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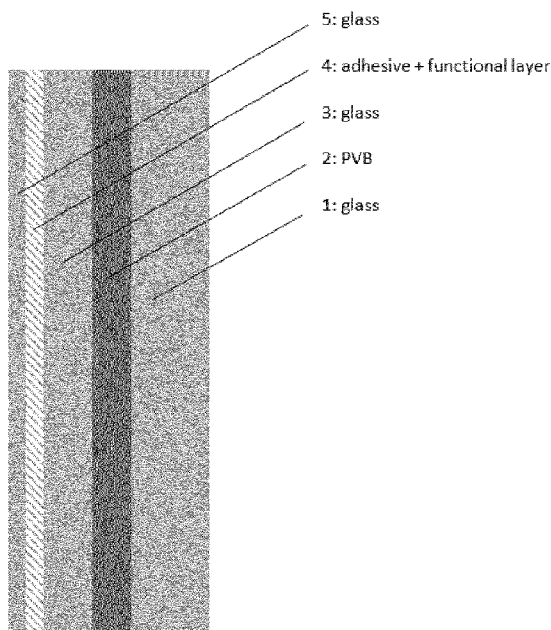
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(54) Title: FUNCTIONALIZED LAMINATED SAFETY GLASS AND PROCESS OF MANUFACTURING THE SAME



(57) Abstract: The invention is directed to a laminate comprising layers in the sequence: First sheet of glass having a thickness less than or equal to 2.5 mm, preferable less than or equal to 2.1 mm; first adhesive layer; second sheet of glass having a thickness of less than or equal to 2.5 mm, preferable less than or equal to 2.1 mm or 1.8 mm or 1.6mm; functional layer; second adhesive layer; third glass sheet having a thickness of less than 2.0 mm.



Functionalized laminated safety glass and process of manufacturing the same

Described is a laminated safety glass and process of manufacturing the same, comprising functional layers, which are sensitive to typical autoclave conditions.

Background

- 5 Laminated safety glass is produced by bonding at least two panes of glass together. Therefor typically a hot-melt adhesive like polyvinyl butyral or an ionomer is used. The glass and the adhesive are typically processed during an autoclave process, which utilizes high temperature around 140°C and pressure of about 12 bar to ensure proper performing laminates.
- 10 As there is an ongoing need of further functionalizing laminated safety glass with regard to energy control, displaying information or heating function, there is also a need for incorporating certain functional layers within or onto the laminated safety glass. These functional layers, however, are typically prone to be damaged during the autoclave process due to their (e.g. thermal or mechanical) sensitivity.
- 15 Such functional laminates are especially important for automotive glass like windshields. However, especially automotive windshields are highly demanding parts regarding safety, requiring autoclave conditions to form a well performing part.

Thus a laminated safety glass with sufficient mechanical properties and a process of manufacturing the same is proposed, which also enables incorporation of functional
20 layers.

Object of the invention is a laminate comprising layers in the sequence: First sheet of glass having a thickness less than or equal to 2.5 mm, preferable less than or equal to 2.1 mm; first adhesive layer; second sheet of glass having a thickness of less than or equal to 2.5 mm, preferable less than or equal to 2.1 mm or 1.8 mm or 1.6mm;
25 functional layer; second adhesive layer; third glass sheet having a thickness of less than 2.0 mm.

Possible adhesives to attach the functional layer are pressure sensitive adhesives, PSA, cross-linkable adhesives or thermoplastic processible adhesives. Preferred are
30 transparent, thermoplastic interlayers based on polyvinyl acetals like polyvinyl

butyral; polyvinyl alcohol; ionomeric films like SentryGlas®; Poly(methyl methacrylate); ethylene-vinyl acetate; polyvinyl chloride; thermoplastic polyurethane and Hybrar™ (styrene block copolymers with a flexible vinyl polydiene block, hydrogenated and non-hydrogenated).

- 5 Preferred for the first layer are plasticized PVB interlayer films with a thickness of 0.38 to 1.15 mm which are commercial available for example under the tradename TROSIFOL.

Most preferred for first and/or second adhesive layer are polyvinyl butyral interlayers having a plasticizer content ranging from 0 weight percent to 40 w-%, more
10 preferably 5 w-% to 0 w-% in order to avoid migration of plasticizer into the functional layer and / or its supportive substrate. The thickness of the second adhesive interlayer ranges from 10 µm to 1.52 mm, preferably from 10 µm to 200 µm to enable not to increase thickness of the final device.

The average molar mass of the polyvinyl butyral utilized for forming the second
15 adhesive layer ranges from 10,000 g/mol to 110,000 g/mol. Preferred are polyvinyl butyral having a glass transition temperature of 63°C to 73°C and/or a softening temperature of 100°C-225°C according to DIN ISO 4625. More preferable are polyvinyl butyrals having an average molar mass between 20,000 g/mol to 45,000 g/mol and or having a glass transition temperature of 63°C to 64°C and/or having a
20 softening temperature 125°C-190°C according to DIN ISO 4625.

The functional layer which shall be applied onto at least one of the outer surfaces of the first laminate, may be a heatable structure like a metal mesh, metallic nanowires or a metal grid based on gold, silver, tungsten, copper, aluminium or iron; closed
25 transparent conductive layers based on indium tin oxide, fluorine tin oxide, aluminium zinc oxide or antimony tin oxide; a holographic optical element which may be based on a photopolymer supported by a polymeric, transparent substrate; an electrochromic layer; a transparent, organic light-emitting device; a transparent, organic photovoltaic module; or combinations of these comprising a stand-alone layer and / or supported by a transparent polymeric substrate, which covers the
30 whole initial windshield laminate or parts of it.

These functional layers, especially holographic optical elements may be damaged during the harsh conditions of an autoclaving process. Further they are sensitive to the usage of the laminate as windscreen, as the layers are very thin ranging from 100 nm to 2mm and thus showing low mechanical loadability. Holographic optical elements are typically 3 μ m to 30 μ m thick, fragile structures on a supportive, transparent polymeric substrate like polyamide.

In order to protect these sensitive, functional layers against environmental influences like mechanical loads causing scratches or oxygen causing degradation, a third glass pane is applied on top of the functional layer which is adhered by above mentioned adhesives.

The first and second glass layer may have the same or a different thickness and may be any glass type suitable for windscreens.

The third glass layer protecting the functional layer is preferably very thin, ranging from 25 μ m to 1mm, preferably from 25 μ m to 500 μ m, most preferred from 25 μ m to 210 μ m like the commercial available Corning® Willow® Glass or from Schott, Germany (e.g. D 263® T eco AF 32® eco) in order to avoid significant increase of thickness and weight of the final laminated device.

By reducing the thickness of the inner glass pane [3] of the resulting triple glass laminate by the thickness of the functional layer and its adhesive [4] and the thin outer glass pane [5], the functional tri-laminate shows the same thickness as a regular, non-functionalized laminated windshield. This thickness retention enables the same process ability as regular windshield laminates and doesn't require changes at downstream production steps.

Another object of the invention is a process to manufacture a laminate by laminating a first glass sheet having a thickness of less than or equal to 2.5 mm preferable less than or equal to 2.1 mm; and a second glass sheet having a thickness of less than or equal to 2.5 mm, preferable less than or equal to 2.1 mm or 1.8 mm or 1.6mm; with an interposed first adhesive layer in a first step under autoclave conditions, and then laminating on the outer surface of at least one glass sheet a third glass sheet having a thickness of less than 2.0 mm with an interposed functional layer and a second adhesive layer in a second step under non-autoclave conditions.

In order to ensure a proper performing laminate it is proposed to have a two-step process: In a first step a regular windshield laminate is produced by pre-lamination not in an autoclave (e.g. in a vacuum bag) followed by final lamination in an
5 autoclave which is well-known to the person skilled in the art. These procedures ensure a proper bubble-free laminate regarding mechanical and safety properties.

In a second step, the functional layer is applied onto the inner or outer surface of the glass laminate, thereby covering the whole surface or only parts of it, by any kind of adhesive and/or process which enables preserving of the functional layer to be
10 applied.

For example, in the first step a non-functionalized windshield laminate as known in the art may be formed with a regular autoclave process, comprising two 2.1 mm thick glass panes and a 0.38 mm thick PVB interlayer in between.

In a second step the functional layer, with or without a supportive carrier film made
15 from e.g. polyamide, transparent, polymeric substrate, having a total thickness of 0.1 mm, the hot-melt adhesive as for example polyvinyl butyral thin films having 0% to < 5 % plasticizer content, form of a 0.1 mm thick interlayer and the thin glass having a thickness of 0.2 mm are applied onto the surface of the non-functionalized windshield laminate. Acylates, PSA and others may also be employed as adhesives.

20 The process utilized for applying the sensitive, functional layers and the thin glass with the adhesive onto the pre-laminate is characterized by significant lower temperature and pressure than a regular autoclave process.

The functional layer and the thin glass may be applied to the pre-laminate by laying the functional layer on top of the pre-laminate, followed by an adhesive interlayer
25 and the thin glass sequentially; or by laying an adhesive interlayer on top of the pre-laminate, followed by the functional layer and the thin glass sequentially; or by laying an adhesive interlayer on top of the pre-laminate, followed by the functional layer, another adhesive interlayer and the thin glass sequentially. Hereafter a pressure ranging from a vacuum (0,2 bar) to 11 bar, preferably ranging from a vacuum to 5
30 bar, most preferred ranging from a vacuum to 2 bar; and a temperature of 90°C to

139°C, preferably 100°C to 125°C, most preferred 100°C to 110°C are applied to the stack.

Employing acrylates like e.g. LOCTITE DSP 3194 may be cured by UV-light at room temperature.

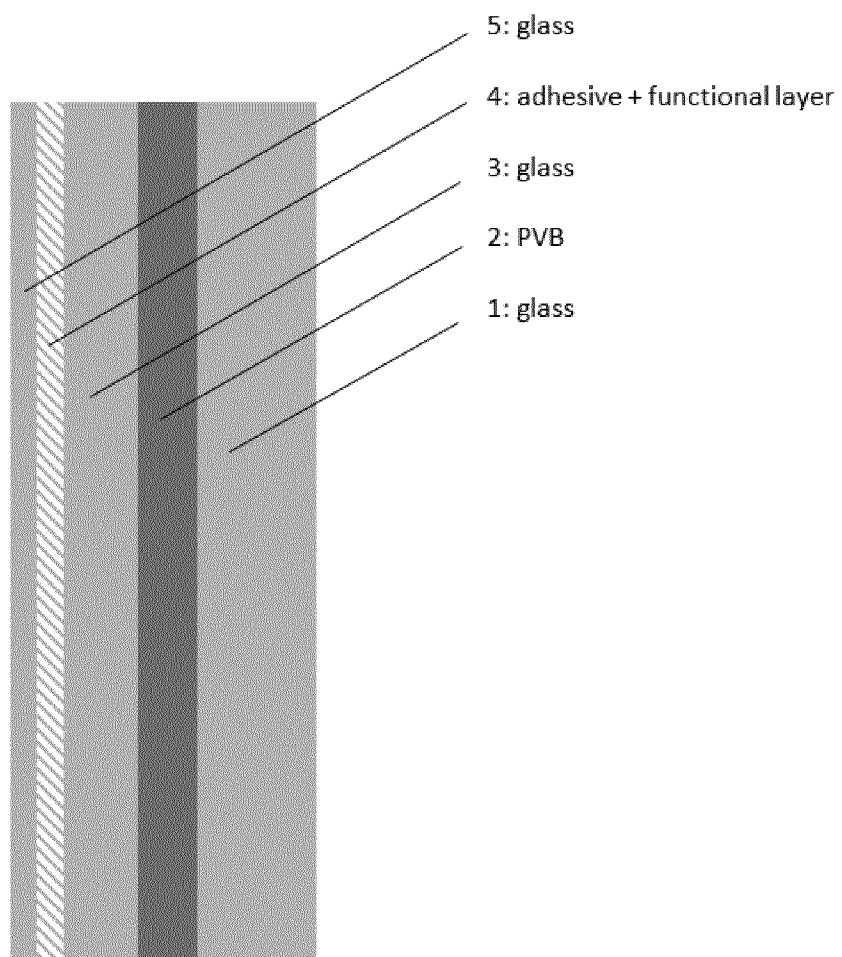
Claims

- 1 Laminate comprising layers in the sequence:
First sheet of glass having a thickness less than or equal to 2.5 mm, first
adhesive layer; second sheet of glass having a thickness of less than or
5 equal to 2.5 mm; functional layer; second adhesive layer; third glass sheet
having a thickness of less than 2.0 mm.
- 2 Laminate according to claim 1 characterized in that the first and/or second
adhesive layer comprises plasticized polyvinylacetal.
- 10 3 Laminate according to claim 1 or 2 characterized in that the second
adhesive layer has a glass transition temperature of 63°C to 73°C
- 15 4 Laminate according to claim 1 or 2 characterized in that the second
adhesive layer has a softening temperature of 100°C-225°C according to
DIN ISO 4625.
- 20 5 Laminate according to claim 1 to 4 characterized in that the second
adhesive layer comprises a mixture of polyvinyl acetal with 0 – 40 whgt %
plasticizer.
- 25 6 Laminate according to claim 1 to 5 characterized in that the second
adhesive layer comprises polyvinyl butyral with an average molar mass
between 10,000 g/mol to 110,000 g/mol.
- 30 7 Laminate according to claim 1 to 6 characterized in that the functional
layer is selected from the group consisting of a heat able structure, a metal
mesh, metallic nanowires, a metal grid a closed transparent conductive
layer a holographic optical element an electrochromic layer; a transparent
organic light-emitting device; a transparent organic photovoltaic module.
- 8 Laminate according to claim 1 to 7 characterized in that the functional
layer is supported by a transparent polymeric substrate.

- 9 Process to manufacture a laminate by laminating a first glass sheet having
a thickness of less than or equal to 2.5 mm and a second glass sheet
5 having a thickness of less than or equal to 2.5 mm with an interposed first
adhesive layer in a first step under autoclave conditions, and then
laminating on the outer surface of at least one glass sheet a third glass
sheet having a thickness of less than 2.0 mm with an interposed functional
layer and a second adhesive layer in a second step under non-autoclave
10 conditions.

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Drawings



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/081858

A. CLASSIFICATION OF SUBJECT MATTER
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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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/311497 A1 (AOKI SHIGEAKI [JP]) 17 December 2009 (2009-12-17)	1
Y	claim 1 paragraphs [0039], [0043], [0045] -----	2-9
X	US 2005/002081 A1 (BETEILLE FABIEN [FR] ET AL) 6 January 2005 (2005-01-06)	1
A	claims 25-30 figures paragraphs [0003], [0007], [0021], [0022], [0031], [0032], [0035] - [0039], [0052], [0078], [0095], [0096] -----	2-9
X	WO 2017/094884 A1 (ASAHI GLASS CO LTD [JP]) 8 June 2017 (2017-06-08) table 1 claims 1,5 paragraphs [0059] - [0061] -/-	1



Further documents are listed in the continuation of Box C.



See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/081858

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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