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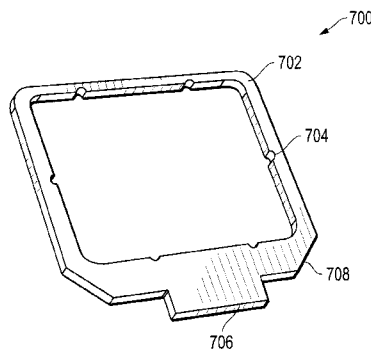


FIG. 7

(57) Abstract: A polymer sheet includes a polyurethane core. The polyurethane core has a first major surface and a second major surface opposite the first major surface. The polymer sheet can have at least one functional layer overlying a major surface. The polymer sheet has a thickness t_{ps} . The polyurethane core has a thickness t_{pc} . In embodiments t_{pc} can be at least 0.5 t_{ps} . The polyurethane core can have at least one of the following property: (i) a Scratch Resistance Rating, as further described herein, of not greater than about 10 wt%, (ii) an elongation at break of at least 200 %, (iii) a tensile strength at break of at least 0.5 MPa, (iv) a loss of tensile strength of at least 5% when exposed to UV light according to standard ASTM D2565-99. The polymer sheet can be used for gaskets or bonding tapes.

FOAM GASKET AND BONDING TAPE BASED ON POLYURETHANE DISPERSIONS

TECHNICAL FIELD

This disclosure in general relates to polyurethane foam products and in particular to gaskets and bonding tapes.

BACKGROUND ART

Demand for electronic products has been increasing at an ever accelerating rate. In particular, demand for mobile electronic devices, such as telephones, game consoles, music players, flat screen televisions, laptop computers, and tablet computers, are becoming more prevalent in society than ever before. Such electronic devices and in particular, such mobile electronic devices can be damaged easily when exposed to environmental conditions, particularly humidity or moisture.

Typical electronic devices are housed within a casing formed in several sections that fit together and are secured by screws or by compression fittings. Such casings generally utilize gaskets to at least partially isolate the inside of the casing from the external environment.

In the mobile electronic devices industry, there is increasing pressure to reduce the weight and cost associated with devices. Oftentimes, the industry turns to lighter materials, such as plastics for the casings and seeks to use lighter materials for the gaskets and other components. However, thin-walled plastic casings can exhibit some degree of flexibility, placing additional strain on gaskets. Conventional gaskets that have poor response to repeated compression can fail to reform a seal between the casing portions after stress in adequate time to prevent dust and particulate from entering the device. Accumulation of dust and particulate can ultimately lead to degradation of device components and failure of the device.

Foam bonding tapes are ideal for a variety of applications where bonding and joining of components are needed, most prevalent in the electronic, automotive, and transportation industry. Bonding tapes reduce or eliminate the need for mechanical fasteners such as rivets or screws, liquid adhesives, or welds. This leads to shorten

production periods, higher productivity, lower costs, and improved product appearance. Bonding tapes have a foam core based on polyurethane (PU), polyolefin, acrylic polymers, and others. Polyurethane foam cores show improved performance with respect to dissipating vibrations and distributing stress. However, conventional PU foam tapes may not meet all demands of the application. For instance, for large dimension parts such as car body side molding, there can be difference of thermal expansion between the body side molding and the car body, which creates additional strain on the bonding tape. Over time, repetition of such additional strain can ultimately lead to degradation of the bonding between car body and the body side molding.

As such, improved sealing gaskets and bonding tapes would be desirable.

BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure may be better understood, and its numerous features and advantages made apparent to those skilled in the art by referencing the accompanying drawings.

FIG. 1, FIG. 2, FIG. 3, FIG. 4, FIG. 5, and FIG. 6 include illustrations of exemplary foam materials useful in making sealing gaskets

FIG. 7 includes an illustration of an exemplary seal gasket.

FIG. 8A and FIG. 8B include illustrations of an exemplary seal gasket configuration in an electronic device.

FIG. 9 includes an illustration of an exemplary foam material useful in making bonding tapes.

FIG. 10 includes an illustration of an exemplary bonding tape as manufactured for commerce.

FIG. 11 and FIG. 12 include Compression Force Deflection and Force-to-Compress data as measured from samples according to embodiments.

The use of the same reference symbols in different drawings indicates similar or identical items.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In a first aspect, a polymer sheet includes a polyurethane core. The polyurethane core has a first major surface and a second major surface opposite the first major surface. The polymer sheet can have at least one functional layer overlying a major surface. The polymer sheet has a thickness t_{PS} . The polyurethane core has a thickness t_{PC} . In embodiments t_{PC} can be at least 0.5 t_{PS} . In other embodiments, the polyurethane core includes a polyurethane polymer. The polyurethane core can have at least one of the following property:

- (i) a Scratch Resistance Rating, as further described herein, of not greater than about 10 wt%,
- (ii) an elongation at break of at least 200 %,
- (iii) a tensile strength at break of at least 0.5 MPa,
- (iv) a loss of tensile strength of at least 5% when exposed to UV light according to standard ASTM D2565-99.

In a second aspect, an assembly includes a first member and a second member and a gasket. The gasket can be compressed between the first member and the second member. The gasket can include a polyurethane core having a first major surface and a second major surface opposite the first major surface. In embodiments, the gasket can be compressed between the first and the second member at a compression of at least about 10%. The polyurethane core can include a polyurethane polymer. The polyurethane core can include one of the above described properties (i) through (iv), namely, a Scratch Resistance Rating of not greater than about 10 wt%, an elongation at break of at least 200 %, a tensile strength at break of at least 0.5 MPa, or a loss of tensile strength of at least 5% when exposed to UV light according to standard ASTM D2565-99.

In a third aspect, a method of preparing a polymer sheet includes frothing a polyurethane dispersion into a froth. The froth can be casted onto a liner. The casted froth can be treated to have a uniform thickness. The method can further include drying the casted froth to form a polyurethane core. The polyurethane core has a thickness t_{PF} . In embodiments t_{PF} can be at least 0.5 of the total thickness of the polymer sheet. The polyurethane core can include one of the above described properties (i) through (iv), with respect to Scratch Resistance Rating, elongation at

break, tensile strength at break, or loss of tensile strength when exposed to UV light according to standard ASTM D2565-99.

As illustrated in FIG. 1, a gasket 100 includes a polyurethane foam layer 102 having a top surface and a bottom surface. The foam layer 102 can be a polyurethane foam formed from a polyurethane dispersion, a surfactant, a thickener, a pigment, and an optional solvent, an optional chain extender or crosslinking agent.

As polyurethane dispersions within the meaning of the present invention, the following dispersion can be used, optionally in combination:

a) Anionic aliphatic polyester polyurethane dispersions

Among these, the following products sold by the Bayer MaterialScience AG can be used: Impranil® LP RSC 1380, DL 1537 XP, DL 1554 XP.

b) Anionic aliphatic polyester polyurethane dispersions

Among these, the following products sold by the Bayer MaterialScience AG can be used: Impranil® LP DSB 1069

c) Aliphatic polycarbonate ester polyether polyurethane dispersions

Among these, the following polyurethane dispersion sold by the Bayer MaterialScience AG can be used: Impranil® DLU Dispersion.

d) Anionic polycarbonate polyurethane dispersions

Among these, the following polyurethane dispersion sold by the Bayer MaterialScience AG can be used: Impranil® DL 2288 XP Dispersion

These are high solids (about 60%) polyurethane dispersions. All products are free from organic cosolvents, thickening agents and external emulsifiers.

As surfactant, which also act as foam stabilizer, the following compounds can be used: Stokal® STA, Stokal® SR

As thickener, Borchigel[®] ALA can be used. As pigment, SP-9695 from Shanghai Yuanhe Chemical can be used. As an optional solvent, generic isopropyl alcohol (IPA) can be used.

As an optional cross-linker or chain extender, Cymel[®] 325 or Imprafix[®] 2794 XP can be used. Yet, other cross-linkers can be used as well. For example, optional cross-linker can be melamine-based cross-linkers, an isocyanate-based cross-linker, or a polyaziridine based cross-linker. In one particular embodiment, the melamine-based cross-linker is melamine.

The foregoing stated examples for a polyurethane dispersion, a surfactant, a thickener, a pigment, and a solvent, are solely exemplary, wherein each represents a broader class of compounds that can be used. It is understood that amounts and ingredients can be modified or replaced with other commercially available ingredients to obtain the claimed polymer sheet.

For example, the above surfactant can be modified or replaced with another surfactant. The additional or replacing surfactant can be selected from ether sulfates, fatty alcohol sulfates, sarcosinates, organic amine oxides, sulfonates, betaines, organic acid amides, sulfosuccinates, sulfonic acids, alkanolamides, ethoxylated fatty alcohols, sorbinates, or any combination thereof

Referring to FIG. 1, a release liner 1044 overlies the foam core 102 over a major surface. In one embodiment (not illustrated), only one release liner 1042 covers a first major surface of the foam core 102, while the second major surface remains uncovered. In another embodiment, as shown in FIG. 1, two release liners, 1042 and 1044, overlie the two major surfaces of the foam core 102.

The foam core and the at least one release liner form a polymer sheet. In embodiments the polymer sheet has a primary aspect ratio, defined as the ratio of the largest dimension of the polymer sheet, i.e., length, over the second largest dimension, i.e., width of the polymer sheet. The a primary aspect ratio of the polymer sheet can be at least about 100, such as at least about 200, at least about 400, at least about 800, at least about 1000, or at least about 1500.

In embodiments, the foam core 102 can have a thickness of at least about 0.2 mm, such as at least about 0.4 mm, at least about 0.6 mm, at least about 0.8 mm, at least about 1.0 mm, at least about 1.2 mm, at least about 1.4 mm, at least about 1.6 mm, at least about 1.8 mm, at least about 2.0 mm, or at least about 2.2 mm. In yet other embodiments, the polyurethane foam core can have a thickness of not greater than about 3.0 mm, such as not greater than about 2.8 mm, not greater than about 2.6 mm, not greater than about 2.4 mm, not greater than about 2.2 mm, not greater than about 2.0 mm, not greater than about 1.8 mm, or not greater than about 1.6 mm.

In embodiments, the polyurethane core 102 can have a density as measured according to ASTM D3574 of at least 50 kg/m^3 , such as at least about 60 kg/m^3 , at least about 70 kg/m^3 , at least about 80 kg/m^3 , at least about 90 kg/m^3 , at least about 100 kg/m^3 , at least about 120 kg/m^3 , at least about 140 kg/m^3 , at least about 160 kg/m^3 , at least about 180 kg/m^3 , or at least about 200 kg/m^3 . In other embodiments, the polyurethane core can have a density of not greater than about 350 kg/m^3 , such as not greater than about 330 kg/m^3 , not greater than about 310 kg/m^3 , not greater than about 290 kg/m^3 , not greater than about 270 kg/m^3 , not greater than about 250 kg/m^3 , not greater than about 230 kg/m^3 , not greater than about 210 kg/m^3 , not greater than about 190 kg/m^3 , not greater than about 170 kg/m^3 , not greater than about 150 kg/m^3 , not greater than about 130 kg/m^3 , or not greater than about 110 kg/m^3 .

Moreover, in embodiments, the polyurethane foam core comprises cells. The cells can be closed, semi-open, or open. At least 50% of the cells can have a cell diameter of at least about 30 microns, such as at least about 40 microns, at least about 50 microns, at least about 60 microns, at least about 70 microns, at least about 80 microns, at least about 90 microns, at least about 100 microns, at least about 120 microns, and not greater than about 160 microns. In other embodiments, at least 50% of the cells can have a cell diameter of, not greater than about 160 microns, not greater than about 140 microns, not greater than about 120 microns, not greater than about 100 microns, not greater than about 90 microns, not greater than about 80 microns, not greater than about 70 microns, or not greater than about 60 microns.

Moreover, the polyurethane core can further include a flame retardant or a filler. The filler can be selected from bentonite, kaolin, powdered glass, glass beads,

glass fibers, calcium carbonate, quartz sand, fluoropolymer, thermoplastic, microspheres, or any combination thereof.

To form the foam, a polyurethane dispersion in mixture with a surfactant, a pigment, an optional solvent, an optional cross-linker, and an optional filler can be frothed mechanically. In addition, a blowing agent, such as a blowing agent can be used. In an example, the mixture can be frothed in the presence of a gas, such as air, nitrogen, or a noble gas including, for example, helium, neon, or argon.

Blowing agents can be used, alone or as mixtures with each other. Blowing agents can be selected from a broad range of materials, including hydrocarbons, halohydrocarbons, ethers, esters and partially halogenated hydrocarbons, ethers and esters, or the like. Typical physical blowing agents have a boiling point between minus 50°C and positive 100°C, and preferably between about -50°C and 50°C. Exemplary physical blowing agents include the CFC's (chlorofluorocarbons) such as 1,1-dichloro-1-fluoroethane, 1,1-dichloro-2,2,2-trifluoro-ethane, monochlorodifluoromethane, and 1-chloro-1,1-difluoroethane; the FC's (fluorocarbons) such as 1,1,1,3,3,3-hexafluoropropane, 2,2,4,4-tetrafluorobutane, 1,1,1,3,3,3-hexafluoro-2-methylpropane, 1,1,1,3,3-pentafluoropropane, 1,1,1,2,2-pentafluoropropane, 1,1,1,2,3-pentafluoropropane, 1,1,2,3,3-pentafluoropropane, 1,1,2,2,3-pentafluoropropane, 1,1,1,3,3,4-hexafluorobutane, 1,1,1,3,3-pentafluorobutane, 1,1,1,4,4,4-hexafluorobutane, 1,1,1,4,4-pentafluorobutane, 1,1,2,2,3,3-hexafluoropropane, 1,1,1,2,3,3-hexafluoropropane, 1,1-difluoroethane, 1,1,1,2-tetrafluoroethane, and pentafluoroethane; the fluoroethers such as methyl-1,1,1-trifluoroethylether and difluoromethyl-1,1,1-trifluoroethylether; hydrocarbons such as n-pentane, isopentane, and cyclopentane; methylene chloride; or any combination thereof. Such blowing agents can be used in an amount of 5% to 50% by weight of the reactive composition, typically 10% to 30% by weight of the reactive composition.

Returning to FIG. 1, the foam layer 102 has a top surface and a bottom surface that are characterized by a skin. The skin, for example, is substantially free of pores. For example, the skin associated with the top surface and the bottom surface can be substantially continuous including few, if any, breaks or openings.

In fact, the skin can be hard enough to exhibit scratch resistance. Scratch resistance can be determined with a Taber[®] Abraser. Scratch resistance was quantified by determining a Scratch Resistance Rating. The Scratch Resistance Rating is the loss in weight percentage of the mass of a sample having a diameter of 100 mm after exposure to 500 cycles on a Taber 5135 Rotary Abraser using Calibrate H-18 wheels at a speed of 60 cycles per minute. Accordingly, the fraction of [Mass (before test)-Mass (after test)]/Mass (before test) in percent provides the Scratch Resistance Rating.

In embodiments, the Scratch Resistance Rating is not greater than 10 wt%, such as not greater than about 8 wt%, not greater than about 6 wt%, not greater than about 5 wt%, not greater than about 4 wt%, or not greater than about 2 wt%.

Further referring to FIG. 1, the release liner, 1042 or 1044, can include paper, a polymer film, or any combination thereof. An exemplary paper includes a coated paper. An exemplary polymer film is formed of polyolefin, polyester, polyamide, polyvinyl chloride, fluoropolymer, polyimide, or any combination thereof. An exemplary polyolefin includes polyethylene, polypropylene, or any combination thereof. An exemplary polyester includes poly(ethylene terephthalate) (PET). In another example, the polymer film is formed of a liquid crystal polymer, such as an aromatic polyester or a polyesteramide.

In an example, the release liner, 1042 or 1042 can have a thickness in a range of 0.01 mm to 0.1 mm. For example, the liner can have a thickness in a range of 25 microns to 180 microns, such as a range of 25 microns to 150 microns, or even a range of 25 microns to 100 microns. In embodiments, the release liner can have a thickness of at least about 0.01 mm, such as at least about 0.015 mm, at least about 0.02 mm, at least about 0.025 mm, at least about 0.03 mm, at least about 0.035 mm, or at least about 0.04 mm. In other embodiments, the release liner can have a thickness of not greater than about 0.1 mm, such as not greater than about 0.09 mm, not greater than about 0.08 mm, not greater than about 0.075 mm, not greater than about 0.07 mm, not greater than about 0.065 mm, not greater than about 0.06 mm, not greater than about 0.055 mm, or not greater than about 0.05 mm. Further, the release liner can have a base weight in a range of 10 g/m² to 400 g/m², such as a range of 30 g/m² to 350 g/m², or even a range of 40 g/m² to 300 g/m².

In a particular example, the surfaces of the foam layer in contact with the release liner exhibits a desirable range of adhesion to a release liner (PET film) as determined by the method described in the Examples. For example, the surface of the foam layer in contact with the release liner (PET) can exhibit an adhesion of approximately 0.01 N/in or lower. Alternatively, the surface can have an initial adhesion in a range of 0.01 N/in to 0.2 N/in, a range of 0.015 N/in to 0.2 N/in, or even a range of 0.02 N/in to 0.2 N/in.

Upon removal of the release liner or separation from the release liner, a surface of the foam layer can exhibit a desirable tack. Tack is measured in accordance with the method described in the Examples. For example, the tack can be at least 0.1 N, such as at least 0.2 N, for example, in a range of 0.2 N to 1.2 N, such as a range of 0.3 N to 1.2 N or 0.3 N to 1.0 N.

FIG. 2 illustrates another embodiment of the polymer sheet. As depicted, a topcoat 206 can overlie the first major surface of the foam core 102. The topcoat can include an acrylic coating, a polyurethane coating, or a combination thereof. In a particular embodiment, the topcoat includes a silicone modified polyurethane coating. In embodiments, the topcoat can have thickness of at least about 0.001 mm, such as at least about 0.002 mm, at least about 0.003 mm, or at least about 0.004 mm. In other embodiments, the topcoat can have thickness of not greater than about 0.01 mm, such as not greater than about 0.009 mm, not greater than about 0.008 mm, not greater than about 0.007 mm, not greater than about 0.006 mm, or not greater than about 0.005 mm.

Referring further to FIG. 2, a permanent liner 204 can be disposed over the second major surface. In embodiments, the permanent liner 204 can include a thermoplastic. For example, the thermoplastic is selected from polyethylene, polyester, polyimide, or any combination thereof. In a particular embodiment, the polyethylene includes ultra-high molecular weight polyethylene.

Similar to the release liner, the permanent liner can have a thickness of at least about 0.01 mm, such as at least about 0.015 mm, at least about 0.02 mm, at least about 0.025 mm, at least about 0.03 mm, at least about 0.035 mm, or at least about 0.04 mm. In other embodiments, the permanent liner can have a thickness of not greater than

about 0.1 mm, such as not greater than about 0.09 mm, not greater than about 0.08 mm, not greater than about 0.075 mm, not greater than about 0.07 mm, not greater than about 0.065 mm, not greater than about 0.06 mm, not greater than about 0.055 mm, or not greater than about 0.05 mm.

FIG. 3 depicts a further development from the polymer sheet 200 of FIG. 2. In FIG. 3, an adhesive layer 308 is disposed over the permanent liner 204. The adhesive layer can be an acrylic adhesive, a pressure sensitive adhesive, a silicon adhesive, of a rubber hot melt adhesive. Similar to the permanent liner, the adhesive layer 308 can have a thickness of at least about 0.01 mm, such as at least about 0.015 mm, at least about 0.02 mm, at least about 0.025 mm, at least about 0.03 mm, at least about 0.035 mm, or at least about 0.04 mm. In other embodiments, the adhesive layer can have a thickness of not greater than about 0.1 mm, such as not greater than about 0.09 mm, not greater than about 0.08 mm, not greater than about 0.075 mm, not greater than about 0.07 mm, not greater than about 0.065 mm, not greater than about 0.06 mm, not greater than about 0.055 mm, or not greater than about 0.05 mm.

In further examples, the polymer sheet can include subcombinations of the elements shown in FIGs. 1-3. For example, two liners, one being a release liner and one being a permanent liner can be disposed over the first and second major surface, respectively. Alternatively, two permanent liners can overlie both major surfaces. Accordingly, for an assembly having two permanent liners, one or both liner can be overlaid with an adhesive.

FIGs. 4-6 are analogous to FIGs. 1-3 with the difference that the foam core has a film 406 embedded. Accordingly, a film 406 has two major surfaces, on both of which a polyurethane foam core 402 is disposed. The stack of film 406 and polyurethane foam layers 402 (402/406/402) form now the core of the polymer sheet.

Analogous to FIG. 1, the core stack 402/406/402 in FIG. 4 can be overlaid with release liners 4042 and 4044. Likewise analogous to FIG. 2, the core stack 402/406/402 in FIG. 5 can be covered by a topcoat 510 (analogous to topcoat 206) and a permanent liner 508 (analogous to permanent liner 204). Additionally, as shown in FIG. 6, the polymer sheet 500 of can further include an adhesive layer (analogous to layer 308) to form polymer sheet 600.

The film 406 functions to stabilize the core during when torsion and shear forces are affecting the polymer sheet. The film 406 can include a thermoplastic. For example, the thermoplastic can be selected from polyethylene, polyester, polyimide, or any combination thereof. In one particular example, the polyethylene includes ultra-high molecular weight polyethylene. Similar to the permanent liner, the film 406 can have a thickness of at least about 0.01 mm, such as at least about 0.015 mm, at least about 0.02 mm, at least about 0.025 mm, at least about 0.03 mm, at least about 0.035 mm, or at least about 0.04 mm. In other embodiments, the adhesive layer can have a thickness of not greater than about 0.1 mm, such as not greater than about 0.09 mm, not greater than about 0.08 mm, not greater than about 0.075 mm, not greater than about 0.07 mm, not greater than about 0.065 mm, not greater than about 0.06 mm, not greater than about 0.055 mm, or not greater than about 0.05 mm. Moreover, the thickness of stack 402/406/402 can be identical to the thickness of the foam core 102 as described above.

In particular, the foam layer is formed of a polyurethane foam having a structural feature where the foam core forms the major component of the polymer sheet as shown in the cross-sectional thickness ratio, where t_{PC} (thickness of the polyurethane core) is at least 0.5 t_{PS} (thickness of polymer sheet), such as at least 0.55 t_{PS} , at least 0.6 t_{PS} , at least 0.65 t_{PS} , at least 0.7 t_{PS} , at least 0.75 t_{PS} , at least 0.8 t_{PS} , at least 0.82 t_{PS} , at least 0.84 t_{PS} , at least 0.86 t_{PS} , at least 0.88 t_{PS} , at least 0.9 t_{PS} , or at least 0.92 t_{PS} . In one embodiment, the polymer sheet is formed in to a roll. The roll can have a diameter of at least about 0.5 m, such as at least about 0.8 m, at least about 0.9 m, at least about 1.0 m, at least about 1.1 m, at least about 1.2 m, or at least about 1.3 m. In another embodiment, the roll has a diameter of not greater than about 2.0 m, such as not greater than about 1.9 m, not greater than about 1.8 m, not greater than about 1.7 m, not greater than about 1.6 m, or not greater than about 1.5 m.

Moreover, the foam layer is formed of a polyurethane foam having inherent properties such as Scratch Resistance Rating (as described herein), Elongation at Break, Tensile Strength at Break, and Loss of Tensile Strength after UV Exposure.

The elongation at break of the polyurethane foam can be at least about 300 %, such as at least about 400 %, at least about 500 %, at least about 600 %, at least about

700 %, at least about 800 %, at least about 900 %, at least about 1000 %, at least about 1200 %, at least about 1400 %, at least about 1600 %, or at least about 1800 %.

The Tensile Strength at Break can be at least about 0.5 MPa, such as at least about 0.7 MPa, at least about 1 MPa, at least about 1.5 MPa, at least about 2 MPa, at least about 2.5 MPa, at least about 3 MPa, at least about 3.5 MPa, at least about 4 MPa, at least about 4.5 MPa, at least about 5 MPa, at least about 5.5 MPa, or at least about 6 MPa.

The Loss of Tensile Strength when exposed to UV light according to standard ASTM D2565-99 is at least about 5 %, such as at least about 8 %, at least about 10 %, at least about 12 %, at least about 14 %, at least about 16 %, at least about 18 %, at least about 20 %, at least about 22 %, at least about 25 %, or at least about 30 %.

Further, the foam layer is formed of a polyurethane foam having material properties such as density, a recovery time, force-to-compress (FTC), compression force deflection (CFD), or compression set. Polyurethane foams, particularly those formed as described in the method below, exhibit properties that are particularly suited for use in sealing gaskets.

In an example, the foam layer has a density of not greater than 350 kg/m³ as measured in accordance with ASTM D3574. For example, the density can be not greater than about 330 kg/m³, not greater than about 310 kg/m³, not greater than about 290 kg/m³, not greater than about 270 kg/m³, not greater than about 250 kg/m³, not greater than about 230 kg/m³, not greater than about 210 kg/m³, not greater than about 190 kg/m³, not greater than about 170 kg/m³, not greater than about 150 kg/m³, not greater than about 130 kg/m³, or not greater than about 110 kg/m³. In an example, the density of the foam layer is in a range of 50 kg/m³ to 250 kg/m³, such as a range of 60 kg/m³ to 250 kg/m³, a range of 100 kg/m³ to 250 kg/m³, a range of 100 kg/m³ to 200 kg/m³, or even a range of 125 kg/m³ to 200 kg/m³.

A unique property exhibited by the foam layer, particularly those formed as described below, is recovery time. The recovery time is the time it takes for a foam to exert 1.5 N force following release from compression according to the method defined in the Examples. For example, the foam can exhibit an 80% recovery time parameter

in a range of 0.001 seconds to 5 seconds, such as a range of 0.001 seconds to 2 seconds, a range of 0.001 seconds to 1 second, a range of 0.005 seconds to 1 second, 0.005 seconds to 0.1 seconds, or even a range of 0.005 seconds to 0.05 seconds. Further, the foam layer can exhibit a desirable 50% recovery time parameter of not greater than 4 seconds, such as not greater than 3 seconds, not greater than 2 seconds, not greater than 1.5 not greater than 1 second, not greater than 0.1 seconds, not greater than 0.01 seconds, or even not greater than 0.001 seconds. In a further example, the film layer can exhibit a 20% recovery time parameter of not greater than 0.002 seconds, such as not greater than 0.0015, or not greater than 0.001 seconds.

In addition, the foam layer exhibits a desirable compression profile. For example, the foam layer can exhibit a desirable instant force-to-compress (FTC) at 25% compression as measured according to ASTM D3574 Test C can be at least about 7 kPa, such as at least about 9 kPa, at least about 11 kPa, at least about 13 kPa, at least about 15 kPa, at least about 17 kPa, at least about 19 kPa, at least about 21 kPa, at least about 23 kPa, at least about 25 kPa, at least about 27 kPa, at least about 29 kPa, at least about 31 kPa, at least about 33 kPa, at least about 35 kPa, at least about 37 kPa, at least about 39 kPa, at least about 41 kPa, at least about 43 kPa, or at least about 45 kPa. In other embodiments, the force-to-compress at 25% compression as measured according to ASTM D3574 Test C can be not greater than about 50 kPa, such as not greater than about 48 kPa, not greater than about 46 kPa, not greater than about 44 kPa, not greater than about 42 kPa, not greater than about 40 kPa, not greater than about 38 kPa, not greater than about 36 kPa, not greater than about 34 kPa, not greater than about 32 kPa, not greater than about 30 kPa, not greater than about 28 kPa, not greater than about 26 kPa, not greater than about 24 kPa, not greater than about 22 kPa, not greater than about 20 kPa, not greater than about 18 kPa, not greater than about 16 kPa, not greater than about 14 kPa, or not greater than about 12 kPa.

Further, the foam layer can exhibit a compression force deflection (CFD), as measured in accordance with ASTM D3574 Test C at 25% compression of at least about 5 kPa, such as at least about 7 kPa, at least about 9 kPa, at least about 11 kPa, at least about 13 kPa, at least about 15 kPa, at least about 17 kPa, at least about 19 kPa, at least about 21 kPa, at least about 23 kPa, at least about 25 kPa, at least about 27 kPa, or at least about 29 kPa. In other embodiments, the foam layer can exhibit a

compression force deflection (CFD), as measured in accordance with ASTM D3574 Test C at 25% compression of not greater than about 35 kPa, such as not greater than about 34 kPa, not greater than about 32 kPa, not greater than about 30 kPa, not greater than about 28 kPa, not greater than about 26 kPa, not greater than about 24 kPa, not greater than about 22 kPa, not greater than about 20 kPa, not greater than about 18 kPa, not greater than about 16 kPa, not greater than about 14 kPa, not greater than about 12 kPa, or not greater than about 10 kPa.

The foam layer can also exhibit a desirable compression set measured in accordance with ASTM D3574 at 70°C for 22 hours and 50% compression of not greater than 15%, such as not greater than 12%, or even not greater than 10%. The foam layer can exhibit a compression set measured in accordance with ASTM D3574 at 23°C for 22 hours at 50% compression of not greater than 10%, such as is not greater than about 8%, such as not greater than about 7%, not greater than about 6%, not greater than about 5%, not greater than about 4%, not greater than about 3%, or not greater than about 2%.

In a particular example, the polymer sheet is formed by applying a froth onto a moving carrier for a drying or curing oven. The resulting film is rolled for later storage and can be dispensed and cut into a desirable shape to form a sealing gasket or bonding tape. The froth can be formed from polyurethane dispersions. The polyurethane dispersions can be frothed to include a gas, such as air, nitrogen, or a noble gas including, for example, helium, neon, or argon.

In embodiments, the froth can have froth density of at least about 100 g/L, such as at least about 110 g/L, at least about 120 g/L, at least about 130 g/L, at least about 140 g/L, at least about 150 g/L, at least about 170 g/L, at least about 190 g/L, at least about 210 g/L, at least about 230 g/L, or at least about 250 g/L. In yet other embodiments, the froth density is not greater than about 1200 g/L, such as not greater than about 1100 g/L, not greater than about 1000 g/L, not greater than about 900 g/L, not greater than about 800 g/L, not greater than about 700 g/L, not greater than about 600 g/L, not greater than about 500 g/L, not greater than about 400 g/L, or not greater than about 300 g/L.

Frothing and also ingredients provide for a certain froth viscosity. In embodiments, the froth can have a viscosity of not greater than about 18000 cps, such as not greater than about 17000 cps, not greater than about 16000 cps, not greater than about 15000 cps, not greater than about 14000 cps, not greater than about 13000 cps, not greater than about 12000 cps, not greater than about 11000 cps, not greater than about 10000 cps, not greater than about 9000 cps, not greater than about 8000 cps, not greater than about 7000 cps, not greater than about 6000 cps, or not greater than about 5000 cps. In other embodiments, the froth can have a viscosity of at least about 800 cps, such as at least about 900 cps, at least about 1000 cps, at least about 1500 cps, at least about 2000 cps, at least about 2500 cps, at least about 3000 cps, at least about 3500 cps, or at least about 4000 cps.

The froth is applied as a foam layer to a carrier, which, for example, moves the foam layer through an oven. The carrier can be a release liner, a permanent liner, or a removable carrier having a non-stick surface. For example, the carrier can be coated with a release agent, such as a silicone release coating, or can include a non-stick material, such as a fluoropolymer, e.g., Teflon®.

In an example, prior to entering the oven, a film can be applied over the foam layer. The film can constrain the growth of the foam layer to limit the thickness of the foam layer. For example, the film can have a tension applied between rollers, the tension limiting the expansion of the foam layer. Alternatively, the film can be free of tension and can allow the foam layer to expand to its full extent.

Alternatively, a blade or knife can spread the mixture to form a uniform thickness in the foam layer before it enters the oven. Alternatively, front rollers associated with the film can act to control the thickness of the mixture entering the oven.

After deposition on the carrier and after the optional film is placed over the foam layer, the foam layer enters an oven to further facilitate foaming and cross-linking. The oven can have a temperature in a range of 50°C to 180°C, such as a range of 50°C to 120°C, a range of 70°C to 115°C, or even a range of 100°C to 115°C. In embodiments, the temperature can be at least about 50 °C, such as at least about 60 °C, at least about 70 °C, at least about 80 °C, at least about 90 °C, at least about

100 °C, at least about 110 °C, at least about 120 °C, or at least about 130 °C. In other embodiments, the temperature is not greater than about 180 °C, such as not greater than about 170°C, not greater than about 160°C, or not greater than about 150°C.

After drying or at least partially curing within the oven the optional film can be removed and the carrier can be separated from the foam layer. The foam layer can be rolled into a roll. Alternatively, one or more of the film or carrier can remain attached to the foam to form a liner such as a release liner.

For example, a liner can be applied over the carrier. The froth can be applied over the liner. A film can be applied over the froth as it enters the oven. After drying or at least partially curing, the liner is separated from the carrier and rolled with the polyurethane foam into a roll. Optionally, a release coating, such as a silicone release coating, can be applied between the carrier and the liner or between the liner and the froth. Similarly, the film is separated from the polyurethane foam layer. The resulting construction includes a foam layer and liner. The liner can be a permanent liner or a release liner.

In an alternative embodiment, the froth is dispensed onto a carrier. A film is applied over the froth as it enters the oven. After drying or at least partially curing, the film forms a liner and is rolled with the polyurethane foam into roll. Optionally, an additional liner can be applied over the carrier. The liner can be incorporated into the film product and rolled into roll. As such, liners can be applied to the foam layer as a release film from the support layer, as the film itself, as a liner released from the film, as the carrier itself, or any combination thereof.

In a particular example, the resulting film and optional liner configurations can be dispensed from a roll and cut into shapes to form sealing gaskets. For example, FIG. 7 includes an illustration of an exemplary sealing gasket 700 cut from a polymer sheet. The sheet, including a film layer 702, can be cut into desirable shapes including inner contours 704 or outer contours 706. For example, the shape of the sealing gasket can be stamped, die cut, or laser cut from the dispensed film layers.

A difference between polymer sheets made from polyurethane dispersions (PUD) and polymer sheets made from polyurethane precursors such as polyols and

isocyanates in the final product is the amount of aromatic residues and aromatic polymer groups in the polymeric scaffold. In general, foams made from polyols and isocyanates have a higher content of aromatic residues. Accordingly, as an inherent property the foams from polyurethane precursors, polyols and isocyanates, are less susceptible to UV exposure since the higher aromatic content absorb UV radiation. Conversely, foams from PUD, which have lesser amounts of aromatic residues or aromatic groups in the polymer, would show a loss of mechanical properties, e.g., tensile strength, after extended exposure to UV radiation. Therefore, one option to differentiate between foams made from precursors, polyols and isocyanates, and foams made from PUD is by exposing samples to UV radiation and measuring loss of a mechanical property, such as elongation at break or tensile strength at break. Such measurements can be made according to ASTM D2565-99. The sample that shows the greater loss is likely the sample that was made from PUD.

Another option to differentiate between a PUD made foam and traditionally made foam is by determining the amount of polymer catalyst in the resulting foam product. Since PUD are already polymerized polyurethane mixtures, no or little amounts of catalysts are necessary to complete the reaction to the final product. Accordingly, PUD foams have a lower content of catalysts. Accordingly, the polyurethane core of the present embodiments include a catalyst in an amount less than for conventional polyurethanes, namely of not greater than about 0.3 wt%, such as not greater than 0.2 wt%, not greater than 0.1 wt%, not greater than 0.05 wt%, not greater than 0.01 wt%, not greater than 0.005 wt%, not greater than 0.001 wt%, not greater than 0.0005 wt%, or not greater than 0.0001 wt%. The polyurethane catalyst can be selected from the group consisting of triethylamine, tributylamine, N-methylmorpholine, N-ethylmorpholine, N,N,N',N'-tetramethylethylenediamine, pentamethyl-diethylenetriamine, 1,4-diazabicyclo(2.2.2)octane, N-methyl-N'-dimethylaminoethylpiperazine, bis-(dimethylaminoalkyl)piperazines, N,N-dimethylbenzylamine, N,N-dimethylcyclohexylamine, N,N-diethylbenzylamine, bis-(N,N-diethylaminoethyl) adipate, N,N,N',N'-tetramethyl-1,3-butanediamine, N,N-dimethyl- β -phenylethylamine, 1,2-dimethylimidazole, 2-methylimidazole, 2,2-bis-(dimethylaminoethyl) ether, di-n-octyltin mercaptide, tin(II) acetate, tin(II) octoate, tin(II) ethylhexoate, tin(II) laurate, dibutyltin(IV) oxide, dibutyltin(IV) dichloride,

dibutyltin(IV) diacetate, dibutyltin(IV) dilaurate, dibutyltin(IV) maleate, and dioctyltin(IV) diacetate.

FIG. 8A depicts the cross-sectional view and components of an electronic device 800, such as tablet computer, having an upper bezel 802, an intermediate frame 804, and LCD display 810, a backlight frame 806 including backlight tubes 814 and diffuser film 812.

FIG. 8B depicts an enlarged view of a section of the disassembled device to further disclose the location for outer gasket 816 located between the cover sheet 8102 of the LCD screen 8104 and upper bezel 802. Inner gasket 818 is located between intermediate frame 804 and LCD screen 8104. The position of the two gaskets display the diversity polyurethane gaskets are exposed to. Gasket 806 has sealing function to separate external factors (dust and moisture) from the internal components, while inner gasket 804 has a spacing and a cushioning function, both of which need to be constant as the device heats and cools during periods of use. This example demonstrates the broad spectrum of demand that gaskets (and bonding tapes) have to satisfy.

In embodiments, the gaskets are compressed between first and second members of an electronic device, such as a circuit, a display part, an electronic screen, an electronic screen cover, a frame, a housing part, or any combination thereof. At least one of the components can be an electronic screen, the electronic screen including diodes, such as LEDs or LCDs. The gaskets can be compressed to at least 10%, such as at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, or at least about 75%. In other embodiments, the compression is not greater than about 90%, such as not greater than about 85%, not greater than about 80%, not greater than about 75%, not greater than about 70%, not greater than about 65%, not greater than about 60%, not greater than about 55%, not greater than about 50%, not greater than about 45%, or not greater than about 45%.

FIG. 9 depicts a cross-sectional view of a bonding tape 900 having a foam core 902, which can be identical to foam core 102 of FIGs. 1-3 or foam core stack

402/406/402 of FIGs. 4-6. The foam core is covered on both major surfaces with an adhesive layer 904, which is in structure and quality identical to adhesive layer 308 (FIG.3) and 612 (FIG. 6). The adhesive layer 904 can be covered with one or two release liners 906 to ensure that the adhesive properties remain intact until deployment.

FIG. 10 depicts another example of the bonding tape 900 in a rolled configuration. Here, the tape has only one release liner 906. The single release liner 906 serves as a protection layer for both adhesive layers 904 since the bonding tape is formed into a roll 1000.

EXAMPLES

Compression Force Deflection and Force-To-Compress

Compression force deflection (CFD) and Force-To-Compress were measured in accordance with ASTM D3574 Test C at compression of 10%, 20%, 30%, . . . , 90%. Results are depicted in FIGs. 11 and 12. Samples of Examples 1-3 were prepared using the ingredients and amounts as shown in Table 1. The various froth samples were mechanically agitated to a froth density of 271 g/L and spread at Wet Gap of 1.25 mm. Table 1 shows that the samples differ in Froth densities. The samples were dried in a oven at temperatures in a range of 110°C to 120°C.

Table 1

	Example 1	Example 2	Example 3
Raw material	weight/g	weight/g	weight/g
Impranil 1554	150	150	150
Impranil 1537	150	150	150
Impranil 1380			
Impranil 1069			
Impranil DLU			
Stokal STA	9	9	9
Stokal SR	9	9	9
Borchigel ALA	4	4	4
ST-9695	12	12	12
IPA			
Cymel 325			
Froth Density/(g/L)	260	353	735
Froth Viscosity(cps)	12000	11480	5820
Wet Gap/mm	1.25	1.25	1.25
Appearance	Good	Good	Good
Rebound Time/s	<0.5 s	<0.5 s	<0.5 s
Density/(g/cm ³)	0.154	0.209	0.462
Thickness/mm	1.1	0.71	0.74

Recovery Time

The recovery time is the time a foam takes to exert a force of 1.5 N after release from 10 seconds of compression. The recovery time is determined in accordance with the method defined below and is expressed in terms of the percent compression prior to release. For example, the 20% recovery time is the time a foam takes to exert the desired force following 20% compression.

The method for determining the recovery time is a) compress a foam layer to a set percent compression (e.g., 20%, 50% or 80%) based on the foam's original thickness at a rate of 0.16 mm/sec using a flat probe having a surface area of 491 mm², b) hold compression for 10 seconds, c) move the probe to a position corresponding to 85% of the original thickness, d) measure the force exerted by the foam for approximately 30 seconds, and e) release compression. The recovery time is the

amount of time the foam takes to exert 1.5 N on the probe when positioned at 85% of the original thickness.

Samples of Examples 4-8 were prepared using the ingredients and amounts as shown in Table 2. The various froth samples were prepared as described above for the compression examples. Afterwards samples of Examples 4-8 were subjected to the 50% recovery time test and the results are shown in Table 2.

Table 2

	Example 4	Example 5	Example 6	Example 7	Example 8
Raw material	weight/g	weight/g	weight/g	weight/g	weight/g
Impranil 1554	200				
Impranil 1537			200		
Impranil 1380				200	
Impranil 1069					200
Impranil DLU		200			
Stokal STA	6	6	6	6	6
Stokal SR	6	6	6	6	6
Borchigel ALA	3	3	3	3	3
ST-9695	12	12	12	12	12
IPA	1	1	1	1	1
Cymel 325	3	3	3	3	3
Froth Density/(g/L)	271	271	271	271	271
Froth Viscosity/(cps)		9520	11700	6340	
Wet Gap/mm	1.25	1.25	1.25	1.25	1.25
Recovery Time/s	0.5s	5s	30s	2s	1s
Density/(g/cm ³)	0.15	0.15	0.163	0.188	0.151
Thickness/mm	0.95	1.04	0.98	0.88	0.9

Compression Set

The compression set were measured in accordance with ASTM D3574 at 23°C for 22 hours at 50%. Examples 9-22 were prepared as depicted in Tables 3A-3C and described above for the compression examples. Table 3A shows the results for formulations with variation of the polyurethane dispersions; Table 3B shows the

results with variation in the amounts of crosslinker Cymel[®] 325; and Table 3C shows the results with variation in the amounts of surfactant Stokal[®] SR.

Table 3A

	Example 9	Example 10	Example 11	Example 12	Example 13
Raw material	weight/g	weight/g	weight/g	weight/g	weight/g
Impranil 1554	200				
Impranil 1537			200		
Impranil 1380				200	
Impranil 1069					200
Impranil DLU		200			
Stokal STA	6	6	6	6	6
Stokal SR	6	6	6	6	6
Borchigel ALA	3	3	3	3	3
ST-9695	12	12	12	12	12
IPA	1	1	1	1	1
Cymel 325	3	3	3	3	3
Froth Density/(g/L)	271	271	271	271	271
Froth Viscosity(cps)		9520	11700	6340	
Wet Gap/mm	1.25	1.25	1.25	1.25	1.25
Density/(g/cm ³)	0.15	0.15	0.163	0.188	0.151
Thickness/mm	0.95	1.04	0.98	0.88	0.9
C-set @ R.T.	9.80%	24.70%	42.70%	39.20%	39.00%

Table 3B

	Example 14	Example 15	Example 16	Example 17	Example 18
Raw material	weight/g	weight/g	weight/g	weight/g	weight/g
Impranil 1554	200	200	200	200	200
Impranil1537					
Impranil1380					
Impranil1069					
ImpranilDLU					
Stokal STA	6	6	6	6	6
Stokal SR	6	6	6	6	6
Borchigel ALA	3	3	3	3	3
ST-9695	12	12	12	12	12
IPA	1	1	1	1	1
Cymel 325	3	6	9	10	20
Froth Density/(g/L)	271	271	271	271	271
Froth Viscosity(cps)		9520	11700	6340	
Wet Gap/mm	1.25	1.25	1.25	1.25	1.25
Density/(g/cm ³)	0.15	0.15	0.163	0.188	0.151
Thickness/mm	0.95	1.04	0.98	0.88	0.9
C-set @ R.T.	9.80%	17.00%	0.72%	0.63%	7.00%

Table 3C

	Example 19	Example 20	Example 21	Example 22
Raw material	weight/g	weight/g	weight/g	weight/g
Impranil 1554	200	200	200	200
Impranil1537				
Impranil1380				
Impranil1069				
ImpranildLU				
Stokal STA	6	6	6	6
Stokal SR	6	10	14	20
Borchigel ALA	3	3	3	3
ST-9695	12	12	12	12
IPA	1	1	1	1
Cymel 325	3	3	3	3
Froth Density/(g/L)	271	271	271	271
Froth Viscosity(cps)		9520	11700	6340
Wet Gap/mm	1.25	1.25	1.25	1.25
Density/(g/cm ³)	0.15	0.15	0.163	0.188
Thickness/mm	0.95	1.04	0.98	0.88
C-set @ R.T.	9.80%	5.00%	2.88%	2.88%

Scratch Resistance Test

Scratch resistance was determined with a Taber[®] Abraser. Scratch resistance was quantified by determining a Scratch Resistance Rating. The Scratch Resistance Rating is the loss in weight percentage of the mass of a sample having a diameter of 100 mm after exposure to 500 cycles on a Taber 5135 Rotary Abraser using Calibrade H-18 wheels at a speed of 60 cycles per minute. Accordingly, the fraction of:

$$[\text{Mass (before test)} - \text{Mass(after test)}] / \text{Mass (before test)}$$

in percent provides the Scratch Resistance Rating.

Samples according to Example 2 above were prepared, discs having a diameter of 100 mm were cut out, weighted, and tested on the Taber 5135 Rotary Abraser equipped with Calibrade H-18 wheels at a speed of 60 cycles/minute. Samples were reweighted after 300, 500, and 700 cycles and the percentage of weight

loss determined. The weight loss in weight percentage after 500 cycles provide the Scratch Resistance Rating.

Comparison Samples were also prepared from K10 gasketing foam, available from Saint-Gobain Performance Plastic Inc. Comparison Example A is a disc of K10 having a thickness of 1.0 mm. Comparison Example B is a disc made from a foam obtained from Rogers Foam Corp., product number 4790-92-090-030. Table 4 depicts the measured weight losses.

Table 4

Number of Cycles	Weight Loss/ wt%		
	Example 2	Comparison Example A	Comparison Example B
300	1.82	4.62	25.4
500	2.28	10.22	<i>Sample broke</i>
700	4.61	22.83	<i>Sample broke</i>

Note that not all of the activities described above in the general description or the examples are required, that a portion of a specific activity may not be required, and that one or more further activities may be performed in addition to those described. Still further, the order in which activities are listed are not necessarily the order in which they are performed.

In the foregoing specification, the concepts have been described with reference to specific embodiments. However, one of ordinary skill in the art appreciates that various modifications and changes can be made without departing from the scope of the invention as set forth in the claims below. Accordingly, the specification and figures are to be regarded in an illustrative rather than a restrictive sense, and all such modifications are intended to be included within the scope of invention.

As used herein, the terms “comprises,” “comprising,” “includes,” “including,” “has,” “having” or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a process, method, article, or apparatus that comprises a list of features is not necessarily limited only to those features but may include other features not expressly listed or inherent to such process, method, article, or apparatus. Further, unless expressly stated to the contrary, “or” refers to an inclusive-or and not to an exclusive-or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

Also, the use of “a” or “an” are employed to describe elements and components described herein. This is done merely for convenience and to give a general sense of the scope of the invention. This description should be read to include one or at least one and the singular also includes the plural unless it is obvious that it is meant otherwise.

Benefits, other advantages, and solutions to problems have been described above with regard to specific embodiments. However, the benefits, advantages, solutions to problems, and any feature(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential feature of any or all the claims.

After reading the specification, skilled artisans will appreciate that certain features are, for clarity, described herein in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features that are, for brevity, described in the context of a single embodiment, may also be provided separately or in any subcombination. Further, references to values stated in ranges include each and every value within that range.

CLAIMS:

1. A polymer sheet comprising:
a polyurethane core, having a first major surface and a second major surface opposite the first major surface; and
at least one functional layer, wherein the polymer sheet has a thickness t_{PS} and the polyurethane core has a thickness t_{PC} , wherein t_{PC} is at least 0.5 t_{PS} , wherein the polyurethane core comprises polyurethane polymer, wherein the polyurethane core has at least one of the following property:
 - (i) a Scratch Resistance Rating of not greater than about 10 wt%,
 - (ii) an elongation at break of at least 200 %,
 - (iii) a tensile strength at break of at least 0.5 MPa,
 - (iv) a loss of tensile strength of at least 5% when exposed to UV light according to standard ASTM D2565-99.
2. The polymer sheet according to claim 1, wherein the polymer sheet has a primary aspect ratio of at least about 100, such as at least about 200, at least about 400, at least about 800, at least about 1000, or at least about 1500.
3. The polymer sheet according to claim 1, wherein the functional layer is selected from the group of a permanent liner, a release liner, a topcoat, an adhesive, or any combination thereof.
4. The polymer sheet according to claim 3, wherein the permanent liner includes a thermoplastic.
5. The polymer sheet according to claim 4, wherein the thermoplastic is selected from polyethylene, polyester, polyimide, or any combination thereof.
6. The polymer sheet according to claim 5, wherein the polyethylene includes ultra-high molecular weight polyethylene.
7. The polymer sheet according to claim 3, wherein the permanent liner, the release liner, or the adhesive layer has a thickness of at least about 0.01 mm, such as at least about 0.015 mm, at least about 0.02 mm, at least about 0.025 mm, at least about 0.03 mm, at least about 0.035 mm, or at least about 0.04 mm.

8. The polymer sheet according to claim 3, wherein the permanent liner, the release liner, or the adhesive layer has a thickness of not greater than about 0.1 mm, such as not greater than about 0.09 mm, not greater than about 0.08 mm, not greater than about 0.075 mm, not greater than about 0.07 mm, not greater than about 0.065 mm, not greater than about 0.06 mm, not greater than about 0.055 mm, or not greater than about 0.05 mm.

9. The polymer sheet according to claim 3, wherein the release liner includes a polyester, polyethylene, polypropylene, paper, or any combination thereof.

10. The polymer sheet according to claim 3, wherein the topcoat includes an acrylic coating, a polyurethane coating, or a combination thereof.

11. The polymer sheet according to claim 10, wherein the polyurethane coating includes a silicone modified polyurethane coating.

12. The polymer sheet according to claim 3, wherein the topcoat as thickness of at least about 0.001 mm, such as at least about 0.002 mm, at least about 0.003 mm, or at least about 0.004 mm.

13. The polymer sheet according to claim 3, wherein the topcoat has a thickness of not greater than about 0.01 mm, such as not greater than about 0.009 mm, not greater than about 0.008 mm, not greater than about 0.007 mm, not greater than about 0.006 mm, or not greater than about 0.005 mm.

14. The polymer sheet according to claim 3, wherein the adhesive is an acrylic adhesive, a pressure sensitive adhesive, a silicon adhesive, or a rubber hot melt adhesive.

15. The polymer sheet according to claim 1, wherein the polymer sheet is in form of a roll.

16. The polymer sheet according to claim 15, wherein the roll has a diameter of at least about 0.5 m, such as at least about 0.8 m, at least about 0.9 m, at least about 1.0 m, at least about 1.1 m, at least about 1.2 m, or at least about 1.3 m.

17. The polymer sheet according to claim 15, wherein the roll has a diameter of not greater than about 2.0 m, such as not greater than about 1.9 m, not greater than about 1.8 m, not greater than about 1.7 m, not greater than about 1.6 m, or not greater than about 1.5 m,

18. An assembly comprising:

a first member and a second member; and

a gasket compressed between the first member and the second member, wherein the gasket includes a polyurethane core, having a first major surface and a second major surface opposite the first major surface; and

the gasket is compressed between the first and the second member at a compression of at least about 10%,

wherein the polyurethane core comprises a polyurethane polymer, wherein the polyurethane core has at least one of the following properties:

(i) a Scratch Resistance Rating of not greater than about 10 wt%,

(ii) an elongation at break of at least 200 %,

(iii) a tensile strength at break of at least 0.5 MPa,

(iv) a loss of tensile strength of at least 5% when exposed to UV light according to standard ASTM D2565-99.

19. The assembly according to claim 18, wherein the assembly is an electronic device and the first member and the second member are components of the electronic device.

20. The assembly according to claim 19, wherein the components are selected from a circuit, a display part, an electronic screen, an electronic screen cover, a frame, a housing part, or any combination thereof.

21. The assembly according to claim 19, wherein the at least one of the components is an electronic screen, the electronic screen including diodes.

22. The assembly according to claim 21, wherein the diodes include LEDs or LCDs.

23. The assembly according to claim 18, wherein the compression is at least about 20% , such as at least about 25%, at least about 30%, at least about 35%, at least

about 40%, at least about 45%, at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, or at least about 75%.

24. The assembly according to claim 18, wherein the compression is not greater than about 90%, such as not greater than about 85%, not greater than about 80%, not greater than about 75%, not greater than about 70%, not greater than about 65%, not greater than about 60%, not greater than about 55%, not greater than about 50%, not greater than about 45%, or not greater than about 45%.

25. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the polyurethane core has a thickness of at least about 0.2 mm, such as at least about 0.4 mm, at least about 0.6 mm, at least about 0.8 mm, at least about 1.0 mm, at least about 1.2 mm, at least about 1.4 mm, at least about 1.6 mm, at least about 1.8 mm, at least about 2.0 mm, or at least about 2.2 mm.

26. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the polyurethane core has a thickness of not greater than about 3.0 mm, such as not greater than about 2.8 mm, not greater than about 2.6 mm, not greater than about 2.4 mm, not greater than about 2.2 mm, not greater than about 2.0 mm, not greater than about 1.8 mm, or not greater than about 1.6 mm.

27. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the polyurethane core has multiple layers.

28. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the Scratch Resistance Rating is not greater than about 8 wt%, such as not greater than about 6 wt%, not greater than about 5 wt%, not greater than about 4 wt%, or not greater than about 2 wt%.

29. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the Elongation at Break is at least about 300 %, such as at least about 400 %, at least about 500 %, at least about 600 %, at least about 700 %, at least about 800 %, at least about 900 %, at least about 1000 %, at least about 1200 %, at least about 1400 %, at least about 1600 %, or at least about 1800 %.

30. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the tensile strength at break is at least about 0.7 MPa, such as at least about 1 MPa, at least about 1.5 MPa, at least about 2 MPa, at least about 2.5 MPa, at least about 3 MPa, at least about 3.5 MPa, at least about 4 MPa, at least about 4.5 MPa, at least about 5 MPa, at least about 5.5 MPa, or at least about 6 MPa.

31. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the loss of tensile strength when exposed to UV light according to standard ASTM D2565-99 is at least about 8 %, such as at least about 10 %, at least about 12 %, at least about 14 %, at least about 16 %, at least about 18 %, at least about 20 %, at least about 22 %, at least about 25 %, or at least about 30 %.

32. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the polyurethane core has at least one of the following performance data:

- (i) a compression force deflection at 25% compression of at least 3 kPa;
- (ii) a force to compress at 25% compression of at least 6 kPa and;
- (iii) a recovery time of not greater than 5 seconds according to ASTM D3574
- (iv) a compression set of not greater than 10% after compression of 50% at room temperature for 22 hours according to ASTM D3574.

33. The polymer sheet according to claim 32, wherein the compression force deflection at 25% compression is at least about 5 kPa, such as at least about 7 kPa, at least about 9 kPa, at least about 11 kPa, at least about 13 kPa, at least about 15 kPa, at least about 17 kPa, at least about 19 kPa, at least about 21 kPa, at least about 23 kPa, at least about 25 kPa, at least about 27 kPa, or at least about 29 kPa.

34. The polymer sheet according to claim 32, wherein the compression force deflection at 25% compression is not greater than about 35 kPa, such as not greater than about 34 kPa, not greater than about 32 kPa, not greater than about 30 kPa, not greater than about 28 kPa, not greater than about 26 kPa, not greater than about 24 kPa, not greater than about 22 kPa, not greater than about 20 kPa, not greater than about 18 kPa, not greater than about 16 kPa, not greater than about 14 kPa, not greater than about 12 kPa, or not greater than about 10 kPa.

35. The polymer sheet according to claim 32, wherein the force to compress at 25% compression is at least about 7 kPa, such as at least about 9 kPa, at least about 11 kPa, at least about 13 kPa, at least about 15 kPa, at least about 17 kPa, at least about 19 kPa, at least about 21 kPa, at least about 23 kPa, at least about 25 kPa, at least about 27 kPa, at least about 29 kPa, at least about 31 kPa, at least about 33 kPa, at least about 35 kPa, at least about 37 kPa, at least about 39 kPa, at least about 41 kPa, at least about 43 kPa, or at least about 45 kPa.

36. The polymer sheet according to claim 32, wherein the force to compress at 25% compression is not greater than about 50 kPa, such as not greater than about 48 kPa, not greater than about 46 kPa, not greater than about 44 kPa, not greater than about 42 kPa, not greater than about 40 kPa, not greater than about 38 kPa, not greater than about 36 kPa, not greater than about 34 kPa, not greater than about 32 kPa, not greater than about 30 kPa, not greater than about 28 kPa, not greater than about 26 kPa, not greater than about 24 kPa, not greater than about 22 kPa, not greater than about 20 kPa, not greater than about 18 kPa, not greater than about 16 kPa, not greater than about 14 kPa, or not greater than about 12 kPa.

37. The polymer sheet according to claim 32, wherein the recovery time from 50 % compression is not greater than 4 seconds, not greater than 3 seconds, or not greater than 2 seconds.

38. The polymer sheet according to claim 32, wherein the compression set is not greater than about 8%, such as not greater than about 7%, not greater than about 6%, not greater than about 5%, not greater than about 4%, not greater than about 3%, or not greater than about 2%.

39. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the polyurethane polymer comprises a crosslinker.

40. The polymer sheet or the assembly according to claim 39, wherein the crosslinker is a melamine-based crosslinker, an isocyanate-based crosslinker, or a polyaziridine based crosslinker.

41. The polymer sheet or the assembly according to claim 40, wherein the melamine-based crosslinker is melamine.

42. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the polyurethane core has a density of at least 50 kg/m^3 , such as at least about 60 kg/m^3 , at least about 70 kg/m^3 , at least about 80 kg/m^3 , at least about 90 kg/m^3 , at least about 100 kg/m^3 , at least about 120 kg/m^3 , at least about 140 kg/m^3 , at least about 160 kg/m^3 , at least about 180 kg/m^3 , or at least about 200 kg/m^3 .

43. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the polyurethane core has a density of not greater than about 350 kg/m^3 , such as not greater than about 330 kg/m^3 , not greater than about 310 kg/m^3 , not greater than about 290 kg/m^3 , not greater than about 270 kg/m^3 , not greater than about 250 kg/m^3 , not greater than about 230 kg/m^3 , not greater than about 210 kg/m^3 , not greater than about 190 kg/m^3 , not greater than about 170 kg/m^3 , not greater than about 150 kg/m^3 , not greater than about 130 kg/m^3 , or not greater than about 110 kg/m^3 .

44. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the polyurethane core comprises cells, wherein at least 50% of the cells have a cell diameter of at least about 30 microns, such as at least about 40 microns, at least about 50 microns, at least about 60 microns, at least about 70 microns, at least about 80 microns, at least about 90 microns, at least about 100 microns, at least about 120 microns, and not greater than about 160 microns.

45. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the polyurethane core comprises cells, wherein at least 50% of the cells have a cell diameter of, not greater than about 160 microns, not greater than about 140 microns, not greater than about 120 microns, not greater than about 100 microns, not greater than about 90 microns, not greater than about 80 microns, not greater than about 70 microns, or not greater than about 60 microns.

46. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the polyurethane core further comprises a surfactants, a pigment, a flame retardant, a thickener, a filler, or any combination thereof.

47. The polymer sheet or the assembly according to claim 46, wherein the filler is selected from the group consisting of bentonite, kaolin, powdered glass, glass

beads, glass fibers, calcium carbonate, quartz sand, fluoropolymer, thermoplastic, microspheres, and any combination thereof.

48. The polymer sheet or the assembly according to claim 46, wherein the surfactant is selected from the group consisting of ether sulfates, fatty alcohol sulfates, sarcosinates, organic amine oxides, sulfonates, betaines, organic acid amides, sulfosuccinates, sulfonic acids, alkanolamides, ethoxylated fatty alcohols, sorbinates, and any combination thereof.

49. The polymer sheet or the assembly according to any one of claims 1 through 24, wherein the polyurethane core further comprises a catalyst in an amount of not greater than about 0.3 wt%, such as not greater than 0.2 wt%, not greater than 0.1 wt%, not greater than 0.05 wt%, not greater than 0.01 wt%, not greater than 0.005 wt%, not greater than 0.001 wt%, not greater than 0.0005 wt%, or not greater than 0.0001 wt%.

50. The polymer sheet or the assembly according to claim 49, wherein the catalyst is selected from the group consisting of triethylamine, tributylamine, N-methylmorpholine, N-ethylmorpholine, N,N,N',N'-tetramethylethylenediamine, pentamethyl-diethylenetriamine, 1,4-diazabicyclo(2.2.2)octane, N-methyl-N'-dimethylaminoethylpiperazine, bis-(dimethylaminoalkyl)piperazines, N,N-dimethylbenzylamine, N,N-dimethylcyclohexylamine, N,N-diethylbenzylamine, bis-(N,N-diethylaminoethyl) adipate, N,N,N',N'-tetramethyl-1,3-butanediamine, N,N-dimethyl- β -phenylethylamine, 1,2-dimethylimidazole, 2-methylimidazole, 2,2-bis-(dimethylaminoethyl) ether, di-n-octyltin mercaptide, tin(II) acetate, tin(II) octoate, tin(II) ethylhexoate, tin(II) laurate, dibutyltin(IV) oxide, dibutyltin(IV) dichloride, dibutyltin(IV) diacetate, dibutyltin(IV) dilaurate, dibutyltin(IV) maleate, and dioctyltin(IV) diacetate.

51. A method of preparing a polymer sheet, the method comprising
 frothing a polyurethane dispersion into a froth;
 casting the froth onto a liner;
 treating the froth to have a uniform thickness;
 drying the froth to form a polyurethane core having a thickness t_{PF} and t_{PF}
 being at least 0.5 of a total thickness of the polymer sheet,

wherein the polyurethane core comprises polyurethane polymer, wherein the polyurethane core has at least one of the following property:

- (i) a Scratch Resistance Rating of not greater than about 10 wt%,
- (ii) an elongation at break of at least 200 %,
- (iii) a tensile strength at break of at least 0.5 MPa,
- (iv) a loss of tensile strength of at least 5% when exposed to UV light

according to standard ASTM D2565-99.

52. The method according to claim 51 further comprising casting a topcoat layer onto the foam polymer.

53. The method according to claim 52, wherein the topcoat includes an acrylic coating, a polyurethane coating, or a combination thereof.

54. The method according to claim 53, wherein the polyurethane coating includes a silicone modified polyurethane coating.

55. The method according to claim 52, wherein the topcoat as thickness of at least about 0.001 mm, such as at least about 0.002 mm, at least about 0.003 mm, or at least about 0.004 mm.

56. The method according to claim 52, wherein the topcoat has a thickness of not greater than about 0.01 mm, such as not greater than about 0.009 mm, not greater than about 0.008 mm, not greater than about 0.007 mm, not greater than about 0.006 mm, or not greater than about 0.005 mm.

57. The method according to claim 51 further comprising applying a film onto the foam polymer.

58. The method according to claim 57, wherein the film includes a thermoplastic.

59. The method according to claim 58, wherein the thermoplastic is selected from polyethylene, polyester, polyimide, or any combination thereof.

60. The method according to claim 59, wherein the polyethylene includes ultra-high molecular weight polyethylene.

61. The method according to claim 57, wherein the film has a thickness of at least about 0.01 mm, such as at least about 0.015 mm, at least about 0.02 mm, at least about 0.025 mm, at least about 0.03 mm, at least about 0.035 mm, or at least about 0.04 mm.

62. The method according to claim 57, wherein the film has a thickness of not greater than about 0.1 mm, such as not greater than about 0.09 mm, not greater than about 0.08 mm, not greater than about 0.075 mm, not greater than about 0.07 mm, not greater than about 0.065 mm, not greater than about 0.06 mm, not greater than about 0.055 mm, or not greater than about 0.05 mm.

63. The method according to claim 57, further comprising casting a second froth layer onto the film.

64. The method according to claim 51, wherein frothing includes mechanical frothing, or gas frothing,

65. The method according to claim 64, wherein the gas frothing includes blowing with a gas or a blowing agent.

66. The method according to claim 65, wherein the gas is selected from air, nitrogen, an inert gas, or any combination thereof.

67. The method according to claim 65, wherein the blowing agent includes a hydrohalocarbon.

68. The method according to any one of claims 51 through 64, wherein the polyurethane dispersion further comprises a surfactants, a pigment, a flame retardant, a thickener, a filler, or any combination thereof.

69. The method according to claim 68, wherein the filler is selected from the group consisting of bentonite, kaolin, powdered glass, glass beads, glass fibers, calcium carbonate, quartz sand, fluoropolymer, thermoplastic, microspheres, and any combination thereof..

70. The method according to claim 68, wherein the surfactant is selected from the group consisting of ether sulfates, fatty alcohol sulfates, sarcosinates, organic amine oxides, sulfonates, betaines, organic acid amides, sulfosuccinates, sulfonic

acids, alkanolamides, ethoxylated fatty alcohols, sorbinates, and any combination thereof.

71. The method according to any one of claims 51 through 64, wherein the froth has a froth density of at least about 100 g/L, such as at least about 110 g/L, at least about 120 g/L, at least about 130 g/L, at least about 140 g/L, at least about 150 g/L, at least about 170 g/L, at least about 190 g/L, at least about 210 g/L, at least about 230 g/L, or at least about 250 g/L.

72. The method according to any one of claims 51 through 64, wherein the froth has a froth density of not greater than about 1200 g/L, such as not greater than about 1100 g/L, not greater than about 1000 g/L, not greater than about 900 g/L, not greater than about 800 g/L, not greater than about 700 g/L, not greater than about 600 g/L, not greater than about 500 g/L, not greater than about 400 g/L, or not greater than about 300 g/L.

73. The method according to any one of claims 51 through 64, further comprising drying the froth at a temperature of at least about 50 °C, such as at least about 60 °C, at least about 70 °C, at least about 80 °C, at least about 90 °C, at least about 100 °C, at least about 110 °C, at least about 120 °C, or at least about 130 °C.

74. The method according to claim 73, wherein the temperature is not greater than about 180 °C, such as not greater than about 170°C, not greater than about 160°C, or not greater than about 150°C.

75. The method according to any one of claims 51 through 64, wherein the froth has a viscosity of not greater than about 18000 cps, such as not greater than about 17000 cps, not greater than about 16000 cps, not greater than about 15000 cps, not greater than about 14000 cps, not greater than about 13000 cps, not greater than about 12000 cps, not greater than about 11000 cps, not greater than about 10000 cps, not greater than about 9000 cps, not greater than about 8000 cps, not greater than about 7000 cps, not greater than about 6000 cps, or not greater than about 5000 cps.

76. The method according to any one of claims 51 through 64, wherein the froth has a viscosity of at least about 800 cps, such as at least about 900 cps, at least

about 1000 cps, at least about 1500 cps, at least about 2000 cps, at least about 2500 cps, at least about 3000 cps, at least about 3500 cps, or at least about 4000 cps.

1 / 7

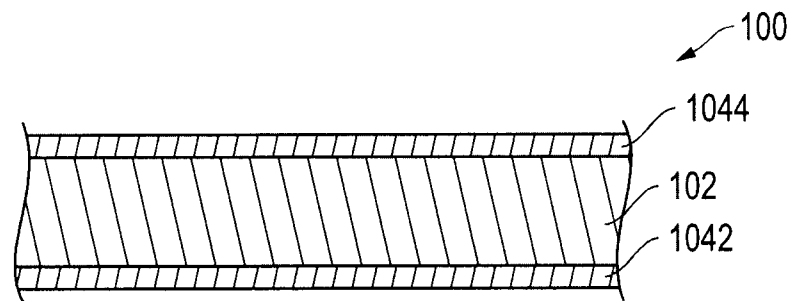


FIG. 1

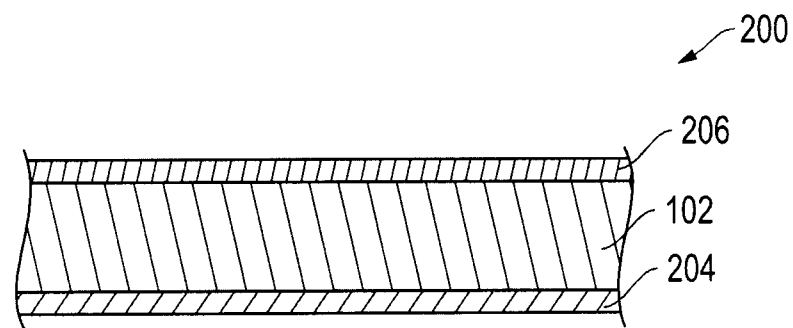


FIG. 2

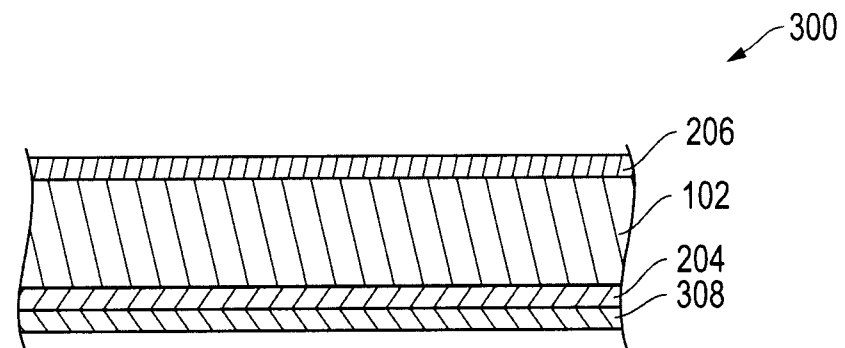


FIG. 3

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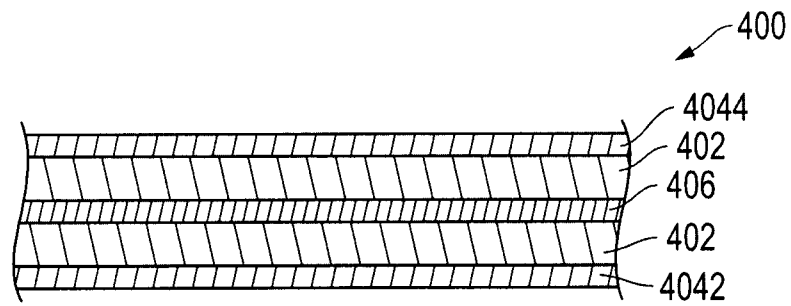


FIG. 4

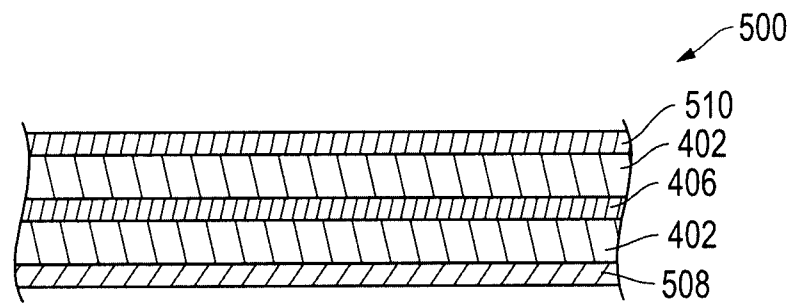


FIG. 5

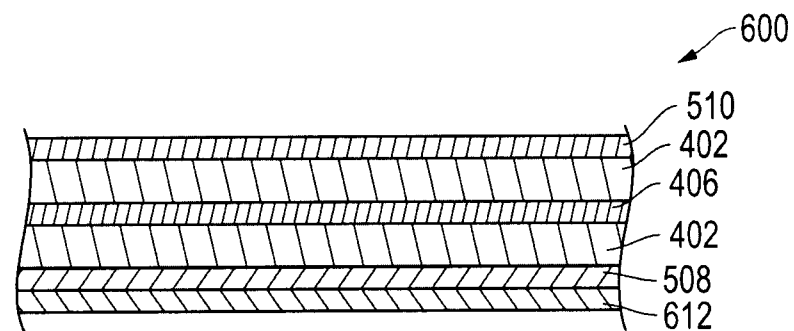


FIG. 6

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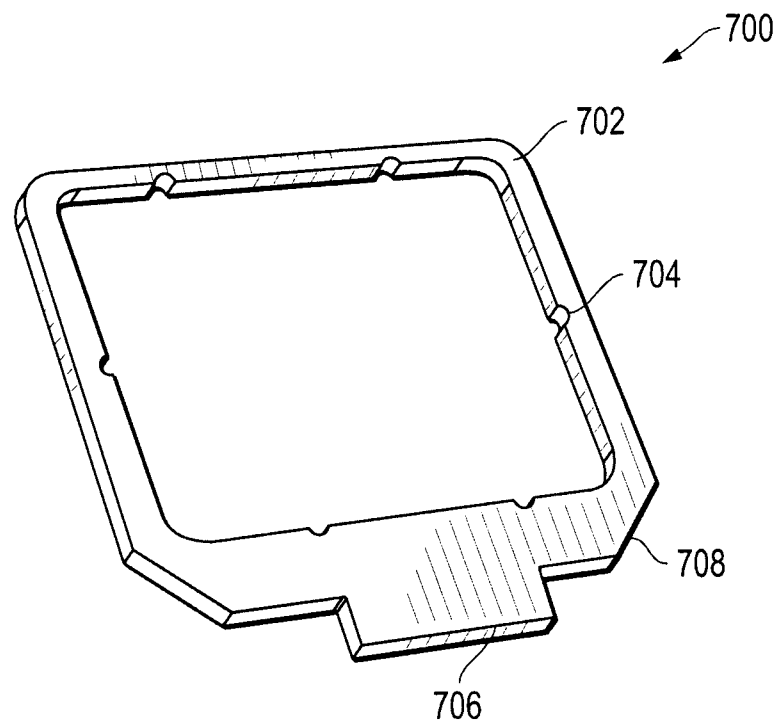
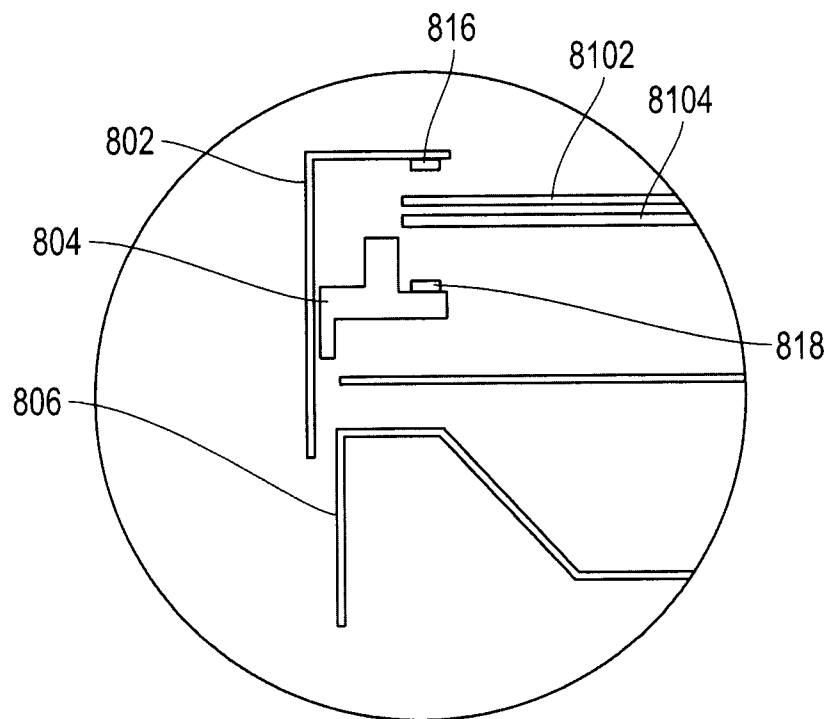
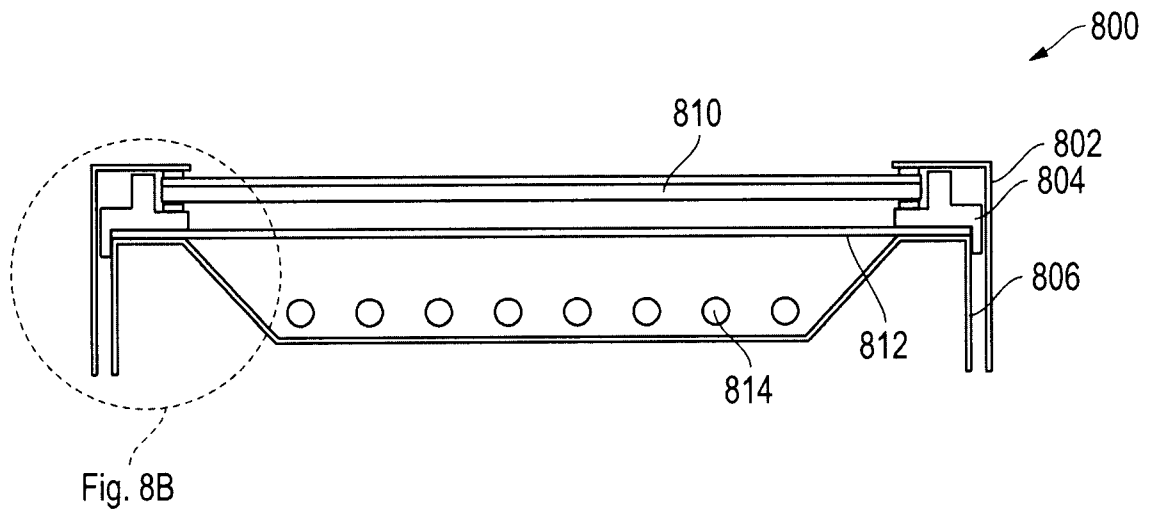


FIG. 7

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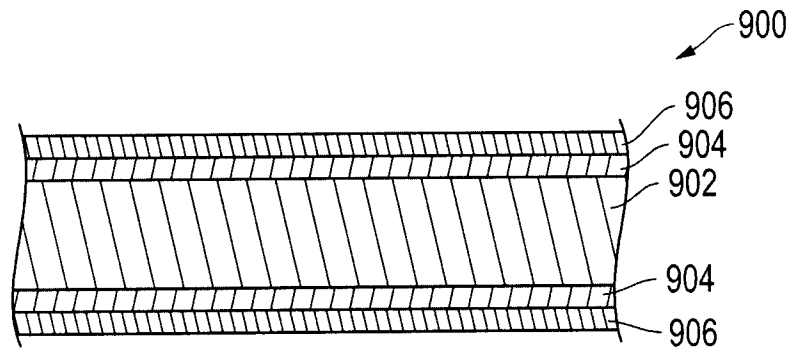


FIG. 9

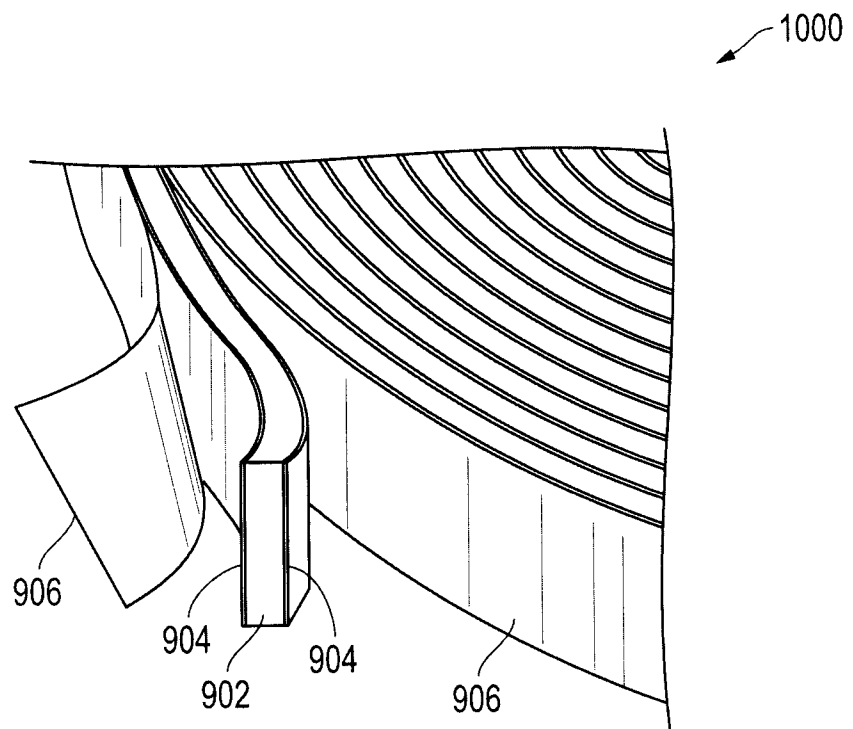


FIG. 10

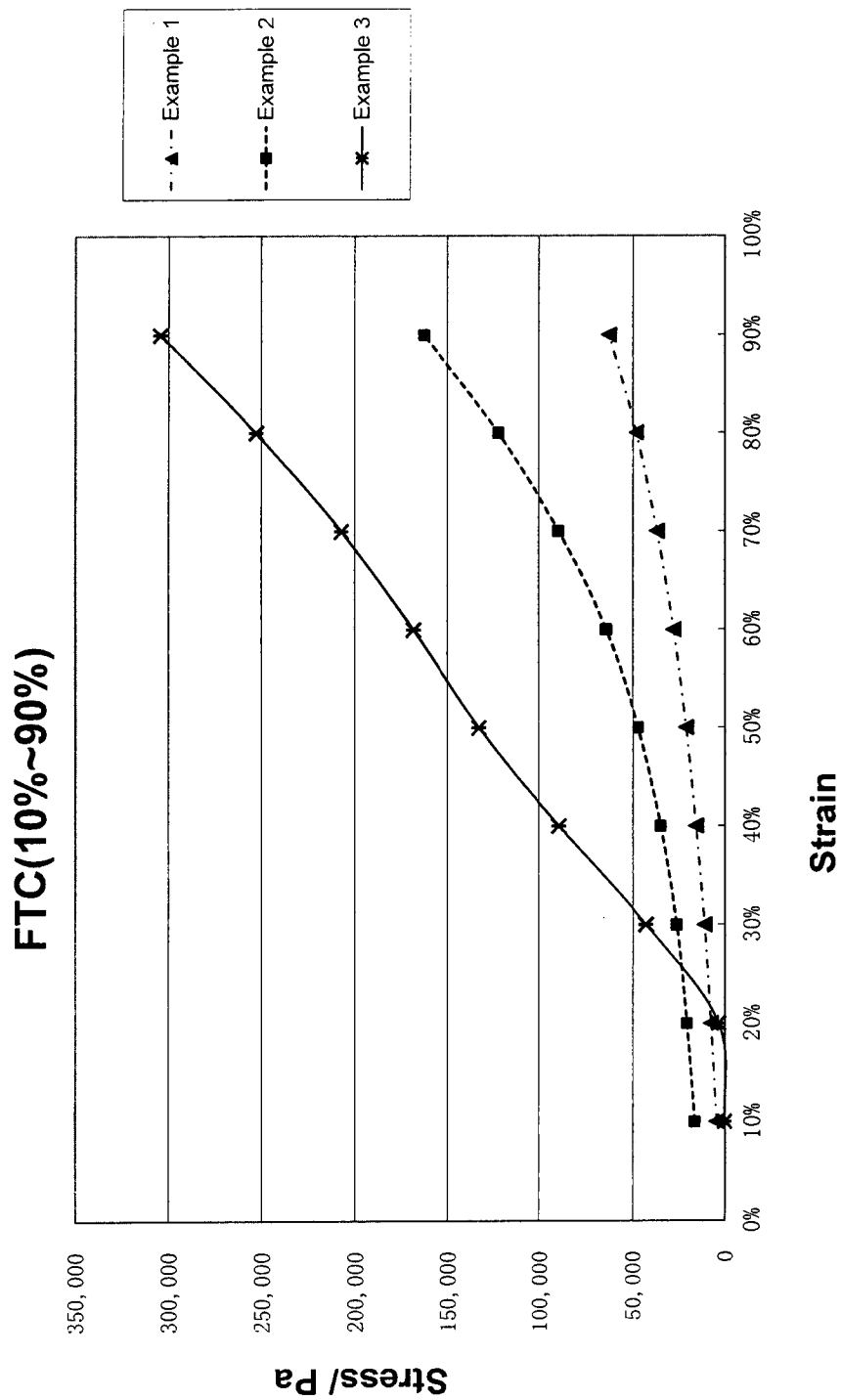


FIG. 11

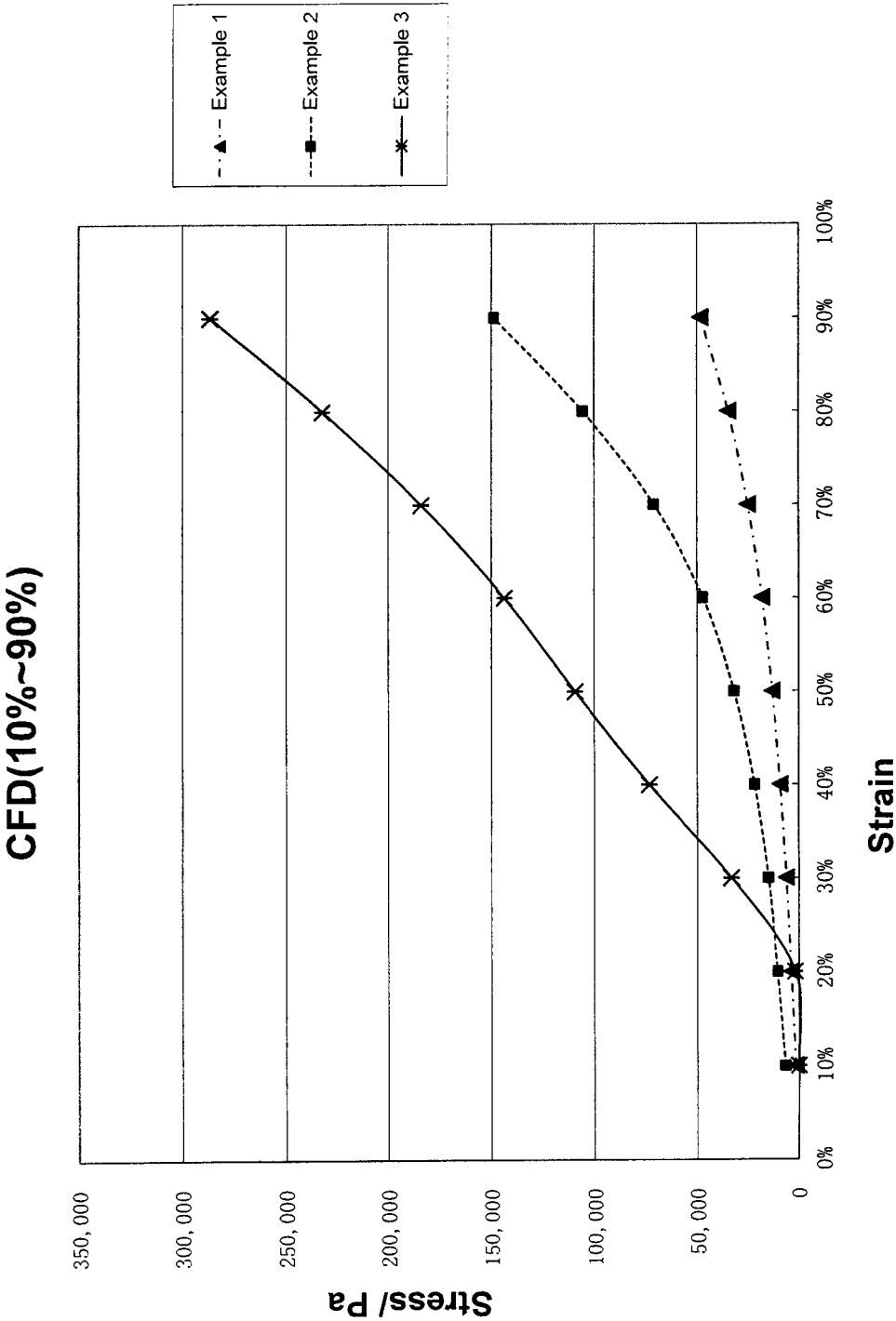


FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/001765

A. CLASSIFICATION OF SUBJECT MATTER

See the extra sheet

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)

IPC: B32B 5; B32B 27; F16J 15

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

CNPAT, CNKI, WPI, EPODOC, USTXT, WOTXT, EPTXT, CATXT: PU, POLYURETHANE, LAYER?, CORE?, SANDWICH?, SCRATCH RESISTANCE RATING, TENSILE STRENGTH, SHEET?, GASKET?, FOAM?, THICKNESS, RELEASE LINER?, ELECTRON+

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2011020549 A1 (SAINT-GOBAIN PERFORMANCE PLASTICS COR), 27 January 2011 (27.01.2011), see description, paragraphs [0048] , [0049], paragraphs [0084] to [0086] and figures 1 to 7	1-76
A	WO 2012006543 A2 (SAINT-GOBAIN PERFORMANCE PLASTICS CORP), 12 January 2012 (12.01.2012), see description, page 9, line 28 to page 11, line 25, page 12, line 16 to page 13, line 17 and figures 3 and 5	1-76
A	US 2004157035 A1 (GORE ENTERPRISE HOLDINGS INC), 12 August 2004 (12.08.2004), the whole document	1-76
A	CN 101850639 A (INOUE MTP KK et al.), 06 October 2010 (06.10.2010), the whole document	1-76
A	CN 1386091 A (WORLD PROPERTIES INC [US]), 18 December 2002 (18.12.2002), the whole document	1-76

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:	“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
“A” document defining the general state of the art which is not considered to be of particular relevance	“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
“E” earlier application or patent but published on or after the international filing date	“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
“L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	“&” document member of the same patent family
“O” document referring to an oral disclosure, use, exhibition or other means	
“P” document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 30 August 2013 (30.08.2013)	Date of mailing of the international search report 03 Oct. 2013 (03.10.2013)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer XIONG, Yanbing Telephone No. (86-10)62084082

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/001765

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/001765

A. CLASSIFICATION OF SUBJECT MATTER

B32B 5/18 (2006.01) i

B32B 27/40 (2006.01) i

F16J 15/00 (2006.01) i