LIDSTOCK LAMINATE FOR POULTRY PACKAGING

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ABSTRACT

A laminate useful as a lidstock for poultry packaging generally includes a first film capable of bonding directly to a surface comprising foamed polystyrene at a bond strength ranging from about 0.5 to about 5.0 lb per inch, a second film bonded to the first film, and a printed image trapped between the first and second films. At least one of the first and second films may have a free shrink at 185°F. in at least one direction of at least about 10%. Further, the laminate may have a gas transmission rate greater than about 3000 cubic centimeters per square meter per day per 1 atmosphere of gas pressure differential measured at 0% relative humidity and 23°C.
LIDSTOCK LAMINATE FOR POULTRY PACKAGING

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a packaging film and, more particularly, to a laminate useful as a lidstock for sealing to a foamed polystyrene tray. The resultant package is advantageously used to package poultry.

[0002] It is common in food packaging operations for a food product, such as fresh meat, to be placed on a support member, such as a thermoformed expanded polystyrene tray having a central depressed area and a surrounding peripheral flange. A thermoplastic film or laminate is typically then positioned over the food and bonded to the peripheral flange to enclose the food product. In such arrangement, the thermoplastic film or laminate is generally referred to as the “lid” or “lidstock” for the tray or other support member.

[0003] Bonding of the lid to the support member is typically accomplished by effecting a “heat seal” between the lid and support member, generally by engaging the outside of the lid with a heated bar in the form of a closed geometrical shape corresponding with the shape of the flange. The bar compresses the lid against the flange. In so doing, heat transfers from the heated bar to the outside of the lid, through the thickness of the lid, and to the inside sealant layer of the lid and the flange of the support member. The resulting heat and compression causes the contacting surfaces of the lid and support member to become molten and to intermix with one another. The heating bar is then removed to allow the sealed area to cool and form a sealed bond.

[0004] In order to ensure that the packaged food product remains free from dust, dirt, moisture, and other external contaminants, it is important that the lidstock be capable of forming a strong, hermetic seal with the support member. In the past, it has generally been necessary to provide a liner on the inner surface of the support member in order to provide a surface to which the lidstock can be bonded. This is because it is difficult to bond lidstock materials directly to the foamed surface of a support member flange via heat sealing as described above. As a result, prior to thermoforming a polystyrene foam sheet into a tray or other support member, a separate film has typically been laminated to a surface of the sheet to form a liner, which is disposed on the inner surface of the support member cavity and upper surface of the flange upon thermoforming the sheet into a support member. As may readily be appreciated, such a step adds time, complexity, and expense to the tray manufacturing process, and generally also makes it more difficult to recycle excess foam sheet that invariably results from the process.

[0005] When packaging fresh red meat in packages that comprise a lidded support member, a liner has also been generally necessary in order to provide a sufficient barrier to the ingress of oxygen into the package, since foamed support members themselves typically do not provide a sufficient barrier to the passage of oxygen. Such liners would be disadvantageous for the packaging of poultry, however, in that packaged poultry produces hydrogen sulfide gas, which has an unpleasant odor that is very disagreeable to most consumers. Poultry therefore requires highly gas-permeable packaging material to allow such gas to be gradually released from the package, i.e., as it is generated by the poultry. If the gas is not released from the package in a gradual manner, it becomes trapped within the package and is then essentially released all-at-once in the presence of the consumer when the consumer opens the package, much to the displeasure of the consumer. A non-lined, foamed polystyrene support member would be ideal for poultry packaging, due to its relatively high degree of gas-permeability and low cost in comparison to a lined support member, provided that a suitable lidding material could be bonded thereto in such a manner as to form a hermetic seal between the lid and support member.

[0006] It is also desirable for the lidstock to be printed. Such printing provides important information to the end-user of the packaged food—information such as the ingredients of the packaged food, the nutritional content, packaging opening instructions, food handling and preparation instructions, and food storage instructions. The printing may also provide a pleasing image and/or trademark or other advertising information to enhance the retail sale of the packaged product. Such printed information may be placed on the outside surface of the lidstock. However, such surface printing is directly exposed to a heated bar during the heat seal operation that seals the lid to the support member. As a result, the surface printing may become smeared or otherwise degraded. Surface printing is also exposed to other physical abuses during distribution and display of the packaged product. Such abuse may also degrade the clarity and presentation of the printed image. Means for protecting the printed image is therefore desired.

[0007] Accordingly, there is a need in the art for a lidstock material that meets the foregoing requirements for poultry packaging.

SUMMARY OF THE INVENTION

[0008] The present invention addresses one or more of the aforementioned problems.

[0009] A laminate useful as a lidstock comprises:

[0010] a. a first film capable of bonding directly to a surface comprising foamed polystyrene at a bond strength ranging from about 0.5 to about 5.0 lb/in. per inch;

[0011] b. a second film bonded to the first film; and

[0012] c. a printed image trapped between the first and second films,

[0013] wherein:

[0014] at least one of the first and second films has a free shrink at 185° F. in at least one direction of at least about 10%, and

[0015] the laminate has a gas transmission rate greater than about 3000 cubic centimeters per square meter per day per 1 atmosphere of gas pressure differential measured at 0% relative humidity and 23° C.

[0016] Another aspect of the invention is directed towards a package, comprising:

[0017] a. a product support member for supporting a product thereon, the support member comprising foamed polystyrene; and
b. a laminate, comprising a first film and a second film bonded together with a printed image trapped therebetween,

wherein:

at least one of the first and second films has a free shrink at 185°F. in at least one direction of at least about 10%,

the laminate has a gas transmission rate greater than about 3000 cubic centimeters per square meter per day per 1 atmosphere of gas pressure differential measured at 0% relative humidity and 23°C, and

the first film is bonded to the support member in the form of a peelable, hermetic seal that extends around the product to enclose the product between the laminate and support member, the seal having a bond strength ranging from about 0.5 to about 5.0 lb/in per inch.

A further aspect of the invention is directed towards a package, comprising:

a. a product support member for supporting a product thereon, the support member having an upper surface consisting essentially of foamed polystyrene; and

b. a film bonded directly to the upper surface of the support member in the form of a peelable, hermetic seal that extends around the product to enclose the product between the film and support member, the seal having a bond strength ranging from about 0.5 to about 5.0 lb/in per inch, the film having a free shrink at 185°F. in at least one direction of at least about 10% and a gas transmission rate greater than about 3000 cubic centimeters per square meter per day per 1 atmosphere of gas pressure differential measured at 0% relative humidity and 23°C.

Yet another aspect of the invention pertains to a package, comprising:

a. a product support member for supporting a product thereon; and

b. a laminate, comprising a first film and a second film bonded together,

wherein:

the first film is bonded to a surface of the support member in the form of a peripheral seal that extends around the product to enclose the product between the film and support member, and

the second film is cross-linked to a greater degree relative to the first film such that the second film has a melt flow index of less than about 1.0 g/10 min and the first film has a melt flow index of greater than about 1.0 g/10 min.

The foregoing laminates and packages made therefrom are ideally suited for poultry packaging. The laminates have a sufficiently high degree of permeability to allow the hydrogen sulfide produced by packaged poultry to gradually permeate out of the package. Further, the laminates can bond directly to foamed polystyrene with a hermetic, peelable heat-seal so that a non-lined, foamed polystyrene tray may be used, which adds further permeability to the package and is easier and less costly to manufacture than a tray having a film liner. The laminates are also heat-shrinkable, thereby forming a tight, aesthetically-pleasing lid for the package as a result of being heat-sealed to the tray. Moreover, the laminates can accommodate a trap-printed image between the first and second films, thereby protecting the image from degradation during distribution and display.

These and other objects, advantages, and features of the invention will be more readily understood and appreciated by reference to the detailed description of the invention and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the sealed package of the present invention; and

FIG. 2 is a fragmentary, representational sectional view of the inventive laminate and sealed package of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The inventive laminate comprises a first, sealant film laminated to a second, heat-resistant film. A printed image is preferably trapped between the first and second films. First film may be monolayer, two-layer, or have three or more layers (as shown in FIG. 2). Also, second film may be monolayer, two-layer, or have three or more layers (as shown in FIG. 2). The laminate may be sealed to support member (e.g., a tray as shown) to form sealed package enclosing food product, e.g., a poultry product such as chicken, turkey, cornish hen, pheasant, duck, etc.

First, Sealant Film

The sealant film defines an inside (i.e., food side) surface and an outside surface opposite the inside surface. The polymer material (i.e., component or blend of components) that forms the inside surface has a melting point and appropriate chemical characteristics to facilitate heat sealing laminate to support member. If the sealant film is monolayer, then it may have the composition, attributes, and physical characteristics as discussed in conjunction with the Sealant Layer section below.

The sealant film may have any total thickness as long as it provides the desired properties (e.g., permeability, flexibility, Young's modulus, optics, strength) for the given packaging application of expected use. The sealant film may have a thickness of less than about any of the following: 10 mils, 5 mils, 4 mils, 3 mils, 2 mils, 1.5 mils, 1.4 mils, 1.3 mils, 1.2 mils, 1.1 mils, and 1.0 mil. (A "mil" is equal to 0.001 inch.) The sealant film may also have a thickness of at least about any of the following: 0.3 mils, 0.4 mils, 0.5 mils, 0.6 mils, 0.7 mils, 0.75 mils, 0.8 mils, 0.9 mils, 1.0 mil, 1.2 mil, 1.4 mil, and 1.5 mil. The thickness of the sealant film may be greater than, equal to, or less than the thickness of the second, heat-resistant film.

The sealant film preferably has a gas transmission rate of at least about any of the following: 5,000, 10,000, 15,000, 20,000, and 50,000 cubic centimeters per square meter per day per 1 atmosphere of gas pressure.
The sealant film 12 may be heat-shrinkable so that, upon being heat-sealed to support member 18, the resultant heat exposure will cause the film to tighten as it attempts to shrink while being bonded to the support member. Such tightening produces an aesthetically appealing packaging appearance. The sealant film 12 may have a free shrink in at least one direction (i.e., machine or transverse direction) or in at least each of two directions (machine and transverse directions), measured at 185°F, of at least about 10%, such as at least about 15%, 20%, 25%, 30%, 35%, 40%, 50%, 55%, 60%, or 65%. Further, the sealant film may have a free shrink in at least one direction (machine or transverse direction) or at least each of two directions (machine and transverse directions) of at least about any of the foregoing shrink values when measured at any of 185°F, 190°F, 200°F, or 210°F.

As is known in the art, the total free shrink is determined by summing the percent free shrink in the machine (longitudinal) direction with the percentage of free shrink in the transverse direction. For example, a film which exhibits 50% free shrink in the transverse direction and 40% free shrink in the machine direction has a total free shrink of 90%. Although preferred, it is not required that the film have shrinkage in both directions. Unless otherwise indicated, each reference to free shrink in this application means a free shrink determined by measuring the percent dimensional change in a 10 cm x 10 cm specimen when subjected to selected heat (i.e., at a certain temperature exposure) according to ASTM D 2732. Also, a reference herein to the shrink attributes of a film that is a component of a laminate refers to the shrink attributes of the film itself, which can be measured by separating the film from the laminate.

The sealant or first film 12 is preferably multilayer (i.e., includes two or more layers) so that the layers in combination impart the desired performance characteristics to the sealant film. The sealant film 12 may, for example, comprise from 2 to 15 layers, at least 3 layers, at least 4 layers, at least 5 layers, from 2 to 4 layers, from 2 to 5 layers, or from 5 to 9 layers. As used herein, the term “layer” refers to a discrete film component which is coextensive with the film and has a substantially uniform composition.

A multilayer sealant film includes a sealant layer 28 forming the food-side or inside surface 24 and a outer or print-side layer 30 forming the outside or non-food surface 26 of the sealant film. The multilayer sealant film may also include one or more additional layers 32, such as core, bulk, and tie layers.

Below are some examples of multilayer film combinations in which the alphabetical symbols designate the resin layers. Where the multilayer sealant film representation below includes the same letter more than once, each occurrence of the letter may represent the same composition or a different composition within the class that performs a similar function.


“A” is the sealant layer (heat seal layer), as discussed below.

“B” is a core or bulk layer, as discussed below.

“C” is a tie layer, as discussed below.

“D” is an outer or print-side layer, as discussed below.

Sealant Layer of the Sealant Film

Sealant layer 28 forms the inside surface 24 of the laminate 10. Sealant layer 28 facilitates the heat-sealing of laminate 10 to another object, such as support member tray 18. Preferably, sealant layer 28 includes selected components that are capable of bonding directly to a surface comprising or consisting essentially of foamed polystyrene, e.g., a support member such as 18 formed from foamed polystyrene and having no film or “liner” on the inner or upper sealing surfaces thereof to facilitate bonding. More preferably, sealant layer 28 of the first, sealant film 12 is capable of bonding to a foamed polystyrene surface in the form of a heat-seal, e.g., a peripheral heat-seal between the sealant film and a flanged support member as described above. As discussed in further detail below, such heat-seal is more preferably a peelable, hermetic seal, i.e., one that maintains seal integrity during packaging, transportation, and placement in a retail display case for consumer purchase, but which can be conveniently opened via peeling by the consumer just prior to cooking the packaged food product 22. It has been discovered that a peelable, hermetic seal between the sealant film and a foamed surface may be achieved when the bond-strength therebetween ranges from about 0.5 to about 5.0 lb/inch of film width.

When support member 18 is formed from foamed polystyrene or similar materials, a bond-strength that falls within the desired range of 0.5 to 5.0 lb/inch may be achieved when sealant layer 28 includes one or more copolymers or terpolymers comprising a styrene component and a rubbery component, wherein the rubbery component has at least one, carbon-carbon double bond and comprises no more than about 50 wt. % of the thermoplastic elastomer. Preferred materials comprise a block copolymer or terpolymer, wherein the rubbery component is distributed in the copolymer or terpolymer between styrene endblocks. Preferred examples of such block copolymers or terpolymers that are useful in accordance with the present invention include the following: styrene-ethylene-butylene-styrene block copolymer (SEBS), styrene-butadiene-styrene block copolymer (SBS), and styrene-isoprene-styrene block copolymer (SIS). As an alternative to block copolymers and terpolymers, random copolymers and terpolymers comprising styrene and a rubbery component may be employed, such as polybutadiene/styrene rubber.

Other materials that may be employed in sealant layer 28 include polystyrene (PS), blends of PS and elastomers, such as, e.g., polybutadiene rubber, butyl rubber, polychloroprene rubber, acrylonitrile-butadiene rubber, vinylpyridine rubber, ethylene-propylene rubber, etc.; ethylene/vinyl acetate copolymer, particularly those having a vinyl acetate content of at least about 15 weight percent; and ethylene/methyl acrylate copolymer.

The sealant layer 28 may have a composition such that any one of the above described polymers comprises at least about any of the following weight percent values: 30, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, and 100% by weight of the layer.
The thickness of the sealant layer is selected to provide sufficient material to effect a strong heat seal bond, yet not so thick so as to negatively affect the gas-permeability of the sealant film by decreasing such permeability to an unacceptable level. The sealant layer may have a thickness of at least about any of the following values: 0.01, 0.02, 0.025 mls, 0.05 mls, 0.1 mls, 0.15 mls, 0.2 mls, 0.25 mls, 0.3 mls, 0.35 mls, 0.4 mls, 0.45 mls, 0.5 mls, and 0.6 mls. For example, the sealant layer may have a thickness ranging from about 0.025 to about 1 mil, from about 0.025 to about 0.6 mls, or from about 0.05 to about 0.3 mls. Further, the thickness of the sealant layer as a percentage of the total thickness of the sealant film 12 may range, e.g., from about 1 to about 50 percent, from about 5 to about 45 percent, from about 10 to about 45 percent, from about 15 to about 40 percent, from about 15 to about 35 percent, or from about 15 to about 30 percent.

Outside Interface Layer of the Sealant Film

The outside interface layer 30 of sealant film 12 may provide the surface upon which a printed image (e.g., printed information) is applied, in which case the layer is preferably capable of providing a surface that is compatible with the selected print ink system. Further, the outside layer 30 provides the outside surface 26 that interfaces with second film 14 and to which the second film 14 is directly laminated, as discussed in more detail below.

The outside layer 30 may include any of the thermoplastics or compositions as discussed above in conjunction with the sealant layer 28. The outside layer 30 may have a composition or thickness (or both) substantially similar to the sealant layer 28. Preferred polymers for outside layer 30 include one or more of the following: styrenic-based copolymers, terpolymers, and blends as described above with respect to sealant layer 28, heterogeneous (Zeigler-Natta catalyzed) ethylene/alpha-olefin copolymers such as linear low density polyethylene, homogenous (single-site, metallocene-catalyzed) ethylene/alpha-olefin copolymers, polyethylene homopolymers (LDPE or HDPE), propylene homopolymers, polypropylene copolymers such as propylene/ethylene copolymer, polyamides, copolyamides, polyesters, and copolyesters, either alone or in combination. The outside layer 30 may have a composition such that any one of the above-described polymers comprises at least about any of the following weight percent values: 30, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, and 100% by weight of the layer.

The outside layer 30 may have a thickness of from about 0.025 to about 1 mil, such as from about 0.025 to about 0.6 mil or from about 0.05 to about 0.3 mil. The thickness of the outer layer may range as a percentage of the total thickness of the sealant film of, e.g., from about 1 to 50 percent, 3 to 45 percent, 5 to 40 percent, 7 to 35 percent, or 7 to 30 percent. Useful thicknesses for the outer layer include at least about any of the following values: 0.025 mil, 0.05 mil, 0.1 mil, 0.15 mil, 0.2 mil, and 0.25 mil.

Additional Layers of the Sealant Film

The sealant film 12 may include one or more additional layers 32, such as a tie, core, or bulk layers. A tie layer is an inner film layer having the primary purpose of adhering two layers of a film together. The tie layers, if present in the sealant film, may have the composition and other attributes as described below in conjunction with the tie layers that may also be used in second film 14.

A core or bulk layer may be an inner film layer having a primary purpose other than as a tie layer—for example, serving to provide a multilayer film with a desired level of strength, modulus, or optics. A core or bulk layer may include one or more of the polymers and/or have a composition as described above with respect to the sealant layer 28 and/or outer layer 30.

Each of the additional layers 32 may have a thickness of about 0.05 to about 0.5 mls, such as from about 0.1 to about 0.2 to about 0.5 mls. The thickness of an additional layer may range as a percentage of the total thickness of the sealant film of, e.g., from about 1 to about 80 percent, 3 to about 50 percent, 5 to about 40 percent, 7 to about 35 percent, or 7 to about 30 percent. Preferably, adjacent film layers have different compositions.

Second, Heat-Resistant Film

The second, heat-resistant film 14 defines an inside surface 34 and an outside surface 36 opposite the inside surface. The outside surface 36 of the heat-resistant film 14 forms the surface that may engage the heated bar of a heat-sealing device (not shown) used in sealing laminate 10 to support member 18, as discussed in more detail below. The outside layer 40 forms the outside surface 36 of the heat-resistant film.

The heat-resistant film 14 may have any total thickness as long as it provides the desired properties (e.g., permeability, flexibility, Young’s modulus, optics, strength) for the given packaging application of expected use. The heat-resistant film may have a thickness of less than about any of the following: 10 mls, 5 mls, 4 mls, 3 mls, 2 mls, 1.5 mls, 1.2 mls, and 1.1 mls. The heat-resistant film may also have a thickness of at least about any of the following: 0.2 mls, 0.25 mls, 0.3 mls, 0.35 mls, 0.4 mls, 0.45 mls, 0.5 mls, 0.6 mls, 0.75 mls, 0.8 mls, 0.9 mls, 1 mls, 1.2 mls, and 1.5 mls.

The heat-resistant film 14 preferably has a construction that enables the film to withstand the heat transferred thereto from the heated bar of a heat-seal device during heat-sealing/packaging operations. Such construction also preferably provides the film with abuse- and impact-resistance. With these attributes, the heat-resistant film 14 thus provides protection to the laminate during packaging, shipment, storage, and customer inspection at retail.

Heat-resistant film 14 preferably has a gas transmission rate of at least about any of the following: 5,000, 10,000, 15,000, 20,000, and 50,000 cubic centimeters per square meter per day per 1 atmosphere of gas pressure differential measured at 0% relative humidity and 23°C, measured according to ASTM D-3985.

The heat-resistant film 14 may be heat-shrinkable so that, upon being heat-sealed to support member 18, the result shall cause the film to tighten as it attempts to shrink while being bonded to the support member. Such tightening produces an aesthetically appealing packaging appearance. The heat-shrinkability of the film 14 may be greater than, the same as, or lesser than that of sealant film 12. Heat-resistant film 14 may have a free shrink...
in at least one direction (i.e., machine or transverse direction) or in at least each of two directions (machine and transverse directions), measured at 185°F, of at least about 10%, such as at least about 15%, 20%, 25%, 30%, 40%, 50%, 55%, 60%, or 65%. Further, the sealant film may have a free shrink in at least one direction (machine or transverse direction) or in at least each of two directions (machine and transverse directions) of at least about any of the foregoing shrink values when measured at any of 185°F, 190°F, 200°F, or 210°F.

[0066] The heat-resistant or second film 14 is preferably multilayer so that the layers in combination impart the desired performance characteristics to the heat-resistant film. The heat-resistant film 14 may comprise multiple layers, for example 2 layers, from 2 to 15 layers, 3 layers, at least 3 layers, at least 4 layers, at least 5 layers, from 2 to 4 layers, from 2 to 5 layers, and from 5 to 9 layers.

[0067] A multilayer heat-resistant film includes: i) an inside, interface layer 38 forming the inside surface 34 of the heat-resistant film and which, upon lamination, interfaces with and is bonded to the outside layer 30 of the sealant film 12, and ii) a heat-resistant, outside layer 40 forming the outside surface 36 of the heat-resistant film 14. The inside layer 38 may be directly adhered to the outside layer 40. Alternatively, one or more inner layers 42, such as tie, core, and bulk layers, may exist between the inside layer 38 and the outside layer 40.

[0068] Below are some examples of layer combinations for the multilayer heat-resistant film 14 in which the alphabetical symbols designate the resin layers. Where the multilayer heat-resistant film representation below includes the same letter more than once, each occurrence of the letter may represent the same composition or a different composition within the class that performs a similar function.

[0069] E/F, E/C/F, E/B/F, E/C/B/F, E/B/C/F, E/C/B/C/F

[0070] “B” is a core or bulk layer, as discussed above with respect to the sealant film.

[0071] “C” is a tie layer, as discussed below.

[0072] “E” is the inside layer of the heat-resistant film, as discussed below.

[0073] “F” is an outside or heat-resistant layer of the heat-resistant film, as discussed below.

Heat-Resistant Layer of the Heat-Resistant Film

[0074] During heat-sealing, the outside, heat-resistant layer 40 will be directly exposed to the heat seal bar of the heat-sealing equipment (not shown) when forming the sealed package 20. Thus, the outside layer 40 preferably provides heat-resistant characteristics to second film 14 (and laminate 10) to help prevent “burn-through” during heat sealing. This is because in forming package 20 by conductive heat-sealing of the laminate 10 to support member 18, sealant layer 28 is placed in contact with the support member 18, while the outside layer 40 is proximate the heated bar of the heat sealing apparatus. The heat seal bar transfers heat through the outside layer 40, through laminate 10, and to the sealant layer 28 to form a heat seal 44 between the laminate and support member 18. Accordingly, outside layer 40 may be exposed to the highest temperature during the sealing operation.

[0075] The heat-resistant film 14 may also be exposed to environmental stresses, for example once the heat-resistant film is incorporated into laminate 10 and formed into a package 20. Such environmental stresses include abrasion and other abuse during processing and shipment. Thus, the outside layer 40 preferably provides enhanced resistance to abuse.

[0076] The outside layer 40 may include one or more of any of the following: polyolefins (e.g., polyethylenes, polypropylenes), polyamides, polyesters, polystyrenes, polycarbonates. In order to provide high gas-permeability, however, outside layer 40 preferably comprises one or more polyolefins, polystyrenes, or polycarbonates. For example, layer 40 may include any of these polymers in an amount of at least 50 weight %, more preferably at least 70%, still more preferably at least 90%, and most preferably 100% by weight of the layer.

[0077] The outside layer 40 may have a thickness from about 0.025 to about 1.25 mils, such as from about 0.05 to about 0.6 mil or from about 0.1 to about 0.3 mil. The thickness of the outside layer may range as a percentage of the total thickness of the heat-resistant film, e.g., from about 1 to 50 percent, 3 to 45 percent, 5 to 40 percent, 7 to 35 percent, or 7 to 30 percent. Useful thicknesses for the outside layer include at least any of the following values: 0.05 mils, 0.1 mils, 0.15 mils, 0.2 mils, 0.25 mils, 0.3 mils, 0.35 mils, and 0.4 mils.

Tie Layers of the Sealant and/or Heat-Resistant Film

[0078] The heat-resistant film 14 and/or sealant film 12 may include one or more tie layers, which have the primary purpose of improving the adherence of two layers of a film to each other. Tie layers may include polymers having grafted polar groups so that the polymer is capable of covalently bonding to polar polymers. Useful polymers for tie layers include ethylene/unsaturated acid copolymers, ethylene/unsaturated ester copolymers, anhydride-modified polyolefin, polyurethane, and mixtures thereof. Preferred polymers for tie layers include one or more of ethylene/vinyl acetate copolymer having a vinyl acetate content of at least 12 weight %, ethylene/methyl acrylate copolymer having a methyl acrylate content of at least 20 weight %, anhydride-modified ethylene/methyl acrylate copolymer having a methyl acrylate content of at least 20%, anhydride-modified ethylene-alpha-olefin copolymer, such as an anhydride grafted LLDPE, and other modified, e.g., anhydride-modified, olefin polymers.

[0079] Modified polymers or anhydride-modified polymers include polymers prepared by copolymerizing an unsaturated carboxylic acid (e.g., maleic acid, fumaric acid), or a derivative such as the anhydride, ester, or metal salt of the unsaturated carboxylic acid with—or otherwise incorporating the same into—an olefin homopolymer or copolymer. Thus, anhydride-modified polymers have an anhydride functionality achieved by grafting or copolymerization.

[0080] The tie layers are of sufficient thickness to provide the adherence function, as is known in the art. Each tie layer may be of a substantially similar or a different composition and/or thickness.

Inside Layer of the Heat-Resistant Film

[0081] The inside layer 38 of the heat-resistant film 14 may provide the surface upon which a printed image (e.g.,
printed information) is applied, in which case the inside layer is preferably capable of providing a surface that is compatible with the selected print ink system. Further, the inside layer 38 provides the inside surface 34 that interfaces with sealant film 12 and to which the sealant film 12 is directly laminated, i.e., inside layer 38 interfaces and bonds with outside layer 30 of sealant film 12 as discussed in more detail below. The inside layer 38 may be a heat-resistant layer.

[0082] The inside layer 38 may include any of the thermoplastics or compositions as discussed above in conjunction with the outside layer 30 of the sealant film 12. The inside layer 38 may have a thickness of from about 0.025 to about 1.25 mils, such as from about 0.05 to about 0.6 mil or from about 0.1 to about 0.3 mils. The thickness of the inside layer 38 may range as a percentage of the total thickness of the heat-resistant film 14 of, e.g., from about 1 to 50 percent, 3 to 45 percent, 5 to 40 percent, 7 to 35 percent, or 7 to 30 percent. Useful thicknesses for the inside layer include at least about any of the following values: 0.05 mil, 0.1 mil, 0.15 mil, 0.2 mil, and 0.25 mil.

Additives of Sealant and/or Heat-Resistant Films

[0083] One or more layers of the sealant and or heat-resistant films of laminate 10 may include one or more additives useful in packaging films, such as, antiblocking agents, slip agents, antifog agents, colorants, pigments, dyes, flavorants, antimicrobial agents, meat preservatives, antioxidants, fillers, radiation stabilizers, and anticlastic agents. Such additives, and their effective amounts, are known in the art.

[0084] An antifog agent may advantageously be incorporated into sealant layer 28 or coated onto sealant layer 28, because sealant layer 28 forms the inside surface 24 adjacent the interior of the sealed package 20. The other layers of films 12 and 14 may also contain an antifog agent therein, e.g., when sealant layer 28 is relatively thin such that it cannot contain sufficient antifog additive to provide adequate antifog functionality. Suitable antifog agents may fall into classes such as esters of aliphatic alcohols, esters of polyglycol, polyethers, polyhydric alcohols, esters of polyhydric aliphatic alcohols, polyethoxylated aromatic alcohols, nonionic ethoxylates, and hydrophilic fatty acid esters. Useful antifog agents include polyoxyethylene, sorbitan monostearate, polyoxyethylene sorbitan monolaurate, polyoxyethylene monopalmitate, polyoxyethylene sorbitan tristearate, polyoxyethylene sorbitan trioleate, polyoxypropylene, polyoxyethylene fatty acids, polyoxyethylated 4-nonylphenol, polyhydric alcohol, propylene diol, propylene triol, and ethylene diol, monoglyceride esters of vegetable oil or animal fat, mono- and/or diglycerides such as glycerol mono- and dioleate, glycercyl stearate, monophenyl polyethoxylate, and sorbitan monolaurate. The antifog agent is incorporated in an amount effective to enhance the antifog performance of the laminate 10.

Cross-Linking of the Sealant and/or Heat-Resistant Films

[0085] One or more of the thermoplastic layers of the sealant and/or heat-resistant films —or at least a portion of the entire sealant and/or heat-resistant films—may be cross-linked to improve the strength of the film, improve the orientation of the film, and help to avoid burn through during heat seal operations.

[0086] Preferably, the second, heat-resistant film 14 is cross-linked to a greater degree relative to the first, sealant film 12. The higher degree of cross-linking in second film 14 enhances the heat-resistance thereof while the lower degree of cross-linking in first film 12 enhances the heat-sealability thereof. The heat-resistant film 14 is preferably cross-linked at a dosage of at least about 40 kGy (kiloGray) while the sealant film 12 is preferably cross-linked, if at all, at a dosage of less than about 40 kGy (1 rad=0.01 Gy). For example, the heat-resistant film 14 may be exposed to at least about any of the following dosages: 50 kGy, 60 kGy, 70 kGy, 80 kGy, 90 kGy, 100 kGy, 110 kGy, or 120 kGy. For example, a dosage ranging from about 50 to about 100 kGy, such as about 60 to about 90 kGy, may be employed. For sealant film 12, a dosage of less than about any of the following may be employed: 35 kGy, 30 kGy, 25 kGy, 20 kGy, 15 kGy, 10 kGy, or 5 kGy. In many instances, no cross-linking will be required for sealant film 12. Where cross-linking is desired, a dosage ranging from about 10 to 35 kGy, such as between about 20 to 30 kGy, may be applied.

[0087] As a result of such differences in cross-linking, the second, heat-resistant film 14 preferably has a melt flow index of less than about 1.0 g/10 min. and the first, sealant film 12 preferably has a melt flow index of greater than about 1.0 g/10 min, as determined in accordance with ASTM D-1238 at 230° C. and with a 21.5 KG weight. Thus, heat-resistant film 14 may have a melt flow index of less than about any of the following: 0.9 g/10 min., 0.8 g/10 min., 0.7 g/10 min., 0.6 g/10 min., 0.5 g/10 min., 0.4 g/10 min., 0.3 g/10 min., 0.2 g/10 min., or 0.1 g/10 min. Sealant film 12 may have a melt flow index of greater than about any of the following: 5 g/10 min., 10 g/10 min., 20 g/10 min., 30 g/10 min., 40 g/10 min., 50 g/10 min., 70 g/10 min., 90 g/10 min., 100 g/10 min., 200 g/10 min/g/10 min., 300 g/10 min., 400 g/10 min., or 500 g/10 min.

[0088] Cross-linking may be achieved by using chemical additives or by subjecting one or more film layers to one or more energetic radiation treatments—such as ultraviolet, X-ray, gamma ray, beta ray, and high energy electron beam treatment—to induce cross-linking between molecules of the irradiated material.

[0089] If desired, means other than cross-linking may be employed to achieve the differences in melt flow index between the first and second films, e.g., by constructing such films from different materials.

[0090] Manufacture and Orientation of the Sealant and Heat-Resistant Films

[0091] The first, sealant film 12 and second, heat-resistant film 14 may each be separately manufactured by thermoplastic film-forming processes known in the art (e.g., tubular or blown-film extrusion, coextrusion, extrusion coating, flat or cast film extrusion). A combination of these processes may also be employed.

[0092] Each of the sealant film 12 and heat-resistant film 14 may be oriented (i.e., before lamination as discussed below) or non-oriented. Either or both of the sealant film 12 and the heat-resistant film 14 may be oriented in either the machine (i.e., longitudinal) or the transverse direction, preferably in both directions (i.e., biaxially oriented), for example, in order to enhance the optics, strength, and
durability of the film. Orientation of each film is also a preferred means for providing the heat-shrinkability characteristics as discussed above. Each of the sealant and heat-resistant films may independently be oriented in at least one direction at one of the following ratios: from about 2.5:1 to about 8:1, from about 2.7:1 to about 6:1, from about 2.8:1 to about 5:1, from about 2.9:1 to about 4.8:1, from about 3.0:1 to about 4.6:1, or from about 3.2:1 to about 4.4:1.

Laminate

[0093] Laminate 10 includes sealant film 12 laminated to heat-resistant film 14, preferably trapping the printed image 16 between the sealant and heat-resistant films. Preferably, at least one of the inside sealant film 12 and/or the outside heat-resistant film 14 are heat-shrinkable as discussed above so that the resulting laminate 10 presents a superior appearance upon sealing to the support member 18 (as described below).

[0094] When laminate 10 is used for poultry packaging, it preferably has a gas transmission rate greater than about 3000 cubic centimeters per square meter per day per 1 atmosphere of gas pressure differential measured at 0% relative humidity and 23°C, such as at least about 3500, 4000, 4500, 5000, 5500, 6000, or 6500 cubic centimeters per square meter per day per 1 atmosphere of gas pressure differential measured at 0% relative humidity and 23°C.

[0095] Laminate 10 preferably has a free shrink in at least one direction (i.e., machine or transverse direction) or in at least each of two directions (machine and transverse directions), measured at 185°F, of at least about 10%, such as at least about 15%, 20%, 25%, 30%, 40%, 50%, 55%, 60%, or 65%. Further, the laminate may have a free shrink in at least one direction (machine or transverse direction) or in at least each of two directions (machine and transverse directions) of at least about any of the foregoing shrink values when measured at any of 185°F, 190°F, 200°F, or 210°F. This may be achieved by selecting at least one of the first and second films 12 and/or 14 to have a free shrink at 185°F in at least one direction of at least about 10%, as described above with respect to each film. If desired, only one of films 12 or 14 may have such free shrink functionality; the other may have less heat-shrinkability or no heat-shrinkability.

[0096] The thickness of the laminate may be less than about any of the following values: 5, 4, 3, 2.5, 2.4, 2.3, 2.2, 2.1, 2, 1.9, 1.8, 1.7, 1.5, 1.25, and 1.0 mils.

Trap Printed Image

[0097] A printed image 16 is preferably disposed (i.e., trap printed) between the sealant and heat-resistant films at the interface between the outside surface 26 of sealant film 12 and the inside surface 34 of the heat-resistant film 14. This may be accomplished by printing one or more images 16 on one or both of these surfaces before laminating the films together, so that upon lamination the printed images 16 are “trapped” between the two films. For example, the printed image may be “reverse trap printed” by printing the image onto surface 34 of the heat-resistant film.

[0098] As discussed below, heat-resistant film 14 is preferably transparent so that the trapped image 16 is visible therethrough in order to provide information to the retail purchaser of the package. Accordingly, package 10 may be provided with consumer-specific information at the time of packaging at a centralized packaging facility, in the form of a printed image trapped within the laminate 10 used at part of the sealed package 20. The availability of trap printed information in laminate 10 reduces and potentially eliminates the need for additional package printing or labeling at the retail distribution point. The printed image 16 may include indicia such as product information, nutritional information, source identification, and other information, as discussed above.

[0099] To form the printed image, one or more layers of ink are printed onto the print surface. The ink is selected to have acceptable ink adhesion, appearance, and heat resistance once printed on the film. The film may be printed by any suitable method, such as rotary screen, gravure, or flexographic techniques. Inks and processes for printing on plastic films are known to those of skill in the art. See, for example, Leach & Pierce, The Printing Ink Manual, (5th ed., Kluwer Academic Publishers, 1993), which is incorporated herein in its entirety by reference.

[0100] To improve the adhesion of the ink to the surface of the sealant or heat-resistant film, the surface of the sealant or heat-resistant film may be treated or modified before printing. Surface treatments and modifications include: i) mechanical treatments, such as corona treatment, plasma treatment, and flame treatment, and ii) primer treatment. Surface treatments and modifications are known to those of skill in the art. The flame treatment is less desirable for a heat-shrinkable film, since heat may prematurely shrink the film. The ink system should be capable of withstanding without diminished performance the temperature ranges to which it will be exposed during lamination, heat sealing, packaging, and end use.

[0101] If a trap-printed image 16 is not necessary or desired for the particular packaging application in which the laminate will be used, e.g., where no image is desired or where a surface-printed image will suffice, the second, heat-resistant film 14 may be omitted. In such an alternative embodiment, the lid would not be a laminate but would comprise only the sealant film 12. In this event, the outside layer 30 of sealant film 12 preferably has a heat-resistant composition and functionality similar to that described above with respect to outside layer 40 of second film 14.

Appearance Characteristics of the Laminate

[0102] Each of laminate 10 and heat-resistant film 14 preferably has low haze characteristics. Haze is a measurement of the transmitted light scattered more than 2.5° from the axis of the incident light. Haze is measured against the outside surface 36 of the heat-resistant layer 40 of second film 14, according to the method of ASTM D 1003-95. All references to “haze” values in this application are by this standard. Preferably, the haze of either laminate 10 or heat-resistant film 14 is no more than about (in ascending order of preference) 20%, 15%, 10%, 9%, 8%, or 7%.

[0103] Laminate 10 preferably has a gloss, as measured against the outside surface 36 of the heat-resistant layer 40 of at least about (in ascending order of preference) 40%, 50%, 60%, 63%, 65%, 70%, 75%, or 80%. These percentages represent the ratio of light reflected from the sample to the original amount of light striking the sample at the
designated angle. All references to “gloss” values in this application are in accordance with ASTM D 2457-90 (45° angle).

[0104] Preferably, laminate 10 is substantially transparent (at least in the non-printed regions) so that the packaged food item 22 is visible through the laminate. “Transparent” as used herein means that the material transmits incident light with negligible scattering and little absorption, enabling objects (e.g., packaged food or print) to be seen clearly through the material under typical unaided viewing conditions (i.e., the expected use conditions of the material). If laminate 10 is transparent then both heat-resistant film 14 and sealant film 12 are also transparent. Optionally, heat-resistant film 14 may be transparent while sealant film is opaque, in which case laminate 10 is opaque while trap print 16 is still clearly visible through heat-resistant film 14. Preferably, the clarity of any of the laminate 10, sealant film 12, and heat-resistant film 14 are at least about any of the following values: 45%, 50%, 55%, and 60%, as measured in accordance with ASTM D1746-92. Similarly, the transmittance of laminate 10 is preferably at least about 60%, 65%, 70%, 75%, 80%, 85%, or 90%, as measured in accordance with ASTM

Manufacture of the Laminate

[0105] To manufacture laminate 10, the outside surface 26 of the sealant film 12 is placed adjacent to or in contact with the inside surface 34 of heat-resistant film 14 so that the films may be bonded together by a suitable lamination technique. Suitable lamination techniques are known in the art, and include adhesive bonding, reactive surface modification (e.g., corona treatment, flame treatment, or plasma treatment), heat treatment, pressure treatment, heat-welding, and combinations thereof. Suitable lamination methods are described in U.S. Pat. No. 5,779,050 issued Jul. 14, 1998 to Kocher et al entitled “Lidded Package Having a Tab to Facilitate Peeling,” which is incorporated herein in its entirety by reference.

[0106] Heat-resistant film 14 may be directly laminated to sealant film 12. The term “directly laminated” as used herein means that a first film is bonded to a second film by a suitable lamination method without an additional film between the first and second films. The first film (e.g., sealant film) may be considered as “directly laminated” to the second film (e.g., heat-resistant film)—even if additional material is present between the first and second films—if the additional material is present primarily to facilitate the lamination of the first and second films (e.g., an adhesive used in adhesive lamination) or to form part of the trap print (e.g., a printed image) between the first and second films.

[0107] As a reactive surface modification lamination method, corona treatment may be combined with pressure and, optionally, heat immediately after the corona treatment. The corona treatment provides the film with a reactively modified surface to enhance lamination bonding. The amount of corona discharge to which the films are exposed is directly proportional to the amount of power supplied to the corona treatment units, and also indirectly proportional to the speed at which the films are passed through the units. In general, corona treatment units operate by passing a high voltage electrical current through an electrode positioned adjacent a film surface to be treated. The electrode then produces an electrical discharge which ionizes the surrounding air to cause reactive surface modification, e.g., oxidation, of the treated film surface.

[0108] Any desired combination of power input to the corona unit and film speed may be employed to achieve a desired bond-strength between the films. The amount of power supplied to the corona treatment units may range, for example, from about 0.02 to about 0.5 kilowatts (kw) per inch of film width. The film speed through the corona treatment unit may range, for example, from about 10 to about 2000 feet/minute.

Sealed Package

[0109] The lidstock laminate 10 may be heat sealed to support member 18 to form sealed package 20.

Support Member

[0110] Support member 18 is a component of package 20 in addition to laminate 10. Product 22 (e.g., a poultry or other food product) may be disposed on or in support member 18. For example, poultry products may be disposed in a tray-like support member comprising, for example, expanded polystyrene sheet material that has been thermoformed into a desired shape for supporting the poultry product. Product support member 18 preferably is in the form of a tray having side walls 50 and base 52—which define cavity 46 into which the product 22 may be disposed. A peripheral flange 48 preferably extends from side walls 50 to provide a sealing surface for attachment of lid 10 to the support member 18 to enclose the product 22 within the cavity 46.

[0111] Although the drawings show support member 18 in one configuration, support member 18 may have any desired configuration or shape, such as rectangular, round, or oval. The support member may be substantially rigid, semi-rigid, or flexible.

[0112] Flange 48 may also have any desired shape or design, such as the substantially flat design presenting a single sealing surface as shown in the drawings, or a more elaborate design which presents two or more sealing surfaces, such as the flange configurations disclosed in U.S. Pat. Nos. 5,348,752 and 5,439,132, the disclosures of which are incorporated herein by reference.

[0113] Support member 18 may be formed from any material useful for the expected end use condition, including polyvinyl chloride, polyethylene terephthalate, polystyrene, polycrils (e.g., high density polyethylene or polypropylene), paper pulp, nylon, and polyurethane. The support member may be foamed or non-foamed as desired. Preferably support member 18 is permeable to the passage of gas therethrough, particularly when product 22 is a poultry product. When poultry products are to be packaged in package 20, support member 18 preferably has a thickness and composition sufficient to provide a gas transmission rate of at least about (in ascending order of preference) 1000, 1500, 2000, 2500, 3000 or 3500 cubic centimeters per square meter per day per 1 atmosphere of gas pressure differential measured at 0% relative humidity and 23° C. Preferably, support member 18 comprises foamed polystyrene. Suitable polystyrenes include polystyrene homopolymer, high impact polystyrene (HIPS), styrene/butadiene
copolymer, styrene/maleic anhydride copolymer (SMA), polyphenylene oxide (PPO), and blends thereof. More preferably, the support member consists essentially of foamed polystyrene, i.e., without any liners on the inner/upper surface 54 or outer surface 56. Such a support member is less expensive to manufacture and provides a higher gas transmission rate than a lined support member. When lidded by laminate 10 in accordance with the present invention, which forms hermetic yet peelable seal with peripheral flange 48 of support member 18, the resultant package 20 is highly advantageous for the packaging of poultry products.

Manufacture of the Sealed Package

[0114] To make sealed package 20, the item to be packaged (e.g., product 22) is placed on support member 18. Laminate 10 is then placed over the support member so that the sealant film 12 of the laminate contacts the support member 18. Laminate 10 may be supplied from a larger web of the laminate, for example, from a roll that is unwound to supply laminate as needed.

[0115] A heated bar or other heated member engages the outside surface 36 of laminate 10, typically in the form of a closed geometrical shape corresponding to the shape of the peripheral flange 48 of the support member, to compress the laminate against the flange of the support member. The resulting heat transfer and compression causes the sealant layer 28 of the laminate and the upper surface 54 of the support member in the area of flange 48 to soften and intermix with one another. The heating bar is removed to allow the sealed area to cool and form a sealed bond, i.e., heat-seal 44. The excess lid material extending beyond the flange may be trimmed by a cutting operation. Further, if the laminate is supplied from a roll, portions may be severed from the web before, after, or simultaneously with the heat-welding of the laminate to support member 18. Laminate 10 may be severed by a conventional cutting device (e.g., a sharp cutting instrument or a thermal cutting device such as a heated wire or heated blade). A representative process for heat-sealing a lid to a support member is described in U.S. Pat. No. 5,779,050 to Kocher, which was previously incorporated by reference.

[0116] The resulting heat-weld or heat-seal 44 preferably extends continuously around the upper surface of flange 48 to hermetically seal or enclose product 22 within package 20. In this manner, laminate 10 and support member 18 preferably form a substantially gas-permeable enclosure for product 22 to protect it from contact with the surrounding environment, including dirt, dust, moisture, and microbial contaminants. At the same time, the gas-permeability of the package 20 allows a packaged poultry product 22 to gradually expel hydrogen sulfide gas between the time that the product is packaged and the time when a consumer opens the package, thereby preventing an accumulation of the gas in the package so that the consumer is not subjected to a sudden release of the accumulated gas when he or she opens the package.

[0117] The sealing of the laminate 10 to support member 18 may be by one or more heat sealing methods, including thermal conductance sealing (as described above), impulse sealing, ultrasonic sealing, and dielectric sealing. As a result of the above-described heat-shrinkability of the first film 12 and/or second film 14, such heat sealing causes laminate 10 to heat-contract while restrained by heat seal 44, thereby rendering the laminate, as lidded on support member 18, in a tensioned state with a tight, aesthetically-pleasing appearance.

[0118] Product 22 is shown as a “high profile” product—that is, a product having a maximum height that is above the maximum height of support member 18 (i.e., the level at which flange 48 is located) such that the portion of the product that extends above the level of flange 48 will be in contact with lid 10. However, a “low profile” product—that is, a product having a maximum height that is below the maximum height of support member 18—may also be packaged in accordance with the present invention. When a high profile configuration is employed, the laminate/lid 10 is preferably in tensioned contact with the portion of the product that extends above the flange, e.g., as a result of being in a heat-contracted state as discussed above.

Seal Strength

[0119] As noted above, the first, sealant film 12 is capable of bonding directly to a surface comprising foamed polystyrene at a bond strength ranging from about 0.5 to about 5.0 lb, per inch. Accordingly, when support member 18 comprises foamed polystyrene and is non-lined, the bond strength of heat-seal 44 ranges from about 0.5 to about 5.0 lb, per inch. It has been found that a peel strength falling within such range advantageously provides a seal that is both hermetic, i.e., protects product 22 from contact with the surrounding environment, and also peelable, i.e., readily openable by a consumer. The bond strength of such heat-seal may be determined in accordance with ASTM D882-97 as a measurement of the amount of force required to separate the sealant layer of the laminate from the support member to which the sealant layer has been sealed, e.g., by using an Instron tensile tester with crosshead speed is 20 inches per minute, with at least three, 1-inch wide, representative samples of the laminate 10 heat-sealed to flange 48.

[0120] The following examples are presented for the purpose of further illustrating and explaining the present invention and are not to be taken as limiting in any regard.

EXAMPLES

[0121] In the examples below, the following materials were used:

[0122] RAW MAIL: “LLDPE1”
[0123] TRADE NAME: ATTANE 4203
[0124] SUPPLIER: DOW
[0125] GENERIC NAME: RESIN-POLYETHYLENE, LINEAR LOW DENSITY
[0126] CHEMICAL NATURE: ETHYLENE/ OCTENE COPOLYMER
[0127] KEY PROPERTIES: MF 0.80; D-0.905; MP 123 DEGREES C; 11.5% OCTENE
[0128] RAW MAIL: “AF”
[0129] TRADE NAME: ATMOS 300K SPECIAL
[0130] SUPPLIER: CROMPTON (FORMERLY WITCO)
A trap-printed laminate having the composition and construction shown in Table 1 was formed by laminating a First (sealant) Film, having a printed image on its Fifth (outside, interface) layer, to a Second Film via corona treatment bonding by corona-treating the surface layer of each film that forms the lamination interface (Fifth layer of First Film and First layer of Second Film) and pressing the films together such that the treated surfaces contact and bond with one another. The Example 1 laminate had a total thickness of 1.3 mils and a gas transmission rate of 5700 cc/m²-day-atm. (0% RH, 73° F). The First Film was biaxially oriented and had a free shrink measured at 185° F. of 32% in the machine direction and 36% in the transverse direction, a thickness of 0.650 mils, and a melt flow index of 17.9 g/10 min. The First Film was irradiated with electron-beam radiation at a dosage of 30 kGy. The Second (heat-resistant) Film was biaxially oriented and had a free shrink measured, at 185° F. of 29% in the machine direction and 26% in the transverse direction, a thickness of 0.650 mils, and a melt flow index of 0.3 g/10 min. The Second Film was irradiated with electron-beam radiation at a dosage of 75 kGy.

### Example 1

<table>
<thead>
<tr>
<th>Film Designation (Function)</th>
<th>Layer Designation (Function)</th>
<th>Layer Composition (weight %)</th>
<th>Thickness Ratio of Layer/Total Film</th>
</tr>
</thead>
<tbody>
<tr>
<td>First (Sealant) Film</td>
<td>First (inside, sealant layer)</td>
<td>97% SBC2</td>
<td>0.146/0.650</td>
</tr>
<tr>
<td></td>
<td>3% AF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second (tie layer)</td>
<td>96% EVA</td>
<td>0.040/0.650</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4% AF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third (bulk, core)</td>
<td>96% LLDPE1</td>
<td>0.258/0.650</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4% AF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth (tie layer)</td>
<td>96% EVA</td>
<td>0.049/0.650</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4% AF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 1-continued

<table>
<thead>
<tr>
<th>Film Designation</th>
<th>Layer Designation (Function)</th>
<th>Layer Composition (weight %)</th>
<th>Thickness Ratio of Layer/Total Film</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fifth (outside, interface layer)</td>
<td>96% SBC1</td>
<td>4% AF</td>
<td>0.147/0.650</td>
</tr>
<tr>
<td>Lamination Interface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second (Heat-Resistant) Film</td>
<td>First (inside, interface layer)</td>
<td>94% LLDPE2</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Second</td>
<td>96% LLDPE1</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Third</td>
<td>96% EVA</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Fourth (bulk, core)</td>
<td>96% SBC1</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Fifth</td>
<td>96% EVA</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Sixth</td>
<td>96% LLDPE1</td>
<td>4% AF</td>
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<tr>
<td></td>
<td>Seventh (outside, abuse)</td>
<td>94% LLDPE2</td>
<td>4% AF</td>
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</tbody>
</table>

Example 2

A trap-printed laminate having the composition and construction shown in Table 2 was formed by laminating a First (sealant) Film, having a printed image on its Fifth (outside, interface) layer, to a Second Film via corona treatment bonding by corona-treating the surface layer of each film that forms the lamination interface (Fifth layer of First Film and First layer of Second Film) and pressing the films together such that the treated surfaces contact and bond with one another. The Example 2 laminate had a total thickness of 1.3 mils and a gas transmission rate of 5600 cc/m²-day-atm. (0% RH, 73°F). The First Film was biaxially oriented and had a free shrink measured at 185°F of 30% in the machine direction and 33% in the transverse direction, a thickness of 0.650 mils, and a melt flow index of 16.55 g/10 min. The First Film was irradiated with electron-beam radiation at a dosage of 30 kGy. The Second (heat-resistant) Film was biaxially oriented and had a free shrink measured at 185°F of 29% in the machine direction and 26% in the transverse direction, a thickness of 0.650 mils, and a melt flow index of 0.3 g/10 min. The Second Film was irradiated with electron-beam radiation at a dosage of 75 kGy.

TABLE 2

<table>
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<tr>
<th>Film Designation</th>
<th>Layer Designation (Function)</th>
<th>Layer Composition (weight %)</th>
<th>Thickness Ratio of Layer/Total Film</th>
</tr>
</thead>
<tbody>
<tr>
<td>First (Sealant) Film</td>
<td>First (inside, sealant layer)</td>
<td>97% SBC2</td>
<td>3% AF</td>
</tr>
<tr>
<td></td>
<td>Second (tie layer)</td>
<td>96% EVA</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Third (bulk, core)</td>
<td>96% LLDPE1</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Fourth (tie layer)</td>
<td>96% EVA</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Fifth (outside, interface layer)</td>
<td>97% SBC2</td>
<td>3% AF</td>
</tr>
<tr>
<td>Lamination Interface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second (Heat-Resistant) Film</td>
<td>First (inside, interface layer)</td>
<td>94% LLDPE2</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Second</td>
<td>96% LLDPE1</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Third</td>
<td>96% EVA</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Fourth (bulk, core)</td>
<td>96% SBC1</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Fifth</td>
<td>96% EVA</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Sixth</td>
<td>96% LLDPE1</td>
<td>4% AF</td>
</tr>
<tr>
<td></td>
<td>Seventh (outside, abuse)</td>
<td>94% LLDPE2</td>
<td>4% AF</td>
</tr>
</tbody>
</table>
Example 3

[0172] A trap-printed laminate having the composition and construction shown in Table 3 was formed by laminating a First (sealant) Film, having a printed image on its Fifth (outside, interface) layer, to a Second Film via corona treatment bonding by corona-treating the surface layer of each film that forms the lamination interface (Fifth layer of First Film and First layer of Second Film) and pressuring the films together such that the treated surfaces contact and bond with one another. The Example 3 laminate had a total thickness of 1.3 mils and a gas transmission rate of 5200 cc/m²-day-atm. (0% RH, 73°F). The First Film was biaxially oriented and had a free shrink measured at 185°F of 27% in the machine direction and 25% in the transverse direction, a thickness of 0.650 mils, and a melt flow index of 32.3 g/10 min. The First Film was irradiated with electron-beam radiation at a dosage of 30 kGy. The Second (heat-resistant) Film was biaxially oriented and had a free shrink measured at 185°F of 29% in the machine direction and 26% in the transverse direction, a thickness of 0.650 mils, and a melt flow index of 0.3 g/10 min. The Second Film was irradiated with electron-beam radiation at a dosage of 75 kGy.

<table>
<thead>
<tr>
<th>Film Designation</th>
<th>Layer Designation</th>
<th>Layer Composition (Function)</th>
<th>Thickness Ratio of Layer/Total Film</th>
</tr>
</thead>
<tbody>
<tr>
<td>First (Sealant) Film</td>
<td>First (inside, sealant layer)</td>
<td>97% SBC2</td>
<td>0.143</td>
</tr>
<tr>
<td></td>
<td>3% AF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Second (tie layer)</td>
<td>96% EVA</td>
<td>0.061</td>
</tr>
<tr>
<td></td>
<td>4% AF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Third (bulk, core)</td>
<td>96% SBC1</td>
<td>0.016</td>
</tr>
<tr>
<td></td>
<td>4% AF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fourth (tie layer)</td>
<td>96% EVA</td>
<td>0.016</td>
</tr>
<tr>
<td></td>
<td>4% AF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fifth (outside, interface layer)</td>
<td>94% LLDPE2</td>
<td>0.163</td>
</tr>
<tr>
<td></td>
<td>[Printed Image]</td>
<td>4% AF</td>
<td>2% AB</td>
</tr>
<tr>
<td></td>
<td>Lamination Interface</td>
<td>94% LLDPE2</td>
<td>0.087</td>
</tr>
<tr>
<td></td>
<td>4% AF</td>
<td>2% AB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Second (Heat-Resistant) Film</td>
<td>96% LLDPE1</td>
<td>0.098</td>
</tr>
<tr>
<td></td>
<td>4% AF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Third</td>
<td>96% EVA</td>
<td>0.048</td>
</tr>
<tr>
<td></td>
<td>4% AF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fourth (bulk, core)</td>
<td>96% SBC1</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td>4% AF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fifth</td>
<td>96% EVA</td>
<td>0.048</td>
</tr>
<tr>
<td></td>
<td>4% AF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sixth</td>
<td>96% LLDPE1</td>
<td>0.097</td>
</tr>
<tr>
<td></td>
<td>4% AF</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seventh (outside, abuse)</td>
<td>94% LLDPE2</td>
<td>0.078</td>
</tr>
<tr>
<td></td>
<td>4% AF</td>
<td>2% AB</td>
<td></td>
</tr>
</tbody>
</table>

Example 4

[0173] The laminates of Examples 1-3 were each sealed to the flange of a polystyrene foam tray to form a lid for the tray. The trays were CD-92 meat trays commercially available from the Cryovac Division of Sealed Air Corporation, and had no sealant liner on the flange of the trays. Thus, the laminates were sealed directly to the foamed surface of the tray flange. Sealing was accomplished by placing the laminates over the tray, with the First Layer of the First Film in contact with the flange. A heat seal was formed between the First Layer and the flange using a 'hot bar'-type lidding apparatus from Ross Industries. The hot sealing bar was maintained at a temperature of 290°F and applied a contact pressure to each laminate and flange of 80 psi with a 1 second dwell time.

[0174] After the laminates were sealed to the trays, six (6) 1-inch wide strips of the flange with the laminate sealed thereto were cut from each tray, in both the length and width dimensions of the trays. The strips were used to measure the bond-strength between the laminate and the foamed flange using an Instron tensile tester with a crosshead speed of 20 inches per minute. The maximum amount of force required to cause a separation of the bond between the laminate and the foam was measured in accordance with ASTM D882-97. The results were averaged for each of the six samples in both the length and width dimension for each sealed laminate/tray. The results are reported in Table 4.

<table>
<thead>
<tr>
<th>Laminate</th>
<th>Width</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1</td>
<td>1.92</td>
<td>1.06</td>
</tr>
<tr>
<td>Example 2</td>
<td>2.1</td>
<td>1.16</td>
</tr>
<tr>
<td>Example 3</td>
<td>1.76</td>
<td>1.04</td>
</tr>
</tbody>
</table>

TABLE 4
Each of Examples 1-3 exhibited a bond-strength to polystyrene foam that fell within the desired range of 0.5 to 5.0 lb/inch.

**Example 5**

The laminates of Examples 1 and 3 were tested for the following optical properties: haze (ASTM D-1003-00), gloss (ASTM D-2457-97), transmittance (ASTM D-1003-00), and clarity (ASTM D-1746-97). The results are summarized in Table 5.

<table>
<thead>
<tr>
<th>Laminate</th>
<th>Haze (%)</th>
<th>Gloss (%)</th>
<th>Transmittance (%)</th>
<th>Clarity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1</td>
<td>6.1</td>
<td>80</td>
<td>94.2</td>
<td>61.8</td>
</tr>
<tr>
<td>Example 3</td>
<td>6.6</td>
<td>80</td>
<td>93.6</td>
<td>61.8</td>
</tr>
</tbody>
</table>

Such optical properties are suitable for commercial packaging applications.

The above descriptions are those of preferred embodiments of the invention. Various alterations and changes can be made without departing from the spirit and broader aspects of the invention as defined in the claims, which are to be interpreted in accordance with the principles of patent law, including the doctrine of equivalents. All parts and percentages are by weight, unless otherwise indicated or well understood in the art. Except in the claims and the specific examples, or where otherwise expressly indicated, all numerical quantities in this description indicating amounts of material, reaction conditions, use conditions, molecular weights, and/or number of carbon atoms, and the like, are to be understood as modified by the word “about” in describing the broadest scope of the invention. Any reference to an item in the disclosure or to an element in the claim in the singular using the articles “a,” “an,” “the,” or “said” is not to be construed as limiting the item or element to the singular unless expressly so stated. Each ASTM test reference and method referred to in this application is incorporated herein in its entirety by reference.

What is claimed is:

1. A laminate, comprising:
   a. a first film capable of bonding directly to a surface comprising foamed polystyrene at a bond strength ranging from about 0.5 to about 5.0 lb/inch;
   b. a second film bonded to the first film; and
   c. a printed image trapped between the first and second films,

   wherein:

   at least one of the first and second films has a free shrink at 185°F in at least one direction of at least about 10%,

   the laminate has a gas transmission rate greater than about 3000 cubic centimeters per square meter per day per 1 atmosphere of gas pressure differential measured at 0% relative humidity and 23°C,

2. The laminate of claim 1, wherein the second film is cross-linked to a greater degree relative to the first film.

3. The laminate of claim 1, wherein the second film has a melt flow index of less than about 1.0 g/10 min. and the first film has a melt flow index of greater than about 1.0 g/10 min.

4. The laminate of claim 1, wherein the laminate has a clarity of at least about 45%.

5. The laminate of claim 1, wherein the second film has a haze of no more than about 20%, measured against an outer surface of the second film.

6. A package, comprising:
   a. a product support member for supporting a product thereon, the support member comprising foamed polystyrene; and
   b. a laminate, comprising a first film and a second film bonded together with a printed image trapped therebetween,

   wherein:

   at least one of the first and second films has a free shrink at 185°F in at least one direction of at least about 10%,

   the laminate has a gas transmission rate greater than about 3000 cubic centimeters per square meter per day per 1 atmosphere of gas pressure differential measured at 0% relative humidity and 23°C,

   the first film is bonded to the support member in the form of a peelable, hermetic seal that extends around the product to enclose the product between the laminate and support member, the seal having a bond strength ranging from about 0.5 to about 5.0 lb/inch.

7. The package of claim 6, wherein:

   the support member has an upper surface consisting essentially of foamed polystyrene, and

   the first film is bonded directly to the upper surface of the support member.

8. The package of claim 7, wherein the bond between the first film and support member is a heat-seal.

9. The package of claim 6, wherein the laminate is heat-contracted.

10. The package of claim 6, wherein the laminate is in tensioned contact with at least a portion of the product.

11. The package of claim 10, wherein the laminate is heat-contracted.

12. The package of claim 6, wherein the second film is cross-linked to a greater degree relative to the first film.

13. The package of claim 6, wherein the second film has a melt flow index of less than about 1.0 g/10 min. and the first film has a melt flow index of greater than about 1.0 g/10 min.

14. The package of claim 6, wherein the laminate has a clarity of at least about 45%.

15. The package of claim 6, wherein the second film has a haze of no more than about 20%, measured against an outer surface of the second film.

16. A package, comprising:
   a. a product support member for supporting a product thereon, the support member having an upper surface consisting essentially of foamed polystyrene; and
   b. a film bonded directly to the upper surface of the support member in the form of a peelable, hermetic seal that extends around the product to enclose the product.
between the film and support member, the seal having a bond strength ranging from about 0.5 to about 5.0 lb per inch, the film having a free shrink at 185° F. in at least one direction of at least about 10% and a gas transmission rate greater than about 3000 cubic centimeters per square meter per day per 1 atmosphere of gas pressure differential measured at 0% relative humidity and 23° C.

17. The package of claim 16, wherein the bond between the film and support member is a heat-seal.

18. The package of claim 16, wherein the film is heat-contracted.

19. The package of claim 16, wherein the film is in tensioned contact with at least a portion of the product.

20. A package, comprising:
   a. a product support member for supporting a product thereon; and
   b. a laminate, comprising a first film and a second film bonded together,

wherein:

the first film is bonded to a surface of the support member in the form of a peripheral seal that extends around the product to enclose the product between the film and support member, and

the second film is cross-linked to a greater degree relative to the first film such that the second film has a melt flow index of less than about 1.0 g/10 min. and the first film has a melt flow index of greater than about 1.0 g/10 min.

21. The package of claim 20, wherein the bond between the first film and support member is a heat-seal.

22. The package of claim 20, wherein:

   a. the support member has an upper surface consisting essentially of foamed polystyrene; and

   b. the first film is bonded directly to the upper surface of the support member.

23. The package of claim 22, wherein the bond between the first film and support member is a peelable, hermetic seal having a bond strength ranging from about 0.5 to about 5.0 lb per inch.

24. The package of claim 20, wherein at least one of the first and second films has a free shrink at 185° F. in at least one direction of at least about 10%.

25. The package of claim 20, wherein the laminate has a gas transmission rate greater than about 3000 cubic centimeters per square meter per day per 1 atmosphere of gas pressure differential measured at 0% relative humidity and 23° C.

26. The package of claim 20, further including a printed image trapped between the first and second films.

* * * *