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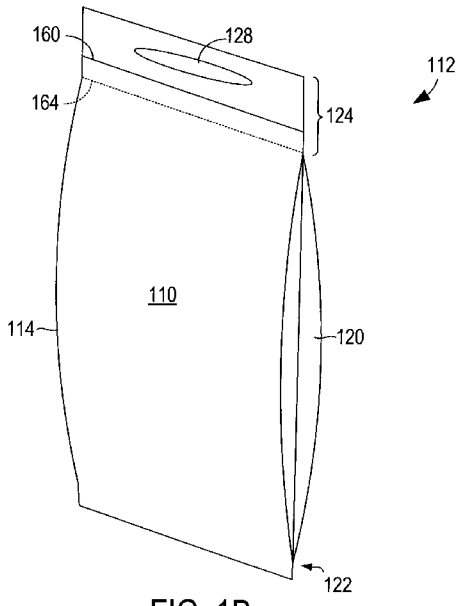

FIG. 1B

(57) Abstract: A package includes at least one closed end including a pair of opposed package panels, each face of the pair of opposed package faces including an interior side and an exterior face, at least one panel comprising a woven polymer material, wherein the interior faces of the package panels are joined to one another to define an interior joined area, the joined panels being folded towards and joined to the exterior face of the package to define a second joined area.

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HIGH STRENGTH PACKAGES AND PACKAGING MATERIALS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Patent Application No. 12/616,371, filed November 11, 2009, which is a continuation-in-part of U.S. Patent Application No. 11/824,175, filed June 28, 2007, now abandoned, which claims the benefit of U.S. Provisional Application No. 60/817,488, filed June 29, 2006. This application also claims the benefit of U.S. Provisional Application No. 61/247,983, filed October 2, 2009 and of U.S. Provisional Application No. 61/278,060, filed October 2, 2009. Each of the above applications is incorporated by reference in its entirety.

OTHER RELATED APPLICATIONS

This application is related to U.S. Patent Application No. 12/776,468, filed May 10, 2010, U.S. Patent Application No. 12/776,483, filed May 10, 2010, U.S. Patent Application No. 12/776,494, and U.S. Patent Application No. 12/776,507, filed May 10, 2010, each of which is incorporated by reference herein in its entirety.

BACKGROUND

There is a need for high strength, tamper resistant packaging materials for many applications including, for example, pet food, bird seed, grains, controlled environment feeding (e.g., in test laboratories), livestock feed, and so on.

It is known to use woven materials, for example, woven polymeric materials (i.e., polymeric filaments that are woven into a mesh), to impart strength to packaging materials. Such woven materials are typically used in combination with other materials to provide the desired degree of impermeability, strength, stiffness, and other attributes. However, such materials may be difficult to join to other materials and present numerous challenges when being formed into a package.

For example, in traditional packaging formation, the ends of two panels or faces of a tubular structure are typically brought together and joined via adhesive, heat sealing, or otherwise to form a pinch seal. However, in many instances, in particular

where a woven polymer layer is used, the area to be joined is quite thick, and therefore, difficult to join without using relatively thick heat seal layers (or a relatively high amount of adhesive material), which, in some instances, may require high heat sealing temperatures. Unfortunately, the application of too much heat can cause the woven polymer to soften and/or distort, thereby compromising the integrity of the structure. Additionally, even where a pinch seal is successfully formed, the seal often tends to be weak, and may fail when the package is being filled. As a result, packages using woven polymer materials are typically sewn or stitched and/or taped at one or both ends to reinforce the seal. However, this process is complicated and costly. Additionally, such processes are prone to issues caused by needle breakage, which may result in contamination of the product with broken needles or needle shards.

To overcome these obstacles, it has been proposed to "step cut" one panel or face of the package (such that one panel or face is longer than the other), and simply fold the longer panel over the shorter panel, as disclosed in U.S. Patent No. 6,800,051. This generally reduces the thickness of the overlapping areas to be sealed. However, woven materials are generally difficult to cut in this manner without unraveling and forming strings that cause other processing issues.

Thus, there is a need for high strength packaging materials including woven polymeric materials that are capable of being formed into packages. There is also a need for a method of forming a package including woven materials in which a sufficiently strong heat seal can be formed without the need for sewing.

SUMMARY

This application is directed generally to a material for forming packages or other constructs (i.e., a "packaging material"), a method of making the packaging material, a method of forming a package from the material, and packages formed therefrom. The packaging material generally includes a woven polymer substrate and a pair of facing systems on opposite sides of the substrate. Each facing system may include a plurality of layers including, but not limited to, polymer films, polymer or polymeric coatings or layers, paper layers, other woven materials, or any other

suitable material. At least a portion of the outermost surface of each facing system may be heat sealable (via application of adhesive, polymer coatings, or otherwise) such that a portion of each facing system can be joined to itself to form a package. As a result, the packaging material can be sealed using a variety of seal types, for example, a pinch seal, a single fold pinch seal (or shear seal, i.e., a combination of a pinch seal and a foldover seal), a double fold pinch seal (or double shear seal), a fin seal, or any other suitable seal. Notably, any of such seals may be made using a straight cut, that is, without the need for a step cut or notched panel that reduces the thickness of the sealed area. The present inventors have discovered that the packaging materials of the present disclosure may be used to form strong bonds that can withstand conventional filling operations without the need for sewing, taping, or other mechanical reinforcement. Thus, the present packaging material provides great flexibility in forming packages.

Although several exemplary packaging materials are disclosed herein, numerous packaging materials are contemplated by this disclosure.

In one example, each facing system generally includes a polymer film layer. One or both of the polymer film layers may be heat sealable for forming the packaging material into a package. The heat sealable layers enable the packaging material to be formed into a variety of packages using different end seals without having the problems commonly associated with sealing packages containing woven polymer layers.

In another example, one facing system of the packaging material includes a polymer film layer that is joined to the substrate, and the other facing system comprises a blend of heat sealable materials, for example, linear low density polyethylene, low density polyethylene, and ethylene/methacrylic acid. The polymer film layer may be heat sealable if desired, or another heat sealable material may overlie the polymer film layer. In one variation of this example, the polymer film layer comprises a polyolefin, for example, biaxially oriented polypropylene. However, numerous other possibilities are contemplated.

In still another example, both facing systems comprise a blend of heat sealable materials, for example, linear low density polyethylene, low density polyethylene, and ethylene/methacrylic acid, or any other suitable material.

The packaging material may be used to form various packages or other constructs. In some instances, the packaging material may be used for packaging a food item that is coated with or contains an oily or greasy substance, for example, a trans fatty acid oil, a low trans fatty acid oil, a non-trans fatty acid oil, a saturated oil, an unsaturated oil, grease, fat, or butter (collectively "oil" or "oils"), that potentially can penetrate one or more components of the packaging material. In some particular examples, the packaging material may be used to form packages or other constructs for containing food items, pet food, bird seed, or any other suitable item. Accordingly, in each of such examples and in any other embodiment contemplated hereby, the facing systems may include numerous other layers or materials, as needed to attain the desired attributes for the packaging material. For example, the packaging material may include one or more oil resistant layers. Additionally or alternatively, the packaging material may include one or more tie layers to improve adhesion (e.g., hot tack and/or seal strength) between various layers. Other applications are contemplated.

Other aspects and features of the present invention will become apparent in view of the figures and the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

The description refers to the accompanying drawings, some of which are schematic, in which like reference characters refer to like parts throughout the several views, and in which:

FIG. 1A is a schematic cross-sectional view of an exemplary packaging material according to various aspects of the disclosure;

FIG. 1B is a schematic front perspective view of an exemplary package formed from the packaging material of **FIG. 1A**;

FIG. 1C is a schematic rear elevation view of the package of **FIG. 1B** with a shear seal at one end of the package and a double shear seal (i.e., a double fold pinch closure) at the other end of the package;

FIG. 1D is a schematic cross-sectional view of a bottom portion of the package of **FIG. 1C**, taken along line **1D-1D** of **FIG. 1C**;

FIG. 1E is a schematic cross-sectional view of a bottom portion of the package of **FIG. 1C**, taken along line **1E-1E** of **FIG. 1C**;

FIG. 1F is a schematic cross-sectional view of a top portion of the package of **FIG. 1C**, taken along line **1F-1F** of **FIG. 1C**;

FIG. 1G is a schematic front perspective view of a tubular construct for forming a package, with its right and left side panels folded inwardly;

FIG. 1H is a schematic rear elevation view of a first end of the construct of **FIG. 1G** in a generally flattened configuration, with the end being closed with a pinch seal;

FIG. 1I is a schematic cross-sectional view of a top portion of the construct of **FIG. 1H**, taken along line **1I-1I** of **FIG. 1H**, with only the cross-section being shown, and with a portion of the interior of the construct being shown;

FIG. 1J is a schematic cross-sectional view of a top portion of the construct of **FIG. 1H**, taken along line **1J-1J** of **FIG. 1H**;

FIG. 1K is a schematic rear elevation view of a second end of the construct of **FIG. 1G** in a generally flattened configuration, with the end being closed with a pinch seal;

FIG. 1L is a schematic cross-sectional view of a top portion of the construct of **FIG. 1K**, taken along line **1L-1L** of **FIG. 1K**;

FIG. 2 is a schematic cross-sectional view of an exemplary packaging material in accordance with various aspects of the disclosure;

FIG. 3 is a schematic cross-sectional view of another exemplary packaging material in accordance with various aspects of the disclosure; and

FIG. 4 is a schematic cross-sectional view of still another exemplary packaging material in accordance with various aspects of the disclosure.

DESCRIPTION

Various aspects of the invention may be illustrated by referring to the figures, which depict examples of packaging materials and packages formed therefrom. For purposes of simplicity, like numerals may be used to describe like features. Although several different exemplary aspects, implementations, and embodiments of the various inventions are provided, numerous interrelationships between, combinations thereof, and modifications of the various inventions, aspects, implementations, and embodiments are contemplated hereby.

FIG. 1A schematically illustrates an exemplary material for forming a package (i.e., a packaging material) **100**. The packaging material **100** generally includes a woven polymer substrate **102** and a pair of facing systems **104**, **106**, each of which may include one or more layers that are coextruded and/or otherwise joined to one another. Such layers may include polymer films, polymer or polymeric coatings or layers, paper layers, other woven or nonwoven materials, or any other suitable material. Each facing system **104**, **106** of the packaging material **100** includes an outermost surface **108**, **110** that respectively defines the inner (i.e., interior) and outer (i.e., exterior) sides or faces **108**, **110** of the packaging material **100** (and/or resulting package **112**).

Each side **108**, **110** of the packaging material **100** includes (or is provided with) at least one area or zone (not shown) that is capable of being joined to the respective same side of the packaging material **100** using a heat sealable material, adhesive, or otherwise. As a result, the packaging material **100** may be formed into numerous packages using various end closures or seals.

By way of illustration, **FIGS. 1B** and **1C** schematically illustrate a front perspective view (**FIG. 1B**) and a rear elevation view (**FIG. 1C**) of an exemplary package **112** formed from the packaging material **100** of **FIG. 1A**. The package **112** includes a pair of opposed panels or faces **114**, **116**, a pair of optionally gusseted (i.e., folded or pleated) side panels **118**, **120** (shown with dashed lines in **FIG. 1C**), and a pair of end closures **122**, **124**. As shown in **FIG. 1C**, each panel **114**, **116**, **118**, **120** (some of which are hidden from view) and the overall flattened package **112** has a first dimension, for example, a length, extending in a first direction, for example, a

longitudinal direction, **D1**, and a second dimension, for example, a width, extending in a second direction, for example, a transverse direction, **D2**. The package **112** also may include a longitudinal seal **126** (**FIG. 1C**), for example, a lap seal or fin seal, extending along the first dimension (e.g., length) of the package **112**. The package **112** may further include an integral grasping feature or handle **128** generally comprising an aperture or cutout **128** extending through end closure **124.**

Each end closure **122**, **124** may comprise a plurality of seals, for example, heat seals, adhesive bonds, or otherwise. More particularly, at least one of the end closures **122**, **124** may comprise a shear seal closure (or simply "shear seal") including at least two joined areas or seals, for example, a pinch seal (or fin seal) and a foldover seal, which may, in some embodiments, be in an at least partially overlapping or superposed configuration with one another. For example, as shown in **FIGS. 1D** and **1E**, end closure **122** comprises a shear seal closure including two seals **130**, **132** in a superposed configuration, with seal **130** generally comprising a pinch seal (e.g., where two panels are joined together in a facing relationship) and seal **132** generally comprising a foldover seal (e.g., where one portion of the package is folded over and joined to another portion of the package) (sometimes referred to as a "same surface seal" or "same surface foldover seal"). Accordingly, the shear seal closure **122** may be referred to as a "single fold pinch seal closure" or simply "single fold pinch seal". In contrast, end closure **124** includes three seals **134**, **136**, **138** in an at least partially superposed configuration to define a double shear seal closure or double fold pinch seal closure (or simply "double shear seal" or double fold pinch seal"), with seal **134** comprising a pinch seal and seals **136**, **138** comprising foldover seals (**FIG. 1F**).

The present inventors have discovered that shear seals (or shear seal closures) provide exceptional strength, as compared with other conventional closures or seals. Specifically, the present inventors have determined that the strength of a shear seal is about two orders of magnitude greater than a pinch seal alone. For example, it has been shown that for one particular packaging material, the seal strength of a pinch seal is about 7.4 psi, while the strength of a shear seal formed from the same material is about 75 psi. Thus, a shear seal may be capable of withstanding commercial package forming and filling operations without little or no risk of the end closure

failing. This presents a significant advantage over other commercially available packages including a woven polymer substrate **102** (**FIG. 1A**), where costly and cumbersome step cutting, taping, sewing, or other mechanical fastening processes are needed to ensure that the end closure has sufficient strength to withstand the filling operation. However, it is contemplated that in some embodiments, sewing, taping, or other mechanical fasteners may be used if desired to further strengthen or reinforce the shear seal or other end closure.

FIG. 1G schematically illustrates an exemplary construct or structure **140** that may be used to form the package **112** of **FIGS. 1B** and **1C**. The construct **140** comprises a sheet of packaging material **100** configured to have a generally tubular shape with a pair of open ends **142**, **144** and an interior space **146**. Notably, the edges (generally indicated at **148**) of the various panels **114**, **116**, **118**, **120** may be straight cut (e.g., at least substantially straight cut (i.e., not step cut) at one or both ends **142**, **144** of the structure **140**, as shown in **FIG. 1G**. In the illustrated embodiment, the packaging material is positioned so that the outermost surface of the first facing system (**FIG. 1A**) generally defines the interior side **108** of the construct **140** and the outermost surface of the second facing system (**FIG. 1A**) generally defines the exterior surface **110** of the construct **140**. However, it will be appreciated that any other structure for forming a package may be used. Further, it will be appreciated that the present discussion applies to structures having one end sealed or otherwise closed.

The sealed areas **122**, **124** may be formed according to various methods. For ease of explanation, the following discussion describes a stepwise formation of the various seals **130**, **132**, **134**, **136**, **138**. However, it will be appreciated that any of such seals may be formed simultaneously or in any other sequence, for example, as described in U.S. Patent Application No. 12/776,507, filed May 10, 2010, which is incorporated by reference herein in its entirety.

Turning now to **FIG. 1H**, which schematically depicts one end **142** of the construct **140** in isolation, at least a portion of the interior side **108** of panels **114**, **116**, **118**, **120** may be joined to one another to form a pinch seal **130**, as illustrated schematically in **FIGS. 1I** and **1J**. To do so, the interior side **108** of one or more of panels **114**, **116**, **118**, **120** may comprise (or have applied to at least a portion thereof)

a heat sealable and/or adhesive material, for example, a heat sealable polymer film, a heat sealable coating, a hot melt adhesive, or any other suitable material for forming an end closure or seal, as needed to create the desired heat seal (e.g., to provide strength, protection from contamination or infestation by insects, and so on).

When exposed to heat, the heat sealable and/or adhesive material is operative for joining the interior faces **108** to one another to form a sealed area **150** (e.g., first sealed area or pinch sealed area or interior sealed area) of the construct **140**, as shown schematically in **FIG. 1H**. In this example, the sealed area **150** generally has a first dimension **D1p** extending in the first direction between the edge **148** of the panels **114**, **116**, **118**, **120** and a longitudinal seal edge or boundary **152**, and a second dimension **D2p** substantially equal to the second dimension (e.g., width) of the flattened construct **140** (and/or the second dimension of panels **114**, **116**). However, it will be appreciated that the pinch sealed area **150** may be spaced from the edge **148** of the panels and/or may have other transverse and/or longitudinal dimensions.

The pinch seal **130** may generally be formed at a temperature below the distortion or softening temperature of the woven polymer substrate **102** (**FIG. 1A**) and/or any other components of the packaging material **100** that are not intended to be softened. For example, where the woven polymer substrate **102** comprises polypropylene, which typically softens at about 350°F, the heat seal temperature for forming the pinch seal **130** may generally be less than about 350°F, for example, from about 250°F to about 300°F. However, numerous other possibilities are contemplated.

In some embodiments, the heat sealable and/or adhesive material may lie outside of the area **150** to be sealed. For example, all or a portion of the interior surface **108** of the construct **140** may comprise a heat sealable polymer film or polymeric material. In such cases, heat may be applied to the desired seal area **150** to activate (e.g., soften) the heat sealable material in the sealing area **150** and form the desired bond **130** between the interior faces **108** of any of panels **114**, **116**, **118**, **120**, as desired.

The foldover seal **132** may then be formed by folding all or a portion of the first dimension **D1p** of the pinch sealed area **150** towards panel **116** to bring the

exterior side **110** of the pinch sealed area **150** into a facing, contacting relationship with another portion of the exterior side of the panel **116**, in this example, an adjacent portion **154** of the exterior side of panel **116** (delineated with dashed lines in **FIG. 1H**). The pinch sealed area **150** may then be joined to this portion **154** of panel **116** to form the foldover seal **132** (**FIGS. 1D** and **1E**).

To do so, all or a portion of the area to be sealed **154** may be provided with a heat sealable and/or adhesive material (either on the pinch sealed area **150**, the intended sealing area **154** on panel **116**, or both), as needed to create the desired bond **132** between the respective areas. The area of the resulting foldover seal generally defines a seal area **154** (e.g., a second seal area or foldover seal area or exterior seal area) generally coextensive with the pinch seal area **150** (**FIGS. 1C** and **1D**).

The foldover seal **132** may generally be formed at a temperature below the distortion or softening temperature of the woven polymer substrate **102** (**FIG. 1A**) and/or any other components of the packaging material **100** that are not intended to be heat sealed. For example, where a heat sealable and/or adhesive material overlies the interior surface **108** of one or more of panels **114**, **116**, **118**, **120** in an area adjacent to the area to be foldover sealed (in this example, the interior side **108** of the construct **112** adjacent to exterior sealing area **154**, the foldover seal **132** may generally be formed at a temperature below the heat seal temperature of the heat sealable material and/or adhesive on the interior **108** of the respective panel(s) **114**, **116**, **118**, **120**. For example, in a stepwise seal formation (with the pinch seal **120** being formed before the foldover seal **132**), where the woven polymer substrate **102** comprises polypropylene, which softens at about 350°F, and where the heat seal material on the interior side **108** of the construct **112** heat seals at a temperature of from about 250°F to about 300°F, the heat seal temperature for forming the foldover seal **132** may generally be less than about 250°F, for example, from about 200°F to about 225°F. In contrast, where the seals **130**, **132** are formed concurrently, the heat seal temperature for forming the foldover seal **132** may be about the same as, less than, or greater than the heat seal temperature of the pinch seal **130**, provided that the heat seal temperatures of both seals **130**, **132** are less than the softening temperature of the substrate **102**.

If needed, ambient or cool air may be directed towards the opposite side of the construct **140** adjacent to the area to be foldover sealed (in this example, towards panel **114** in an area adjacent to sealing area **154**) to prevent the interior **108** of the panels **114**, **116**, **118**, **120** from being joined to one another (which would reduce the volume of the interior space **146**). However, other possibilities are contemplated.

In some embodiments, the heat sealable and/or adhesive material may lie outside of the area to be sealed **154**. For example, all or a portion of the exterior surface **110** of the construct **112** may comprise a heat sealable polymer film or polymeric material or coating. In such cases, heat may be applied to the desired sealing area **154** to activate the heat sealable material in the sealing area **154** and form the desired bond **132**, as desired.

It will be noted that in the illustrated embodiment, the pinch seal area **150** is folded over along the seal boundary **152** and joined to an area of the exterior surface **110** directly adjacent to the pinch sealed area **150** (such that the volume of the package is optimized). However, it is contemplated that the pinch seal area **150** may be folded over and joined to the exterior surface **110** of panel **116** at an alternate point, for example, spaced from boundary line **152**, if desired.

As stated above, the shear seal closure **122** (formed by combining a pinch seal **130** and a foldover seal **132**) provides substantial improvement in strength as compared with a pinch seal alone. Nonetheless, despite their superior strength, packages including a shear seal closure **122** are relatively easy to open. To do so, the user may first peel the pinch sealed area **150** away from the exterior **110** of the package to release the foldover seal **132**. The user may then open the pinch seal **130** either by separating panels **114**, **116** from one another along the end of the package, or by grasping the panels **114**, **116** and pulling them apart distal from the end of the package (such that the pinch seal **130** releases from the interior of the package towards the end of the package). Notably, this sequential opening or unbonding of each seal **130**, **132** enables the consumer to access the contents of the package fairly easily, while the combined strength of the seals **130**, **132** provides exceptional strength for filling and handling the package **112**.

Nonetheless, if desired, additional features may be provided to further facilitate opening of the package. For example, it is contemplated that a portion of the pinch sealed area **150** may remain separate from (i.e., unjoined to or unattached from) the exterior surface **110** of panel **116** to provide a means of grasping the pinch sealed area **150** to facilitate opening the package **112**. In one example, the ends **156** of the pinch sealed area **150** may remain unattached so the user may grasp the unattached ends **156** for opening the package in the manner described above. In another example, all or a portion of the edge **148** of the pinch sealed area **150** (formerly the edge **148** of the panels) may remain unjoined. In doing so, a flap or free edge (e.g., a transverse flap or free edge) may be formed to facilitate opening the package.

FIG. 1K depicts the opposite end **144** of the structure **140** in isolation, in a generally flatted configuration. To form end closure **124** according to one exemplary method, a pinch seal **134** may be formed between respective portions of the interior sides **108** of panels **114**, **116** proximate to the end of the structure **140** to form a pinch sealed area **158** (e.g., first sealed area), as shown in **FIG. 1L**. A portion **158a** of the pinch sealed area **158** may then be folded towards panel **116** along line **160** (shown schematically for ease of explanation), such that the exterior side **110** of panel **116** within the pinch sealed area **158a** is brought into a facing, contacting relationship with the adjacent portion **162** of the exterior side **110** of panel **116** (shown schematically with dashed lines in **FIG. 1H** for ease of explanation). The remaining portions **158a**, **158b** of the pinch sealed area **158** may then be folded away from the exterior side **110** of panel **116** along line **164** (shown schematically with dashed lines in **FIG. 1H** for ease of explanation), such that the exterior side **110** of panel **114** within the pinch sealed area **158a** is brought into a facing, contacting relationship with the adjacent portion **158b** of the exterior side **110** of panel **114**, as shown in **FIG. 1F**.

Heat may then be applied to the overlapped areas **158a**, **158b** to form a pair of foldover seals **136**, **138** and corresponding foldover sealed areas **158a**, **158b** (e.g., second and third sealed areas). In doing so, lines **160**, **164** may become seal boundaries or "fold" lines **160**, **164** (**FIGS. 1B** and **1C**) (in which line **164** is hidden from view and shown with a dashed line in **FIG. 1B**, and line **160** is hidden from view and shown with a dashed line in **FIG. 1C**).

As discussed above, to form the desired bonds between the panels **114**, **116**, all or a portion of the areas to be sealed **158a**, **158b** may be provided with a heat sealable and/or adhesive material, as discussed above in connection with end seal **122**. Further, if desired, ambient or cool air may be used to prevent the interior **108** of the panels **114**, **116** from sealing to one another adjacent to the foldover seal **138**, as discussed above.

In this example, the second and third seal areas **158a**, **158b** are in a substantially overlapping, superposed relationship with one another. Additionally, the foldover seals **136**, **138** generally have the same first and second dimensions, such that the seal areas **158a**, **158b** are generally coextensive. Further, it will be noted that, in this example, the sealed areas **158a**, **158b** are spaced from the end of the package **112** such that a marginal portion **158c** of the pinch sealed area **158** is in a non-superposed relationship with sealed areas **158a**, **158b**. However, other possibilities are contemplated. For example, in some embodiments, the marginal portion **158c** of the sealed area **158** may be omitted if desired.

If desired, a cutout or aperture **128** may be provided within the end closure **124** to define a handle or other grasping feature for carrying the package **112**. The cutout **128** may generally extend through the pinch sealed area **158**, and in particular example, the cutout **128** may extend through the pinch sealed area **158c** proximate to the end of the package **112**. However, in other embodiments, the cutout may also extend through the second and/or third sealed areas. Alternatively still, the pinch sealed area **158** may be spaced from the end of the package **112**, and the cutout **128** may extend through an unsealed area. Other possibilities are contemplated. In this example, the cutout **128** is depicted as having a generally oval shape. However, any other suitable shape may be used.

While certain packages are described herein, numerous other package configurations are contemplated. Each package may have any suitable shape and size as needed to contain various contents, and may contain any number and configuration of seals needed for the particular application. For some applications, the bags may include slits or other features that permit the air to escape after filling the bag. This

allows a plurality of bags to be packed more efficiently into boxes or other cartons for shipping.

Likewise, countless packaging materials **100 (FIG. 1A)** may be used in accordance with the disclosure to form any of the constructs and structures described above, with the substrate **102** and facing systems **104**, **106** being selected to impart various properties to the resulting packaging material. By way of illustration, and not limitation, several exemplary packaging materials **200**, **300**, **400** are illustrated schematically in **FIGS. 2-4**. Each packaging material **200**, **300**, **400** generally includes a woven polymer substrate **202**, **302**, **402** and a respective pair of facing systems **104**, **106**; **204**, **206**; **304**, **306**, each of which may include a plurality of layers, as discussed above in connection with **FIG. 1A**. For purposes of convenience, some layers of the packaging materials **200**, **300**, **400** may be described as "overlying" or being disposed "on" other layers. However, it will be appreciated that each packaging material **200**, **300**, **400** may be inverted, such that other layers may be said to "overlie" or be disposed "on" one another. Accordingly, such terminology is provided merely for convenience of explanation and not limitation in any manner.

It will also be appreciated that numerous other packaging materials are contemplated by the disclosure, and that each of such packaging materials may include various layers. Layers may be added or omitted as needed. It also will be appreciated that various materials may be used to form each layer of the packaging material, and that each layer may have various basis weights or coat weights and may be present in the packaging material in any suitable relative amount, depending on the particular application. Further, it will be appreciated that each layer may serve more than one purpose in a particular packaging material, and that the layer names are provided for convenience of explanation and not limitation in any manner.

Turning now to **FIG. 2**, a first exemplary packaging material **200** includes a woven polymer substrate **202**, a first facing system **204** comprising a first polymer film layer **212** and a tie layer (e.g., a first tie layer) **214** disposed between the substrate **202** and the first polymer film layer **212**, and a second facing system **206** comprising a second polymer film layer **216**, which may be optionally printed with ink **218**, and a tie layer (e.g., a second tie layer) **220** disposed between the substrate **202** and the

second polymer film layer **216.** Each layer **202**, **212**, **214**, **216**, **218**, **220** is in a substantially facing, contacting relationship with the respective adjacent layer(s). Alternatively, in other embodiments, the second polymer film layer **216** may be reverse printed such that the ink **218** lies between the second polymer film layer **216** and the second tie layer **220**.

When used to form a package, the first polymer film layer **212** (i.e., the outermost surface of the first polymer film layer **212**) generally faces inwardly and/or defines the interior surface **208** of the package, and the second polymer film layer **216** (i.e., the outermost surface of the second polymer film layer **216** and/or ink **218**, where present) generally defines the exterior surface **210** of the package. Accordingly, one or both polymer film layers **212**, **216** may comprise heat sealable materials.

The substrate **202** generally comprises a base material from which the packaging material is formed. In one particular embodiment, the substrate **202** may comprise a woven polymer, for example, a woven polypropylene. The substrate **202** may have a denier of from about 500 to about 1600 dpf, for example, from about 600 to about 1200 dpf (denier per filament), for example, from about 700 to 1000 dpf, and in one example, the substrate **202** comprises a woven material having a denier of about 850 dpf. Likewise, the substrate **202** may have any suitable weave, for example, from about 5x5 to about 16x16, for example, from about 8x8 to about 12x12, for example, about 10x10. Other weaves are contemplated, for example, 6x8, 9x15, 15x5, etc. In one particular example, the substrate **202** comprises a woven polypropylene having a denier of about 850 dpf and a 10x10 weave. One example of such a material is commercially available from Mayur Wovens Pvt., Ltd. (India). However, countless other deniers, ranges of deniers, weaves, ranges of weaves, and other substrates may be used.

The first polymer film layer **212** and the second polymer film layer **216** may be used to impart strength, water resistance, heat sealability, and/or other attributes to the packaging material **200**. Where heat sealability is desired, one or both polymer films **212**, **216** may generally comprise a thermoplastic polymer having a sufficiently low melting or softening point so the heat seal can be initiated at a relatively low

temperature ("heat seal temperature"), for example, from about 180°F to about 300°F. Additionally, the polymer may be selected to provide a wide hot tack sealing window, such that the heat seal may be formed over a range of temperatures with the degree of tackiness for the desired duration.

Examples of suitable polymers may include, for example, polypropylene (PP), for example, biaxially oriented polypropylene (BOPP) (e.g., BEM19 BOPP film, Vifan USA, Inc., Morristown, TN), polyethylene terephthalate (PET), metallized polyethylene terephthalate, low density polyethylene (LDPE), poly(ethylene-co-methacrylic acid) (EMAA) (e.g., Surlyn® films available from DuPont, Wilmington, Delaware), or any other suitable material.

The polymer film layers **212**, **216** may generally have any suitable thickness (i.e., caliper), for example, from about 0.4 to about 1.5 mil, for example, from about 0.5 to about 1.2 mil. In one example, one or both polymer film layers **212**, **216** may have a thickness of about 0.7 mil. In another example, one or both polymer film layers **212**, **216** may have a thickness of about 1 mil. However, other suitable thicknesses and ranges of thicknesses are contemplated.

In one particular example, the first polymer film layer **212** may comprise low density polyethylene (LDPE). In one variation of this example, the first polymer film layer **212** may have a thickness of from about 0.5 to about 3 mil, for example, from about 0.8 to about 1.5 mil, for example, about 1 mil. However, other suitable materials are contemplated.

In another particular example, the second polymer film layer **216** may comprise biaxially oriented polypropylene (BOPP). In one variation of this example, the second polymer film layer **216** may have a thickness of from about 0.4 to about 1 mil, for example, from about 0.6 to about 0.8 mil, for example, about 0.7 mil. However, other suitable materials are contemplated.

In still another particular example, the first polymer film layer **212** may comprise LDPE having a thickness of from about 0.8 to about 1.5 mil, for example, about 1 mil, and the second polymer film layer **216** may comprise BOPP having a thickness of from about 0.4 to about 1 mil, for example, about 0.7 mil. However, numerous other configurations of layers are contemplated.

It will be appreciated that in an alternate embodiment, layers **212** and/or **216** may be used to provide strength and/or water resistance, while one or more other layers (not shown) may be provided for heat sealability. Countless possibilities are contemplated.

The tie layers **214**, **220** generally serve to join two adjacent layers, but may have additional functionality if desired. In this example, tie layer **214** is generally operative for joining the first polymer film layer **212** and the substrate **202**, and tie layer **220** is generally operative for joining the second polymer film layer **216** and the substrate **202**.

Each tie layer **214**, **220** may have any suitable composition and basis weight needed to attain the desired level of adhesion between the adjacent layers. For example, where the adjacent layers comprise PP (e.g., layers **202**, **216**), tie layer **220** may comprise PP. Some examples of PPs that may be suitable for use in a tie layer **220** include HMX 340 and HMX 370, both commercially available from Chevron Phillips Chemical Company LLC (The Woodlands, TX).

As another example, where the adjacent layers (e.g., layers **202**, **212**) comprise PP (e.g., layer **202**) and LDPE (e.g., layer **212**), the tie layer **214** may comprise a blend of polymers. The blend may include one or more components that provide adhesion to the substrate **202** and one or more components that provide adhesion to the first polymer film layer **212**.

In one particular example, the blend may comprise a blend of linear low density polyethylene (LLDPE), for example, metallocene catalyzed LLPDE ("m-LLDPE") and LDPE. The present inventors have discovered that this exemplary blend provides superior processability and adhesive properties. One example of an LLDPE that may be suitable for use is Dow Affinity PT 1450G1 (Dow Chemical Co., Midland, MI) (believed to be m-LLDPE). While not wishing to be bound by theory, it is believed that Dow Affinity PT 1450G1 LLDPE may include one or more components that may enhance the adhesion with PP. One example of an LDPE that may be suitable is Chevron 1018 LDPE (Chevron Phillips Chemical Co. LLC, The Woodlands, TX). Other examples of LDPEs that may be suitable include, but are not

limited to, Westlake EC-482 (Westlake Chemical Corp., Houston, TX) and Marflex® 1013 LDPE (Phillips Chemical Co. LLC, The Woodlands, TX).

The relative amounts of LLDPE (e.g., m-LLDPE) and LDPE in the tie layer **214** may vary for each application. The blend may generally comprise from about 70% to about 95% LLDPE and about 5% to about 30% LDPE (by weight), for example, from about 80% to about 90% LLDPE and about 10% to about 20% LDPE. In one exemplary embodiment, the blend may comprise about 85% LLDPE and about 15% LDPE. However, other suitable amounts and ratios of LDPE and PP may be used.

In other embodiments, the tie layer **214** may comprise a blend of PP and LDPE. Numerous other possibilities are contemplated.

Each tie layer **214**, **220** may have any suitable basis weight, for example, from about 1 to about 15 lb/ream, for example, from about 6 to about 10 lb/ream. In one specific example, one of the tie layers **214**, **220** has a basis weight of about 8 lb/ream. In another example, both of the tie layers **214**, **220** have a basis weight of from about 8 lb/ream. However, other basis weights and ranges of basis weights are contemplated.

To form the packaging material **200** according to one exemplary method, the substrate **202** and polymer film layers **212**, **216** may be provided as rolls of materials that can be unwound and brought together. Tie layer **220** may be extruded into a nip between the layers **202**, **216** to form an extrusion lamination bond between layers **202**, **216**. Likewise, tie layer **214** may be extruded into a nip between layers **202**, **212** to form an extrusion lamination bond between layers **202**, **212**. The packaging material **200** may be cooled if needed and wound into a roll.

It will be understood by those of skill in the art that in this and other embodiments, one or more processing additives may be incorporated into any of the various layers as needed or desired. Thus, for example, some such layers or compositions may include surfactants, anti-foaming agents, plasticizers, and additives to modify abrasion resistance and slip. Other additives or components may be selected to improve adhesion to the substrate or to other layers or components within the packaging material, to increase resistance to oil permeation, or to provide other

functions or attributes. Examples of such additives include, but are not limited to, cationic primers to enhance bonding, organic or inorganic fillers, for example, talc, calcium carbonate, magnesium carbonate, silica, calcium oxide, alumina, titanium dioxide, any other filler, or any combination thereof. Numerous other possibilities are contemplated hereby.

FIG. 3 schematically illustrates another exemplary packaging material **300**. The packaging material **300** includes a substrate **302** including a pair of opposed sides, a first facing system **304** including a tie layer **312** (e.g., a first tie layer), a core layer **314**, and a heat seal layer **316** disposed on a first side of the substrate **302**, and a second facing system **306** including a polymer film layer **318**, which may optionally be printed with an ink **320**, and a tie layer **322** (e.g., a second tie layer) disposed on a second side of the substrate **302**. In an alternate embodiment (not shown), the polymer film layer **318** may include printing (i.e., ink **320**) on the exterior surface **310** of the film **318**.

Each layer or material **302**, **312**, **314**, **316**, **318**, **320**, **322** is in a substantially facing, contacting relationship with the respective adjacent layer(s) or material. When used to form a package, polymer film layer **318** (i.e., the outermost surface **310** of polymer film layer **318**) generally faces outwardly and/or at least partially defines the exterior surface **310** of the package, and heat seal layer **316** (i.e., the outermost surface **308** of heat seal layer **316**) generally faces inwardly and/or defines the interior surface **308** of the package.

The substrate **302** may be any suitable material, for example, the woven polymer materials described in connection with **FIG. 2**.

Layers **312**, **314**, **316** generally define a multifunctional polymer system **304**. The polymer system **304** may be used to impart numerous properties to the packaging material **300**. Thus, while the layers of the polymer system **304** may be described independently, it will be appreciated that the layers cooperate with one another to enhance the packaging material **300**, as will be discussed below.

The heat seal layer **316** generally renders the interior side **308** of the packaging material **300** heat sealable. This may be desirable for numerous package configurations. The core layer **314** generally comprises a polymer layer, which may,

if desired, impart various attributes to the packaging material **300**. By way of example, and not limitation, the core layer **314** may serve as a barrier layer to oils (i.e., as an oil resistant layer). This may be important where the contents of the package include a fatty or oily component, for example, as with pet food, bird seed, etc. The tie layer **312** generally joins the core layer **314** to the substrate **302**. However, in some embodiments, the tie layer may be omitted, such that the core layer **314** also serves as a tie layer.

In some instances, the core layer **314** may be selected to have a melting point that is greater than the heat seal temperature to ensure that the integrity of the core layer **314** is maintained during the heat sealing process. In other instances, the core layer **314** may comprise a blend of materials, at least one of which may have a melting point less than the heat seal temperature. In such embodiments, the lower melting component(s) may soften during the heat sealing process, such that a portion of the core layer **314** serves as a heat seal material or layer in conjunction with heat seal layer **316**. Thus, depending on the materials selected, each of the various layers **312**, **314**, **316** may cooperate in various ways to achieve a desired result.

In one exemplary embodiment, the heat seal layer **316** may comprise a blend of low density polyethylene (LLDPE), low density polyethylene (LDPE), and an ethylene/methacrylic acid copolymer (EMA). The LLDPE may be a metallocene LLDPE (m-LLDPE). The ratio of each component may vary for each application. In one example, the blend may comprise from about 60% to 100% LLDPE, from 0 to about 35% LDPE, and from 0 to about 5% EMA. In another example, the blend may comprise from about 60% to about 80% LLDPE, from about 15% to about 35% LDPE, and from about 1 to about 5% EMA. In still another example, the blend may comprise about 60% LLDPE, about 35% LDPE, and about 5% EMA, such that the ratio of the components is about 12:7:1. However, other blends of LLDPE, LDPE, and EMA are contemplated.

The present inventors have found that a blend of LLDPE, LDPE, and EMA offers superior processability and resulting heat seal strength. Specifically, the present inventors have found that by adding LLDPE to LDPE, the melting point (and, therefore, the heat seal temperature) is lowered from about 230°F to about 220°F, and

that by adding EMA to the mixture of LLDPE and LDPE, the melting point (and, therefore, the heat seal temperature) of the blend is lowered to about 210-215°F. As a result, the heat seal may be initiated at a lower temperature, which allows for the packaging material **300** to be heat sealed at greater processing speeds without distorting the woven PP substrate or BOPP film. The present inventors have also found that the heat seal formed from the blend of LLDPE, LDPE, and EMA has superior strength relative to a heat seal formed from any of the individual components.

While various LLPDEs, LDPEs, and EMAs may be used, one example of an LLDPE that may be suitable for use is Dow Affinity PT 1450G1 (Dow Chemical Co., Midland, MI) (believed to be m-LLDPE). While not wishing to be bound by theory, it is believed that Dow Affinity PT 1450G1 LLDPE may include one or more components that may enhance the affinity with PP. One example of an LDPE that may be suitable is Chevron 1018 LDPE (Chevron Phillips Chemical Co. LLC, The Woodlands, TX). Other examples of LDPEs that may be suitable are set forth above in connection with the discussion of the exemplary packaging material **200** of **FIG. 2**.

The heat seal layer **316** may have any suitable basis weight, for example, from about 1 to about 5 lb/ream, for example, from about 2 to about 4 lb/ream, for example, about 3 lb/ream. In one specific example, the heat seal layer **316** has a basis weight of about 3.06 lb/ream. However, other basis weights and ranges thereof are contemplated.

The tie layer **312** may be formed from any suitable material that sufficiently adheres to (and therefore joins) the adjacent layers. In one example, the tie layer **312** may comprise a blend of LLDPE, LDPE, and EMA, as described above. The ratio of each component may vary for each application. In one variation, the blend may comprise from about 60% to 100% LLDPE, from 0 to about 35% LDPE, and from 0 to about 5% EMA. In another variation, the blend may comprise from about 60% to about 80% LLDPE, from about 15% to about 35% LDPE, and from about 1 to about 5% EMA. In still another variation, the blend may comprise about 60% LLDPE, about 35% LDPE, and about 5% EMA, such that the ratio of the components is about 12:7:1. Other blends of LLDPE, LDPE, and EMA are contemplated.

The present inventors have discovered that this exemplary blend provides superior processability and adhesive properties with a variety of substrates. By way of illustration, and not limitation, it is known that it is difficult to adhere various polymers layers to polypropylene (PP) (e.g., in the substrate **302**) at high processing speeds. However, the exemplary blend of LLDPE, LDPE, and EMA, which has a relatively low melting point (about 210-215°F as compared with about 350°F for PP), tends to flow readily into the spaces between the woven filaments, even at high processing speeds (e.g., 2000-2500 ft/min). Additionally, where Dow Affinity 1450G1 LLPDE is used, the present inventors have found that the tie layer **312** has a greater affinity for core layers including PP (e.g., core layer **314**), as compared with other LLDPEs. As stated above, while not wishing to be bound by theory, it is believed that the Dow Affinity 1450G1 LLDPE includes one or more components that enhance the affinity of the LLPDE to PP.

The tie layer **312** may have any suitable basis weight, for example, from about 0.5 to about 5 lb/ream, for example, from about 0.75 to about 2 lb/ream, for example, about 1 lb/ream. In one specific example, the tie layer **312** has a basis weight of about 1.19 lb/ream. Other ranges and basis weights are contemplated.

In one exemplary embodiment, the core layer **314** may comprise a blend of PP and LDPE. The relative amounts of PP and LDPE in the core layer **314** may vary for each application. The blend may generally comprise from about 70% to about 90% PP and about 10% to about 30% LDPE. In each of various examples, the blend may comprise about 75% PP and about 25% LDPE, about 80% PP and about 20% LDPE, or about 85% PP and about 15% LDPE. However, other suitable amounts and ratios of LDPE and PP may be used.

The present inventors have discovered these exemplary blends of PP and LDPE in the core layer **314** provide an excellent balance of properties for various packaging materials. For example, as compared with a core layer **314** comprising only PP (i.e., without the LDPE), a core layer **314** including from about 80 to about 85% PP and about 15 to 20% LDPE (by weight) provides about the same level of oil resistance as a core layer **314** comprising 100% PP. Further, the presence of the LDPE improves adhesion with the adjacent layers. By way of example, where the

heat seal layer **316** and/or the tie layer **312** comprise a blend of LLDPE, LDPE, and EMA (e.g., as discussed above), the blend of LDPE and PP in the core layer **314** has a greater affinity for the polymer blend of the heat seal layer **316** and/or the tie layer **312**, as compared with PP alone.

Further, since LDPE has a lower melting point than PP (about 230°F for LDPE and about 320°F for PP), in some cases, depending on the heat seal temperature and other processing conditions, the LDPE in the core layer **314** and the tie layer **312** may soften during the heat sealing process, such that a part of the core layer **314** and tie layer **312** also effectively serves as part of the heat seal layer **316**. In such cases, the basis weight of the heat seal layer **316** and/or the tie layer **312** may be reduced, thereby reducing the cost of the overall structure.

By way of illustration, the present inventors have found that a packaging material including:

a heat seal layer **316** having a basis weight of about 1.3 lb/ream and comprising a blend of about 60% LLDPE, about 35% LDPE, and about 5% EMA (by weight);

a core layer **314** having a basis weight of about 3.33 lb/ream and comprising an 80/20 blend of PP/LDPE; and

a tie layer **312** having a basis weight of about 0.37 lb/ream and comprising a blend of about 60% LLDPE, about 35% LDPE, and about 5% EMA,

exhibited better peel strength (i.e., layer to layer adhesion) than a packaging material including:

a heat seal layer **316** having a basis weight of about 3.12 lb/ream and comprising a blend of about 60% LLDPE, about 35% LDPE, and about 5% EMA;

a core layer **314** having a basis weight of about 4 lb/ream and comprising PP; and

a tie layer **312** having a basis weight of about 0.88 lb/ream and comprising a blend of about 60% LLDPE, about 35% LDPE, and about 5% EMA.

Thus, although each polymer system **304** had about the same basis weight (about 5 lb/ream), the packaging material including the blend of LDPE and PP in the core layer **314** exhibited superior peel strength at a reduced cost (based on the present cost of various polymers in each layer). While not wishing to be bound by theory, it is believed that this is because the presence of the LDPE in the core layer contributed to the overall heat sealability of the material, as discussed above.

The core layer **314** may generally have a basis weight of from about 1 to about 8 lb/ream, for example, from about 2 to about 6 lb/ream, for example, about 4 lb/ream. In one specific example, the basis weight of the core layer **314** may be about 3.75 lb/ream. Other ranges and basis weights are contemplated.

The polymer system **304** (i.e., the heat seal layer **316**, core layer **314**, and tie layer **312**) may have any suitable total basis weight. In each of various examples, the polymer system **304** may have a basis weight of about 5 lb/ream, about 5.5 lb/ream, about 6 lb/ream, about 6.5 lb/ream, about 7 lb/ream, about 7.5 lb/ream, about 8 lb/ream, about 8.5 lb/ream, about 9 lb/ream, about 9.5 lb/ream, about 10 lb/ream, about 10.5 lb/ream, about 11 lb/ream, about 11.5 lb/ream, about 12 lb/ream, about 12.5 lb/ream, about 13 lb/ream, about 13.5 lb/ream, about 14 lb/ream, about 14.5 lb/ream, about 15 lb/ream, or any other suitable basis weight.

Further, the components of the polymer system **304** may be present in any suitable ratio. In one example, the weight % ratio of the heat seal layer **316**, core layer **314**, and tie layer **312** may be about 3.06:3.15:1. However, other ratios are contemplated.

In one example, the heat seal layer **316** may have a basis weight of from about 1 to about 5 lb/ream, the core layer **314** may have a basis weight of from about 1 to about 8 lb/ream, and the tie layer **312** may have a basis weight of from about 0.5 to about 5 lb/ream. In another example, the heat seal layer **316** may have a basis weight of from about 2 to about 4 lb/ream, the core layer **314** may have a basis weight of from about 2 to about 6 lb/ream, and the tie layer **312** may have a basis weight of from about 0.75 to about 2 lb/ream. In one particular example, the heat seal layer **316** may have a basis weight of about 3 lb/ream, the core layer **314** may have a basis weight of about 4 lb/ream, and the tie layer **312** may have a basis weight of about 1

lb/ream. In another particular example, the heat seal layer **316** may have a basis weight of about 3.06 lb/ream, the core layer **314** may have a basis weight of about 3.75, and the tie layer **312** may have a basis weight of about 1.19 lb/ream.

The polymer film layer **318** may be used to impart strength, water resistance, heat sealability, and/or other attributes to the packaging material **300**. Where heat sealability is desired, the polymer film **318** may generally comprise a thermoplastic polymer having a sufficiently low melting or softening point so the heat seal can be initiated at a relatively low temperature ("heat seal temperature"), for example, from about 180°F to about 300°F, as discussed above in connection with polymer film layers **212**, **216** of **FIG. 2**. Examples of polymers that may be suitable for the polymer film layer **318** are also discussed in connection with polymer film layers **212**, **216** of **FIG. 2**.

The polymer film layer **318** may have any suitable thickness (i.e., caliper) of, for example, from about 0.4 to about 1.5 mil, for example, from about 0.5 to about 1.2 mil. In one example, the film may have a thickness of about 0.7 mil. However, other suitable thicknesses and ranges of thicknesses are contemplated.

In one particular example, the polymer film layer **318** may comprise biaxially oriented polypropylene (BOPP). In one variation of this example, the polymer film layer **318** may have a thickness of from about 0.4 to about 1 mil, for example, from about 0.6 to about 0.8 mil. In one variation of this example, the polymer film layer **318** may have a thickness of about 0.7 mil. However, other suitable materials are contemplated.

The tie layer **322** generally serves to join the two adjacent layers, in this example, the polymer film layer **318** and the substrate **302**, but may provide functionality if desired. The tie layer **322** may have any suitable composition and basis weight as needed to attain the desired level of adhesion between the adjacent layers. In one particular example, the blend may comprise a blend of linear low density polyethylene (LLDPE), for example, metallocene catalyzed LLPDE ("m-LLDPE") and LDPE. The present inventors have discovered that this exemplary blend provides superior processability and adhesive properties. One example of an LLDPE that may be suitable for use is Dow Affinity PT 1450G1 (Dow Chemical Co.,

Midland, MI) (believed to be m-LLDPE). While not wishing to be bound by theory, it is believed that Dow Affinity PT 1450G1 LLDPE may include one or more components that may enhance the adhesion with PP. One example of an LDPE that may be suitable is Chevron 1018 LDPE (Chevron Phillips Chemical Co. LLC, The Woodlands, TX). Other examples of LDPEs that may be suitable include, but are not limited to, Westlake EC-482 (Westlake Chemical Corp., Houston, TX) and Marflex® 1013 LDPE (Phillips Chemical Co. LLC, The Woodlands, TX). However, numerous other possible tie layers are contemplated.

The relative amounts of LLDPE (e.g., m-LLDPE) and LDPE in the tie layer **322** may vary for each application. The blend may generally comprise from about 70% to about 95% LLDPE and about 5% to about 30% LDPE (by weight), for example, from about 80% to about 90% LLDPE and about 10% to about 20% LDPE. In one exemplary embodiment, the blend may comprise about 85% LLDPE and about 15% LDPE. However, other suitable amounts and ratios of LDPE and PP may be used.

The tie layer **322** may have any suitable basis weight, for example, from about 1 to about 15 lb/ream, for example, from about 6 to about 10 lb/ream. In one specific example, the tie layer **322** has a basis weight of about 8 lb/ream. However, other basis weights and ranges of basis weights are contemplated.

To form the packaging material **300** according to one exemplary method, layers **312**, **314**, **316** may be extruded (individually or coextruded) onto the first side of the substrate **302**. Polymer film layer **318** may be unwound and brought into a facing relationship with the second side of the substrate **302**. The tie layer **322** may be extruded into a nip between the layers **302**, **318** to form an extrusion lamination bond between layers **302**, **318**. However, numerous other steps and sequences of steps are contemplated. In any of such scenarios, one or more of the layers may be coextruded or may be formed and/or joined in a sequential manner. The packaging material **300** may be cooled if needed and wound into a roll.

FIG. 4 schematically illustrates an alternate packaging material **400**. The packaging material **400** includes features that are similar to the packaging material **300** of **FIG. 3**, except for variations noted and variations that will be understood by

those of skill in the art. For simplicity, the reference numerals of similar features are preceded in the figures with a "**4**" instead of a "**3**".

In this example, layers **318**, **320**, **322** of the packaging material **300** of **FIG. 3** are replaced with a polymer system **406** similar to that of polymer system **404**. Specifically, the packaging material **400** includes a substrate **402** including a pair of opposed sides, a first tie layer **412**, a first core layer **414**, and a first heat seal layer **416** disposed on a first side of the substrate **402**, and a second tie layer **424**, a second core layer **426**, and a second heat seal layer **428** disposed on a second side of the substrate **402**, such that the arrangement of layers is generally symmetrical. If desired, the outermost surface **408**, **410** of layers **416** and/or **428** may be printed with ink (not shown).

Each pair of layers (e.g., the first and second heat seal layers **416**, **418**, the first and second core layers **414**, **426**, and the first and second tie layers **412**, **424**) independently may have the same or different composition and/or weight. Exemplary basis weights are provided above with respect to the packaging material **300** of **FIG. 3**.

As with the packaging material **300** of **FIG. 3**, either or both of layers **412**, **424** may be omitted, such that layers **414**, **426** serve as tie layers that join the heat seal layers **416**, **428** to the respective sides of the substrate **402**.

While numerous possibilities are contemplated, this packaging material **400** may find particular use where less strength is needed and/or where a lower cost alternative is desired.

In still another exemplary embodiment (not shown), one or both of the facing systems may comprise a layer of paper that defines the first and/or second surface of the packaging material. It will be appreciated that shear seals and/or other seals may be formed from such materials using a hot melt adhesive or other adhesive material. Numerous other possibilities are contemplated.

Various aspects of the present invention are illustrated further by the following example, which is not to be construed as limiting in any manner.

EXAMPLE

A packaging material having the following structure was made by extrusion laminating the polymer film layers to the woven substrate:

about 0.7 mil BOPP film;
about 8 lb/ream PP;
about 850 dpf 10x10 woven PP substrate;
about 8 lb/ream blend of 80% Dow Affinity m-LLDPE + 20% LDPE;
about 1 mil LDPE film

Various properties of the packaging material were measured. The results are set forth in **Table 1**, in which all values are approximate.

Table 1

Weight (lb/ream)	66.2
Caliper (mils)	7.69
Grease resistance	No grease penetration
Oxygen transmission rate (OTR) ($cc/m^2/day$)	16.01
Water vapor transmission rate (WVTR) (100 $g/m^2/day$)	0.105
Puncture (g)	Would not puncture
Gurley stiffness, MD	132.6
Gurley stiffness, CD	137.9
Tear, MD (g)	Would not tear
Tear, CD (g)	Would not tear
Tensile, MD (lb/in)	Would not break
Tensile, CD (lb/in)	Would not break

Although certain embodiments of this invention have been described with a certain degree of particularity, those skilled in the art could make numerous alterations to the disclosed embodiments without departing from the spirit or scope of this invention. All directional references (e.g., upper, lower, upward, downward, left, right, leftward, rightward, top, bottom, above, below, vertical, horizontal, clockwise, and counterclockwise) are used only for identification purposes to aid the reader's understanding of the various embodiments of the present invention, and do not create limitations, particularly as to the position, orientation, or use of the invention unless specifically set forth in the claims. Joinder references (e.g., joined, attached, coupled, connected, and the like) are to be construed broadly and may include intermediate members between a connection of elements and relative movement between elements.

As such, joinder references do not necessarily imply that two elements are connected directly and in fixed relation to each other.

It will be recognized by those skilled in the art, that various elements discussed with reference to the various embodiments may be interchanged to create entirely new embodiments coming within the scope of the present invention. It is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative only and not limiting. Changes in detail or structure may be made without departing from the spirit of the invention. The detailed description set forth herein is not intended nor is to be construed to limit the present invention or otherwise to exclude any such other embodiments, adaptations, variations, modifications, and equivalent arrangements of the present invention.

Accordingly, it will be readily understood by those persons skilled in the art that, in view of the above detailed description of the invention, the present invention is susceptible of broad utility and application. Many adaptations of the present invention other than those herein described, as well as many variations, modifications, and equivalent arrangements will be apparent from or reasonably suggested by the present invention and the above detailed description thereof, without departing from the substance or scope of the present invention.

While the present invention is described herein in detail in relation to specific aspects, it is to be understood that this detailed description is only illustrative and exemplary of the present invention and is made merely for purposes of providing a full and enabling disclosure of the present invention and to set forth the best mode of practicing the invention known to the inventors at the time the invention was made. The detailed description set forth herein is not intended nor is to be construed to limit the present invention or otherwise to exclude any such other embodiments, adaptations, variations, modifications, and equivalent arrangements of the present invention.

What is claimed is:

1. A package including at least one sealed end, the sealed end comprising:

a first sealed area comprising a first panel and a second panel in an opposed, facing relationship, the first panel and the second panel each having an interior side and an exterior side, the interior side of a portion of each of the first panel and the second panel being joined to one another in a facing, contacting relationship with each other; and

a second sealed area comprising at least a portion of the first sealed area folded over and joined to the first panel such that the exterior side of the first panel of the first sealed area is in a facing, contacting relationship with another portion of the exterior side of the first panel,

wherein at least one of the panels comprises a woven polymer material.

2. The package of claim 1, wherein the first sealed area and the second sealed area are in an at least partially superposed configuration.

3. The package of claim 1, wherein the panels of the first sealed area include an end edge, and the end edge is substantially straight cut.

4. The package of claim 1, wherein the first sealed area comprises a pinch seal.

5. The package of claim 1, wherein the second sealed area comprises a foldover seal.

6. The package of claim 1, wherein

the first sealed area and the second sealed area each have a first dimension extending along the length of the package and a second dimension extending along the width of the package, and

the first dimension of the first sealed area is substantially the same as the first dimension of the second sealed area.

7. The package of claim 1, wherein

the first sealed area and the second sealed area each have a first dimension extending along the length of the package and a second dimension extending along the width of the package, and

the first dimension of the first sealed area is greater than the first dimension of the second sealed area.

8. The package of claim 1, wherein

the first sealed area and the second sealed area each have a first dimension extending along the length of the package and a second dimension extending along the width of the package, and

the second dimension of the first sealed area is greater than the second dimension of the second sealed area.

9. The package of claim 1, further comprising a third sealed area, the third sealed area comprising the second sealed area folded over and joined to the second panel such that the exterior side of the second panel of the second sealed area is in a facing, contacting relationship with another portion of the exterior side of the second panel.

10. The package of claim 9, wherein the second sealed area and the third sealed area are in an at least partially superposed relationship with one another.

11. The package of claim 10, wherein

the second sealed area and the third sealed area each have a first dimension extending along the length of the package and a second dimension extending along the width of the package, and

the first dimension of the second sealed area is substantially the same as the first dimension of the third sealed area.

12. The package of claim 11, wherein the first dimension of first sealed area greater than the respective first dimensions of the second sealed area and the third sealed area.

13. The package of claim 12, wherein the first sealed area includes a marginal area of the package proximate to the end of the package.

14. The package of claim 13, wherein the first sealed area comprises a cutout.

15. The package of claim 12, wherein the second sealed area and the third sealed area are spaced from the end of the package.

16. The package of claim 1, wherein at least one of the panels further comprises

a first facing system joined to a first side of the substrate, the first facing system including an outermost surface defining the interior side of the package; and

a second facing system joined to a second side of the substrate, the second facing system including an outermost surface defining the exterior side of the package,

wherein at least one of the interior side and the exterior side of the packaging material comprises a heat sealable material.

17. A method of forming a package, comprising:

forming a packaging material into a tubular structure having an open end, the tubular structure including a first panel and a second panel in an opposed, facing relationship, each of the first panel and the second panel including an interior side and an exterior side, at least one of the first panel and the second panel comprising a woven polymer material;

forming a first sealed area proximate to the end of the tubular structure, the first sealed area comprising a bond between the interior side of the first panel and the interior side of the second panel; and

forming a second sealed area between the first sealed area and the exterior side of the first panel.

18. The method of claim 17, further comprising forming a third sealed area between the second sealed area and the exterior side of the second panel.

19. The method of claim 17, further comprising forming an aperture in the first sealed area proximate to the end of the structure.

20. A package including at least one closed end, the closed end comprising:

a pair of opposed panels, each of the opposed panels including an interior face and an exterior face, at least one panel comprising a woven polymer material,

wherein the interior faces of the package panels are joined to one another to define an interior joined area, the adjoined panels of the interior joined areas being folded towards and joined to the exterior face of one of the panels to define a second joined area.

21. A packaging material, comprising:

a substrate comprising a woven polymer, the substrate having a first side and a second side opposite one another;

a first facing system joined to the first side of the substrate, the first facing system including an outermost surface defining a first side of the packaging material; and

a second facing system joined to the second side of the substrate, the second facing system including an outermost surface defining a second side of the packaging material opposite the first side,

wherein at least one of the first side and the second side of the packaging material is heat sealable.

22. The packaging material of claim 21, wherein the woven polymer comprises polypropylene.

23. The packaging material of claim 21, wherein the woven polymer has a denier of from about 700 to about 1000 dpf.

24. The packaging material of claim 21, wherein the woven polymer has a denier of about 850 dpf.

25. The packaging material of claim 21, wherein the woven polymer has a mesh size of from about 8x8 to about 12x12.

26. The packaging material of claim 21, wherein the woven polymer has a mesh size of about 10x10.

27. The packaging material of claim 21, wherein

the first facing system comprises a first polymer film layer,

the second facing system comprises a second polymer film layer,

the first polymer film layer and the second polymer film layer respectively defining the first and second sides of the packaging material, wherein at least one of the first polymer film layer and the second polymer film layer comprises a heat sealable material that renders the respective side of the packaging material heat sealable.

28. The packaging material of claim 27, wherein the first polymer film layer comprises low density polyethylene.

29. The packaging material of claim 27, wherein the second polymer film layer comprises biaxially oriented polypropylene.

30. The packaging material of claim 27, wherein the first facing system further comprises a tie layer joining the first polymer film layer to the first side of the substrate.

31. The packaging material of claim 30, wherein the tie layer comprises a blend of linear low density polyethylene and low density polyethylene.

32. The packaging material of claim 31, wherein the linear low density polyethylene is metallocene catalyzed linear low density polyethylene.

33. The packaging material of claim 31, wherein the blend comprises from about 70 to about 90% linear low density polyethylene and from about 10 to about 30% low density polyethylene by weight.

34. The packaging material of claim 33, wherein the blend comprises about 80% linear low density polyethylene and about 20% low density polyethylene by weight.

35. The packaging material of claim 27, wherein the second facing system further comprises a tie layer joining the second polymer film layer to the second side of the substrate.

36. The packaging material of claim 35, wherein the tie layer comprises polypropylene.

37. The packaging material of claim 21, wherein the first facing system comprises a heat seal layer defining the first side of the packaging material, the heat seal layer rendering the first side of the packaging material heat sealable, wherein the heat seal layer comprises a blend of linear low density polyethylene, low density polyethylene, and ethylene/methacrylic acid.

38. The packaging material of claim 37, wherein the heat seal layer comprises about 60% linear low density polyethylene, about 35% low density polyethylene, and about 5% ethylene/methacrylic acid by weight.

39. The packaging material of claim 37, wherein the first facing system further comprises an oil resistant layer disposed between the first side of the substrate and the heat seal layer.

40. The packaging material of claim 39, wherein the oil resistant layer comprises a blend of polypropylene and low density polyethylene.

41. The packaging material of claim 40, wherein the oil resistant layer comprises from about 70 to about 90% polypropylene and about 10 to about 30% low density polyethylene by weight.

42. The packaging material of claim 41, wherein the oil resistant layer comprises about 85% polypropylene and about 15% low density polyethylene by weight.

43. The packaging material of claim 39, wherein the first facing system further comprises a tie layer disposed between the oil resistant layer and the first side of the substrate.

44. The packaging material of claim 43, wherein the tie layer comprises a blend of linear low density polyethylene, low density polyethylene, and ethylene/methacrylic acid.

45. The packaging material of claim 44, wherein the tie layer comprises about 60% LLDPE, about 35% low density polyethylene, and about 5% ethylene/methacrylic acid by weight.

46. The packaging material of claim 37, wherein the second facing system comprises a polymer film layer on the second side of the substrate, the polymer film defining the second side of the packaging material.

47. The packaging material of claim 46, wherein the polymer film comprises biaxially oriented polypropylene.

48. The packaging material of claim 46, wherein the second facing system comprises a tie layer disposed between the polymer film layer and the second side of the substrate.

49. The packaging material of claim 48, wherein the tie layer comprises a blend of linear low density polyethylene and low density polyethylene.

50. The packaging material of claim 49, wherein the tie layer comprises from about 70 to about 90% linear low density polyethylene and from about 10 to about 30% low density polyethylene by weight.

51. The packaging material of claim 50, wherein the tie layer comprises about 80% linear low density polyethylene and about 20% low density polyethylene by weight.

52. The packaging material of claim 37, wherein

the heat seal layer is a first heat seal layer, and

the second facing system comprises a second heat seal layer on the second side of the substrate, the heat seal layer defining the second side of the packaging

material, wherein the heat seal layer comprises a blend of linear low density polyethylene, low density polyethylene, and ethylene/methacrylic acid.

53. The packaging material of claim 52, wherein the second heat seal layer comprises about 60% linear low density polyethylene, about 35% low density polyethylene, and about 5% ethylene/methacrylic acid by weight.

54. The packaging material of claim 52, wherein the second facing system further comprises an oil resistant layer disposed between the second side of the substrate and the second heat seal layer.

55. The packaging material of claim 54, wherein the oil resistant layer comprises from about 70 to about 90% polypropylene and about 10 to about 30% low density polyethylene by weight.

56. The packaging material of claim 54, wherein the second facing system further comprises a tie layer disposed between the oil resistant layer and the second side of the substrate.

57. The packaging material of claim 56, wherein the tie layer comprises a blend of linear low density polyethylene and low density polyethylene.

58. The packaging material of claim 57, wherein the tie layer comprises from about 70 to about 90% linear low density polyethylene and from about 10 to about 30% low density polyethylene by weight.

59. The packaging material of claim 21, wherein

the first side of the packaging material is heat sealable, and

the second facing system comprises paper, the paper defining the second side of the packaging material.

60. The packaging material of claim 59, wherein the second side of the packaging material comprises an adhesive for rendering the second side of the packaging material heat sealable.

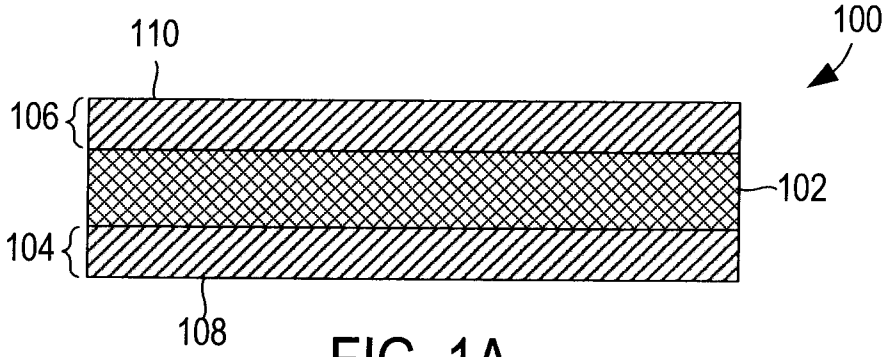

FIG. 1A

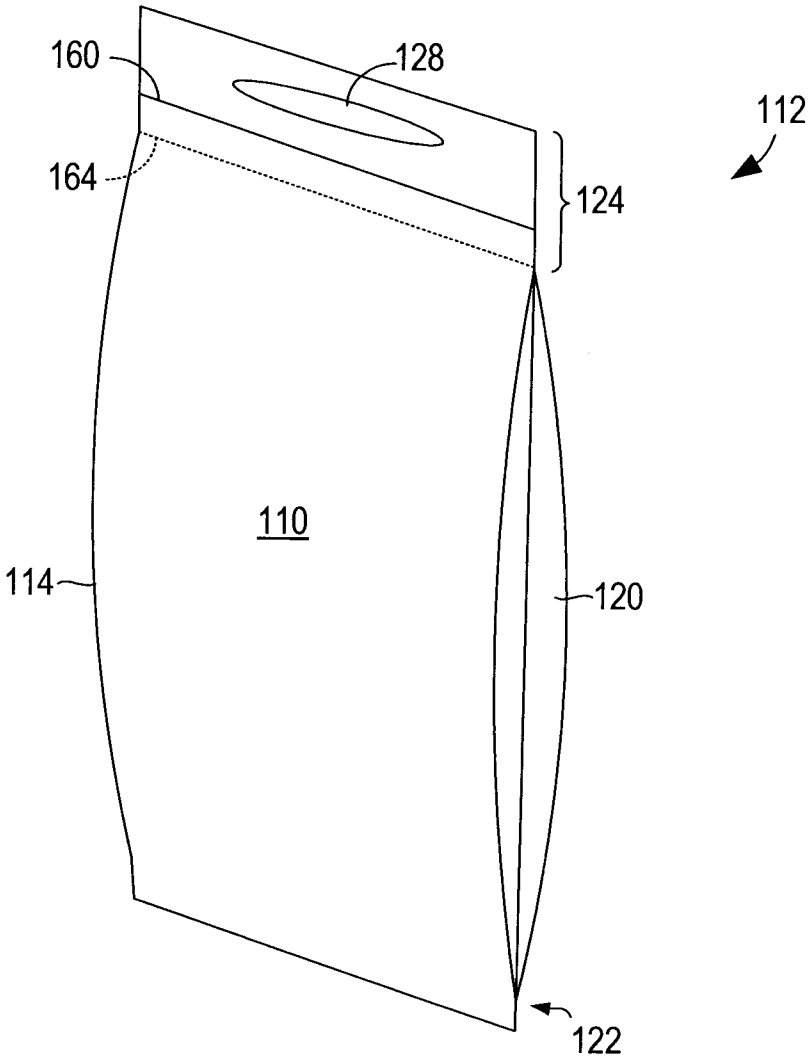

FIG. 1B

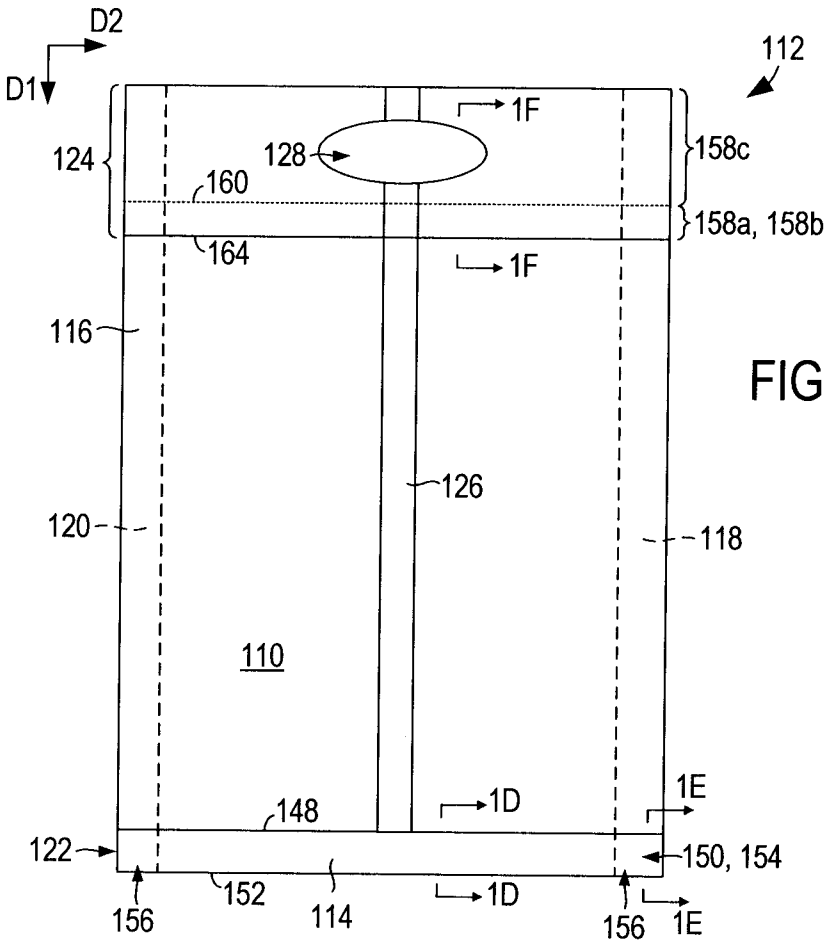

FIG. 1C

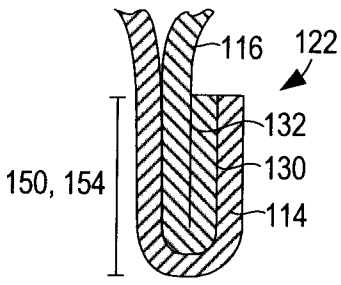

FIG. 1D

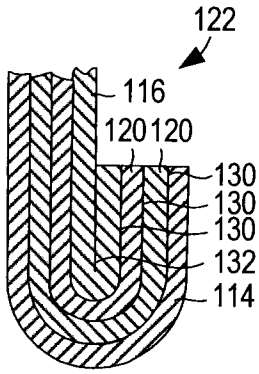

FIG. 1E

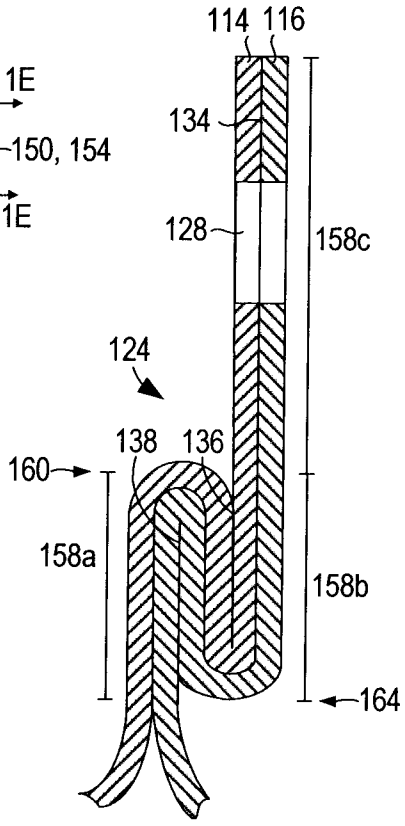

FIG. 1F

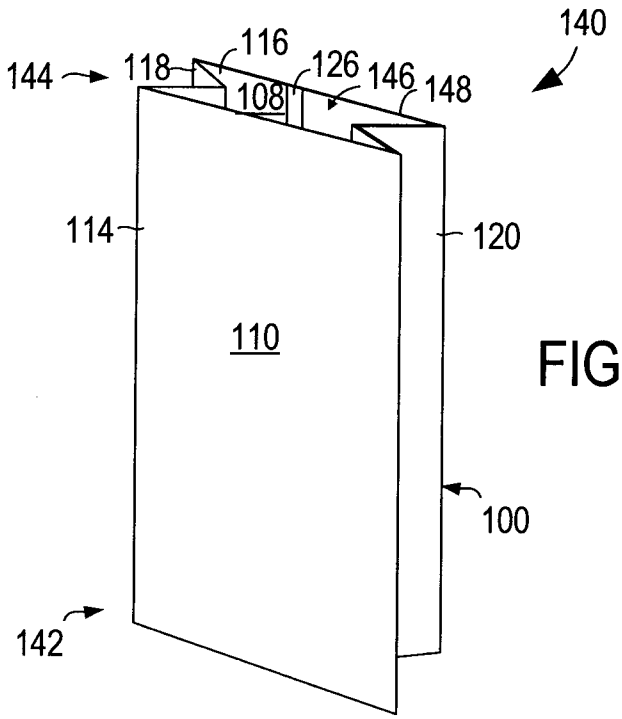

FIG. 1G

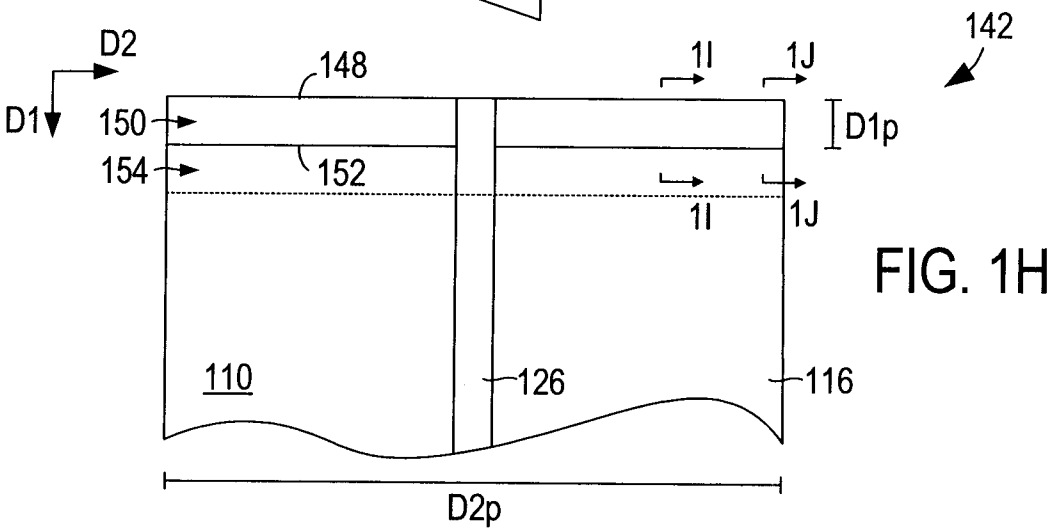

FIG. 1H

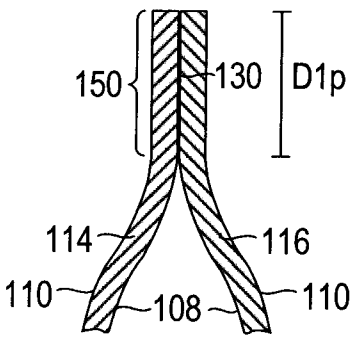

FIG. 1I

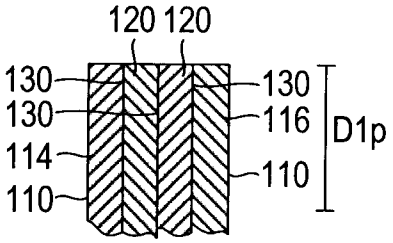

FIG. 1J

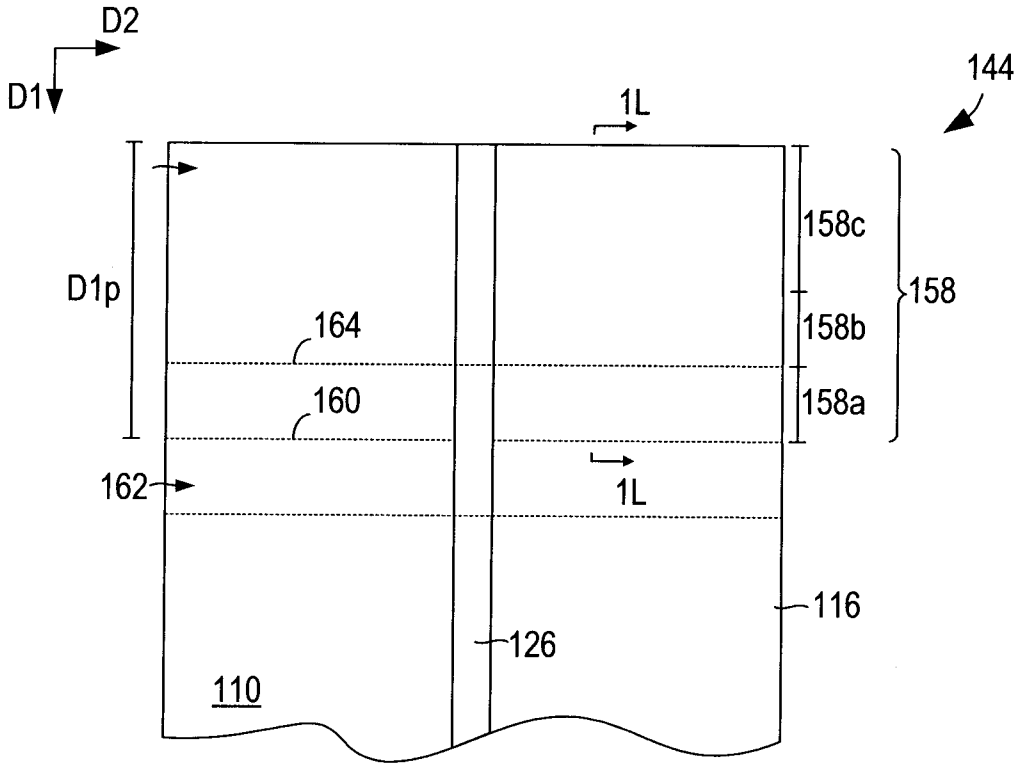
D2
D1
144
1L
158c
158
D1p
164
158b
160
158a
162
1L
116
126
110

FIG. 1K

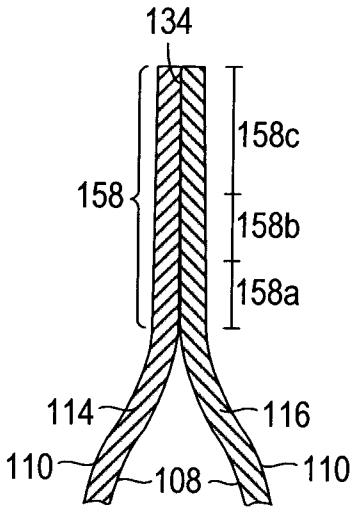
134
158c
158
158b
158a
114
116
110
108
110

FIG. 1L

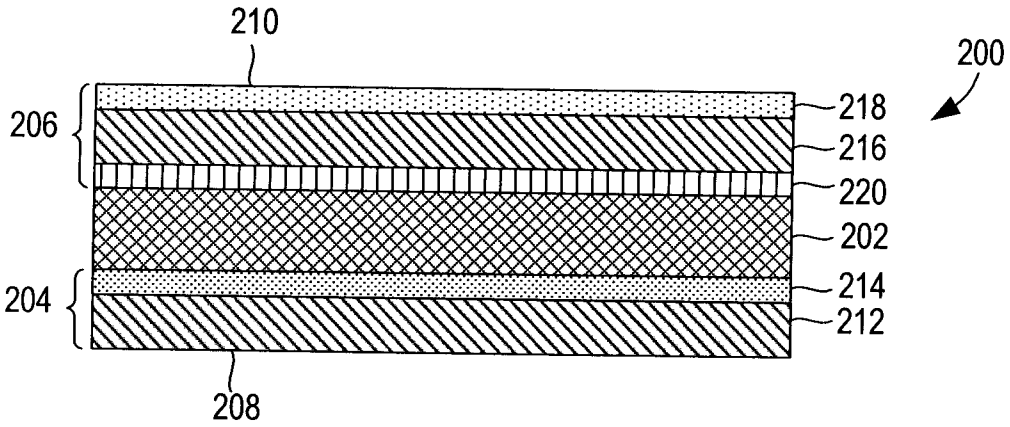

FIG. 2

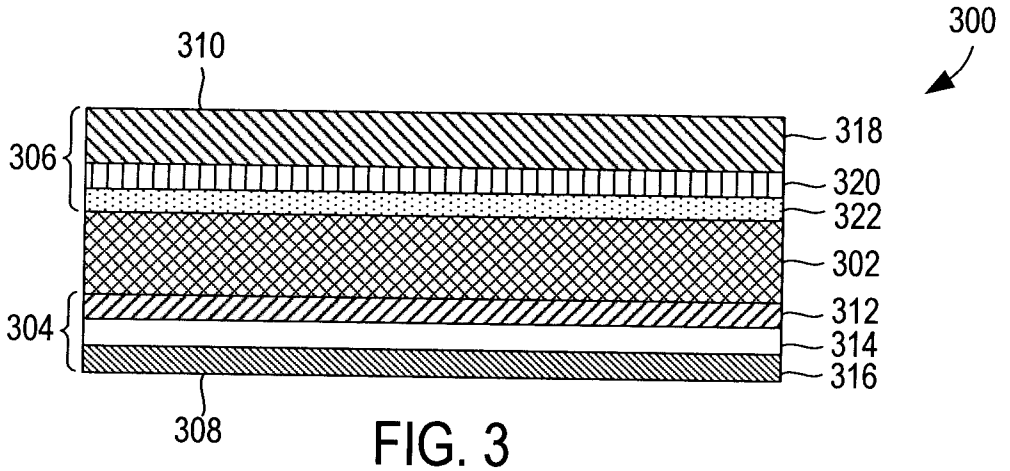

FIG. 3

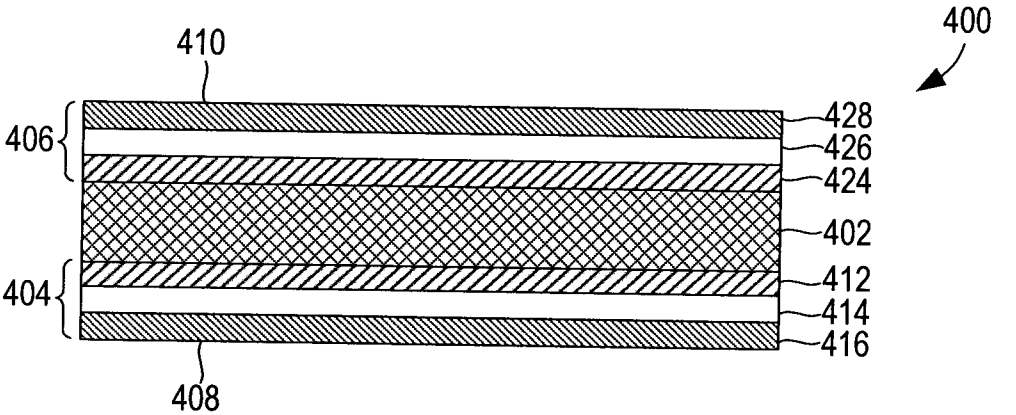

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2010/034179

A. CLASSIFICATION OF SUBJECT MATTER

B65D 75/30(2006.01)i, B65D 30/08(2006.01)i, B65D 65/40(2006.01)i, B65D 33/08(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B65D 75/30; B65D 27/04; B65B 53/00; B65D 27/06; B65D 33/26; B65D 30/10; B65B 55/02

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

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

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

eKOMPASS(KIPO internal) & Keywords: package, seal, fold, strength

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3863835 A1 (GENDRON WILFRED H.) 04 February 1975 See Figure 1 and Column 1 Line 53 - Column 2 Line 23.	1-60
A	JP 2001-048126 A (ASAHI CHEMICAL POLYFLEX CO LTD) 20 February 2001 See Figure 2 and Paragraphs [0007]-[0010].	1-60
A	JP 05-147664 A (DAINIPPON INK & CHEM INC) 15 June 1993 See Figure 3 and Paragraphs [0006]-[0010].	1-60

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

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"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
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 JANUARY 2011 (31.01.2011)	**01 FEBRUARY 2011 (01.02.2011)**

Name and mailing address of the ISA/KR

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Facsimile No. 82-42-472-7140

Authorized officer

KIM, Tae Soo

Telephone No. 82-42-481-5970

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2010/034179

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3863835 A1	04.02.1975	None	
JP 2001-048126 A	20.02.2001	JP 4442956 B2	31.03.2010
JP 05-147664 A	15.06.1993	None	