regions of both of the third and fourth major surfaces 20,22 of the first conventional glass substrate with a localizable ion exchange solution, followed by heating of the solution at temperatures between 350-500°C, then cooling. In another example, after the first conventional glass substrate is manipulated further (e.g., bent), the third and fourth major surfaces 20,22 can be strengthened chemically by contacting one or more regions of only the third major surface 20 of the first conventional glass substrate with a localizable ion exchange solution, followed by heating of the localizable ion exchange solution at a suitable temperature, then cooling.

[0036] Alternatively, one of the third and fourth major surfaces 20,22 of the first conventional glass substrate can be strengthened thermally by contacting one of the third and fourth major surfaces (e.g., fourth major surface 22) of the first conventional glass substrate with a thermal mass and applying a cooling jet on the other major surface (e.g., third major surface 20) in the vicinity of the area opposite the thermal mass.

[0037] Alternatively, the first conventional glass substrate can be strengthened thermally on both of the third and fourth major surfaces 20,22 by using top and bottom air jet in a bendinglehr cooling zone. In one example, air is directed only in one region (e.g., a region to which a mirror button might be attached). The local rapid cooling results in local heat strengthening of the third and fourth major surfaces 20,22 of the first conventional glass substrate.

[0038] Following chemical or thermal strengthening, the first conventional glass substrate in the at least one locally strengthened region 26 can have a surface compression or compressive stress of approximately 100 MPa. Alternatively, or in addition the first conventional glass substrate in the at least one locally strengthened region 26 can have a

DOL of about 10 microns. Alternatively, or in addition, the first conventional glass substrate in the at least one locally strengthened region 26 can have a residual surface CS level of between about 100 MPa to about 400 MPa. Alternatively, or in addition, the first conventional glass substrate in the at least one locally strengthened region 26 can have a DOL of greater than 10 microns. Alternatively, or in addition, the first conventional glass substrate in the at least one locally strengthened region 26 can have a CS level of greater than 400 MPa. Alternatively, or in addition, following chemical or thermal strengthening, the first conventional glass substrate in the at least one locally strengthened region 26 can have a surface compression or compressive stress of approximately 100 MPa and a DOL of about 10 microns; a residual surface CS level of between about 100 MPa to about 400 MPa with a DOL of greater than 10 microns; or a CS level of greater than 400 MPa.

[0039] The disclosure also relates to a method for making a laminate 10, the method comprising:

laminating

a decorated or non-decorated chemically strengthened glass substrate 12 having first and second major surfaces 14,16 and a first thickness (T^1);

a first decorated or non-decorated conventional glass substrate 18 having third and fourth major surfaces 20,22, a second thickness (T^2), and at least one locally strengthened region 26 on at least one of the third and fourth major surfaces 20,22 of the first conventional glass substrate;

at least one adhesive interlayer 24 located between the chemically strengthened glass substrate second major surface 16 and the conventional glass substrate third major surface 20, the adhesive interlayer 24 having a third thickness (T^3); and

adhering

at least one interior attachment, wherein the at least one interior attachment has a footprint that coincides with the at least one locally strengthened region;

wherein:

$T^1 + T^2 + T^3$ is less than about 5 mm (e.g., less than about 4.5 mm and less than about 4 mm);

and

$T^1 < T^2$.

[0040] The method can include locally strengthening at least one region on the at least one of the third and fourth major surfaces 20,22 of the first conventional glass substrate to provide the first decorated or non-decorated conventional glass substrate 18 having third and fourth major surfaces 20,22, a second thickness (T^2), and at least one locally strengthened region 26 on at least one of the third and fourth major surfaces 20,22 of the first conventional glass substrate. As described herein, the locally strengthening can be performed either chemically or thermally.

[0041] The method can include the stepwise laminating of the decorated or non-decorated chemically strengthened glass substrate 12 having first and second major surfaces 14,16 and a first thickness (T^1) with the interlayer to form a first laminate, followed by laminating the first laminate and the first decorated or non-decorated conventional glass substrate 18 having third and fourth major surfaces 20,22, a second thickness (T^2), and at least one locally strengthened region 26 on at least one of the third and fourth major surfaces 20,22 of the first conventional glass substrate.

[0042] Alternatively, the method can include the stepwise laminating of the first decorated or non-decorated conventional glass substrate 18 having third and fourth major surfaces 20,22, a second thickness (T^2), and at least one locally strengthened region 26 on at least one of the third and fourth major surfaces 20,22 of the first conventional glass substrate with the interlayer to form a second laminate, followed by laminating the second laminate and the decorated or non-decorated chemically strengthened glass substrate 12 having first and second major surfaces 14,16 and a first thickness (T^1).

[0043] When the laminate is laminate 40, the laminate 40 has a second decorated or non-decorated conventional glass substrate 42 having first and second major surfaces 44,46 and a third decorated or non-decorated conventional glass substrate 48 having third and fourth major surfaces 50,52, wherein at least one of the third and fourth major surfaces 50,52 of the second conventional glass substrate comprises at least one locally strengthened region 56. In some instances, in addition, at least one of the first and second major surfaces 44,46 of the first conventional glass substrate comprises at least one additional locally strengthened region 58. The regions 56 and 58 can be strengthened by any suitable means including thermally or chemically.

[0044] For example, one or both of the first and second major surfaces 44,46 of the second conventional glass substrate or one or both of the third and fourth major surfaces 50,52 of the third conventional glass substrate can be strengthened chemically by contacting one or more regions of one or both of the first and second major surfaces 44,46 of the second conventional glass substrate or one or both of the third and fourth major surfaces 50,52 of the third conventional glass substrate with a localizable ion exchange solution (e.g., localized using a local containment device to hold the solution in a given area of at least one of the third and fourth major surfaces) comprising alkali metal ions that are larger than the ions in the glass or an ion exchange paste comprising an inorganic substance doped with alkali metal ions that are larger than the ions in the glass. An example of an ion exchange paste is a potassium nitrate-containing clay. The ion exchange paste is applied to one or both of the first and second major surfaces 44,46 of the second conventional glass substrate or one or both of the third and fourth major surfaces 50,52 of the third conventional glass substrate. The paste is then heated at a suitable temperature (e.g., 400-550°C) for a suitable period of time (e.g., about 1-

24 hours). During the heating, the larger ions in the paste exchange with the smaller ions in the glass surface. After cooling, compressive stress is induced in the area(s) where the paste is applied because the larger ions are now in a small site near the surface of the glass. The paste is cleaned off after the local chemical strengthening is complete.

[0045] For example, one or both of the first and second major surfaces 44,46 of the second conventional glass substrate and one or both of the third and fourth major surfaces 50,52 of the third conventional glass substrate can be strengthened chemically by contacting one or more regions of one or both of the first and second major surfaces 44,46 of the second conventional glass substrate and one or both of the third and fourth major surfaces 50,52 of the third conventional glass substrate with a localizable ion exchange solution (e.g., localized using a local containment device to hold the solution in a given area of at least one of the third and fourth major surfaces) comprising alkali metal ions that are larger than the ions in the glass or an ion exchange paste comprising an inorganic substance doped with alkali metal ions that are larger than the ions in the glass. An example of an ion exchange paste is a potassium nitrate-containing clay. The ion exchange paste is applied to one or both of the first and second major surfaces 44,46 of the second conventional glass substrate and one or both of the third and fourth major surfaces 50,52 of the third conventional glass substrate. The paste is then heated at a suitable temperature (e.g., 400-550°C) for a suitable period of time (e.g., about 1-24 hours). During the heating, the larger ions in the paste exchange with the smaller ions in the glass surface. After cooling, compressive stress is induced in the area(s) where the paste is applied because the larger ions are now in a small site near the surface of the glass. The paste is cleaned off after the local chemical strengthening is complete.

[0046] Alternatively, the second conventional glass substrate or the third conventional glass substrate can be strengthened thermally on one or both of the first and second major surfaces 44,46 or on one or both of the third and fourth major surfaces 50,52, respectively, by using top and bottom air jet in a bendinglehr cooling zone. In one example, air is directed only in one region (e.g., a region to which a mirror button might be attached). The local rapid cooling results in local heat strengthening of one or both of the first and second major surfaces 44,46 or one or both of the third and fourth major surfaces 50,52 of the second conventional glass substrate or the third conventional glass substrate, respectively.

[0047] Alternatively, the second conventional glass substrate and the third conventional glass substrate can be strengthened thermally on one or both of the first and second major surfaces 44,46 and one or both of the third and fourth major surfaces 50,52, respectively, by using top and bottom air jet in a bendinglehr cooling zone. In one example, air is directed only in one region (e.g., a region to which a mirror button might be attached). The local rapid cooling results in local heat strengthening of the first and second major surfaces 44,46 and the third

and fourth major surfaces 50,52 of the second conventional glass substrate and the third conventional glass substrate, respectively.

[0048] Following chemical or thermal strengthening, the second conventional glass substrate in the at least one locally strengthened region 56 can have a surface compression or compressive stress of approximately 100 MPa. Alternatively, or in addition, the second conventional glass substrate in the at least one locally strengthened region 56 can have a DOL of about 10 microns. Alternatively, or in addition, the second conventional glass substrate in the at least one locally strengthened region 56 can have a residual surface CS level of between about 100 MPa to about 400 MPa. Alternatively, or in addition, the second conventional glass substrate in the at least one locally strengthened region 56 can have a DOL of greater than 10 microns. Alternatively, or in addition, the second conventional glass substrate in the at least one locally strengthened region 56 can have CS level of greater than 400 MPa. Alternatively, or in addition, following chemical or thermal strengthening, the second conventional glass substrate or the third conventional glass substrate, in the at least one locally strengthened region 58 can have a surface compression or compressive stress of approximately 100 MPa and a DOL of about 10 microns; a residual surface CS level of between about 100 MPa to about 400 MPa with a DOL of greater than 10 microns; or a CS level of greater than 400 MPa.

[0049] The disclosure also relates to a method for making a laminate 40, the method comprising:

laminating

 a second decorated or non-decorated conventional glass substrate 42 having first and second major surfaces 44,46 and a fourth thickness (T^4);

 a third decorated or non-decorated conventional glass substrate 48 having third and fourth major surfaces 50,52, and a fifth thickness (T^5);

 at least one adhesive interlayer 54 located between the first conventional glass substrate second major surface 56 and the second conventional glass substrate third major surface 50, the adhesive interlayer 54 having a sixth thickness (T^6); and

adhering

 at least one interior attachment to the laminate;

wherein:

 at least one of:

 at least one of the first and second major surfaces of the third conventional glass substrate comprising at least one locally strengthened region;

 at least one of the third and fourth major surfaces of the third conventional glass substrate comprising at least one locally strengthened region; and

the at least one locally strengthened region coincides with the footprint of a point of attachment of the at least one interior attachment;

$T^4 + T^5 + T^6$ is less than about 5 mm (e.g., less than about 4.5 mm and less than about 4 mm); and

$T^4 < T^5$.

[0050] The method can include locally strengthening at least one region on the at least one of the third and fourth major surfaces 50,52 of the third conventional glass substrate to provide a third decorated or non-decorated conventional glass substrate 48 having third and fourth major surfaces 50,52, and a fifth thickness (T^5), and at least one locally strengthened region 56 on at least one of the third and fourth major surfaces 50,52 of the third conventional glass substrate. As described herein, the locally strengthening can be performed either chemically or thermally.

[0051] The method can include the stepwise laminating of the second decorated or non-decorated conventional glass substrate 42 having first and second major surfaces 44,46 and a fourth thickness (T^4) with the interlayer to form a third laminate, followed by laminating the third laminate and the third decorated or non-decorated conventional glass substrate 48 having third and fourth major surfaces 50,52, and a fifth thickness (T^5), and at least one locally strengthened region 56 on at least one of the third and fourth major surfaces 50,52 of the third conventional glass substrate.

[0052] Alternatively, the method can include the stepwise laminating of the third decorated or non-decorated conventional glass substrate 48 having third and fourth major surfaces 50,52, and a fifth thickness (T^5), and at least one locally strengthened region 56 on at least one of the third and fourth major surfaces 50,52 of the third conventional glass substrate with the interlayer to form a fourth laminate, followed by laminating the fourth laminate and the a second decorated or non-decorated conventional glass substrate 42 having first and second major surfaces 44,46 and a fourth thickness (T^4).

[0053] In some instances, the method comprises locally strengthening at least one region 58 of the first and second major surfaces 44,46 of the second conventional glass substrate to provide a second decorated or non-decorated conventional glass substrate 42 having first and second major surfaces 44,46, a fourth thickness (T^4), and at least one additional locally strengthened region 58.

[0054] Advantages associated with the locally strengthened regions described herein are various. For example, chemical strengthening of both the third and fourth major surfaces 20,22 of a first decorated or non-decorated conventional glass substrate 18 such that the first decorated or non-decorated conventional glass substrate 18 comprises at least one locally strengthened region 26 is a reduced risk of failure during at least one of the peel test and the pull test and higher CS than thermal strengthening. Chemical strengthening of only the third

major surface 20, on the other hand, results not only in a reduced risk of failure during typical mirror button tests (e.g., at least one of the peel test and the pull test) and higher CS than thermal strengthening, but also acceptable rock-strike performance, especially when the fourth major surface 22 is annealed. Similarly, thermal strengthening of both the third and fourth major surfaces 20,22 of a first decorated or non-decorated conventional glass substrate 18 such that the first decorated or non-decorated conventional glass substrate 18 comprises at least one locally strengthened region 26 is a reduced risk of failure during at least one of the peel test and the pull test and higher. In addition, thermal strengthening can be performed at a bendinglehr cooling zone, thus avoiding added manufacturing processes.

[0055] A typical mirror button test may be described as the mechanical loading of a sample representative of the components of a windshield-mirror button sub-system; including the mirror button, adhesive, and the laminates described herein. Two common tests include a peel test and pull test. See FIG. 4 for an example of a setup for a peel test, wherein laminate 40 is held in place by frame parts 110 and 112 of frame device 114, has a mirror button 100 adhered to fourth major surface 52, and has an implement 120 to which a force can be applied to evaluate the peel strength of laminate 40 in the area to which mirror button 100 is adhered. In both tests, the mirror button is adhered to a small (e.g., 100 mm x 100 mm) laminate and a fixture slides over the mirror button. The peel test applies a transverse load to the end of the fixture opposite the mirror button in order to impart a torque about the mirror button. The pull test applies a parallel load to the end of the fixture which imparts tension on the adhesive bond between the components. The pass/fail criteria requires meeting a minimum load before failure of any component in the sub-system. Test standards are developed by vehicle original equipment manufacturers (OEMs) and/or windshield manufacturers. Test specifics may vary across the industry according to individual manufacturers.

[0056] While this description can include many specifics, these should not be construed as limitations on the scope thereof, but rather as descriptions of features that can be specific to particular embodiments. Certain features that have been heretofore described in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable subcombination. Moreover, although features can be described above as acting in certain combinations and can even be initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination can be directed to a subcombination or variation of a subcombination.

[0057] Similarly, while operations are depicted in the drawings or figures in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve

desirable results. In certain circumstances, multitasking and parallel processing can be advantageous.

[0058] As shown by the various configurations and embodiments illustrated in FIGS. 1 and 2, various embodiments for methods for localized glass strengthening have been described.

[0059] In the foregoing description, like reference characters designate like or corresponding parts throughout the several views shown in the figures. It is also understood that, unless otherwise specified, terms such as “top,” “bottom,” “outward,” “inward,” and the like are words of convenience and are not to be construed as limiting terms. In addition, whenever a group is described as comprising at least one of a group of elements and combinations thereof, it is understood that the group may comprise, consist essentially of, or consist of any number of those elements recited, either individually or in combination with each other.

[0060] Similarly, whenever a group is described as consisting of at least one of a group of elements or combinations thereof, it is understood that the group may consist of any number of those elements recited, either individually or in combination with each other. Unless otherwise specified, a range of values, when recited, includes both the upper and lower limits of the range. As used herein, the indefinite articles “a,” and “an,” and the corresponding definite article “the” mean “at least one” or “one or more,” unless otherwise specified.

[0061] The term “about” as used herein can allow for a degree of variability in a value or range, for example, within 10%, within 5%, or within 1% of a stated value or of a stated limit of a range.

[0062] The term “substantially” as used herein refers to a majority of, or mostly, as in at least about 50%, 60%, 70%, 80%, 90%, 95%, 96%, 97%, 98%, 99%, 99.5%, 99.9%, 99.99%, or at least about 99.999% or more.

[0063] Those skilled in the art will appreciate that many modifications to the embodiments described herein are possible without departing from the spirit and scope of the present disclosure. Thus, the description is not intended and should not be construed to be limited to the examples given but should be granted the full breadth of protection afforded by the appended claims and equivalents thereto. In addition, it is possible to use some of the features of the present disclosure without the corresponding use of other features. Accordingly, the foregoing description of or illustrative embodiments is provided for the purpose of illustrating the principles of the present disclosure and not in limitation thereof and can include modification thereto and permutations thereof.

[0064] Select embodiments of the present disclosure include, but are not limited to, the following:

[0065] Embodiment 1 relates to a laminate comprising:

a decorated or non-decorated chemically strengthened glass substrate having first and second major surfaces and a first thickness (T^1);

a first decorated or non-decorated conventional glass substrate having third and fourth major surfaces and a second thickness (T^2); and

at least one adhesive interlayer located between the chemically strengthened glass substrate second major surface and the conventional glass substrate third major surface, the adhesive interlayer having a third thickness (T^3);

wherein:

$T^1 + T^2 + T^3$ is less than about 5 mm (e.g., less than about 4.5 mm and less than about 4 mm);

$T^1 < T^2$;

at least one of the third and fourth major surfaces of the first conventional glass substrate comprising at least one locally strengthened region; and

the at least one locally strengthened region coincides with a footprint of a point of attachment of at least one interior attachment attached to the laminate.

[0066] Embodiment 2 relates to a laminate comprising:

a second decorated or non-decorated conventional glass substrate having first and second major surfaces and a fourth thickness (T^4);

a third decorated or non-decorated conventional glass substrate having third and fourth major surfaces and a fifth thickness (T^5); and

at least one adhesive interlayer located between the first conventional glass substrate second major surface and the second conventional glass substrate third major surface, the adhesive interlayer having a sixth thickness (T^6);

wherein:

$T^4 + T^5 + T^6$ is less than about 5 mm (e.g., less than about 4.5 mm and less than about 4 mm);

$T^4 < T^5$; and

at least one of:

at least one of the first and second major surfaces of the third conventional glass substrate comprising at least one locally strengthened region;

at least one of the third and fourth major surfaces of the third conventional glass substrate comprising at least one locally strengthened region; and

the at least one locally strengthened region coincides with a footprint of a point of attachment of at least one interior attachment attached to the laminate.

[0067] Embodiment 3 relates to the laminate of Embodiment 2, wherein only the third and fourth major surfaces of the third conventional glass substrate comprises at least one locally strengthened region.

[0068] Embodiment 4 relates to the laminate of Embodiment 2, wherein at least one of the first and second major surfaces of the second conventional glass substrate comprises at least one additional locally strengthened region.

[0069] Embodiment 5 relates to the laminate of Embodiments 1-4, wherein the at least one locally strengthened region is chemically strengthened or thermally strengthened.

[0070] Embodiment 6 relates to the laminate of Embodiments 1-5, wherein the at least one locally strengthened region has a compressive stress (CS) of approximately 100 MPa.

[0071] Embodiment 7 relates to the laminate of Embodiments 1-6, wherein the at least one locally strengthened region has a DOL of about 10 microns.

[0072] Embodiment 8 relates to the laminate of Embodiments 1-7, wherein the at least one locally strengthened region has a residual surface CS level of between about 100 MPa to about 400 MPa.

[0073] Embodiment 9 relates to the laminate of Embodiment 8, wherein the at least one locally strengthened region has a DOL of greater than 10 microns.

[0074] Embodiment 10 relates to the laminate of Embodiments 1-9, wherein the at least one interior attachment is at least one of a rearview mirror, camera bracket, rain sensor, and telephone holder.

[0075] Embodiment 11 relates to the laminate of Embodiments 1-10, wherein the footprint of the point of attachment of the at least one interior attachment is smaller than the at least one locally strengthened region.

[0076] Embodiment 12 relates to the laminate of Embodiments 1-10, wherein the footprint of the point of attachment of the at least one interior attachment is larger than the at least one locally strengthened region.

[0077] Embodiment 13 relates to the laminate of Embodiments 1-10, wherein the footprint of the point of attachment of the at least one interior attachment substantially matches the at least one locally strengthened region.

[0078] Embodiment 14 relates to the laminate of Embodiments 1-13, wherein the laminate comprises less than ten locally strengthened regions.

[0079] Embodiment 15 relates to a method for making a laminate, the method comprising:
laminating

a decorated or non-decorated chemically strengthened glass substrate having first and second major surfaces and a first thickness (T^1);

a first decorated or non-decorated conventional glass substrate having third and fourth major surfaces a second thickness (T^2), and at least one locally strengthened region on at least one of the third and fourth major surfaces of the first conventional glass substrate;

at least one adhesive interlayer located between the chemically strengthened glass substrate second major surface and the conventional glass substrate third major surface, the adhesive interlayer having a third thickness (T^3); and

adhering

at least one interior attachment, wherein the at least one interior attachment has a footprint that coincides with the at least one locally strengthened region;

wherein:

$T^1 + T^2 + T^3$ is less than about 5 mm (e.g., less than about 4.5 mm and less than about 4 mm);

and

$T^1 < T^2$.

[0080] Embodiment 16 relates to the method of Embodiment 15 comprising:

laminating the decorated or non-decorated chemically strengthened glass substrate having first and second major surfaces and a first thickness (T^1) with the interlayer to form a first laminate; and

laminating the first laminate and the first decorated or non-decorated conventional glass substrate having third and fourth major surfaces, a second thickness (T^2), and at least one locally strengthened region on at least one of the third and fourth major surfaces of the first conventional glass substrate.

[0081] Embodiment 17 relates to the method of Embodiment 15 comprising:

laminating the first decorated or non-decorated conventional glass substrate having third and fourth major surfaces, a second thickness (T^2), and at least one locally strengthened region on at least one of the third and fourth major surfaces of the first conventional glass substrate with the interlayer to form a second laminate; and

laminating the second laminate and the decorated or non-decorated chemically strengthened glass substrate having first and second major surfaces and a first thickness (T^1).

[0082] Embodiment 18 relates to a method for making a laminate, the method comprising:

laminating

a second decorated or non-decorated conventional glass substrate having first and second major surfaces and a fourth thickness (T^4);

a third decorated or non-decorated conventional glass substrate having third and fourth major surfaces, and a fifth thickness (T^5);

at least one adhesive interlayer located between the first conventional glass substrate second major surface and the second conventional glass substrate third major surface, the adhesive interlayer having a sixth thickness (T^6); and

adhering

at least one interior attachment to the laminate;

wherein:

at least one of:

at least one of the first and second major surfaces of the third conventional glass substrate comprising at least one locally strengthened region;

at least one of the third and fourth major surfaces of the third conventional glass substrate comprising at least one locally strengthened region; and

the at least one locally strengthened region coincides with the footprint of a point of attachment of the at least one interior attachment;

$T^4 + T^5 + T^6$ is less than about 5 mm (e.g., less than about 4.5 mm and less than about 4 mm);

and

$T^4 < T^5$.

[0083] Embodiment 19 relates to the method of Embodiment 18 comprising:

laminating of the second decorated or non-decorated conventional glass substrate having first and second major surfaces and a fourth thickness (T^4) with the interlayer to form a third laminate; and

laminating the third laminate and the third decorated or non-decorated conventional glass substrate having third and fourth major surfaces, and a fifth thickness (T^5), and at least one locally strengthened region on at least one of the third and fourth major surfaces of the third conventional glass substrate.

[0084] Embodiment 20 relates to the method of Embodiment 18 comprising:

laminating of the third decorated or non-decorated conventional glass substrate having third and fourth major surfaces, and a fifth thickness (T^5), and at least one locally strengthened region on at least one of the third and fourth major surfaces of the third conventional glass substrate with the interlayer to form a fourth laminate; and

laminating the fourth laminate and the second decorated or non-decorated conventional glass substrate having first and second major surfaces and a fourth thickness (T^4).

What is claimed is:

1. A laminate comprising:
 - a decorated or non-decorated chemically strengthened glass substrate having first and second major surfaces and a first thickness (T^1);
 - a first decorated or non-decorated conventional glass substrate having third and fourth major surfaces and a second thickness (T^2); and
 - at least one adhesive interlayer located between the chemically strengthened glass substrate second major surface and the conventional glass substrate third major surface, the adhesive interlayer having a third thickness (T^3);wherein:
 - $T^1 + T^2 + T^3$ is less than about 5 mm;
 - $T^1 < T^2$;
 - at least one of the third and fourth major surfaces of the first conventional glass substrate comprising at least one locally strengthened region; and
 - the at least one locally strengthened region coincides with a footprint of a point of attachment of at least one interior attachment attached to the laminate.
2. A laminate comprising:
 - a second decorated or non-decorated conventional glass substrate having first and second major surfaces and a fourth thickness (T^4);
 - a third decorated or non-decorated conventional glass substrate having third and fourth major surfaces and a fifth thickness (T^5); and
 - at least one adhesive interlayer located between the second conventional glass substrate second major surface and the third conventional glass substrate third major surface, the adhesive interlayer having a sixth thickness (T^6);wherein:
 - $T^4 + T^5 + T^6$ is less than about 5 mm;
 - $T^4 < T^5$; and
 - at least one of:
 - at least one of the first and second major surfaces of the third conventional glass substrate comprising at least one locally strengthened region;

at least one of the third and fourth major surfaces of the third conventional glass substrate comprising at least one locally strengthened region; and
the at least one locally strengthened region coincides with a footprint of a point of attachment of at least one interior attachment attached to the laminate.

3. The laminate of claim 2, wherein only the third and fourth major surfaces of the third conventional glass substrate comprises at least one locally strengthened region.
4. The laminate of claim 2, wherein at least one of the first and second major surfaces of the second conventional glass substrate comprises at least one additional locally strengthened region.
5. The laminate of any one of claims 1-4, wherein the at least one locally strengthened region is chemically strengthened or thermally strengthened.
6. The laminate of any one of claims 1-5, wherein the at least one locally strengthened region has a compressive stress (CS) of approximately 100 MPa.
7. The laminate of any one of claims 1-6, wherein the at least one locally strengthened region has a depth of compressive layer (DOL) of about 10 microns.
8. The laminate of any one of claims 1-7, wherein the at least one locally strengthened region has a residual surface CS level of between about 100 MPa to about 400 MPa.
9. The laminate of claim 8, wherein the at least one locally strengthened region has a DOL of greater than 10 microns.
10. The laminate of claim 9, wherein the at least one interior attachment is at least one of a rearview mirror, camera bracket, rain sensor, and telephone holder.

11. The laminate of claim 9, wherein the footprint of the point of attachment of the at least one interior attachment is smaller than the at least one locally strengthened region.
12. The laminate of claim 9, wherein the footprint of the point of attachment of the at least one interior attachment is larger than the at least one locally strengthened region.
13. The laminate of claim 9, wherein the footprint of the point of attachment of the at least one interior attachment substantially matches the at least one locally strengthened region.
14. The laminate of any one of claims 1-13, wherein the laminate comprises less than ten locally strengthened regions.
15. A method for making a laminate, the method comprising:
laminating
a decorated or non-decorated chemically strengthened glass substrate having first and second major surfaces and a first thickness (T^1);
a first decorated or non-decorated conventional glass substrate having third and fourth major surfaces a second thickness (T^2), and at least one locally strengthened region on at least one of the third and fourth major surfaces of the first conventional glass substrate;
at least one adhesive interlayer located between the chemically strengthened glass substrate second major surface and the conventional glass substrate third major surface, the adhesive interlayer having a third thickness (T^3); and
adhering
at least one interior attachment, wherein the at least one interior attachment has a footprint that coincides with the at least one locally strengthened region;
wherein:
 $T^1 + T^2 + T^3$ is less than about 5 mm; and
 $T^1 < T^2$.
16. The method of claim 15 comprising:
laminating the decorated or non-decorated chemically strengthened glass substrate having first and second major surfaces and a first thickness (T^1) with the interlayer to form a first laminate; and

laminating the first laminate and the first decorated or non-decorated conventional glass substrate having third and fourth major surfaces, a second thickness (T^2), and at least one locally strengthened region on at least one of the third and fourth major surfaces of the first conventional glass substrate.

17. The method of claim 15 comprising:

laminating the first decorated or non-decorated conventional glass substrate having third and fourth major surfaces, a second thickness (T^2), and at least one locally strengthened region on at least one of the third and fourth major surfaces of the first conventional glass substrate with the interlayer to form a second laminate; and

laminating the second laminate and the decorated or non-decorated chemically strengthened glass substrate having first and second major surfaces and a first thickness (T^1).

18. A method for making a laminate, the method comprising:

laminating

a second decorated or non-decorated conventional glass substrate having first and second major surfaces and a fourth thickness (T^4);

a third decorated or non-decorated conventional glass substrate having third and fourth major surfaces, a fifth thickness (T^5);

at least one adhesive interlayer located between the first conventional glass substrate second major surface and the second conventional glass substrate third major surface, the adhesive interlayer having a sixth thickness (T^6); and

adhering

at least one interior attachment to the laminate;

wherein:

at least one of:

at least one of the first and second major surfaces of the third conventional glass substrate comprising at least one locally strengthened region;

at least one of the third and fourth major surfaces of the third conventional glass substrate comprising at least one locally strengthened region; and

the at least one locally strengthened region coincides with the footprint of a point of attachment of the at least one interior attachment;

$T^4 + T^5 + T^6$ is less than 5 mm (e.g., less than 4.5 mm and less than 4 mm);
and
 $T^4 < T^5$.

19. The method of claim 18 comprising:
laminating of the second decorated or non-decorated conventional glass substrate having first and second major surfaces and a fourth thickness (T^4) with the interlayer to form a third laminate; and
laminating the third laminate and the third decorated or non-decorated conventional glass substrate having third and fourth major surfaces, a fifth thickness (T^5), and at least one locally strengthened region on at least one of the third and fourth major surfaces of the third conventional glass substrate.
20. The method of claim 18 comprising:
laminating of the third decorated or non-decorated conventional glass substrate having third and fourth major surfaces, a fifth thickness (T^5), and at least one locally strengthened region on at least one of the third and fourth major surfaces of the third conventional glass substrate with the interlayer to form a fourth laminate; and
laminating the fourth laminate and the second decorated or non-decorated conventional glass substrate having first and second major surfaces and a fourth thickness (T^4).

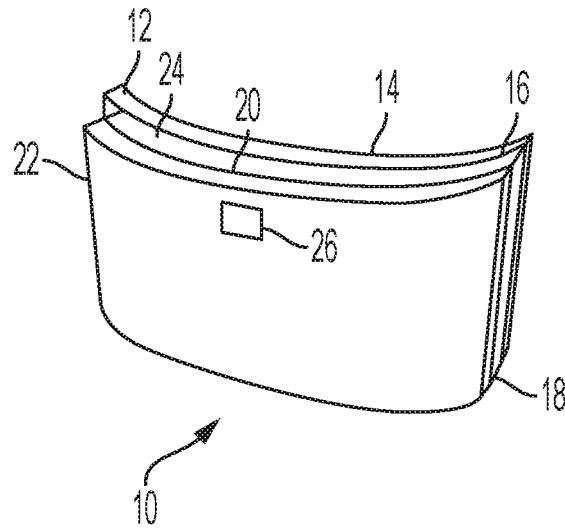


FIG. 1

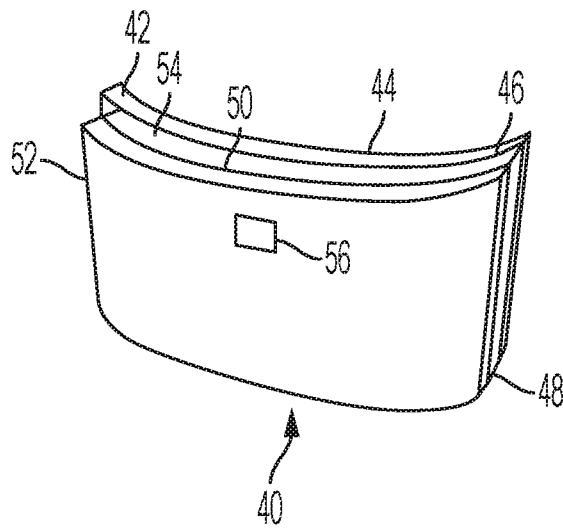


FIG. 2

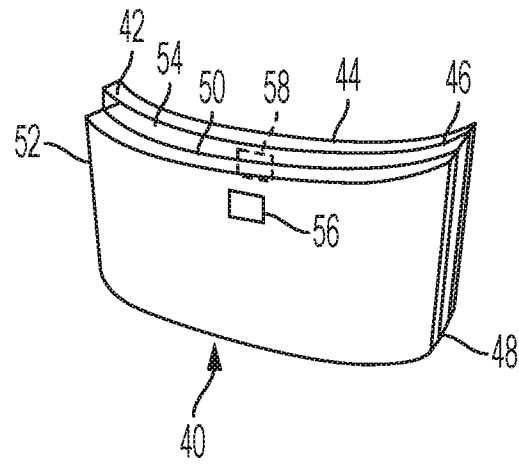


FIG. 3

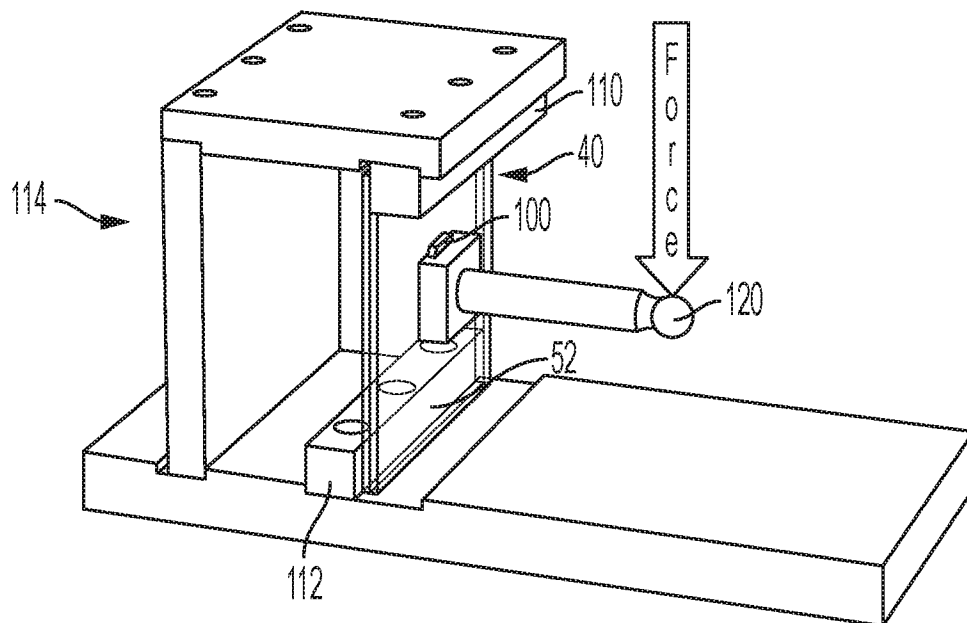


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2020/026501

A. CLASSIFICATION OF SUBJECT MATTER
INV. B32B7/02 B32B7/022 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	WO 2018/178883 A1 (AGP AMERICA SA [PA]) 4 October 2018 (2018-10-04) page 2, line 14 - line 19 page 5, line 12 - line 30 page 6, line 12 - page 7, line 31 page 9, line 4 - line 5 page 10, line 29 - line 33 page 11, line 21 - page 12, line 20 claims 1,5-8,12,15-18 figures 4,6a,6b,7a,7b	1-20
A	WO 2015/031151 A1 (CORNING INC [US]) 5 March 2015 (2015-03-05) paragraphs [0009] - [0011], [0014], [0027], [0050], [0052], [0055] - [0057], [0062], [0064], [0065] claims 1,9,12-41 figures 3-6 ----- -/--	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

23 June 2020

Date of mailing of the international search report

03/07/2020

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2020/026501

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/192428 A1 (SOL JEAN-MARC [FR] ET AL) 19 December 2002 (2002-12-19) paragraphs [0001], [0004], [0008] - [0010], [0023], [0026] - [0028], [0030], [0031] claims 1-4,9-14 figures 1,2 -----	1-20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2020/026501

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