Abstract:

A multilayer blow film, a method of wrapping an article, a method of reducing the noise associated with wrapping an article, a roll of stretch wrap film, and a multilayer blown surface protection film are also disclosed.

(54) Title: MULTILAYER FILM AND METHOD OF MAKING SAME

(57) Abstract: Disclosed herein is a film having an outer layer A in surface contact with a core layer, wherein the outer layer A includes a plastomer, and wherein the outer layer A contains no more than 0.1 wt.% of a C3-C14-based polymer having an Mw < about 5.00x 10^4 g/mol. A method of controlling the peel cling force of a multilayer blown film, a method to produce a multilayer blown film, a method of wrapping an article, a method of reducing the noise associated with wrapping an article, a roll of stretch wrap film, and a multilayer blown surface protection film are also disclosed.
MULTILAYER FILM AND METHOD OF MAKING SAME

PRIORITY

[0001] The present application claims priority to U.S. S.N. 61/566,142, filed on December 2, 2011, entitled, "Multilayer Film and Method of Making Same" the entire disclosures of which are hereby incorporated by reference herein.

BACKGROUND

[0002] Silage stretch film, cling film, blown stretch, and surface protective films preferably include a layer which is intended to stick to itself or another object such as glass, metal, plastic sheeting, or the like to protect the substrate from mild mechanical damage, dust, and moisture. The level of tack must be high enough to allow the film to releasably adhere to the article being wrapped and to itself, while low enough to allow the wrap to be removed from the article, or removed from a roll containing the wrap.

[0003] Low molecular weight polymers, particularly C₄-C₆-based polymers such as polyisobutylene polymers and copolymers (i.e., PIBs) have been used in the surface layers of films to control the level of tackiness. But films including such polymers tend to be excessively noisy when unwound from a film-roll when utilized on a high speed wrapping machine. Such polymers also tend to migrate out of the polymer (i.e., bloom) over time or at common storage temperatures. Thus, films including such polymers typically need to be stored for a period of time in a heated environment in order to stabilize.

SUMMARY

[0004] Embodiments of the invention intend to provide a solution to the films described above. Thus, embodiments of the invention provide a film comprising an outer layer A in surface contact with a core layer, wherein the outer layer A comprises a plastomer, and wherein the outer layer A contains no more than 0.1 wt.% of a C₄-C₆-based polymer having an Mw < about 5.00x10⁴ g/mol. Preferred plastomers comprise an ethylene-based plastomer comprising about 87 mol.% to about 97.5 mol.% of polymer units derived from ethylene and about 13 mol.% to about 2.5 mol.% of polymer units derived from an alpha-olefin having a density of from 0.86 g/cm³ to 0.910 g/cm³, an Mw ≥ 70,000 to < 130,000, and a heat of fusion of greater than 75 J/g as determined by differential scanning calorimetry. In particular embodiments of the invention, the outer layer A further comprises from about 0.1 wt.% to about 45 wt.% of a propylene-based elastomer.
[0005] In another aspect, embodiments of the invention provide a film comprising an outer layer A comprising plastomer in surface contact with a core layer, wherein a fraction of polyolefin polymers having an Mw < about 5.00x10^4 g/mol. comprises < 0.1 wt.% of the outer layer A, based on the weight of the outer layer A. In particular films, the plastomer is present in the outer layer A in an amount of 70.0 wt.% to 100.0 wt.% and comprises a copolymer comprising at least 50.0 wt.% polymer units derived from ethylene and 1.0 wt.% to 35.0 wt.% polymer units derived from a C3-C20 olefin, a composition distribution breadth index (CDBI) above 90%, a density of 0.870 g/cm^3 to 0.910 g/cm^3 and a melt index (ASTM D1238 at 190°C/2.16kg) of 0.5 dg/min. to 5 dg/min.

[0006] In another aspect, embodiments of the invention provide a method of wrapping an article comprising: attaching an end of a film from a film-roll to the article; unwinding the film from the film-roll at a rate from 1 to 400 m/min.; and wrapping the article with the film, wherein the total noise associated with unwinding the film is < 9.0x10^4 dB, wherein the film comprises a core layer interposing an outer layer A and an outer layer B, the outer layer A comprising a plastomer and < 0.1 wt.% of a C4-C10-based polymer having an Mw < about 5.00x10^4 g/mol.

BRIEF DESCRIPTION OF THE FIGURES
[0007] Figure 1 is a graphical representation showing the cling force vs. the propylene-based elastomer concentration in the plastomer, according to an embodiment.

DETAILED DESCRIPTION
[0008] Some applications of the present invention relate to blown films suitable for use as a stretch wrap, including an agricultural wrap. Some films are multilayer blown films comprising a core layer and an outer layer A, wherein outer layer A in some embodiments is suitable for use as outer layer A.

[0009] Throughout the entire specification, including the claims, the following terms shall have the indicated meanings.

[0010] Polymer may be used to refer to homopolymers, copolymers, interpolymer, terpolymers, etc. Likewise, a copolymer may refer to a polymer comprising at least two monomers, optionally with other monomers. All molecular weights are weight average (Mw) unless otherwise noted.

[0011] When a polymer is referred to as comprising a monomer, the monomer is present in the polymer in the polymerized form of the monomer or in the derivative form of the monomer. However, for ease of reference, the phrase "comprising the (respective) monomer" or the like is used as shorthand. Likewise, when catalyst components are described as
comprising neutral stable forms of the components, it is well understood by one skilled in the art, that the active form of the component is the form that reacts with the monomers to produce polymers.

Isoolefin refers to any olefin monomer having two substitutions on the same carbon.

Elastomer or elastomers as used herein, refers to any polymer or composition of polymers consistent with the ASTM D-1566 definition. The terms may be used interchangeably with the term "rubber(s)."

The term "film" of the invention typically refers to blown films having multiple layers (multilayer films). When used in multilayer films, the various polyolefin resins described herein can be used in any layer of the film, or in more than one layer of the film, as desired. When more than one layer of the film is formed, each layer can be individually formulated; i.e., the layers formed of or including the polyethylene resin can have the same or different chemical composition, density, melt index, thickness, etc., depending upon the desired properties of the film.

To facilitate discussion of different film structures of the invention, the following notation is used herein. Each layer of a film is denoted "A" or "B", where "A" indicates a conventional film layer, and "B" indicates a different film layer. Where a film includes more than one A layer or more than one B layer, one or more prime symbols (', '', '', etc.) are appended to the A or B symbol to indicate layers of the same type (conventional or inventive) that can be the same or can differ in one or more properties, such as chemical composition, density, melt index, thickness, and the like, within the range of the parameters defined herein. Finally, the symbols for adjacent layers are separated by a slash (/). Using this notation, a three-layer film having an inner layer, which is also referred to herein as a "core layer" disposed between two outer film layers, the layers would be denoted A/B/A'. Similarly, a five-layer film of alternating layers would be denoted A/B/A7B7A". Unless otherwise indicated, the left-to-right or right-to-left order of layers does not matter, nor does the order of prime symbols; e.g., an A/B film is equivalent to a B/A film, and an A/A'/B/A" film is equivalent to an A/B/A'/A" film, for purposes of the present invention. The relative thickness of each film layer is similarly denoted, with the thickness of each layer relative to a total film thickness of 100 (dimensionless) is indicated numerically and separated by slashes; e.g., the thickness of an A/B/A' film having A and A' layers of 10 microns each and a B layer of 30 microns is denoted as 20/60/20.
As used herein, the term "core layer" is a central layer of the film. The term "outer layer A" is the layer disposed on one side of the core layer, either directly or with other layers disposed between the core layer and the outer layer A, which provides the film with adhesion to itself, or to an article. The term "anti-cling" layer refers to a layer disposed on a side of the core layer directly opposite the side of the outer layer A. Consistent with the outer layer A, the outer layer B, when present, may be disposed directly on the core layer, or other layers may be disposed between the core layer and the outer layer B. The outer layer B provides a lesser amount of adhesion to the outer layer A such that the film may be unrolled from a spool or other type roll without undue force or without the film breaking during the unrolling process.

C₄-C₄-based polymers comprise > 50.0 wt.%, preferably > 85.0 wt.% polymer or oligomer units derived from at least one C₄-C₄ olefin. Some such C₄-C₄-based polymers are oligomers of C₄-C₄ olefins and/or comprise > 5.0 wt.%, particularly > 4.0 wt.%, > 3.0 wt.%, > 2.0 wt.%, > 1.0 wt.%, > 0.1 wt.%, units derived from ethylene and/or propylene. Examples include C₄ olefins which include n-butene, 2-butene, isobutylene, butadiene, and mixtures thereof. Such materials may also be referred to as "polybutene" liquids (or "polybutenies") when the oligomers comprise isobutylene and/or 1-butene and/or 2-butene, which are commonly used as additives for polyolefins to introduce tack or as a processing aid. The ratio of C₄ olefin isomers can vary by manufacturer and by grade, and the material may or may not be hydrogenated after synthesis. Commercial sources of such C₄-C₄-based polymer having an Mw < about 5.00 x 10⁴ g/mol. include BP (Indopol grades) and Infineum (C-Series grades). When the C₄ olefin is exclusively isobutylene, the material may be referred to as "polyisobutylene" or PIB. Commercial sources of PIB include Texas Petrochemical (TPC Enhanced PIB grades). When the C₄ olefin is exclusively 1-butene, the material is referred to as "poly-n-butene" or PNB.

The term "blown film" may include uniaxially, biaxially, and un-oriented multi-layer films. Orientation in the direction of extrusion is known as machine direction (MD) orientation. Orientation perpendicular to the direction of extrusion is known as transverse direction (TD) orientation. The film may be oriented to the same or different extent in each direction. Orientation may be accomplished by stretching a film first in the MD followed by TD orientation, by stretching in the TD followed by stretching in the MD, or by stretching in both MD and TD simultaneously.

In an embodiment of the invention, the film may be produced using machine direction orientation (MDO). In an MDO process, the film is stretched at a temperature below
its melting temperature in order to induce an orientation therein. In an embodiment of the invention, the film can be produced using MDO for annealing purposes.

[0020] In an embodiment of the invention, the film is drawn by a pull roll and threaded through a multiple roll MDO stage which may include pre-heat rolls, various stretching stages with or without annealing rolls between stages, one or more conditioning and annealing rolls, and one or more chill rolls. All rolls may be individually driven and temperature controlled. Stretching of the film in the MDO stage is accomplished by inducing a speed differential between two or more adjacent rolls.

[0021] In an embodiment of the invention, the films can be tailored to specific applications by adjusting the thickness, materials, and order of the various layers, as well as the additives in each layer.

[0022] Additives can be provided in the various film layers, as is well-known in the art.

[0023] As used herein, the term "peel cling" is determined according to ASTM D-5458, or an equivalent thereof.

[0024] In general, the term "natural draw ratio" refers to the stress elongation curve of a film in a region wherein the slope transitions between the slope of the yield plateau region and the slope of the strain hardening region, wherein the natural draw ratio is defined by the intersection between a line drawn through a linear portion of the strain hardening region and a line drawn through a linear portion of the yield plateau region of a film. For purposes herein, the natural draw ratio is determined from a stress-elongation measurement according to ASTM D-882, as the elongation at the intersection of a line drawn through a linear portion of the strain hardening region and a line drawn through a linear portion of the yield plateau region. The lines are calculated as linear regression fits to the data in the linear portions of the curves. The specific range of data points subjected to the linear regression analysis can be chosen by changing the lower elongation limit in steps of, for example, 5%, keeping the overall range constant at, for example, 50% (e.g., 50%-100%, 55%-105%, 60%-110%, etc.), and looking for the range which gives the lowest sum of squared differences between predicted and actual data.

[0025] As used herein, the "noise associated with wrapping an article" refers to the noise above ambient conditions, produced as a stretch wrap film unrolls during the wrapping process of an article at the specified linear rate. The noise produced does not include the noise produced by the wrapping machine, but only refers to the noise produced as the film is unwound from the roll. The total noise associated with wrapping an article includes the ambient noise.
The term "agricultural film" includes silage film, designed to maintain the nutritional value of forage plants such as corn, vegetables, and grasses that continue to respire after cutting. In general, silage films exclude the air so lactic acid fermentation can take place, leaving a feed rich in vitamins and carotene. As is common in the art, silage films include those films which may used to protect feed sources for several months under a variety of conditions.

As used herein, the term "post-blowing thermal history" refers to the temperature at which a film may be maintained after being produced. This term includes the "thermal conditioning" and other processes wherein a film may be maintained at or above a particular temperature for a period of time to influence various properties of the film. The term does not refer to spurious temperatures experienced by a film, e.g., during shipping, packaging, or the like, which are not necessarily intended to produce a particular outcome or enhance a particular property of the film.

Films

Outer layer A

In embodiments of the invention, outer layer A is in surface contact with a first side of a core layer, and polyolefin polymer fractions having an Mw < about 5.00x10^4 g/mol. therein comprise < 0.1 wt.% of the outer layer A. In particular embodiments of the invention, the outer layer A generally includes < 0.1 wt.%, preferably < 0.05 wt.%, < 0.01 wt.%, or 0 wt.% of a C4-Cio-based polymer having an Mw < about 5.00x10^4 g/mol, particularly where the outer layer A has a higher tackiness than optional outer layer B. In this regard where the specification indicates that the outer layer A generally includes less than a certain amount of polyolefin polymer fractions or C4-Cio-based polymer, this is not meant to indicate that such polymer fractions or C4-Cio-based polymer is or must be present. Indeed, it is preferred that the content of low molecular weight polymer fractions, including C4-Cio-based polymers having an Mw < about 5.00x10^4 g/mol. be minimized. Thus, some outer layers A are essentially free of C4-Cio-based polymers having an Mw < about 5.00x10^4 g/mol. (i.e., a C4-Cio-based polymer having an Mw < about 5.00x10^4 g/mol. is not intentionally added to the layer A, or that polyolefin polymer fractions having an Mw < about 5.00x10^4 g/mol. are present in trace quantities indicative of impurity concentrations).

Outer layer A typically includes at least 40.0 wt.%, preferably ≥ 50.0 wt.%, ≥ 60.0 wt.%, ≥ 70.0 wt.%, more preferably ≥ 75.0 wt.%, ≥ 80.0 wt.%, ≥ 90.0 wt.%, or ≥ 95.0 wt.%, based on the total weight of outer layer A, of an ethylene polymer having a density of more than 0.894 g/cm^3. This outer layer A may include fractions of the ethylene polymer with a density of more than 0.894 g/cm^3, having a density of more
than 0.86 g/cm$^3$ to less than 0.910 g/cm$^3$, preferably from 0.88 to 0.905 g/cm$^3$, more preferably from 0.870 g/cm$^3$ to 0.890 g/cm$^3$ (i.e., an ethylene-based plastomer). Such ethylene-based plastomers comprise about 87 mol.% to about 97.5 mol.% of polymer units derived from ethylene and about 13 mol.% to about 2.5 mol.% of polymer units derived from an alpha-olefin comonomer. Such ethylene-based plastomers are typically characterized as having a CDBI $>60$, preferably $>80$, and more preferably $>90$, fractions having an Mw below 15,000 are ignored when determining CDBI as described in PCT Publication No. WO93/03093, specifically columns 7 and 8, as well as in Wild et al, J. Poly. Sci., Poly. Phys. Ed., Vol. 20, p. 441 (1982) and U.S. Patent No. 5,008,204. Preferred plastomers are also characterized by a DSC melting point curve that exhibits the occurrence of a single melting point peak occurring in the region of 50°C to 110°C (second melt rundown) and may have a Mw $\geq 70,000$ to $<130,000$. Such plastomers have a heat of fusion of greater than 75 J/g as determined by differential scanning calorimetry, preferably less than 130.0 J/g, 125.0 J/g, 120.0 J/g, 110.0 J/g, or 100.0 J/g.

[0030] More preferred plastomers also have a molecular weight distribution (Mw/Mn) value $\leq 4.0$, preferably from 1.1 to 3.5. Some preferred ethylene-based plastomers have a 1% secant modulus $< 1.5 \times 10^4$ and as low as about 8$>10^2$ psi or even less. Examples include ethylene-octene; ethylene-hexene; and/or ethylene-butene polymers sold under the trade name EXACT™ (Available from ExxonMobil Chemical Company).

[0031] The outer layer A optionally includes an elastomer, preferably a propylene-based elastomer, in an amount of 0 to 50.0 wt.%, or 0.1 wt.% to about 45 wt.%, preferably 1.0 to 25.0 wt.%, more preferably 2.0 to 20.0 wt.%. As used herein, the term "propylene-based elastomer" includes a random propylene polymer which may comprise a propylene-based elastomeric polymer, produced by random polymerization processes leading to polymers having randomly distributed irregularities in stereoregular propylene propagation. This is in contrast to block copolymers in which constituent parts of the same polymer chains are separately and sequentially polymerized. The term may further indicate that the heat of fusion of the polymer as determined by DSC is less than 75 J/g. Generally, then the melting point as determined by DSC will be below 105°C. This is in contrast to propylene copolymers or atactic polymers containing propylene-derived units, which lack recovery from elastic deformation. The random propylene polymer is "propylene-based" in the sense that the amount of propylene in the polymer is sufficient for propylene sequences to crystallize to provide a detectable heat of fusion. This is in contrast with known elastomeric polymers based
on ethylene and propylene in which the heat of fusion can be attributed to ethylene derived polymer sequences. Preferably, the propylene-based elastomers contain isotactic propylene sequences, separated by stereo- or region-error, or by one or more comonomer units. Preferably, the propylene-based elastomers include at least some comonomer, such as an alpha-olefin, in order to facilitate control of the structure. Preferably the comonomer comprises substantially ethylene, which can aid in achieving economic polymerization conditions by raising the molecular weight and/or permitting an increase of the polymerization temperature. Preferred propylene-based elastomers are available from ExxonMobil Chemical Company under the trade name VISTMAXX™ propylene-based elastomers. These and other suitable propylene-based elastomers are described in U.S. Patent Nos. 6,525,157; 6,982,310; 6,992,158; 6,569,965; 6,573,350; 6,992,159; 7,053,164; 7,056,982; 7,056,992; and 6,635,715, each of which is incorporated herein by reference in its entirety. VERSIFY elastomers available from Dow Chemical Company and TAFMERT™ elastomers available from Mitsui Chemicals including those disclosed in U.S. Patent No. 7,790,281 are also suitable.

Typically the optional plastomer is used in the outer layer A in applications benefiting from a relatively high tackiness in the layer. Some such films include temporary surface protection films, e.g., for temporarily protecting surfaces of vulnerable materials such as plastics, metals and ceramics in the course of manufacture, storage and transportation.

It has also been discovered that addition of propylene-based elastomer to the outer layer A enhances the peel cling force of the film. In an embodiment of the invention, the outer layer A including a propylene-based elastomer provides a film having a peel cling force of about 80 cN to about 150 cN; as determined according to ASTM D-5458; preferably a peel cling force ≥ about 90 cN; preferably greater than or equal to about 100 cN; preferably greater than or equal to about 110 cN, preferably greater than or equal to about 120 cN.

In some cases tackifying additives may be added in small amounts. These are defined herein as substances which provide sticky or adhesive qualities to copolymers, surfaces, films, or articles. Compressor oils and processing stabilizers such as antioxidants, UV stabilizers, antiblock agents, and the like are excluded from this definition. Compatible tackifying additives, if used, would be those which are miscible, or form homogeneous blends, with the polymers of the cling layer at conditions of fabrication and use. A wide variety of tackifying additives are known in the art and include, for example, polybutenes, polyisobutylene, atactic polypropylene, terpene resins, aliphatic and aromatic hydrocarbon resins, alkali metal and glycerol stearates, and hydrogenated resins. In one embodiment, the surface layer of the film comprises from 2 wt.% to 25 wt.% of a hydrocarbon tackifier grafted
to incorporate polar moieties and preferably grafted with maleic anhydride. For more details on tackifiers, see U.S. Patent Nos. 5,114,763; 5,154,981; 5,173,343; and 5,175,049. Notwithstanding this definition of tackifiers, an object of this invention is to provide a means of generally obtaining a film where the adhesive effect is achieved with a minimal use of either an ethylene non-acrylate copolymer or added tackifier.

[0035] In an embodiment of the invention, the films may be "essentially free of tackifying additives," which can be defined as being less than 0.1 wt.% tackifier.

Core Layer

[0036] In an embodiment of the invention, the core layer comprises one or more polyethylene homopolymers or copolymers. Some suitable such polyethylenes include low density polyethylenes (LDPEs) and linear low density polyethylenes as described below.

[0037] LDPE may be obtained from ethylene by polymerization using free-radical initiators under high pressure conditions. Accordingly, LDPE may also be referred to in the art as high pressure polyethylene (HPPE). LDPE is defined for use herein to include heterogeneously branched polymers comprising at least 85 mol.% of units derived from ethylene which is heterogeneously branched and contains less than 7.5 mol.% of units derived from comonomers containing polar moieties such as a carbonyl group, including ethylenically unsaturated esters, e.g., vinyl acetate, ethylene methyl acrylate, ethylene methacrylic acid, or ethylene n-butyl acrylate, particularly vinyl acetate. Some suitable LDPEs have a density of from 0.910 g/cm³ to 0.940 g/cm³, particularly 0.915 g/cm³ to 0.930 g/cm³, although LDPEs having densities above and below this range may also be suitable. LDPEs typically have a melt index ≤ about 1.5 g/10 min., preferably ≤ about 1.0 g/10 min., more preferably ≤ about 0.5 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg and when present comprise at least about 10.0 wt.%, preferably 10.0 wt.% to 30 wt.%, more preferably 15.0 wt.% to 25.0 wt.%, of the core layer, based on the total weight of the core layer.

[0038] Some linear low density polyethylenes (LLDPEs) suitable for use in the core layer may have a density overlapping the range of plastomers and LDPE, i.e., 0.890 g/cm³ to 0.930 g/cm³, typically from 0.915 g/cm³ to 0.930 g/cm³. LLDPEs useful herein include copolymers of ethylene and at least one a-olefin having from 3 to about 20 carbon atoms and have a composition distribution breadth index (CDBI) of at least 70%, a melt index (MI), measured at 190°C and 2.16 kg, of from about 0.1 g/10 min. to about 15 g/10 min., a density of from about 0.910 g/cm³ to about 0.945 g/cm³, and a molecular weight distribution (MWD) of from about 2.5 to about 5.5.
LLDPEs suitable for use in embodiments of the invention also include ethylene copolymers comprising at least 50.0 wt.% ethylene, and have up to 50.0 wt.%, preferably 1.0 wt.% to 35.0 wt.%, even more preferably 1.0 wt.% to 6.0 wt.% of a C3 to C20 comonomer (preferably hexene or octene), based upon the weight of the copolymer. The polyethylene copolymers preferably have a composition distribution breadth index (CDBI) of 60% or more, preferably 60% to 80%, preferably 65% to 80%. In another preferred embodiment, the ethylene copolymers have a density of 0.910 g/cm³ to 0.950 g/cm³ (preferably 0.915 g/cm³ to 0.940 g/cm³, preferably 0.918 g/cm³ to 0.925 g/cm³) and a CDBI of 60% to 80%, preferably between 65% and 80%. Preferably, these polymers are metallocene polyethylenes (mPEs). Some such LLDPEs are available from ExxonMobil Chemical Company under the trade name EXCEED™ mPE resins. Particularly preferred LLDPEs of this type are ethylene/octene copolymer having a melt index of from about 0.5 g/10 min. to about 10.0 g/10 min., particularly from about 0.5 g/10 min. to 2.0 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg. When present such LLDPEs comprise at least about 50.0 wt.% to 100.0 wt.%, preferably 60.0 wt.% to 95 wt.%, more preferably 70.0 wt.% to 90.0 wt.%, of the core layer, based on the total weight of the core layer. LLDPEs of this type are referred to hereinafter as LLDPE-1.

Still other suitable LLDPEs include ethylene copolymers comprising mPEs described in U.S. Patent App. Pub. 2007/0260016 and U.S. Patent No. 6,476,171, e.g., copolymers of an ethylene and at least one alpha olefin having at least 5 carbon atoms obtainable by a continuous gas phase polymerization using supported catalyst of an activated molecularly discrete catalyst in the substantial absence of an aluminum alkyl based scavenger (e.g., triethylaluminum, trimethylaluminum, tri-isobutyl aluminum, tri-n-hexylaluminum, and the like), which polymer has a Melt Index of from 0.1 to 15 (ASTM D-1238, condition E); a CDBI of at least 70%, a density of from 0.910 g/cc to 0.930 g/cc; a Haze (ASTM D-1003) value of less than 20; a Melt Index ratio (12/1; ASTM D-1238) of from 35 to 80; an averaged Modulus (M) (as defined in U.S. Patent No. 6,255,426) of from 20,000 psi to 60,000 psi (13790 N/cm² to 41369 N/cm²) and a relation between M and the Dart Impact Strength (26 inch, ASTM D-1709) in g/mil (DIS) complying with the formula:

\[
\text{DIS} \geq 0.8 \times [100 + e^{(1.71 - 0.000268xM + 2.183x10^{-9} x M^2)}],
\]

where "e" represents 2.7183, the base Napierian logarithm, M is the averaged Modulus in psi and DIS is the 26 inch (66cm) dart impact strength. Some such LLDPEs are available from
ExxonMobil Chemical Company under the trade name ENABLE™ mPE resins. Particularly, preferred core layers including such an LLDPE include an ethylene/hexene copolymer having a melt index of from ≤ 1.5 g/10 min., particularly from about 0.1 g/10 min. to 1.0 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg and have a density of from 0.910 g/cm³ to 0.940 g/cm³, preferably 0.915 g/cm³ to 0.930 g/cm³, more preferably 0.920 g/cm³ to 0.930 g/cm³. When present LLDPEs of this type comprise 5.0 wt.% to < 50.0 wt.%, preferably 10.0 wt.% to 40 wt.%, more preferably 15.0 wt.% to 30.0 wt.%, of the core layer, based on the total weight of the core layer. LLDPEs of this type are referred to hereinafter as LLDPE-2.

[0041] In an embodiment of the invention, the core layer comprises preferably at least about 10.0 wt.% of LLDPE-1 or LLDPE-2 having a melt index ratio (MIR \(I_{21.6}/I_{12.16} \)) ≥ about 35 as determined according to ASTM D-1238. In an embodiment of the invention, the core layer comprises at least about 10.0 wt.% of a heterogeneously branched LDPE with a melt index ≤ about 1.5 g/10 min. as determined according to ASTM D-1238 at 190°C/2.16 kg.

[0042] Suitable films may comprise a core layer which displays the HTC effect. HTC indicates High Throughput High Clarity films, as disclosed in U.S. Patent No. 6,368,545. Accordingly, in an embodiment of the invention, the core layer has a haze < about 10% as determined according to ASTM D-1003, and demonstrates an improvement in optical properties (e.g., a reduction in haze according to ASTM D-1003) when produced under a deformation rate ≥ about 0.6 s⁻¹, as compared to an identical film produced at lower deformation rate.

[0043] Particular core layers include 50.0 wt.% to 100.0 wt.%, preferably 60.0 wt.% to 95 wt.%, more preferably 70.0 wt.% to 90.0 wt.% of LLDPE-1 in combination with at least 5.0 wt.%, 10.0 wt.%, or at least 20 wt.%, particularly 5.0 wt.% to < 50.0 wt.%, preferably 10.0 wt.% to 40 wt.%, more preferably 15.0 wt.% to 30.0 wt.% of LLDPE-2, based on the total weight of the core layer. Some other preferred core layers include 50.0 wt.% to 100.0 wt.%, preferably 60.0 wt.% to 95 wt.%, more preferably 70.0 wt.% to 90.0 wt.% of LLDPE-1 in combination with at least 10.0 wt.%, preferably 10.0 wt.% to 30.0 wt.%, more preferably 15.0 wt.% to 25.0 wt.% of a low density polyethylene, based on the total weight of the core layer.

[0044] In some embodiments of the invention, the core layer of the oriented multilayer film comprises one or more tie layers. When present, tie layers are placed at the exterior portion of the core layer to act as interface for contacting the first and/or second skin layer. For example, in one embodiment, the tie layers form the outer portions of the core layer such that the tie layers are from the region between an interior portion of the core layer and the first and/or second skin layers. The tie layers can comprise any polymer which holds together the two
layers to be joined. While the tie layers are described as a portion of the core layer, one skilled in the art will appreciate that this description is a formality and tie layers may also be described as separate layers, formed by coextrusion, and may be the same or different composition as the interior portion of the core.

**Outer layer B**

[0045] Optional outer layer B is in surface contact with a second side of the core layer opposite the side in contact with outer layer A. Preferably, optional outer layer B comprises a linear low density polyethylene such as LLDPE-1. Alternatively, optional outer layer B may be a Ziegler Natta ethylene-copolymer LLDPE. Examples include the ethylene-butylene Ziegler Natta copolymer available from ExxonMobil Chemical Company under the trade name ExxonMobil LLDPE, particularly, LL1001 XV™. Preferably, optional outer layer B includes 50.0 wt.% to 100.0 wt.%, preferably 80.0 wt.% to 100.0 wt.%, more preferably 90.0 wt.% to 100.0 wt.% of LLDPE-1, Ziegler Natta ethylene-copolymer LLDPE, or blends thereof, based on the total weight of optional outer layer B. In an embodiment of the invention, the outer layer B consists essentially of a LLDPE-1. In an embodiment of the invention, the outer layer B comprises no more than 0.2 wt.%, preferably < 0.1 wt.%, more preferably < 0.05 wt.% of a solid particulate antiblock, based on the weight of layer B. A solid particulate antiblock may also be absent from layer B.

**Blown Films**

[0046] It has been discovered that a blown film comprising an outer layer A, a core layer, and an outer layer B as described herein exhibits a reduced noise when being unwrapped from a roll or spool consistent with use in a wrapping machine. Accordingly, films disclosed herein according to an embodiment demonstrate a reduction in the noise associated with wrapping an article comprising attaching an end of a stretch wrap film from a roll to the article and unwinding the film from the roll and wrapping the article with the film, wherein the film is unwound at a rate from at least about 1, preferably at least 5, preferably at least about 10 m/min. to 120 m/min.

[0047] In an embodiment of the invention, the multilayer blown film may also have a peel cling force from 80.0 cN to about 150.0 cN, when determined according to ASTM D-5458. In an embodiment of the invention, the peel cling force is determined following a post-blowing thermal history consisting only of temperatures below 50°C. Accordingly, the films disclosed in an embodiment herein do not require thermal tempering, as is common in the art, wherein the films are held for a period of time at an elevated temperature to allow various components of the film to rise to the surface of the film. For example, it is common in the art to maintain
films comprising a C_4-C_6-based polymer having an Mw < about 5.00x10^4 g/mol. at an elevated temperature for 24 hours or more to allow the tackifier to migrate to the surface of the film such that an acceptable amount of tack is present for end use. In contrast, the presently claimed invention does not require this thermal history to perform in an acceptable way.

**[0048]** In an embodiment of the invention, the multilayer blown film has a natural draw ratio ≥ about 1.50x10^2%, preferably greater than or equal to about 2.00x10^2%, when determined from a stress-elongation measurement according to ASTM D-882, as described herein.

**[0049]** As discussed above, the addition of propylene-based elastomer to the outer layer A enhances the peel cling force of the film. Accordingly, a method of controlling the peel cling force of a multilayer blown film comprises selecting a core layer composition comprising polyethylene; selecting an outer layer A composition comprising a plastomer and an amount of a polypropylene-based elastomer from about 0.1 wt.% to about 45 wt.%, based on the total weight of the outer layer A composition, extruding the core layer composition and the outer layer A composition from a die to produce a multilayer blown film comprising an outer layer A composition in surface contact with a core layer comprising the core layer composition, wherein the amount of the propylene-based elastomer in the outer layer A composition is selected to control the peel cling force of the multilayer blown film.

**[0050]** In an embodiment of the invention, a method to produce a multilayer blown film comprises selecting a first polyethylene layer comprising a low density polyethylene; selecting a core layer polyethylene comprising at least about 10.0 wt.% of a linear low density polyethylene (LLDPE) having a melt index ratio (MIR I_{21.6}/I_{2.16} @ 190°C) ≥ about 35, as determined according to ASTM D-1238 at 190°C, or at least about 10.0 wt.% of a heterogeneously branched LDPE with a melt index ≤ about 1.5 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg; and selecting a plastomer; followed by extruding the first polyethylene, the core layer polyethylene and the plastomer from a die to produce a multilayer blown film comprising the core polyethylene layer disposed between the first polyethylene layer and the plastomer layer at a strain rate ≥ about 0.6 s⁻¹, wherein the plastomer layer comprises less than about 0.1 wt.% of a C_4-C_6-based polymer having an Mw < about 5.00x10^4 g/mol.

**Stretch-Wrap Films**

**[0051]** In an embodiment of the invention, a roll of stretch wrap film comprises a multilayer blown film unwindably wrapped around a center axis, the film comprising a core layer as described above disposed between an outer layer B and an outer layer A each as
described above, particularly where the core layer comprises at least about 10.0 wt.% of LLDPE-1 or LLDPE-2 having a melt index ratio (MIR $I_{21,6}/I_{12,16}$ @ 190°C) $\geq$ about 35 as determined according to ASTM D-1238 or at least about 10.0 wt.% of a heterogeneously branched LDPE with a melt index $\leq$ about 1.5 g/10 min. as determined according to ASTM D-1238 at 190°C/2.16 kg.; and wherein the stretch wrap film produces noise less than 80 dB when unwound from the roll, preferably as part of a machine wrapping process.

[0052] In an embodiment of the invention, a stretch wrap film comprises a multilayer blown film comprising a core layer as described herein disposed between an outer layer A and an outer layer B each as described above, particularly where the core layer comprises at least about 10.0 wt.% of LLDPE-1 or LLDPE-2 having a melt index ratio (MIR $I_{21,6}/I_{12,16}$ @ 190°C) $\geq$ about 35 as determined according to ASTM D-1238 or at least about 10.0 wt.% of a heterogeneously branched LDPE with a melt index $\leq$ about 1.5 g/10 min. as determined according to ASTM D-1238 at 190°C/2.16 kg.; wherein the stretch wrap film has a peel cling force $\geq$ about 80 cN and less than or equal to about 150 cN, when determined according to ASTM D-5458, and wherein the stretch wrap film has a natural draw ratio $\geq$ about 250%, when determined from stress-elongation measurements according to ASTM D-882.

Surface Protection Films

[0053] In an embodiment of the invention, a film for surface protection that can be removably attached to a substrate comprises a core layer as described herein and an outer layer A each as described above, particularly where the core layer comprises at least about 10.0 wt.% of LLDPE-1 or LLDPE-2 having a melt index ratio (MIR $I_{21,6}/I_{12,16}$ @ 190°C) $\geq$ about 35 as determined according to ASTM D-1238 or at least about 10.0 wt.% of a heterogeneously branched LDPE with a melt index $\leq$ about 1.5 g/10 min. as determined according to ASTM D-1238 at 190°C/2.16 kg. In particular surface protection films, the outer layer A includes a plastomer as described above as well as about 0.1 wt.% to about 45 wt.% of a propylene-based elastomer. In surface protection films including optional outer layer B, outer layer B may include a heterogeneously branched LDPE as described for use in the core layer. The films may also be used in surface protection applications with or without stretching. The films are effective, especially in the temporary protection of surfaces during manufacturing, transportation, and the like.

[0054] The adhesive characteristics of the films described herein may depend on the extrusion conditions and other factors such as the type of comonomer incorporated, the thickness of the film, and the extractables content of the copolymer and resulting film. The films preferably have a thickness of from 10 microns to 50 microns. The outer layer A and the
outer layer B of the films may have a thickness of from 1 micron to 20 microns, preferably from 1.5 microns to 10 microns. The films preferably have at least three layers formed by coextrusion, with an adhesion imparting surface layer constituting from 10% to 60% of the overall thickness.

[0055] In an embodiment of the invention, the layer distribution, as expressed as A/C/B, wherein A represents the outer layer A, C represents the core layer, and B represents the outer layer B may include a relative thickness of B = 1 to 50, C = 10 to 98, and A = 1 to 50, wherein A+B+C = 100, wherein the total thickness of the film is from 10 microns to about 50 microns, preferably from about 15 microns to 30 microns. In an embodiment of the invention, the layer distribution may be from about 5/90/5 to about 10/80/10, up to about 1/2/1 to about 1/1/1.

[0056] Films may further include various conventional additives known in the art, so long as they do not detract from the inventive properties of the films. Examples of conventional additives include fillers; antioxidants (e.g., hindered phenolics; phosphites); anti-cling additives; tackifiers, such as polybutenes, terpene resins, aliphatic and aromatic hydrocarbon resins, alkali metal and glycerol stearates and hydrogenated resins; UV stabilizers; heat stabilizers; antiblocking agents; release agents; anti-static agents; pigments; colorants; dyes; waxes; silica; fillers; talc; and the like.

[0057] Exemplary anti-oxidants include alkylated phenols, hindered phenols, and phenol derivatives. Examples of hindered phenolic antioxidants are commercially available under the IRGANOX™ series of trade designations including IRGANOX™ 565, IRGANOX™ 1010, IRGANOX™ 3052, and IRGANOX™ 1076 from BASF Chemicals (Basel, Switzerland). In one embodiment, the adhesive composition comprises from 0.01 wt.% to 3 wt.% of total antioxidant on an active or neat basis (excluding inerts in as-received commercially available antioxidant packages, and including any antioxidant in the blend components), preferably from 0.05 wt.% to 2 wt.%.

[0058] There are many potential other applications of films produced from the present copolymers. These films can be made into other forms, such as tape, by any one of a number of well-known cutting, slitting, and/or rewinding techniques. The surfaces of the film of this invention can be modified by such known and conventional post-forming techniques such as flame treatment, corona discharge, chemical treatment, and the like.

[0059] In an embodiment of the invention, a method of wrapping an article comprises attaching or contacting an end of a stretch wrap film from a roll to the article; unwinding the film from the roll and wrapping the article with the film, wherein the film is unwound at a rate from 10 to 120 m/min., wherein the total noise associated with unwinding the film is less than
90 dB, wherein the film comprises a core layer as described herein disposed between an outer layer B and an outer layer A, particularly where the core layer comprises at least about 10.0 wt.% of LLDPE-1 or LLDPE-2 having a melt index ratio (MIR $I_{21.6}/I_{2.16} @ 190^\circ\text{C}$) ≥ about 35 as determined according to ASTM D-1238 or at least about 10.0 wt.% of a heterogeneously branched LDPE with a melt index ≤ about 1.5 g/10 min. as determined according to ASTM D-1238 at 190°C/2.16 kg.

[0060] In an embodiment of the invention, a method of wrapping an article comprises attaching or contacting an end of a stretch wrap film as described herein from a roll to the article; unwinding the film from the roll and wrapping the article with the film, wherein the film is unwound at a rate from 10 to 120 m/min., wherein the total noise associated with unwinding the film is less than 85 dB, preferably less than 80 dB, preferably less than 75 dB, with less than 70 dB being still more preferred. In an embodiment of the invention, the noise associated with unwinding the film is less than 20 dB over ambient noise, preferably less than 15 dB over ambient noise, preferably less than 10 dB over ambient noise, with less than 5 dB over ambient noise being more preferred. Noise may be measured according to ASTM E2202-02(2009).

[0061] In an embodiment of the invention, a method of reducing the noise associated with wrapping an article comprising attaching or contacting an end of a stretch wrap film from a roll to the article and unwinding the film from the roll and wrapping the article with the film, wherein the film is unwound at a rate from 10 to 120 m/min., comprising providing the roll of stretch wrap film in the attaching, unwinding and wrapping, wherein the stretch wrap film comprises a core layer as described herein disposed between an outer layer B and an outer layer A, particularly where the core layer comprises at least about 10.0 wt.% of LLDPE-1 or LLDPE-2 having a melt index ratio (MIR $I_{21.6}/I_{2.16} @ 190^\circ\text{C}$) ≥ about 35 as determined according to ASTM D-1238 or at least about 10.0 wt.% of a heterogeneously branched LDPE with a melt index ≤ about min. as determined according to ASTM D-1238 at 190°C/2.16 kg.

**Embodiments**

[0062] Accordingly, the present invention provides the following embodiments of the invention.

A. Embodiments of the invention include a film comprising an outer layer A in surface contact with a core layer, wherein the outer layer A comprises a plastomer, and wherein the outer layer A contains no more than 0.1 wt.% of a C4-C10-based polymer having an Mw < about 5.00x10^4 g/nmol.
B. Embodiments of the invention include films of Embodiment A, wherein the outer layer A further comprises from about 0.1 wt.% to about 45 wt., preferably 1.0 to 25.0 wt.%, more preferably 2.0 to 20.0 wt.% of a propylene-based elastomer.

C. Embodiments of the invention include films of Embodiments A and B, wherein the plastomer comprises an ethylene-based plastomer comprising about 87 mol.% to about 97.5 mol.% of polymer units derived from ethylene and about 13 mol.% to about 2.5 mol.% of polymer units derived from an alpha-olefin, said plastomer having a density of from 0.86 g/cm³ to 0.910 g/cm³, an Mw ≥ 70,000 to < 130,000, and a heat of fusion of greater than 75 J/g, preferably less than 130.0 J/g, 125.0 J/g, 120.0 J/g, 110.0 J/g, or 100.0 J/g, as determined by differential scanning calorimetry; preferably also having a CDBI > 60, preferably > 80, and more preferably > 90, and characterized by a DSC melting point curve that exhibits the occurrence of a single melting point peak occurring in the region of 50°C to 110°C.

D. Embodiments of the invention include films of any of Embodiments A-C, wherein the core layer comprises at least about 50.0 wt.% to 100.0 wt.%, preferably 60.0 wt.% to 95 wt.%, more preferably 70.0 wt.% to 90.0 wt.% (based on the total weight of the core layer) of a first polyethylene that is preferably a linear low density polyethylene.

E. Embodiments of the invention include films of Embodiment D, wherein the first polyethylene comprises at least 50.0 wt.% ethylene and up to 50.0 wt.%, preferably 1.0 wt.% to 35.0 wt.%, even more preferably 1.0 wt.% to 6.0 wt.% of a C₃ to C₂₀ comonomer (based upon the weight of the copolymer), the first polyethylene having a composition distribution breadth index (CDBI) ≥ 60% preferably 60% to 80%, preferably 65% to 80%, and a density of 0.910 g/cm³ to 0.950 g/cm³; preferably 0.915 g/cm³ to 0.940 g/cm³; preferably 0.918 g/cm³ to 0.925 g/cm³.

F. Embodiments of the invention include films of Embodiment E, the first polyethylene comprises an ethylene/octene copolymer having a melt index of from about 0.5 g/10 min. to about 10.0 g/10 min., particularly from about 0.5 g/10 min. to 2.0 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg.

G. Embodiments of the invention include films of any of Embodiments D-F, wherein the core layer further comprises at least about 10.0 wt.%, preferably ≤ 50.0 wt.%, preferably 10.0 wt.% to 40.0 wt.%, more preferably 15.0 wt.% to 30.0 wt.% or 10.0 wt.% to 30.0 wt.% of a second polyethylene (based on the total weight of the core layer). Preferred polyethylenes include linear low density polyethylenes and low density polyethylenes.
H. Embodiments of the invention include films of Embodiment G, wherein the second polyethylene comprises a polyethylene having a melt index of from 0.1 to 15, a compositional distribution breadth index of at least 70%, a density of from 0.910 to 0.930 g/ml, a haze value of less than 20%, a melt index ratio of from 35 to 80, an averaged Modulus (M) of from 20,000 to 60,000 psi, and a relation between M and the dart impact strength in g/mil (DIS) complying with the formula:

\[ \text{DIS} > 0.8 \times \left( 100 + e^{1.71-0.000268} \times M + 2.183 \times 10^{-9} \times M^2 \right), \]

where 'e' represents 2.1783, the base Napierian logarithm, M is the averaged Modulus in psi and DIS is the 66cm dart impact strength. Preferred such second polyethylenes comprise an ethylene/hexene copolymer having a melt index of from \( \leq 1.5 \) g/10 min., particularly from about 0.1 g/10 min. to 1.0 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg and have a density of from 0.915 g/cm\(^3\) to 0.930 g/cm\(^3\), more preferably 0.920 g/cm\(^3\) to 0.930 g/cm\(^3\).

I. Embodiments of the invention include films of Embodiment G, wherein the second polyethylene comprises a heterogeneously branched polyethylene comprising at least 85 mol.% of units derived from ethylene and having a density of from 0.910 g/cm\(^3\) to 0.940 g/cm\(^3\) and a melt index \( \leq \) about 1.5 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg.

J. Embodiments of the invention include films of any of Embodiments A-I, wherein the plastomer has a density of > 0.86 g/cm\(^3\) to < 0.910 g/cm\(^3\), preferably from 0.88 g/cm\(^3\) to 0.905 g/cm\(^3\), more preferably from 0.870 g/cm\(^3\) to 0.890 g/cm\(^3\).

K. Embodiments of the invention include films of any of Embodiments A-J, wherein the film is a multilayer blown film further comprising an outer layer B comprising polyethylene, wherein the outer layer B is in surface contact with a surface of the core layer opposite the outer layer A.

L. Embodiments of the invention include films of Embodiment K, wherein the outer layer B comprises 50.0 wt.% to 100.0 wt.% of a polyethylene comprising at least 50.0 wt.% ethylene and 1.0 wt.% to 35.0 wt.% of a C\(_3\) to C\(_{20}\) alpha-olefin comonomer (based upon the weight of the copolymer), and having a composition distribution breadth index (CDBI) \( \geq 60\% \) and a density of 0.910 g/cm\(^3\) to 0.950 g/cm\(^3\).

M. Embodiments of the invention include films of Embodiment L, wherein the core layer comprises:
about 70 wt.% to 90 wt.% of a first polyethylene having at least 50.0 wt.% ethylene and 1.0 wt.% to 35.0 wt.% of a C3 to C20 alpha-olefin comonomer (based upon the weight of the copolymer), a composition distribution breadth index (CDBI) ≥ 60%, a density of 0.910 g/cm³ to 0.950 g/cm³; and

about 10.0 wt.% to about 30.0 wt.% of a second polyethylene comprising:

i) a polyethylene having a melt index of from 0.1 to 15, a compositional distribution breadth index of at least 70%, a density of from 0.910 to 0.930 g/ml, a haze value of less than 20%, a melt index ratio of from 35 to 80, an averaged Modulus (M) of from 20,000 to 60,000 psi, and a relation between M and the dart impact strength in g/mil (DIS) complying with the formula:

$$\text{DIS} > 0.8 \times [100 \times e^{(11.71 - 0.000268 \times M + 2.183 \times 10^{-9} \times M^2)}],$$

where "e" represents 2.1783, the base Napierian logarithm, M is the averaged Modulus in psi and DIS is the 66 cm dart impact strength; or

ii) a heterogeneously branched polyethylene comprising at least 85 mol.% of units derived from ethylene and having a density of from 0.910 g/cm³ to 0.940 g/cm³ and a melt index ≤ about 1.5 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg.

N. Embodiments of the invention include films of any of Embodiments L-M, wherein the outer layer B comprises ≤ 0.2 wt.%, preferably < 0.1 wt.%, more preferably < 0.05 wt.% of a particulate antiblock, based on the weight of layer B. A solid particulate antiblock may also be absent from layer B.

O. Embodiments of the invention include films of any of Embodiments A-N wherein the film has a natural draw ratio ≥ about 2.50x10²%, when determined from stress-elongation measurements according to ASTM D-882.

P. Embodiments of the invention include films of any of Embodiments A-O wherein the film has a noise rating < 9.0x10¹ dB.

Q. Embodiments of the invention include films of any of Embodiments A-P, wherein the C₄-Cio-based polymer comprises a polyisobutylene polymer or copolymer.

R. Embodiments of the invention include films comprising an outer layer A comprising plastomer in surface contact with a core layer, wherein a fraction of polyolefin polymers, preferably C₄-Cio-based polymers, more preferably polyisobutylene polymer or copolymer, having an Mw < about 5.00x10⁴ g/mol. comprises < 0.1 wt.%, < 0.05 wt.%, < 0.01 wt.%, or 0 wt.% of the outer layer A, based on the weight of the outer layer A.
S. Embodiments of the invention include films of Embodiment R, wherein the plastomer is present in the outer layer A in an amount of 70.0 wt.% to 100.0 wt.%, wherein the plastomer comprises a copolymer comprising at least 50.0 wt.% polymer units derived from ethylene and 1.0 wt.% to 35.0 wt.% polymer units derived from a C3-C20 olefin, a composition distribution breadth index (CDBI) above 90%, a density of 0.870 g/cm³ to 0.910 g/cm³ and a melt index (ASTM D-1238 at 190°C/2.16kg) of 0.5 dg/min. to 5 dg/min.

T. Embodiments of the invention include films of Embodiment S, wherein the outer layer A comprises 85.0 wt.% to 100.0 wt.% of the plastomer and 1.0 wt.% to 10.0 wt.% of at least one propylene-based elastomer; the core layer comprising:

a) about 70 wt.% to 90 wt.% of a first polyethylene having at least 50.0 wt.% ethylene and 1.0 wt.% to 35.0 wt.% of a C3 to C20 alpha-olefin comonomer (based upon the weight of the copolymer), the first polyethylene having a composition distribution breadth index (CDBI) ≥ 60%, and a density of 0.910 g/cm³ to 0.950 g/cm³; and

b) about 10.0 wt.% to about 30.0 wt.% of a second polyethylene comprising:

i) a polyethylene having a melt index of from 0.1 to 15, a compositional distribution breadth index of at least 70%, a density of from 0.910 to 0.930 g/ml, a haze value of less than 20%, a melt index ratio of from 35 to 80, an averaged Modulus (M) of from 20,000 to 60,000 psi, and a relation between M and the dart impact strength in g/mil (DIS) complying with the formula:

\[
\text{DIS} > 0.8 \times 10^{-6} (11.71 - 0.000268M_s - 2.183 \times 10^{-9} M_s^2)
\]

where "e" represents 2.1783, the base Napierian logarithm, M is the averaged Modulus in psi and DIS is the 66cm dart impact strength; or

ii) a heterogeneously branched polyethylene comprising at least 85 mol.% of units derived from ethylene and having a density of from 0.910 g/cm³ to 0.940 g/cm³ and a melt index ≤ about 1.5 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg; and wherein the outer layer B comprises ≥ 40.0 wt.% of a second heterogeneously branched polyethylene comprising at least 85 mol.% of units derived from ethylene and having a density of from 0.910 g/cm³ to 0.940 g/cm³ and a melt index ≤ about 1.5 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg.
U. Embodiments of the invention include films of Embodiment R-T, wherein a peel cling force between the outer layer A and the outer layer B is $\geq 8.0 \times 10^1$ cN, wherein the peel cling force is determined according to ASTM D-5458.

V. Embodiments of the invention include films of any of Embodiments R-U, wherein the peel cling force is $8.0 \times 10^1$ cN to about $1.5 \times 10^2$ cN, determined according to ASTM D-5458.

W. Embodiments of the invention include films of any of Embodiments A-V, wherein the film is a tack film, stretch-wrap, or a surface-protection film.

X. Any of the previous embodiments of the invention, wherein the outer layer A is a tack layer.

Y. Any of the previous embodiments of the invention, including an outer layer B wherein the outer layer B is an anti-cling layer.

Z. Embodiments of the invention include methods of wrapping an article with a film of any of the Embodiments A-Y, wherein the method comprises:

attaching an end of the film from a film-roll to the article;

unwinding the film from the film-roll at a rate from 1 to 400 m/min; and

wrapping the article with the film, wherein the total noise associated with unwinding the film is less than $9.0 \times 10^1$ dB.

preferably the film comprises a core layer interposing an outer layer A and an outer layer B, the outer layer A comprising a plastomer and $< 0.1$ wt.% of a C$_4$-Cio-based polymer having an Mw $< 5.00 \times 10^4$ g/mol.

AA. Embodiments of the invention include methods of Embodiment Z wherein the outer layer B comprising a linear low density polyethylene and the core layer comprises:

a) about 70 wt.% to 90 wt.% of a first polyethylene comprising at least 50.0 wt.% ethylene and 1.0 wt.% to 35.0 wt.% of a C$_3$ to C$_{20}$ alpha-olefin comonomer (based upon the weight of the copolymer), and having a composition distribution breadth index (CDBI) $\geq 60\%$, and a density of 0.910 g/cm$^3$ to 0.950 g/cm$^3$; and

b) about 10.0 wt.% to about 30.0 wt.% of a second polyethylene comprising:

i) a polyethylene having a melt index of from 0.1 to 15, a compositional distribution breadth index of at least 70%, a density of from 0.910 to 0.930 g/ml, a haze value of less than 20%, a melt index ratio of from 35 to 80, an averaged Modulus (M) of from 20,000 to 60,000 psi, and a relation between M and the dart impact strength in g/mil (DIS) complying with the formula:
DIS > 0.8 \chi [100 + e^{1.71-0.000268 \chi M + 2.183 \chi 10^{-9} \chi M^2}]

where "e" represents 2.1783, the base Napierian logarithm, M is the averaged Modulus in psi and DIS is the 66cm dart impact strength; or

ii) a heterogeneously branched polyethylene comprising at least 85 mol.% of units derived from ethylene and having a density of from 0.910 g/cm³ to 0.940 g/cm³ and a melt index ≤ about 1.5 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg.

AB. Embodiments of the invention include methods of any of Embodiments X-Y, wherein the method further includes a post-blowing thermal treatment wherein the temperature does not exceed 50°C.

AC. A method of controlling peel cling force of a multilayer blown film comprising:

selecting a core layer composition comprising any of the core layer compositions of Embodiments D-I or M;

selecting an outer layer A composition comprising any of the outer layers A of Embodiments A-C, J, Q-T, or X; and

extruding the core layer composition and the outer layer A composition to produce the multilayer blown film wherein the layer A composition is in surface contact with the core layer composition.

AD. Embodiments of the invention include methods of Embodiment AC, wherein the method further includes subjecting the multilayer blown film to a post-blowing thermal treatment wherein the temperature does not exceed 50°C.

AE. Embodiments of the invention include a method of making a multilayer blown film comprising:

selecting a core layer composition comprising any of the core layer compositions of Embodiments D-I or M;

selecting an outer layer A composition comprising any of the outer layers A of Embodiments A-C, J, Q-T, or X; and

extruding the core layer composition and the outer layer A composition to produce the multilayer blown film wherein the layer A composition is in surface contact with the core layer composition.

AF. Embodiments of the invention include the method of Embodiment AE further including selecting an outer layer B composition comprising any of the outer layer B compositions of Embodiments K-L, N, or Y; wherein extruding includes extruding the outer layer B
composition on a side of the core layer opposite outer layer A; preferably wherein the strain rate is $\geq$ about 0.6 s$^{-1}$, $\geq$ about 0.7 s$^{-1}$, $\geq$ about 0.8 s$^{-1}$, $\geq$ about 0.9 s$^{-1}$, or $\geq$ about 2.0 s$^{-1}$.

**EXAMPLES**

[0063] A number of Examples and Comparative Examples were produced to demonstrate embodiments of this disclosure. The test methods utilized herein are disclosed in Table 1.

<table>
<thead>
<tr>
<th>Table 1. Test methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>Clarity</td>
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<tr>
<td>Density of Plastics by Gradient Technique</td>
</tr>
<tr>
<td>Elmendorf Tear Strength</td>
</tr>
<tr>
<td>Gloss 45°</td>
</tr>
<tr>
<td>Gloss</td>
</tr>
<tr>
<td>Impact resistance by free-falling dart: method A and B</td>
</tr>
<tr>
<td>Peel cling of stretch wrap film</td>
</tr>
<tr>
<td>Tensile Properties on stretch film</td>
</tr>
</tbody>
</table>

[0064] The components utilized to produce the Examples are listed in Table 2.

<table>
<thead>
<tr>
<th>Table 2. Components Used</th>
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<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Metallocene ethylene-hexene copolymer</td>
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<td>Metallocene ethylene-hexene copolymer</td>
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<td>Metallocene ethylene-hexene copolymer</td>
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<tr>
<td>Ziegler Natta ethylene-butylene copolymer</td>
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<tr>
<td>Polysobutylene tackifier</td>
</tr>
<tr>
<td>Ethylene-octene plastomer</td>
</tr>
<tr>
<td>Ethylene-octene plastomer</td>
</tr>
<tr>
<td>Propylene-based elastomer</td>
</tr>
<tr>
<td>Propylene-based elastomer</td>
</tr>
<tr>
<td>LDPE</td>
</tr>
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<td>LDPE</td>
</tr>
</tbody>
</table>

**Coextrusion Processes**

[0065] The films are produced by blown film coextrusion where at least two molten polymer compositions are extruded and bonded together in a molten condition in a die exit. The films are formed, while cooling progressively, after stretching, orientation and crystallization until the film reaches a take up device (e.g., a pair of pinch rollers) enclosing the top of the bubble.
[0066] The blown film is pulled upwards after exiting from the die and is simultaneously inflated and stretched transversely sideways to an extent according to a standard blow up ratio such that the inflation provide the transverse direction (TD) stretch, while the upwards pull by the pinch rollers provide a machine direction (MD) stretch. As the polymer cools after exiting the die and inflation, it crystallizes at the frost line to prevent further MD or TD orientation, as is readily known in the art. All of the films exemplified herein are produced on a Windmoeller \& Hoelscher 3-layer coextrusion blown film line with following features:

- Extruder A (skin layer, outside of bubble): 60 mm diameter, smooth bore;
- Extruder B (core layer): 90 mm diameter, grooved feed;
- Extruder C (skin layer, inside of bubble): 60 mm diameter, grooved feed; 250 mm die diameter;
- 1.4 mm or HQ 1.25-2.25 mm die gap; and
- IBC and Optifil P2K thickness profile control.

[0067] All films are processed under the same conditions with temperature settings ranging from approximately 190°C to 200°C on the die and extruder setpoint, with approximately 200 kg/hr output.

[0068] In the examples, Comparative Examples CE1, CE2, CE3, and CE5 are references using polyisobutene (PIB) as a tackifier. Comparative Example CE4 is a non-PIB example showing the need for PIB as a tackifier in conventional films. Examples E6, E7, E8, and E9 show an embodiment having a plastomer/HTC arrangement with a density of the plastomer of 0.882 g/cc. Example E6-bis shows a plastomer density of 0.902 g/cc. Examples E6, E6 bis, E7, and E8 utilize ENABLE™ 27-03 as the HTC inducing material; Example E9 includes a low M1 LDPE as the HTC inducing material. The data are presented in Table 3, wherein examples are labeled with the prefix "E" and comparative examples are labeled with the prefix "CE".

[0069] As the data shows, in addition to the improved cling force, some of the inventive examples also provide beneficial effects on toughness (tensile at break), dart impact, Elmendorf tear in MD, and optical properties.

[0070] The cling force and noise associated with unwinding is determined on the comparative examples comprising the low molecular weight tackifier (PW60) after aging of the film for two weeks at 50°C to allow the polyisobutylene to migrate to the surface, which is the common practice in the art. However, the inventive examples are measured without any thermal aging of the material.
Furthermore, unwinding of the exemplary films from a roll produces essentially no noise from the unwinding process in contrast to the Comparative Examples which included PIB, all of which produced considerable noise above ambient upon unwinding.

<table>
<thead>
<tr>
<th>Table 3. Coextruded Film – Low Noise</th>
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<tr>
<td>Example</td>
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<td>EXCEED™ 1018CA, wt.%</td>
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<td>LD150BW, wt.%</td>
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<td>ExactTM 8201, wt.%</td>
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<td>Charity, %</td>
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<td>Elmendorf Tack TD, g/µm</td>
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<td>Durometer, g/µm</td>
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<table>
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<th>Tensile Properties on stretch film MD</th>
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<tr>
<td>10% Offset yield stress, MPa</td>
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<td>2nd yield stress, MPa</td>
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<tr>
<td>Delta 1st and 2nd yield, MPa</td>
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<td>Tensile strength at break, MPa</td>
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<td>Tensile elongation at break, %</td>
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<td>Energy, mJ/mm²</td>
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<tr>
<td>Force at NDR, MPa</td>
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<td>Delta 2nd yield and force at NDR, MPa</td>
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<td>Tensile elongation at break, %</td>
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<tr>
<td>1% modulus, MPa</td>
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<td>Orientation Factor TD-MD-Modulus, MPa</td>
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Table 3 (continued)

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<td>--</td>
<td>--</td>
<td>--</td>
<td>36.6</td>
<td>71.6</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>762</td>
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</table>

* Noise determination represents the noise measured at a distance of 1 meter from the roll and is an average over 1 min. using a Solci-2 station winder at 40 m/min. with ambient noise between 68-72 dB.

The noise during unwinding is determined using a Quest Technologies Sound Level Meter 2200. The measurements are acquired in a production environment having an ambient noise between 68 and 72 dB. The measurements are obtained using a range of 50 - 120 dB, weighting factor A and response factor F. Measurements are made after reset in run mode giving average noise level (setting LEQ) and represent the average during approximately 1 minute of unwinding on a Dolci 2 station winder at approximately 40 m/min. at a distance of 1 meter from the winding machine. Ambient noise is not subtracted from the noise of the unwinding. As such, the reported noise level includes the ambient noise. As the data show, the noise of the inventive films is essentially identical to the ambient noise and thus, the unwinding of an embodiment of the inventive films does not produce noise.

In another set of examples, the propylene-based elastomer is included. As the data shows, the cling can be tailored according to the required cling level through use of either a lower density plastomer and/or by selecting the blend ratio of the plastomer to the propylene-based elastomer. The blend of the plastomer and the propylene-based elastomer results in a level of tackiness which is higher than would be obtainable with either material alone. The use of an increased amount of propylene-based elastomer may induce cling forces which are so high, typically greater than 150 cN, that the film would not be as useful as a stretch film due to the possible inability to remove the film from the roll, but which may be suitable for a number of other uses which require cling forces higher than 150 cN. The data is shown in Table 4, wherein Examples 6, 7, 8, and 9 from Table 3 are included to show the improvement obtained upon selection of the propylene-based elastomer.

In Examples 6, 7, 8, and 9 EXACT™ 8201 forms a tacky layer. Examples 10 and 11 each have 2.5% VISTAMAXX™ 6201 in EXACT™ 8201 as the tacky layer, with different layer distribution, wherein the tacky layer is the thinnest layer. Example 12 has 5% VISTAMAXX™ 6102 and Example 13 has 20% VISTAMAXX™ 6102 in the tacky layer.
Table 5 below shows film examples having an amount of propylene-based elastomer selected to target a cling force suitable for use as a stretch wrap film. Example 6 bis from Table 3, shows EXACT™ 0201 as the tacky layer. Examples 14 and 14 bis each have 2.5% VISTAMAXX™ 6201 in EXACT™ 0201 as the tacky layer with a different layer distribution, wherein the tacky layer is the thinnest layer. Example 15 has 5% VISTAMAXX™ 6102, Example 16 has 10% VISTAMAXX™ 6102, and Example 18 has 20% VISTAMAXX™ 6102. Example 17 uses VISTAMAXX™ 6202F at 10% in EXACT™ 0201.
In both cases, with higher VISTAMAXX™ concentrations, higher tackiness is achieved. The maximum measurable force using the test as described in the Examples is around 250 cN. Above this value, the values are not representative of the true peel strength.

Figure 1 shows a graphical representation of the Cling Force vs. the VISTAMAXX™ concentration in the plastomer-containing outer layer A as shown in the above Examples. Accordingly, the level of cling force may be controlled by selecting the amount of the propylene-based elastomer in the outer layer A.

Any range of numbers recited in the specification hereinabove or in the claims hereinafter, such as that representing a particular set of properties, units of measure, conditions, physical states or percentages, is intended to literally incorporate expressly herein by reference or otherwise, any number falling within such range, including any subset of numbers or ranges subsumed within any range so recited.

All documents referred to above are incorporated by reference herein in their entirety unless stated otherwise, including any priority documents and/or testing procedures to the extent they are not inconsistent with this text, provided however that any priority document not named in the initially filed application or filing documents is NOT incorporated by reference herein. As is apparent from the foregoing general description and the specific embodiments of the invention, while forms of the invention have been illustrated and described, various modifications can be made without departing from the spirit and scope of the invention. Accordingly, it is not intended that the invention be limited thereby. In some
embodiments of the invention, the composition is substantially free (i.e., present only at impurity levels or not purposely added to a described composition) of any additive or component not specifically enumerated herein. Advantages described for certain embodiments may or may not be present in other embodiments. Likewise, the term "comprising" is considered synonymous with the term "including" for purposes of Australian law. Likewise whenever a composition, an element or a group of elements is preceded with the transitional phrase "comprising", it is understood that we also contemplate the same composition or group of elements with transitional phrases "consisting essentially of," "consisting of," "selected from the group consisting of," or "is" preceding the recitation of the composition, element, or elements and vice versa.
CLAIMS
1. A film comprising an outer layer A in surface contact with a core layer, wherein the outer layer A comprises a plastomer, and wherein the outer layer A contains no more than 0.1 wt.% of a GrCio-based polymer having an Mw < about 5.00x10^4 g/mol.

2. The film of claim 1, wherein the outer layer A further comprises from about 0.1 wt.% to about 45 wt.% of a propylene-based elastomer.

3. The film of claim 1, wherein the plastomer comprises an ethylene-based plastomer comprising about 87 mol.% to about 97.5 mol.% of polymer units derived from ethylene and about 13 mol.% to about 2.5 mol.% of polymer units derived from an alpha-olefin, the plastomer having a density of from 0.86 g/cm^3 to 0.910 g/cm^3, an Mw ≥ 70,000 to < 130,000, and a heat of fusion of greater than 75 J/g as determined by differential scanning calorimetry.

4. The film of claim 1, wherein the core layer comprises a first polyethylene.

5. The film of claim 4, wherein the first polyethylene comprises at least 50.0 wt.% ethylene and 1.0 wt.% to 35.0 wt.% of a C3 to C20 alpha-olefin comonomer (based upon the weight of the copolymer), a composition distribution breadth index (CDBI) ≥ 60%, and a density of 0.910 g/cm^3 to 0.950 g/cm^3.

6. The film of claim 5, wherein the core layer further comprises at least about 10.0 wt.% of a second polyethylene.

7. The film of claim 6, comprising 10.0 wt.% to 30.0 wt.% of the second polyethylene.

8. The film of claim 7, wherein the second polyethylene comprises a polyethylene having a melt index of from 0.1 to 15, a compositional distribution breadth index of at least 70%, a density of from 0.910 to 0.930 g/ml, a haze value of less than 20%, a melt index ratio of from 35 to 80, an averaged Modulus (M) of from 20,000 to 60,000 psi, and a relation between M and the dart impact strength in g/mil (DIS) complying with the formula:

   \[
   \text{DIS} > 0.8 \times 10^{0.6} \times (11.71 - 0.000268 \times M + 2.183 \times 10^{-9} \times M^2),
   \]

   where \( e \) represents 2.1783, the base Napierian logarithm, \( M \) is the averaged Modulus in psi and DIS is the 66cm dart impact strength.

9. The film of claim 7, wherein the second polyethylene comprises a heterogeneously branched polyethylene comprising at least 85 mol.% of units derived from ethylene and having a density of from 0.910 g/cm^3 to 0.940 g/cm^3 and a melt index ≤ about 1.5 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg.

10. The film of claim 1, wherein the plastomer has a density of 0.870 g/cm^3 to 0.890 g/cm^3.
11. The film of claim 1, wherein the film is a multilayer blown tack film further comprising an outer layer B comprising polyethylene, wherein the outer layer B is in surface contact with a surface of the core layer opposite the outer layer A.

12. The film of claim 11, wherein the outer layer B comprises 50.0 wt.% to 100.0 wt.% of a polyethylene having at least 50.0 wt.% ethylene and 1.0 wt.% to 35.0 wt.% of a C3 to C₆ alpha-olefin comonomer (based upon the weight of the copolymer), a composition distribution breadth index (CDBI) ≥ 60%, and a density of 0.910 g/cm³ to 0.950 g/cm³.

13. The film of claim 12, wherein the core layer comprises:

about 70 wt.% to 90 wt.% of a first polyethylene having at least 50.0 wt.% ethylene and 1.0 wt.% to 35.0 wt.% of a C3 to C₂₀ alpha-olefin comonomer (based upon the weight of the copolymer), a composition distribution breadth index (CDBI) ≥ 60%, a density of 0.910 g/cm³ to 0.950 g/cm³; and

about 10.0 wt.% to about 30.0 wt.% of a second polyethylene comprising:

i) a polyethylene having a melt index of from 0.1 to 15, a compositional distribution breadth index of at least 70%, a density of from 0.910 to 0.930 g/ml, a haze value of less than 20%, a melt index ratio of from 35 to 80, an averaged Modulus (M) of from 20,000 to 60,000 psi, and a relation between M and the dart impact strength in g/mil (DIS) complying with the formula:

\[ \text{DIS} > 0.8 \times 10^{1.1 \log_{10} \text{M}_{w}} - 0.000268 + 2.183 \times 10^{-9} \times \text{M}_{w} \]

where "e" represents 2.1783, the base Napierian logarithm, M is the averaged Modulus in psi and DIS is the 66cm dart impact strength; or

ii) a heterogeneously branched polyethylene comprising at least 85 mol.% of units derived from ethylene and having a density of from 0.910 g/cm³ to 0.940 g/cm³ and a melt index ≤ about 1.5 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg.

14. The film of claim 13, wherein the outer layer B comprises ≤ 0.2 wt.% of a particulate antiblock, based on the total weight of the outer layer B.

15. The film of claim 1 having a natural draw ratio ≥ about 2.50x10²%, when determined from stress-elongation measurements according to ASTM D-882.

16. The film of claim 1 has a noise rating ≤ 9.0x10⁴ dB.

17. The film of claim 1, wherein the C₄-C₂₀-based polymer comprises a polyisobutylene polymer or copolymer.
18. A film comprising an outer layer A comprising plastomer in surface contact with a core layer, wherein a fraction of polyolefin polymers having an Mw < about 5.00x10^4 g/mol. comprises < 0.1 wt.% of the outer layer A, based on the weight of the outer layer A.

19. The film of claim 18, wherein the plastomer is present in the outer layer A in an amount of 70.0 wt.% to 100.0 wt.%, wherein the plastomer comprises a copolymer comprising at least 50.0 wt.% polymer units derived from ethylene and 1.0 wt.% to 35.0 wt.% polymer units derived from a C₃-C₂₀ olefin, a composition distribution breadth index (CDBI) above 90%, a density of 0.870 g/cm³ to 0.910 g/cm³ and a melt index (ASTM D-1238 at 190°C/2.16 kg) of 0.5 dg/min. to 5 dg/min.

20. The film of claim 19, wherein the outer layer A comprises 85.0 wt.% to 100.0 wt.% of the plastomer and 1.0 wt.% to 10.0 wt.% of at least one propylene-based elastomer; the core layer comprising:

a) about 70 wt.% to 90 wt.% of a first polyethylene having at least 50.0 wt.% ethylene and 1.0 wt.% to 35.0 wt.% of a C₃ to C₂₀ alpha-olefin comonomer (based upon the weight of the copolymer), the first polyethylene having a composition distribution breadth index (CDBI) ≥ 60%, and a density of 0.910 g/cm³ to 0.950 g/cm³; and

b) about 10.0 wt.% to about 30.0 wt.% of a second polyethylene comprising:

i) a polyethylene having a melt index of from 0.1 to 15, a compositional distribution breadth index of at least 70%, a density of from 0.910 to 0.930 g/ml, a haze value of less than 20%, a melt index ratio of from 35 to 80, an averaged Modulus (M) of from 20,000 to 60,000 psi, and a relation between M and the dart impact strength in g/mil (DIS) complying with the formula:

\[ \text{DIS} > 0.8 \times [100 + e^{(11.71 - 0.000268xM + 2.183x10^{-9}xM^2)}], \]

where "e" represents 2.1783, the base Napierian logarithm, M is the averaged Modulus in psi and DIS is the 66cm dart impact strength; or

ii) a heterogeneously branched polyethylene comprising at least 85 mol.% of units derived from ethylene and having a density of from 0.910 g/cm³ to 0.940 g/cm³ and a melt index ≤ about 1.5 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg.
21. The film of claim 18, wherein a peel cling force between the outer layer A and the outer
layer B is \( \geq \) about \( 8.0 \times 10^4 \) cN, wherein the peel cling force is determined according to ASTM
D-5458.

22. The film of claim 18, wherein the peel cling force is \( 8.0 \times 10^4 \) cN to about \( 1.5 \times 10^5 \) cN,
determined according to ASTM D-5458.

23. The film of claim 18, wherein the film is a tack film or a surface-protection film.

24. A method of wrapping an article comprising:

attaching an end of a film from a film-roll to the article;

unwinding the film from the film-roll at a rate from 1 to 400 m/min.; and

wrapping the article with the film, wherein the total noise associated with unwinding
the film is less than \( 9.0 \times 10^4 \) dB,

wherein the film comprises a core layer interposing an outer layer A and an outer layer
B, the outer layer A comprising a plastomer and \(< 0.1 \) wt.\% of a \( \alpha \)-olefin based polymer having
an Mw \(< \) about \( 5.00 \times 10^4 \) g/mol.

25. The method of claim 24, wherein the outer layer B comprises a linear low density
polyethylene and the core layer comprises:

a) about 70 wt.% to 90 wt.% of a first polyethylene comprising at least 50.0 wt.%
ethylene and 1.0 wt.% to 35.0 wt.% of a \( \alpha \)3 to \( \alpha \)0 alpha-olefin comonomer (based upon the
weight of the copolymer), and having a composition distribution breadth index (CDBI) \( \geq 60\% \),
and a density of 0.910 \( g/cm^3 \) to 0.950 \( g/cm^3 \); and

b) about 10.0 wt.% to about 30.0 wt.% of a second polyethylene comprising:

i) a polyethylene having a melt index of from 0.1 to 15, a compositional
distribution breadth index of at least 70\%, a density of from 0.910 to
0.930 g/ml, a haze value of less than 20\%, a melt index ratio of from 35
to 80, an averaged Modulus (M) of from 20,000 to 60,000 psi, and a
relation between M and the dart impact strength in g/mil (DIS)
complying with the formula:

\[
\text{DIS} > 0.8 \times 10^{(11.71 - 0.000268 \times M + 2.183 \times 10^{-9} \times M^2)}
\]

where "e" represents 2.1783, the base Napierian logarithm, M is the
averaged Modulus in psi and DIS is the 66cm dart impact strength; or

ii) a heterogeneously branched polyethylene comprising at least 85 mol.%
of units derived from ethylene and having a density of from 0.910 \( g/cm^3 \)
to 0.940 \( g/cm^3 \) and a melt index \( \leq \) about 1.5 g/10 min., as determined
according to ASTM D-1238 at 190°C/2.16 kg; and wherein the outer layer B comprises ≥ 40.0 wt.% of a second heterogeneously branched polyethylene comprising at least 85 mol.% of units derived from ethylene and having a density of from 0.910 g/cm³ to 0.940 g/cm³ and a melt index ≤ about 1.5 g/10 min., as determined according to ASTM D-1238 at 190°C/2.16 kg.
Figure 1

Cling Force vs. Propylene Based Elastomer Concentration in Plastomer

R² = 0.9337
**INTERNATIONAL SEARCH REPORT**

International application No
PCT/US2012/061418

A. CLASSIFICATION OF SUBJECT MATTER

INV. B32B27/08 B32B7/02 B32B27/32 C08L23/08 C08L23/14

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B32B C08L

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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<td>examples</td>
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☐ 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 another 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

"X" document member of the same patent family

Date of the actual completion of the international search: 28 January 2013

Date of mailing of the international search report: 04/02/2013

Name and mailing address of the ISA/
European Patent Office, P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
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Fax: (+31-70) 340-3016

Authorized officer

Li chau, Hol ger
**INTERNATIONAL SEARCH REPORT**

**Box No. II**  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ claims Nos.: 1. 3-25 (a) partially
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

   see [T]H[ E] R[U][ N][E][ R][ I][N][F][O][R][M][A][T][I][O][N] sheet PCT/ISA/21

3. □ Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III**  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos. :

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos. :

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.
Continuation of Box 11.2

Claims Nos.: 1, 3-25 (al 1 partially)

The present application apparently relates to a multilayer film which comprises an outer layer comprising a plasticizer, and not comprising more than 0.1% by weight of a C4-CIO based polymer having a molecular weight \(M_w\) of less than about 5.00x10^4 g/mol, preferably not comprising more than 0.1% by weight of any polyolefin polymers having a molecular weight \(M_w\) of less than about 5.00x10^4 g/mol. The exact significance of the term "about" however remains unclear, which results in considerable doubts as to the precise extent of the protection which is sought, contrary to the requirements of Artic cle 6 PCT. For the present search, the term "about" therefore has been ignored. Even with the term "about" being ignored, multilayer films of this kind however appear to be very well known. In this context, reference is in particular made to example 1 of US 7790281 B2 as cited in the present application, as well as to the examples or preferred embodiments of US 2010/129632 Al, of US 2009/269566 Al, of US 2008/095 960 Al, of US 2008/38530 Al, of US 2007/06560 Al, of EP 1736309 Al, of US 2006/17650 Al, of US 2004/15853 Al, of WO 2004/024443 Al, of US 2004/118853 Al, of EP 1300238 A2, of US 6521338 Bl, of US 6492010 Bl, of WO 02/20685 A2, of WO 2001/028929 Al, of WO 01/70497 A2, of US 2001/021460 Al, of US 6168826 Bl, of EP 1022131 Al, of US 5985426 A, of WO 98/29249 Al, of US 5279872 A, and of US 5272016 A, to name but a fraction of the most relevant disclosures. The above subject-matter in fact is so obviously new that this can hardly be considered the invention for which protection is sought, nor does it become evident from the present claims what is actually supposed to be the invention, even when the description is taken into account. Thus, although the literal wording of the present claims might be clear, the claims in the relevant lack clarity in the sense of Artic cle 6 PCT. Moreover, in view of the very large number of highly relevant disclosures, it does not appear possible to determine "from scratch" for which subject-matter contained in the present application protect is might legibly be sought either, and again, the requirements of Artic cle 6 PCT cannot be considered to be met. In conclusion, a meaningful search over the entire scope of the present claims was not considered feasible, and the applicant upon request not having provided any further indication, the search has been limited to those multilayer films in which the outer layer additionally comprises from 0.1% by weight to 45% by weight of a propylene-based elastomer, as specified in present dependent (product-) claims 2.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international prelimary examination (Rule 66.1(e) PCT). The applicant is advised that the EP0 policy when acting as an International Preliminary Examination Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EP0, the applicant is reminded that a search may be carried
out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.
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<th>Patent document cited in search report</th>
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