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(54) Title: POLYMER COMPOSITIONS AND ARTICLES MADE THEREFROM

(57) Abstract: A polymer composition and articles made therefrom are provided. The composition comprises: (a) Component A having (i) at least 50 wt% ethylene moieties; and (ii) up to 50 wt% of a C₃ to C₂₀ comonomer moieties, a density of about 0.860 to about 0.965 g/cm³, a melt index of about 0.1 to about 10.0 g/10min and a branching index of about 0.96 to about 1.0; and (b) Component B having: (i) at least 65 wt% ethylene moieties; and (ii) up to 35 wt% of a C₃ to C₂₀ comonomer moieties, the wt% based upon total the total weight of Component B, a density of about 0.905 to about 0.945 g/cm³, a melt index (MI) of about 0.1 to about 10.0 g/10 min, and a branching index (g') of about 0.7 to about 0.95. Films made using the polymer composition exhibit excellent toughness and processability.



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POLYMER COMPOSITIONS AND ARTICLES MADE THEREFROM

FIELD OF THE INVENTION

5 [0001] The present invention relates to polymer compositions. More particularly, the invention relates to polymer compositions comprising a blend of linear low density polyethylenes.

BACKGROUND OF THE INVENTION

10 [0002] Blends of linear low density polyethylene (LLDPE), which can be prepared by either Ziegler-Natta catalyst or metallocene catalyst, and low density polyethylene (LDPE) are commonly used to form articles such as films, sheets, coatings, and laminates. The LLDPE provides good toughness (e.g., tear strength, dart impact and puncture resistance) and hot tack force, and the LDPE provides good processability (e.g., melt temperature, melt pressure and motor load). However, the LDPE can also disadvantageously cause a
15 significant loss of toughness and hot tack force.

[0003] That said, what is needed in the art is polymer compositions suitable for use in films, sheets, coatings, and laminates that provide improved toughness and hot tack force without compromising processability.

SUMMARY OF THE INVENTION

20 [0004] In one aspect, this disclosure relates to films comprising: (a) component A having at least about 50 wt% of ethylene moieties, up to about 50 wt% of C₃ to C₂₀ comonomer moieties, a density of about 0.860 to about 0.965 g/cm³, a melt index of about 0.1 to about 10.0 g/10min and a branching index of about 0.96 to about 1; and (b) component B having: at least 65 wt% ethylene moieties, up to 35 wt% of a C₃ to C₂₀ comonomer moieties, a density of
25 about 0.905 to about 0.945 g/cm³, a melt index of about 0.1 to about 10.0 g/10 min, and a branching index (g') of about 0.7 to about 0.95. Films made using the polymer composition exhibit excellent toughness and processability. In various embodiments, the compositions described herein are used to form articles such as films, sheets, coatings, and laminates.

[0005] In another aspect, this disclosure relates to films comprising a blend of about 75
30 wt% of component A and about 25 wt% of component B and thickness is greater than about 20 μm and one or more of: (a) an Elmendorf Tear of greater than about 20g in the machine direction; and (b) a dart impact of greater than about 50 g/μm; and (c) a puncture force at break of greater than about 30N; and (d) a hot tack peak force of greater than 5 N/30mm.

[0006] These and other features, aspects, and advantages of the present disclosure will
35 become better understood with regard to the following description and appended claims.

BRIEF DESCRIPTION OF THE FIGURES

[0007] Figures 1 and 2 provide an illustrative comparison of the hot tack properties of films formed using conventional blends and the novel blend described herein.

DETAILED DESCRIPTION OF THE INVENTION

5 [0008] Various specific embodiments, versions and examples of the invention will now be described, including preferred embodiments and definitions that are adopted herein for purposes of understanding the claimed invention. While the following detailed description gives specific embodiments, those skilled in the art will appreciate that these embodiments are exemplary only, and that the invention can be practiced in other ways. For purposes of
10 determining infringement, the scope of the invention will refer to any one or more of the appended claims, including their equivalents, and elements or limitations that are equivalent to those that are recited. Any reference to the "invention" may refer to one or more, but not necessarily all, of the inventions defined by the claims.

[0009] That said, polymer compositions comprising a blend of a first component
15 (Component A) and a second component (Component B) are described herein. These compositions may be used to form articles such as films, sheets, coatings, and laminates having excellent toughness and sealing without compromising processability.

Component A

[0010] In accordance with various exemplary embodiments, the compositions described
20 herein comprise from about 1 to about 99 wt% of Component A, or about 20 to about 90 wt% of Component A, or about 50 to about 85 wt%, or about 70 to about 80 wt%, or about 75 wt%, based upon total weight of the composition. Ranges from any lower limit to any upper limit are contemplated. In one embodiment, Component A comprises a LLDPE.

[0011] In various embodiments, Component A comprises at least about 1 wt% ethylene
25 moieties, or at least about 20 wt% ethylene moieties, or at least about 40 wt% ethylene moieties, or at least about 50 wt% of ethylene moieties, or at least about 60 wt% of ethylene moieties. The wt%s are based upon total weight of the copolymer.

[0012] In various embodiments, Component A is copolymer. As used herein, the term
30 "copolymer" includes polymers having more than two types of monomers, such as terpolymers. Component A may have up to about 99 wt% comonomer moieties, or up to about 90 wt% of comonomer moieties, or up to about 70 wt% of comonomer moieties, or up to about 50 wt% of comonomer moieties, or about 1 to about 35 wt% of comonomer moieties, or about 1 to about 20 wt% of comonomer moieties, the wt% based upon total weight of Component A.

[0013] In various embodiments, the comonomer comprises one or more α -olefins. Suitable α -olefins include, for example, C₃-C₂₀ α -olefins, or C₃-C₁₀ α -olefins, or C₃-C₈ α -olefins. The α -olefin comonomer may be linear or branched, and two or more comonomers may be used, if desired. Examples of suitable α -olefin comonomers include propylene, butene, 1-pentene; 1-pentene with one or more methyl, ethyl, or propyl substituents; 1-hexene; 1-hexene with one or more methyl, ethyl, or propyl substituents; 1-heptene; 1-heptene with one or more methyl, ethyl, or propyl substituents; 1-octene; 1-octene with one or more methyl, ethyl, or propyl substituents; 1-nonene; 1-nonene with one or more methyl, ethyl, or propyl substituents; ethyl, methyl, or dimethyl-substituted 1-decene; 1-dodecene; and styrene. Specifically, but without limitation, the combinations of ethylene with a comonomer may include: ethylene propylene, ethylene butene, ethylene 1-pentene; ethylene 4-methyl-1-pentene; ethylene 1-hexene; ethylene 1-octene; ethylene decene; ethylene dodecene; ethylene 1-hexene 1-pentene; ethylene 1-hexene 4-methyl-1-pentene; ethylene 1-hexene 1-octene; ethylene 1-hexene decene; ethylene 1-hexene dodecene; ethylene 1-octene 1-pentene; ethylene 1-octene 4-methyl-1-pentene; ethylene 1-octene 1-hexene; ethylene 1-octene decene; ethylene 1-octene dodecene; combinations thereof and like permutations. In one embodiment, the comonomer comprises one or more of vinyl acetate (VA), acrylic acid (AA), or methyl methacrylate (MA).

[0014] In various embodiments, Component A may have one or more of the following properties:

(a) a density (sample prepared according to ASTM D-4703, and the measurement according to ASTM D-1505) of about 0.860 to about 0.965 g/cm³, or about 0.905 to 0.940 g/cm³, or about 0.912 to about 0.935 g/cm³;

(b) a Melt Index ("MI", ASTM D-1238, 2.16 kg, 190°C) of about 0.1 to about 10.0 g/10min, or about 0.5 to about 5 g/10min, or about 1 to about 3.0 g/10min;

(c) a Melt Index Ratio ("MIR", I_{21.6}(190°C, 21.6 kg)/I_{2.16}(190°C, 2.16 kg)) of about 1 to about 40, or about 10 to about 30, or about 15 to about 20, or about 16 to about 18. In an exemplary embodiment, component A has a lower MIR than component B;

(d) a Composition Distribution Breadth Index ("CDBI") of up to about 85%, or up to about 75%, or about 5 to about 85%, or 10 to 75%. The CDBI may be determined using techniques for isolating individual fractions of a sample of the resin. The preferred technique is Temperature Rising Elution Fraction ("TREF"), as described in Wild, et al., J. Poly. Sci., Poly. Phys. Ed., Vol. 20, p. 441 (1982), which is incorporated herein for purposes of U.S. practice; and/or

(e) a branching index of about 0.9 to about 1.0, or about 0.96 to about 1.0, or about 0.97 to about 1.0. Branching Index is an indication of the amount of branching of the polymer and is defined as $g' = [Rg]_{br}^2/[Rg]_{lin}^2$. "Rg" stands for Radius of Gyration, and is measured using a Waters 150 gel permeation chromatograph equipped with a Multi-Angle Laser Light Scattering ("MALLS") detector, a viscosity detector and a differential refractive index detector. "[Rg]_{br}" is the Radius of Gyration for the branched polymer sample and "[Rg]_{lin}" is the Radius of Gyration for a linear polymer sample. It is well known in the art that as the g' value decreases, long-chain branching increases. By way of reference, low density polyethylene (LDPE) typically has a g' of about 0.2 to about 0.5, or about 0.3 to about 0.4. Moreover, Table 1 provides exemplary g' values of various commercially available LDPE and LLDPEs.

[0015] Component A is not limited by any particular method of preparation and may be formed using any process known in the art. For example, Component A may be formed using gas phase, solution, or slurry processes.

[0016] In one embodiment, Component A is formed in the presence of a Ziegler-Natta catalyst, such as those based upon titanium compounds (e.g., $TiCl_4$) and organometallic aluminium compounds. Useful Ziegler-Natta catalyzed polymers include those commercially available from ExxonMobil Chemical Company in Houston, Texas, such as those sold under the trade designation ExxonMobil™ LLDPE.

[0017] In another embodiment, Component A is formed in the presence of a single-site catalyst, such as a metallocene catalyst. For example, Component A may be a metallocene polyethylene (m-PE) produced using mono- or bis-cyclopentadienyl transition metal catalysts in combination with an activator of alumoxane and/or a non-coordinating anion in solution, slurry, high pressure or gas phase. The catalyst and activator may be supported or unsupported and the cyclopentadienyl rings may be substituted or unsubstituted. m-PEs useful as Component A include those commercially available from ExxonMobil Chemical Company in Houston, Texas, such as those sold under the trade designation EXCEED™ and EXACT™.

Component B

[0018] In accordance with various exemplary embodiments, the compositions described herein comprise from about 99 to about 1 wt% of Component B, or about 10 to about 80 wt%, or about 15 to about 50 wt%, or about 10 to about 30 wt%, or about 25 wt%, based upon total weight of the composition. Ranges from any lower limit to any upper limit are contemplated.

[0019] Component B may comprise at least 1 wt% ethylene moieties, or at least 30 wt% ethylene moieties, or at least 50 wt% of ethylene moieties, or at least 65 wt% ethylene moieties, or at least 75 wt% ethylene moieties. The wt%s based upon total weight of the copolymer. In one embodiment, Component B is a LLDPE.

5 [0020] In various embodiments, Component B is a copolymer comprising up to about 99 wt% comonomer moieties, or up to about 50 wt% of comonomer moieties, or up to about 70 wt% of comonomer moieties, about 1 to about 35 wt% comonomer moieties, or about 1 to about 20 wt% of comonomer moieties, or about 1 to about 10 wt% comonomer moieties (the comonomer being any of those described herein) and the wt%s based upon total weight of
10 Component B.

[0021] In various embodiments, Component B may have one or more of the following properties:

(a) a density (sample prepared according to ASTM D-4703, and the measurement according to ASTM D-1505) of about 0.905 to about 0.945 g/cm³, or about 0.915 to about
15 0.940 g/cm³;

(b) a Melt Index ("MI", ASTM D-1238, 2.16 kg, 190°C) of about 0.1 to about 10.0g/10min, or 0.5 to about 5.0 g/10min, or about 1 to about 3.0 g/10min;

(c) a Melt Strength of greater than about 2.0 cN, or greater than about 4.0 cN.

Melt Strength was determined using the Rheotens 71-97 in combination with the Rheograph
20 2002 as described: (1) Rheograph 2002 has: temperatures of 190°C and 230°C, die: 30/2, piston speed: 0.178 mm/s, shear rate: 40.050 sec⁻¹, wheels: grooved; (2) Strand: length: 100 mm, V₀: 10 mm/s; and (3) Rheotens: gap: 0.7 mm, acceleration: 12.0 mm/s². For each material, several measurements were performed. The complete amount of material present in the barrel of the Rheograph is extruded through the die and is being picked up by the rolls of
25 the Rheotens. Once the strand is placed between the rolls, the roll speed is adjusted till a force 0 is measured once the strand touches the ground. This beginning speed V_s is the speed of the strand through the nip of the wheels at the start of the test. Once the test is started, the speed of the rolls is increased with a 12.0 mm/s² acceleration and the force is measured for each given speed. After each strand break, or strand slip between the rotors, the measurement is
30 stopped and the material is placed back between the rolls for a new measurement, which is started when the strand again touches the ground. A new curve is recorded. Measuring continues until all material in the barrel is used. After testing, all the obtained curves are saved. Curves, which are out of line, are deactivated. The remaining curves, are cut at the

same point at break or slip (maximum force measured), and are used for the calculation of a mean curve. The numerical data of this calculated mean curves are reported;

(d) a relation between Melt Index in g/10 min and Melt Strength in cN according to the formula:

5
$$MS = -2.6204 * MI + 7.5686;$$

(e) a Melt Index Ratio ("MIR", $I_{21.6}(190^{\circ}\text{C}, 21.6 \text{ kg})/I_{2.16}(190^{\circ}\text{C}, 2.16 \text{ kg})$) of about 20 to about 100, or about 25 to about 95, or greater than 30 to about 90, or greater than about 35 to about 80. In one embodiment, the MIR can be determined according to the following formula:

10
$$\ln(\text{MIR}) = -18.20 - 0.2634 \ln(\text{MI}, I_{2.16}) + 23.58 \times [\text{density}, \text{g/cm}^3];$$

(f) a Composition Distribution Breadth Index ("CDBI", determined according to the procedure disclosed herein) of greater than about 50%, or greater than about 60%, or greater than 75%, or greater than 85%;

(g) a molecular weight distribution ("MWD") of about 2.0 to about 5.5; MWD is measured using a gel permeation chromatograph ("GPC") equipped with a differential refractive index ("DRI") detector; and/or

(h) a branching index ("g'"), (determined according to the procedure described herein) of about 0.5 to about 0.97, or about 0.7 to about 0.95.

[0022] Component B is not limited by any particular method of preparation and may be formed using any process known in the art. For example, Component B may be formed using gas phase, solution, or slurry processes.

[0023] In one embodiment, Component B is formed in the presence of a Ziegler-Natta catalyst. In another embodiment, Component B is formed in the presence of a single-site catalyst, such as a metallocene catalyst (such as any of those described herein). Polymers useful as Component B in this invention include those disclosed in U.S. Patent No. 6,255,426, entitled "Easy Processing Linear Low Density Polyethylene" (Lue), which is hereby incorporated by reference for this purpose, and include those commercially available from ExxonMobil Chemical Company in Houston, Texas, such as those sold under the trade designation ENABLE™.

30 **Additional Components**

[0024] In various embodiments, one or more additional polymers and/or additives may be included in the composition, in one or more components of the composition, and/or in an article formed from the composition, such as a films, sheets, coatings, or laminates.

[0025] Additional polymers include, for example, one or more: additional LLDPEs, LDPEs, high density polyethylenes (HDPEs), copolymers of vinyl acetate, methyl acetate, butyl acetate, acrylic acids, and/or ionomers, and terpolymers (such as those commercially available from ExxonMobil Chemical Company in Houston, Texas under the trade designation Exact™ plastomer, Escorene™ Ultra ethylene vinyl acetate (EVA), Optema™ ethylene methyl acrylate (EMA), ExxonMobil™ ethylene n-butyl acrylate (EnBA), Escor™ ethylene acrylic acid (EAA), and Iotek™ ionomer), polypropylene and propylene-based elastomers (such as those commercially available from ExxonMobil Chemical Company in Houston, Texas under the trade designation Vistamaxx™).

[0026] Additives include, for example, fillers, primary and secondary antioxidants (e.g., hindered phenolics such as IRGANOX™ 1010 or IRGANOX™ 1076 commercially available from Ciba-Geigy), anti-cling additives, ultraviolet stabilizers, heat stabilizers, plasticizers, anti-blocking agents, release agents, anti-static agents, pigments, colorants, dyes, waxes, silica, fillers, talc, processing aids, and the like.

Articles

[0027] The polymer compositions described herein may be used to form a variety of articles. For example, the compositions can be used to make films, sheets, coatings, and/or laminates. The laminates may be used in combination with a variety of substrates (e.g., paper, board, fabric, aluminum foil, polypropylene films, polyethylene terephthalate (PET) films, polyacetylene (PA) films). Such articles may be produced by any method known or hereinafter devised, e.g., extrusion, coextrusion, and lamination processes.

Formation

[0028] The compositions and articles described herein are not limited by any particular method of preparation, and may be formed using conventional or hereinafter devised equipment and methods.

[0029] In one embodiment, the composition is in-line blended in a film extruder. The composition may be subjected to single layer extrusion or multi-layer extrusion on a distinct layer or in several layers with the same or different blending ratios or polymer types. Film extrusion can be a blown film process or cast film process and may be conducted without additional mixing or hot blending. Additionally, the individual components may be dry compositioned and subsequently melt-mixing in a mixer, or by mixing the components directly together in a mixer (e.g., a Banbury mixer, a Haake mixer, a Brabender mixer, and/or dry mixer), or a single or twin-screw extruder, which may include a compounding extruder

and/or a side-arm extruder used directly downstream of a polymerization process or on-line blending at the converter operation.

[0030] The films may be single layer or multilayer. The blending ratios of Component A to Component B in one or more layers may be the same or different.

5 **Film Properties**

[0031] In accordance with various embodiments, the films formed using the polymer compositions disclosed herein may be any thickness according to the desired properties of the film. For example, the film thickness may be about 1 to about 1000 μm .

10 [0032] In various embodiments, a film having a thickness of about 20 μm or greater comprising a blend of Component A and Component B having a blend ratio of 75:25 (in wt%) and one or more of the following properties (determined by the procedures described herein):

(a) an Elmendorf Tear of greater than about 10g, or greater than about 20g in the machine direction;

(b) a dart impact of greater than about 30 g/ μm , or greater than about 50 g/ μm ;

15 (c) a puncture force at break of greater than about 15N, or greater than about 30N; and

(d) a hot tack peak force of greater than about 2N/30 mm, or greater than about 5N/30mm.

Examples

20 [0033] The advantages of the films described herein will now be further illustrated with reference to the following non-limiting examples.

Properties and Materials

The properties used in the claims and the Examples are determined as follows:

Melt Index (MI) and Melt Flow Rate (MFR) were determined per ASTM D-1238;

25 Density was determined per ASTM D-47-03 and ASTM1505;

Elmendorf Tear was determined per ASTM D-1922;

Dart Impact Strength was determined per ASTM D-1709;

Puncture Force at Break was determined per ASTM D-3763;

Hot Tack Peak Force was determines per ASTM F-1921; and

30 Melt Temperature and Melt Pressure were measured after screen pack.

[0034] Table 1 provides a listing of materials used in the films of Examples.

TABLE 1

Resins Used in Examples		
Component	Brief Description	Commercial Source
ExxonMobil™ LL 1001XV	Ethylene-butene copolymer, MI = 1.0 g/10 min, density = 0.918 g/cm ³ , Ziegler-Natta-catalyzed, UNIPOL™ process	ExxonMobil Chemical Company
ExxonMobil™ LD 150BW	MI = 0.75 g/10 min, density = 0.923 g/cm ³ , LDPE, High Pressure Tubular process	ExxonMobil Chemical Company
EXCEED™ 1018 CA (m-PE)	Ethylene-hexene copolymer, MI = 1.0 g/10 min, density = 0.918 g/cm ³ , metallocene-catalyzed, UNIPOL™ process	ExxonMobil Chemical Company
EXCEED™ 2018 CA (m-PE)	Ethylene-hexene copolymer, MI = 2.0 g/10 min, density = 0.918 g/cm ³ , metallocene-catalyzed, UNIPOL™ process	ExxonMobil Chemical Company
ENABLE™ 20-10CH (m-PE)	Ethylene-hexene copolymer, MI = 1.0 g/10 min, density = 0.920 g/cm ³ , metallocene-catalyzed, UNIPOL™ process	ExxonMobil Chemical Company
ENABLE™ 20-05CH (m-PE)	Ethylene-hexene copolymer, MI = 0.5 g/10 min, density = 0.920 g/cm ³ , metallocene-catalyzed, UNIPOL™ process	ExxonMobil Chemical Company
ENABLE™ 23-05CH (m-PE)	Ethylene-hexene copolymer, MI = 0.5 g/10 min, density = 0.923 g/cm ³ , metallocene-catalyzed, UNIPOL™ process	ExxonMobil Chemical Company
ENABLE™ 27-05CH (m-PE)	Ethylene-hexene copolymer, MI = 0.5 g/10 min, density = 0.927 g/cm ³ , metallocene-catalyzed, UNIPOL™ process	ExxonMobil Chemical Company
ENABLE™ 35-05CH (m-PE)	Ethylene-hexene copolymer, MI = 0.5 g/10 min, density = 0.935 g/cm ³ , metallocene-catalyzed, UNIPOL™ process	ExxonMobil Chemical Company
ExxonMobil™ HTA108	Ethylene homopolymer, MI = 0.7 g/10 min, density = 0.961 g/cm ³ , Ziegler-Natta-catalyzed, UNIPOL™ process	ExxonMobil Chemical Company
Z-N C8LLDPE	Ethylene-octene copolymer, MI = 1.0 g/10 min, density = 0.920 g/cm ³ , Ziegler-Natta-catalyzed, solution process	Supplier 1

[0035] As used herein, "UNIPOL™ process" refers to a polymerization process owned Univation Technologies, a joint venture between ExxonMobil Chemical Company and Dow Chemical Company for manufacturing olefin-based polymers such as polyethylene (PE).

- 5 [0036] The films of Examples 1-3 were made on an Alpine™ mono-layer blown film line with screw size: 75 mm, screw length: 25/1 L/D, die diameter: 200 mm, die gap: 1.5 mm, Blow Up Ratio (BUR): 2.5, throughput: 120 kg/hr.

[0037] The wt% ratios of Examples 1-5 are based upon total weight of the compositions.

Example 1

- 10 [0038] Tables 3-5 illustrate various properties of single-layer films formed using: (1) conventional LLDPE /LDPE blends; and (2) inventive blends of Component A and Component B. As shown, the inventive blends provide a combination of better Elmendorf

Tear, Dart Impact, Puncture and comparable processability. The film extrusion machine temperature settings are shown in Table 2. The length of each Zone is equal to the length of the component (barrel, adaptor, and die) divided by the number of zones in the component.

Table 2

	Zone	°C
Barrel	1	180
	2	180
	3	185
	4	190
Adaptor	6	190
	7	190
	8	190
	9	190
	10	190
Die	11	200
	12	200

5

TABLE 3 - Thin Gauge Film

	Blend 1	Blend 2	Blend 3	Blend 4
Film Thickness (μm)	25	20	20	20
Elmendorf Tear (g, MD/TD)	20/407.5	28/546	34/498	38/590
Dart Impact (g/μm)	69	82	130	82
Puncture (N)	67.5	70	78	66
Melt Temperature (°C)	225	223	219	215
Melt Pressure (Bar)	494	530	540	530
Motor Load (A)	118	130	137	135

Legend for Table 3

Blend 1	LL1001XV / LD150BW blend (75:25 wt% ratio)
Blend 2	LL1001XV / ENABLE™ 23-05CH blend (75:25 wt% ratio)
Blend 3	LL1001XV / ENABLE™ 23-05CH blend (25:75 wt% ratio)
Blend 4	LL1001XV / ENABLE™ 27-05CH blend (50:50 wt% ratio)

TABLE 4 – Medium Gauge Film		
	Blend 1	Blend 2
Film Thickness (μm)	50	40
Elmendorf Tear (g, MD/TD)	55/585	104/856
Dart Impact (g/ μm)	189	216
Puncture (N)	110	120
Melt Temperature ($^{\circ}\text{C}$)	225	212
Melt Pressure (Bar)	494	525
Motor Load (A)	118	136

Legend for Table 4	
Blend 1	LL1001XV TM / LD150BW TM blend (75:25 wt% ratio)
Blend 2	LL1001XV TM / ENABLE TM 27-05CH blend (25:75 wt% ratio)

TABLE 5 - Thick Gauge Film				
	Blend 1	Blend 2	Blend 3	Blend 4
Film Thickness (μm)	100	80	80	80
Elmendorf Tear (g, MD/TD)	290/960	480/1176	376/1176	464/1048
Dart Impact (g/ μm)	384	496	384	360
Puncture (N)	190	216	192	192
Melt Temperature ($^{\circ}\text{C}$)	225	223	215	224
Melt Pressure (Bar)	496	517	530	519
Motor Load (A)	119	131	135	129

Legend for Table 5	
Blend 1	LL1001XV TM / LD150BW TM blend (75:25 wt% ratio)
Blend 2	LL1001XV TM / ENABLE TM 20-05CH blend (50:50 wt% ratio)
Blend 3	LL1001XV TM / ENABLE TM 27-05CH blend (50:50 wt% ratio)
Blend 4	LL1001XV TM / ENABLE TM 23-05CH blend (75:25 wt% ratio)

5

Example 2

[0039] Tables 7-9 illustrate various properties of single-layer films formed using: (1) conventional LLDPE /LDPE blends; and (2) blends of Component A and Component B. As

shown, the inventive blends provide a combination of better Elmendorf Tear, Dart Impact, Puncture, and excellent processability. The film extrusion machine temperature settings are shown in Table 6. The length of each Zone is equal to the length of the component (barrel, adaptor, and die) divided by the number of zones in the component.

Table 6		
	Zone	°C
Barrel	1	180
	2	180
	3	180
	4	185
Adaptor	6	185
	7	185
	8	185
	9	190
Die	10	190
	11	190
	12	190

5

TABLE 7 - Thin Gauge Film					
	Blend 1	Blend 2	Blend 3	Blend 4	Blend 5
Film Thickness (μm)	25	20	20	20	20
Elmendorf Tear (g, MD/TD)	32.5/555	58/386	62/482	114/500	82/494
Dart Impact (g/μm)	196	696	218	265	142
Puncture (N)	37.5	104	86	94	74
Melt Temperature (°C)	236	238	223	233	214
Melt Pressure (Bar)	605	571	576	590	603
Motor Load (A)	142	144	145	148	150

Legend for Table 7	
Blend 1	EXCEED™ 1018CA / LD150BW blend (75:25 wt% ratio)
Blend 2	EXCEED™ 1018CA / ENABLE™ 23-05CH blend (75:25 wt% ratio)
Blend 3	EXCEED™ 1018CA / ENABLE™ 23-05CH blend (25:75 wt% ratio)
Blend 4	EXCEED™ 1018CA / ENABLE™ 27-05CH blend (75:25 wt% ratio)
Blend 5	EXCEED™ 1018CA / ENABLE™ 27-05CH blend (25:75 wt% ratio)

TABLE 8 – Medium Gauge Film				
	Blend 1	Blend 2	Blend 3	Blend 4
Film Thickness (μm)	50	40	40	40
Elmendorf Tear (g, MD/TD)	235/1685	308/732	332/732	312/820
Dart Impact (g/μm)	360	1282	1005	764
Puncture (N)	190	176	160	168
Melt Temperature (°C)	231	235	238	233
Melt Pressure (Bar)	656	585	569	587
Motor Load (A)	144	145	143	147

Legend for Table 8	
Blend 1	EXCEED™ 1018CA / LD150BW™ blend (75:25 wt% ratio)
Blend 2	EXCEED™ 1018CA / ENABLE™ 20-05CH blend (75:25 wt% ratio)
Blend 3	EXCEED™ 1018CA / ENABLE™ 23-05CH blend (75:25 wt% ratio)
Blend 4	EXCEED™ 1018CA / ENABLE™ 27-05CH blend (75:25 wt% ratio)

TABLE 9 - Thick Gauge Film			
	Blend 1	Blend 2	Blend 3
Film Thickness (μm)	100	80	80
Elmendorf Tear (g, MD/TD)	680/3120	688/1368	752/1400
Dart Impact (g/μm)	773	1823	1631
Puncture (N)	330	304	280
Melt Temperature (°C)	236	236	238
Melt Pressure (Bar)	607	607	574
Motor Load (A)	142	150	143

5

Legend for Table 9	
Blend 1	EXCEED™ 1018CA / LD150BW™ blend (75:25 wt% ratio)
Blend 2	EXCEED™ 1018CA / ENABLE™ 20-05CH blend (75:25 wt% ratio)
Blend 3	EXCEED™ 1018CA / ENABLE™ 23-05CH blend (75:25 wt% ratio)

Example 3

[0040] Tables 11-13 illustrate various properties of single-layer films formed using: (1) conventional LLDPE /LDPE blends; and (2) blends of Component A and Component B. As shown, the inventive blends provide a combination of better Elmendorf Tear, Dart Impact, and similar excellent processability.

[0041] Figures 1 and 2 illustrate hot tack peak force of single layer films formed using: (1) conventional LLDPE /LDPE blends; and (2) blends of Component A and Component B. Blend 1 of Fig. 1 and 2 illustrate conventional LLDPE /LDPE blends. Blend 2 illustrates the inventive LLDPE (Component A)/LLDPE (Component B) blends disclosed herein. As shown, the inventive blends provide a higher hot tack peak force. The film extrusion machine temperature settings are shown in Table 10. The length of each Zone is equal to the length of the component (barrel, adaptor, and die) divided by the number of zones in the component.

Table 10		
	Zone	°C
Barrel	1	180
	2	180
	3	180
	4	185
Adaptor	6	185
	7	185
	8	185
	9	190
Die	10	190
	11	190
	12	190

15

Table 11		
	Blend 1	Blend 2
Film Thickness (μm)	20	20
Elmendorf Tear (g, MD/TD)	30/610	184/444
Dart Impact (g/μm)	159	928
Melt Temperature (°C)	222	227
Melt Pressure (Bar)	470	461
Motor Load (A)	123	125

Legend for Table 11 and Fig. 1	
Blend 1	EXCEED™ 2018CA / LD150BW™ blend (75:25 wt% ratio)
Blend 2	EXCEED™ 2018CA / ENABLE™ 20-05CH blend (75:25 wt% ratio)

Table 12					
	Blend 1	Blend 2	Blend 3	Blend 4	Blend 5
Film Thickness (μm)	50	50	50	50	50
Elmendorf Tear (g, MD/TD)	193/1577	521/928	618/1071	554/1068	473/1134
Dart Impact (g/μm)	327	1043	658	478	490
Melt Temperature (°C)	222	227	227	228	220
Melt Pressure (Bar)	470	461	456	450	479
Motor Load (A)	123	125	124	123	127

Legend for Table 12 and Fig. 2	
Blend 1	EXCEED™ 2018CA / LD150BW blend (75:25 wt% ratio)
Blend 2	EXCEED™ 2018CA / ENABLE™ 20-05CH blend (75:25 wt% ratio)
Blend 3	EXCEED™ 2018CA / ENABLE™ 27-05CH blend (75:25 wt% ratio)
Blend 4	EXCEED™ 2018CA / ENABLE™ 35-05CH blend (75:25 wt% ratio)
Blend 5	EXCEED™ 2018CA / ENABLE™ 20-05CH / HTA108 blend (70:20:10 wt% ratio)

Table 13		
	Blend 1	Blend 2
Film Thickness (μm)	100	100
Elmendorf Tear (g, MD/TD)	841/1883	1206/1827
Dart Impact (g/μm)	823	1662
Melt Temperature ($^{\circ}\text{C}$)	222	227
Melt Pressure (Bar)	470	461
Motor Load (A)	123	125

Legend for Table 13	
Blend 1	EXCEED™ 2018CA / LD150BW blend (75:25 wt% ratio)
Blend 2	EXCEED™ 2018CA / ENABLE™ 20-05CH blend (75:25 wt% ratio)

Example 4

5 [0042] Tables 15 illustrate various properties of single-layer films formed using: (1) conventional LLDPE /LDPE blends; and (2) a blend of Component A and Component B. As shown, the inventive blends provide a combination of better Elmendorf Tear, Dart Impact, and Puncture and comparable processability. The film extrusion machine temperature settings are shown in Table 14.

10 [0043] The films of Example 4 were made on an mono-layer blown film line made by China Guangdong Jinming Plastics Equipment Co., Ltd. with screw size: 65 mm, screw length: 30/1 L/D, die diameter: 250 mm, die gap: 1.8 mm, Blow Up Ratio (BUR): 2.5. The length of each Zone is equal to the length of the component (barrel, screen, and die) divided by the number of zones in the component.

15

Table 14		
	Zone	$^{\circ}\text{C}$
Barrel	1	165
	2	205
	3	185
	4	175
Screen	5	175
Die	6	185
	7	190
	8	200

Table 15						
	Blend 1	Blend 2	Blend 3	Blend 4	Blend 5	Blend 6
Film Thickness (μm)	50	50	50	50	50	50
Elmendorf Tear (g, MD/TD)	122/612	92/403	372/668	362/724	551/841	444/776
Dart Impact (g/μm)	173	142	316	561	1138	1122
Puncture (N)	105	90	133	150	170	185
Melt Temperature ($^{\circ}\text{C}$)	200	192	200	197	187	197
Melt Pressure (MPa)	42	36	41	39	35	35
Throughput (kg/h)	120	120	84	90	84	84

Legend for Table 15	
Blend 1	LL1001XV / LD150BW blend (60:40 wt% ratio)
Blend 2	LL1001XV / LD150BW blend (40:60 wt% ratio)
Blend 3	LL1001XV / ENABLE™ 20-05CH blend (60:40 wt% ratio)
Blend 4	LL1001XV / ENABLE™ 20-05CH blend (40:60 wt% ratio)
Blend 5	EXCEED™ 2018CA / ENABLE™ 20-05CH blend (60:40 wt% ratio)
Blend 6	EXCEED™ 2018CA / ENABLE™ 20-05CH blend (60:40 wt% ratio)

5 **Example 5**

[0044] Tables 17 illustrate various properties of single-layer films formed: (1) using conventional LLDPE (Component A)/LDPE blends; and (2) using a blend of Component A and Component B. Column 1 & 2 of Tables 17 illustrate conventional LLDPE(Component A)/LDPE blends. The remaining columns illustrate the inventive LLDPE (Component A)/LLDPE (Component B) blends disclosed herein. As shown, the inventive blends provide a combination of better Elmendorf Tear, Dart Impact, and comparable processability. The film extrusion machine temperature settings are shown in Table 16.

[0045] The films of Example 5 were made on an mono-layer blown film line made by China Guangdong Jinming Plastics Equipment Co., Ltd. with screw size: 65 mm, screw length: 30/1 L/D, die diameter: 250 mm, die gap: 1.8 mm, Blow Up Ratio (BUR): 2.5, throughput: 100 kg/hr. The length of each Zone is equal to the length of the component (barrel, screen, and die) divided by the number of zones in the component.

Table 16		
	Zone	°C
Barrel	1	195
	2	225
	3	190
	4	170
Screen	5	195
Die	6	200
	7	210
	8	215

Table 17						
	Blend 1	Blend 2	Blend 3	Blend 4	Blend 5	Blend 6
Film Thickness (μm)	25	25	25	25	25	25
Elmendorf Tear (g, MD/TD)	65/400	63/540	228/458	278/450	185/445	190/428
Dart Impact (g/μm)	115	145	640	1450	1250	160
Melt Temperature (°C)	195	196	196	198	195	192
Motor Power Consumption (KW)	51	56	55	66	65	57

Legend for Table 17	
Blend 1	LL1001XV / Z-N C8LLDPE / LD150BW blend (34:33:33 wt% ratio)
Blend 2	LL1001XV / EXCEED™ 2018CA / LD150BW blend (34:33:33 wt% ratio)
Blend 3	EXCEED™ 1018CA / ENABLE™ 20-10CH blend (25:75 wt% ratio)
Blend 4	EXCEED™ 1018CA / ENABLE™ 20-10CH blend (75:25 wt% ratio)
Blend 5	EXCEED™ 1018CA / ENABLE™ 20-05CH blend (25:75 wt% ratio)
Blend 6	LL1001XV / ENABLE™ 20-10CH blend (50:50 wt% ratio)

- 5 [0046] The embodiments and tables set forth herein are presented to best explain the present invention and its practical application and to thereby enable those skilled in the art to make and use the invention. However, those skilled in the art will recognize that the foregoing descriptions and tables have been presented for the purpose of illustration and example only. The description as set forth is not intended to be exhaustive or to limit the

invention to the precise form disclosed. Many modifications and variations are possible in light of the teaching herein without departing from the spirit and scope of the claims.

CLAIMS

We claim:

1. A polymer composition comprising:
 - (a) component A having: at least 50 wt% ethylene moieties and up to 50 wt%
5 C₃ to C₂₀ comonomer moieties, the wt %s based upon the total weight of component A, and:
 - i) a density of about 0.86 to about 0.965 g/cm³;
 - ii) a melt index (MI) of about 0.1 to about 10.0 g/10 min;
 - iii) a branching index (g') of about 0.96 to about 1.0; and
 - 10 (b) component B having at least 65 wt% ethylene moieties and up to 35 wt% C₃ to C₂₀ comonomer moities, the wt%s based upon the total weight of component B, and:
 - i) a density of about 0.905 to about 0.945 g/cm³;
 - ii) a melt index (MI) of about 0.1 to about 10.0 g/10 min; and
 - 15 iii) a branching index (g') of about 0.7 to about 0.95.
2. The polymer composition of claim 1, wherein component A has a composition distribution breadth index of 10% to 75%.
3. The polymer composition of claim 1 or 2, wherein component B has a composition distribution breadth index of greater than 75%.
- 20 4. The polymer composition of any of the preceding claims, wherein component A is formed in the presence of a Ziegler-Natta catalyst.
5. The polymer composition of any one of claims 1, 2 and 3, wherein component A is formed in the presence of a metallocene catalyst.
6. The polymer composition of any of the preceding claims, wherein the comonomer
25 moieties in Component A comprise one or more of butene, hexene and octene.
7. The polymer composition of any of the preceding claims, wherein the comonomer moieties in Component B comprise one or more of butene, hexene and octene.
8. The polymer composition of any of the preceding claims, wherein component B is formed in the presence of a metallocene catalyst.
- 30 9. The polymer composition of any of the preceding claims, wherein the C₃ to C₂₀ comonomer moieties in Component A is present in an amount of about 1.0 to about 20.0 wt%, based upon total weight of Component A.

10. The polymer composition of any of the preceding claims, wherein the C₃ to C₂₀ comonomer moieties in Component B is present in an amount of about 1.0 to about 20.0 wt%, based upon total weight of Component B.

11. The polymer composition of any of the preceding claims, wherein Component A has a
5 density of about 0.905 to about 0.940 g/cm³.

12. The polymer composition of any of the preceding claims, wherein Component B has a density of about 0.915 to about 0.940 g/cm³.

13. The polymer composition of any of the preceding claims, wherein the polymer composition comprises 1-99 wt% of Component A and 99-1 wt% of Component B, based
10 upon total weight of the polymer composition.

14. The polymer composition of any of the preceding claims, wherein Component A has a Melt Index Ratio of 10 to 30, and Component B has a Melt Index Ratio of greater than 30 to 100.

15. The polymer composition of any of the preceding claims, wherein the polymer composition further comprises at least one of: an additional linear low density polyethylene, a low density polyethylene, a high density polyethylene, a copolymer of vinyl acetate, a methyl acetate, a butyl acetate, an acrylic acid, an ionomer and a terpolymer.

16. An article comprising the polymer composition of any of the preceding claims, wherein the article is one of a sheet, a coating and a laminate.

20 17. An article comprising the polymer composition of any of the previous claims, wherein the article is a film.

18. The article of claim 17, wherein the film is prepared by one of a blown film process and a cast film process.

19. The film of claim 17 or claim 18, wherein the film has one or more layers and each
25 layer has the same blending ratio of Component A to Component B.

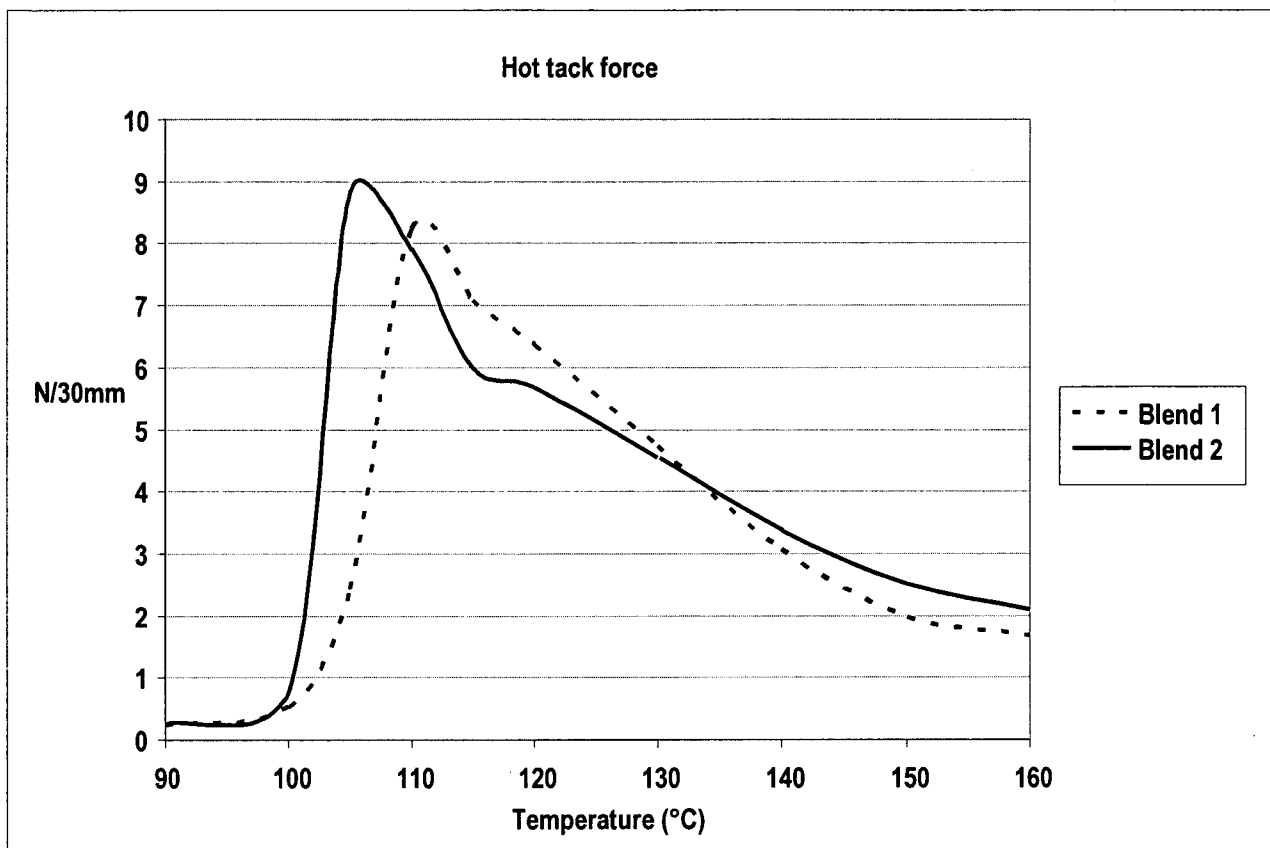
20. The film of claim 17 or claim 18, wherein the film has one or more layers and each layer has a different blending ratio of Component A to Component B.

21. A film having a thickness of greater than about 20μm, the film comprising a polymer composition having:

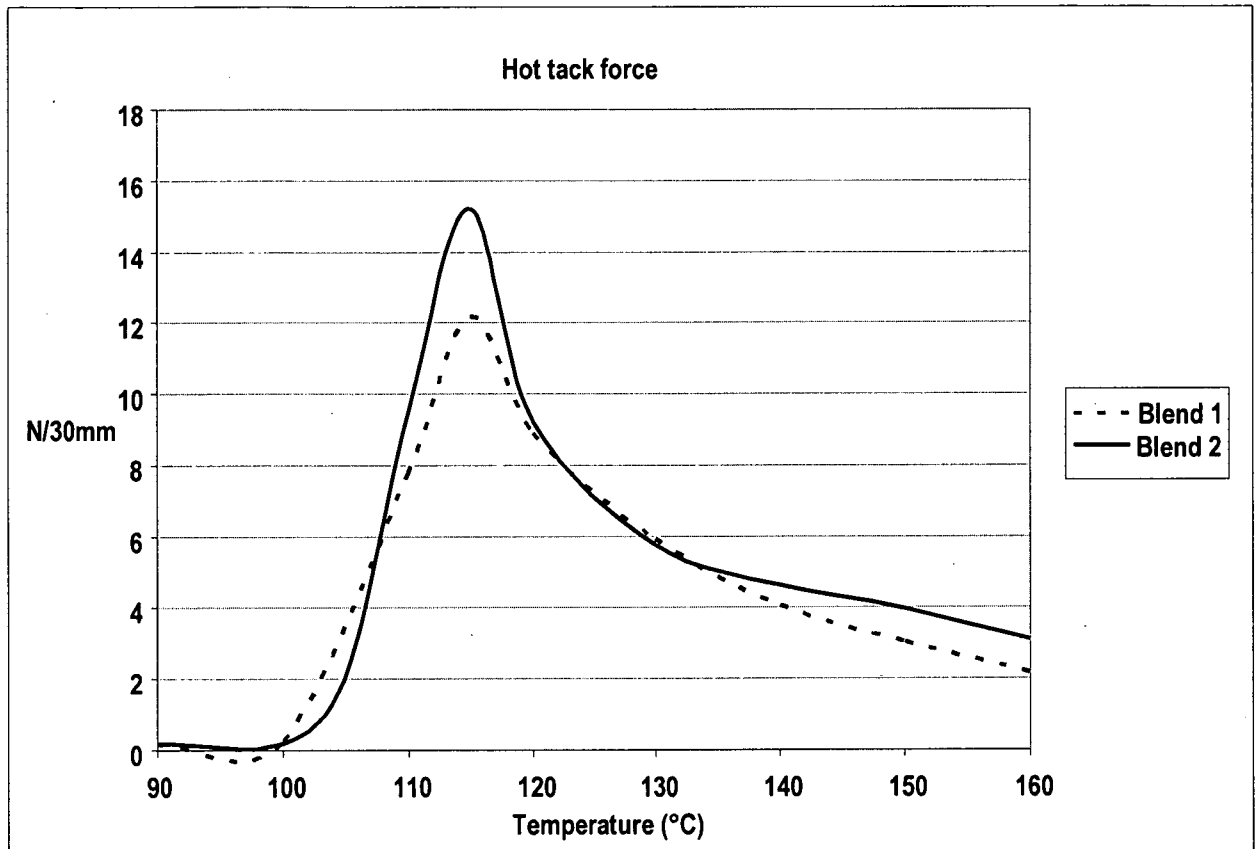
30 (a) about 75 wt% of Component A based upon the total weight of the polymer composition, Component A having at least 50 wt% ethylene moieties and up to 50 wt% C₃ to C₂₀ comonomer moieties based upon the total weight of Component A, and:

i) a density of about 0.86 to about 0.965 g/cm³;

- ii) a melt index (MI) of about 0.1 to about 10.0 g/10 min; and
 - iii) a branching index (g') of about 0.96 to about 1.0; and
- (b) about 25 wt% of Component B, the wt% based upon total weight of the polymer composition, Component B having at least 65 wt% ethylene moieties and up to 35 wt% C₃ to C₂₀ comonomer moieties, the wt%s based upon the total weight of Component B, and:
- i) a density of about 0.905 to about 0.945 g/cm³;
 - ii) a melt index (MI) of about 0.1 to about 10.0 g/10 min; and
 - iii) a branching index (g') of about 0.7 to about 0.95.
22. The film of claim 21, wherein the film has an Elmendorf Tear of greater than about 20g in the machine direction.
23. The film of claim 21 or claim 22, wherein the film has a dart impact of greater than about 50 g/μm.
24. The film of any one of claims 21-23, wherein the film has a puncture force at break of greater than about 30N.
25. The film of any one of claims 21-24, wherein the film has a hot tack peak force of greater than about 5N/30mm.

1/2**Figure 1**

2/2

**Figure 2**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2010/000287

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: C08F10/-,C08F110/-,C08F210/-,C08L23/-

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)

CNPAT,CNKI,WPI,EPODOC, ETHYLENE,PE,POLYETHYLENE,POLYOLEFIN?,OLEFIN?, MELT W INDEX,MI, BRANCHING W INDEX,BRANCH+,DENSITY

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US6870010 B1 (UNIVATION TECHNOLOGIES LLC) 22 Mar. 2005 (22.03.2005) Example 2	1-25
A	US4460750 A (BP CHIM S.A.) 17Jul.1984 (17.07.1984) Table I	1-25

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

☒ See patent family annex.

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

Date of the actual completion of the international search 26 Nov. 2010 (26.11.2010)	Date of mailing of the international search report 16 Dec. 2010 (16.12.2010)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer SHOU,Jianhong Telephone No. (86-10)62084481

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2010/000287

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2010/000287

Continuation of second sheet

A. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC)

C08L23/04 (2006.01) i

C08L23/06 (2006.01) i