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(54) Title: A POLYMERIC BLEND COMPOSITION

(57) **Abstract:** The instant invention provides a polymeric blend composition, injection molded articles, films and sheets made therefrom. The polymeric blend composition according to the present invention comprises: (a) a first component selected from the group consisting of an ethylene/alpha-olefin copolymer and a propylene/ethylene copolymer; wherein said ethylene/alpha-olefin co-polymer has density in the range of from 0.857 to 0.902 g/cm<sup>3</sup>, a melt index (I<sub>2</sub>) in the range of from 0.5 to 30 g/10 minutes, a DCS melting point temperature (second heat) in the range of from 40 to 99°C, a heat of fusion in the range of from 18 to 108 Jg<sup>-1</sup>, and a crystallinity in the range of from 6 to 37 weight percent; and wherein propylene/ethylene copolymer has a melt flow rate in the range of from 1 to 30 g/10 minutes, a DCS melting point temperature (second heat) in the range of from 55 to 85°C, a heat of fusion in the range of from 10 to 40 Jg<sup>-1</sup>, and a crystallinity in the range of from 6 to 21 weight percent; and (b) less than 40 percent by weight of a second component comprising an ethylene vinyl acetate copolymer comprising from 9 to 40 percent by weight of units derived from vinyl acetate, and wherein said ethylene vinyl acetate copolymer has a melt index (I<sub>2</sub>) in the range of from 0.2 to 20 g/10 minutes; wherein Δ<sub>n</sub> is less than 0.003, and wherein Δ<sub>n</sub> is the absolute value of the difference between the refractive index of (a) and (b); and wherein dielectric loss factor of the polymeric blend composition is greater than 0.024, for example in the range of greater than 0.024 to 0.15.

## A POLYMERIC BLEND COMPOSITION

Field of Invention

The instant invention relates to a polymeric blend composition, injection molded articles, 5 films and sheets made therefrom.

Background of the Invention

The use of polyethylene and/or polypropylene based materials in injection molded applications as well as film and/or sheet applications are generally known. However, currently 10 commercially available polyethylene and/or polypropylene based materials fail to meet the required clarity while having acceptable radio frequency weldability.

Therefore, there is a need for a polymeric blend composition having improved clarity properties while possessing acceptable radio frequency weldability.

Summary of the Invention

The instant invention provides a polymeric blend composition, injection molded articles, 15 films and sheets made therefrom.

In one embodiment, the instant invention provides a polymeric blend composition comprising: (a) a first component selected from the group consisting of an ethylene/alpha-olefin copolymer and a propylene/ethylene copolymer; wherein said ethylene/alpha-olefin copolymer has density in the range of from 0.857 to 0.902 g/cm<sup>3</sup>, a melt index (I<sub>2</sub>) in the range of from 0.5 to 30 20 g/10 minutes, a DCS melting point temperature (second heat) in the range of from 40 to 99° C, a heat of fusion in the range of from 18 to 108 Jg<sup>-1</sup>, and a crystallinity in the range of from 6 to 37 weight percent; and wherein propylene/ethylene copolymer has a melt flow rate in the range of from 1 to 30 g/10 minutes, a DCS melting point temperature (second heat) in the range of from 55 to 85° C, a heat of fusion in the range of from 10 to 40 Jg<sup>-1</sup>, and a crystallinity in the range of from 6 to 21 weight 25 percent; and (b) less than 40 percent by weight of a second component comprising an ethylene vinyl acetate copolymer comprising from 9 to 40 percent by weight of units derived from vinyl acetate, and wherein said ethylene vinyl acetate copolymer has a melt index (I<sub>2</sub>) in the range of from 0.2 to 20 g/10 minutes; wherein Δ<sub>n</sub> is less than 0.003, and wherein Δ<sub>n</sub> is the absolute value of the 30 difference between the refractive index of (a) and (b); and wherein dielectric loss factor of the polymeric blend composition is greater than 0.024, for example in the range of greater than 0.024 to 0.15.

In an alternative embodiment, the instant invention further provides an injection molded article comprising the inventive polymeric blend composition.

In another alternative embodiment, the instant invention further provides a film comprising the inventive polymeric blend composition.

5 In another alternative embodiment, the instant invention further provides a sheet comprising the inventive polymeric blend composition.

In another alternative embodiment, the instant invention further provides a multilayer structure comprising the inventive film or sheet.

10 In another alternative embodiment, the instant invention further provides a polymeric blend composition according to the previous embodiments except that the polymeric blend composition has a haze of less than 36 percent.

15 In another alternative embodiment, the instant invention further provides an article comprising; a substrate, and a film associated with at least a surface of the substrate, wherein the film comprises the inventive polymeric blend composition, and wherein said film is coated or laminated to the at least one surface.

#### Detailed Description of the Invention

The instant invention provides a polymeric blend composition, injection molded articles, films and sheets made therefrom. The polymeric blend composition according to the present invention comprises: (a) a first component selected from the group consisting of an ethylene/alpha-olefin copolymer and a propylene/ethylene copolymer; wherein said ethylene/alpha-olefin copolymer has density in the range of from 0.857 to 0.902 g/cm<sup>3</sup>, a melt index (I<sub>2</sub>) in the range of from 0.5 to 30 g/10 minutes, a DCS melting point temperature (second heat) in the range of from 40 to 99° C, a heat of fusion in the range of from 18 to 108 Jg<sup>-1</sup>, and a crystallinity in the range of from 6 to 37 weight percent; and wherein propylene/ethylene copolymer has a melt flow rate in the range of from 1 to 30 g/10 minutes, a DCS melting point temperature (second heat) in the range of from 55 to 85° C, a heat of fusion in the range of from 10 to 40 Jg<sup>-1</sup>, and a crystallinity in the range of from 6 to 21 weight percent; and (b) less than 40 percent by weight of a second component comprising an ethylene vinyl acetate copolymer comprising from 9 to 40 percent by weight of units derived from vinyl acetate, and wherein said ethylene vinyl acetate copolymer has a melt index (I<sub>2</sub>) in the range of from 0.2 to 20 g/10 minutes; wherein Δ<sub>n</sub> is less than 0.003, and wherein Δ<sub>n</sub> is the absolute value of the difference between the refractive index of (a) and (b); and wherein dielectric loss factor of the

polymeric blend composition is greater than 0.024, for example in the range of greater than 0.024 to 0.15.

#### First Component

5 The polymeric blend composition according to the present invention comprises equal to or greater than 40 percent by weight of the first component, for example, equal to or greater than 50 weight percent, or in the alternative, equal to or greater than 60 weight percent.

The first component can be selected from the group consisting of an ethylene/alpha-olefin copolymer, a propylene/ethylene copolymer, and combinations thereof.

#### Ethylene/alpha-olefin copolymer

10 In one embodiment, the first component is an ethylene/alpha-olefin copolymer. The ethylene/alpha-olefin copolymer can be homogenously branched, substantially linear ethylene/alpha-olefin copolymer, commercially available under the trade names AFFINITY and/or ENGAGE from The Dow Chemical Company.

15 The ethylene/alpha-olefin copolymer comprises (a) less than or equal to 100 percent, for example, at least 70 percent, or at least 80 percent, or at least 90 percent, by weight of the units derived from ethylene; and (b) less than 30 percent, for example, less than 25 percent, or less than 20 percent, or less than 10 percent, by weight of units derived from one or more  $\alpha$ -olefin comonomers. The term "ethylene/alpha-olefin copolymer" refers to a polymer that contains more than 50 mole percent polymerized ethylene monomer (based on the total amount of polymerizable monomers) and, 20 optionally, may contain at least one comonomer.

25 The  $\alpha$ -olefin comonomers typically have no more than 20 carbon atoms. For example, the  $\alpha$ -olefin comonomers may preferably have 3 to 10 carbon atoms, and more preferably 3 to 8 carbon atoms. Exemplary  $\alpha$ -olefin comonomers include, but are not limited to, propylene, 1-butene, 1-pentene, 1-hexene, 1-heptene, 1-octene, 1-nonene, 1-decene, and 4-methyl-1-pentene. The one or more  $\alpha$ -olefin comonomers may, for example, be selected from the group consisting of propylene, 1-butene, 1-hexene, and 1-octene; or in the alternative, from the group consisting of 1-hexene and 1-octene.

30 The ethylene/alpha-olefin copolymer has a density in the range of 0.857 to 0.902 g/cm<sup>3</sup>. For example, the density can be from a lower limit of 0.857, 0.862, 0.868, or 0.875, or 0.880 g/cm<sup>3</sup> to an upper limit of 0.885, 0.889, 0.895, or 0.902 g/cm<sup>3</sup>.

The ethylene/alpha-olefin copolymer has a molecular weight distribution ( $M_w/M_n$ ) in the range of from 1.0 to 3.5. For example, the molecular weight distribution ( $M_w/M_n$ ) can be from a lower limit of 1.0, 1.1, or 1.2 to an upper limit of 2.5, 3.0 or 3.5.

5 The ethylene/alpha-olefin copolymer has a melt index ( $I_2$ ) in the range of 0.5 to 30 g/10 minutes. For example, the melt index ( $I_2$ ) can be from a lower limit of 0.5, 1, 2, or 5 g/10 minutes to an upper limit of 5, 10, 15, or 30 g /10 minutes.

The ethylene/alpha-olefin copolymer has a DSC melting point temperature (second heat) in the range of from 40 to 99° C. For example, the DSC melting point temperature (second heat) can be from a lower limit of 40, 47, 54, 64 or 70 ° C. to an upper limit of 78, 82, 90, or 99° C.

10 The ethylene/alpha-olefin copolymer has a heat of fusion in the range of from 18 to 108 Jg<sup>-1</sup>. For example, the heat of fusion can be from a lower limit of 9, 21, 34, 50, or 61 Jg<sup>-1</sup> to an upper limit of 72, 80, 93 or 108 Jg<sup>-1</sup>.

15 The ethylene/alpha-olefin copolymer has a crystallinity in the range of from 6 to 37 weight percent. For example, the crystallinity can be from a lower limit of 3, 7, 12, 17, or 21 weight percent to an upper limit of 25, 28, 32, or 37 weight percent.

The ethylene/alpha-olefin copolymer has a molecular weight ( $M_w$ ) in the range of 50,000 to 250,000 daltons. For example, the molecular weight ( $M_w$ ) can be from a lower limit of 50,000, 60,000, 70,000 daltons to an upper limit of 150,000, 180,000, 200,000 or 250,000 daltons.

20 The ethylene/alpha-olefin copolymer may further comprise additional components such as one or more other polymers and/or one or more additives. Such additives include, but are not limited to, antistatic agents, color enhancers, dyes, lubricants, fillers such as TiO<sub>2</sub> or CaCO<sub>3</sub>, opacifiers, nucleators, processing aids, pigments, primary antioxidants, secondary antioxidants, processing aids, UV stabilizers, anti-blocks, slip agents, tackifiers, fire retardants, anti-microbial agents, odor reducer agents, anti fungal agents, and combinations thereof. The ethylene/alpha-olefin 25 copolymer may contain from about 0.1 to about 10 percent by the combined weight of such additives, based on the combined weight of the ethylene/alpha-olefin copolymer and such additives.

30 Any conventional ethylene (co)polymerization reaction processes may be employed to produce the ethylene/alpha-olefin copolymer. Such conventional ethylene (co)polymerization reaction processes include, but are not limited to, gas phase polymerization process, slurry phase polymerization process, solution phase polymerization process, and combinations thereof using one

or more conventional reactors, e.g. fluidized bed gas phase reactors, loop reactors, stirred tank reactors, batch reactors in parallel, series, and/or any combinations thereof.

Such ethylene/alpha-olefin copolymers are commercially available under the trade names AFFINITY and/or ENGAGE from The Dow Chemical Company.

5 Propylene/ethylene copolymer

In one embodiment, the first component can be a propylene/ethylene copolymer.

In certain other embodiments, the propylene/ethylene copolymer is, for example, a semi-crystalline polymer having a DSC melting point temperature (second heat) in the range of from 55 to 85° C. For example, the DSC melting point temperature (second heat) can be from a lower limit of 10 55, 60 or 65° C to an upper limit of 70, 75, 80 or 85° C.

In one particular embodiment, the propylene/ethylene copolymer is characterized as having substantially isotactic propylene sequences. "Substantially isotactic propylene sequences" means that the sequences have an isotactic triad (mm) measured by  $^{13}\text{C}$  NMR of greater than about 0.85; in the alternative, greater than about 0.90; in another alternative, greater than about 0.92; and in another 15 alternative, greater than about 0.93. Isotactic triads are well-known in the art and are described in, for example, U.S. Patent No. 5,504,172 and International Publication No. WO 00/01745, which refer to the isotactic sequence in terms of a triad unit in the copolymer molecular chain determined by  $^{13}\text{C}$  NMR spectra.

The propylene/ethylene copolymer may have a melt flow rate in the range of from 1 to 30 20 g/10 minutes, measured in accordance with ASTM D-1238 (at 230° C / 2.16 Kg). All individual values and subranges from 1 to 30 g/10 minutes are included herein and disclosed herein; for example, the melt flow rate can be from a lower limit of 1 g/10 minutes, 2 g/10 minutes, 4 g/10 minutes, 5 g/10 minutes, 10 g/10 minutes, or 15 g/10 minutes to an upper limit of 30 g/10 minutes , 25 g/10 minutes, 20 g/10 minutes, 18 g/10 minutes, 15 g/10 minutes, 10 g/10 minutes, 8 g/10 25 minutes, or 5 g/10 minutes.

The propylene/ethylene copolymer has a heat of fusion in the range of from 10 to 40  $\text{Jg}^{-1}$ . For example, the heat of fusion can be from a lower limit of 10, 12, 15, or 20  $\text{Jg}^{-1}$  to an upper limit of 20, 25, 35, or 40  $\text{Jg}^{-1}$ .

The propylene/ethylene copolymer has a crystallinity in the range of from 6 to 21 weight 30 percent. For example, the crystallinity can be from a lower limit of 6, 8, 10, or 15 weight percent to an upper limit of 10, 12, 17 or 21 weight percent.

The crystallinity is measured via Differential scanning calorimetry (DSC) method. The propylene/ethylene copolymer comprises units derived from propylene monomers and units derived from ethylene comonomers.

The propylene/ethylene copolymer comprises from 1 to 40 percent by weight of units derived from ethylene comonomers. All individual values and subranges from 1 to 40 weight percent are included herein and disclosed herein; for example, the weight percent of units derived from ethylene comonomers can be from a lower limit of 1, 3, 4, 5, 7, or 9 weight percent to an upper limit of 40, 35, 30, 27, 20, 15, 12, or 9 weight percent. For example, the propylene/ethylene copolymer comprises from 1 to 35 percent by weight of units derived from ethylene comonomers; or in the alternative, the propylene/ethylene copolymer comprises from 1 to 30 percent by weight of units derived from ethylene comonomers; or in the alternative, the propylene/ethylene copolymer comprises from 3 to 27 percent by weight of units derived from ethylene comonomers; or in the alternative, the propylene/ethylene copolymer comprises from 3 to 20 percent by weight of units derived from ethylene comonomers; or in the alternative, the propylene/ethylene copolymer comprises from 3 to 15 percent by weight of units derived from ethylene comonomers.

The propylene/alpha-olefin copolymer has a molecular weight distribution (MWD), defined as weight average molecular weight divided by number average molecular weight ( $M_w/M_n$ ) of 3.5 or less; in the alternative 3.0 or less; or in another alternative from 1.8 to 3.0.

Such propylene/alpha-olefin copolymers are further described in details in the U.S. Patent Nos. 6,960,635 and 6,525,157, and 8,420,760, each of which is incorporated herein by reference. Such propylene/alpha-olefin copolymers are commercially available from The Dow Chemical Company, under the tradename VERSIFY™, or from ExxonMobil Chemical Company, under the tradename VISTAMAXX™.

#### Second Component

The polymeric blend composition according to the present invention comprises less than 50 percent by weight of the second component, for example, less than 40 weight percent, or in the alternative, less than 30 weight percent. The second component comprises an ethylene vinyl acetate copolymer comprising from 9 to 50 percent by weight of units derived from vinyl acetate; for example from 9 to 40 percent by weight of units derived from vinyl acetate; or in the alternative, from 12 to 35 percent by weight of units derived from vinyl acetate; or in the alternative, from 17 to 29 percent by weight of units derived from vinyl acetate.

## Production

The polymeric blend composition can be prepared via any conventional melt blending process such as extrusion via an extruder, e.g. single or twin screw extruder. The first component, second component, and optionally one or more additives and/or fillers can be melt blended in any 5 order via one or more extruders to form a uniform polymeric blend composition.

In application, the polymeric blend composition can be formed into one or more injection molded articles, one or more films, one or more sheets, one or more tapes, and/or one or more multilayer structures comprising such one or more films, one or more sheets, and/or more tapes via any conventional methods. Such methods include, but are not limited to, injection molding process, 10 blown film extrusion process, and/or cast film extrusion process, and/or sheet calendering process.

In the injection molding process, the polymeric blend composition is fed into an extruder via a hopper. The extruder conveys, heats, melts, and pressurizes the polymeric blend composition to a form a molten stream. The molten stream is forced out of the extruder under pressure through a nozzle into a relatively cool mold held closed thereby filling the mold. The melt cools and hardens 15 until fully set-up. The mold then opens and the molded article is removed.

In blown film extrusion process, the molten polymeric blend composition is extruded through an annular slit die, usually vertically, to form a thin walled tube. Air is introduced via a hole in the centre of the die to blow up the tube like a balloon. Mounted on top of the die, a high-speed air ring blows onto the hot film to cool it. The tube of film then continues upwards, continually cooling, until 20 it passes through nip rolls where the tube is flattened to form a lay-flat tube of film. This lay-flat or collapsed tube is then taken back down the extrusion tower via more rollers. In one embodiment, the polymeric blend composition is formed into a single layer film via a blown film process. In another embodiment, the polymeric blend composition may be formed into a multi-layer blown film structure. In another embodiment, the polymeric blend composition may be formed into a single 25 layer or a multi-layer blown film structure associated with one or more substrates. The blown films prepared according to the present invention may be used as lamination films where the blown film is adhesively laminated to a substrate. The blown films according to the present invention can have a thickness in the range of from 0.5 to 10 mils.

In the cast film extrusion process, a thin film is extruded through a slit onto a chilled, highly 30 polished turning roll, where it is quenched from one side. The speed of the roller controls the draw ratio and final film thickness. The film is then sent to a second roller for cooling on the other side.

Finally it passes through a system of rollers and is wound onto a roll. The cast films according to the present invention have a thickness in the range of from 0.5 to 20 mils.

The sheets according to the present invention can be prepared via calendering process and can have a thickness in the range of from 10 to 30 mils.

5 Injected molded articles of the present invention can be used a valve, container, plaque, cap, toy, and the like. Such injected molded articles can be welded to other polymeric materials such as polyolefin via radio frequency welding (RF welding).

Such films, sheets, tapes, and molded articles have improved clarity and RF weldability while maintaining other properties.

10 Examples

The following examples illustrate the present invention but are not intended to limit the scope of the invention. The examples of the instant invention demonstrate that RF weldability is achieved while maintaining optical properties in accordance with the present invention. The following examples further illustrate that a low haze and transparent compound can be achieved when the difference of the refractive index of the two phases is minimized.

## Formulation Components

Formulation components, i.e. first component and second component, are described in Tables 1 and 2. The properties of the first component, i.e. an ethylene/alpha-olefin copolymer and/or a propylene/ethylene copolymer, are reported in Table 1, and the properties of the second component i.e. ethylene vinyl acetate, are reported in Table 2.

Table 1

1 <sup>st</sup> Component	Density (g/cm <sup>3</sup> )	Melting Point (°C)	MI (@190° C) (when Ethylene is main polymer) or MFR*(@230° C) (g/10 min) (when propylene is main polymer)	Main monomer	Co-monomer	Refractive Index (*)
VERSIFY 3300	0.866	62	8*	Propylene	Ethylene	1.481
VERSIFY 2300	0.866	66	2*	Propylene	Ethylene	1.481
VERSIFY 3200	0.876	85	8*	Propylene	Ethylene	1.486
VERSIFY 2200	0.876	82	2*	Propylene	Ethylene	1.486
VERSIFY 3000	0.890	108	8*	Propylene	Ethylene	1.494
VERSIFY 2000	0.888	107	2*	Propylene	Ethylene	1.493
DOWLEX <sup>TM</sup> SC 2107G	0.917	124	2.3	Ethylene	1-Octene	1.515
DOW <sup>TM</sup> LDPE PG 7008	0.918	106	7.5	Ethylene		1.516
ENGAGE 8411	0.88	76	18	Ethylene	1-Octene	1.494
ENGAGE 8452	0.875	66	3	Ethylene	1-Octene	1.491
AFFINITY KC 8852G	0.875	51	3	Ethylene	1-Octene	1.491
AFFINITY PL 1850G	0.902	97	3	Ethylene	1-Octene	1.507
AFFINITY PL 1845G	0.91	104	3.5	Ethylene	1-Octene	1.511
Exceed 1018 LA	0.918	118	1	Ethylene		1.516

Table 2

2 <sup>nd</sup> Component	VA Content (wt %)	MI (@190°C)	Refractive Index (*)
ELVAX <sup>TM</sup> 460	18	2.5	1.497
Hanwha EVA 1157	18	16	1.497
Taisox <sup>TM</sup> EVA 7360M	21	2	1.494
ELVAX <sup>TM</sup> 360	25	2	1.490
ELVAX <sup>TM</sup> 265	28	3	1.487
ELVAX <sup>TM</sup> 250	28	25	1.487

## Inventive Compositions 1-7 and Comparative Compositions 1-31

5 Inventive Compositions 1-7 and Comparative Compositions 1-31 were compounded on a Coperion ZSK-26 MC 60 L/D twin screw extruder based on the formulation components reported in Tables 4-7. The compounding twin screw extruding process conditions are reported in Table 3. The ZSK-26 MC extruder was operated at 300 RPMS and temperatures at 140°C. The total throughput is 10 50 LB/HR. The strand was water-bath cooled and strand-cutter pelletized in pellet form. Properties of Inventive Compositions 1-7 and Comparative Compositions 1-31 were measured and reported in Tables 4-7.

Table 3

Barrel	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Die
Temperature (°C)	25	25	25	140	140	140	140	140	140	140	140	140	140	140	140	140

Table 4

				Loss Factor @ 27.12 MHz	Weldability	Haze	Delta n								
		Elvax 265													
		Elvax 460													
		Versify 3300													
		Versify 2300													
		Versify 3200													
		Versify 2200													
		Versify 3000													
		Versify 2000													
Inventive Composition 1	0%	0%	40%	40%	0%	0%	20%	0.024	Yes	33.3	0.001				
Inventive Composition 2	0%	0%	35%	35%	0%	0%	30%	0.037	Yes	---	0.001				
Inventive Composition 3	0%	0%	30%	30%	0%	0%	40%	0.048	Yes	30.5	0.001				
Inventive Composition 4	0%	0%	20%	20%	0%	0%	60%	0.073	Yes	29.7	0.001				

Table 5

	Composition	Delta n	Haze	Weldability		Loss Factor @ 27.12 MHz
				Elvax 265	Elvax460	
Comparative	0%	0%	0%	35%	35%	0.022
Composition 1	0%	0%	0%	30%	30%	0.028
Comparative	0%	0%	0%	20%	40%	0.042
Composition 2	0%	0%	0%	20%	60%	0.042
Comparative	0%	0%	0%	0%	0%	0.042
Composition 3	0%	0%	0%	0%	0%	0.042
Comparative	0%	0%	0%	45%	45%	0.008
Composition 4	0%	0%	0%	0%	45%	0.008
Comparative	0%	0%	0%	0%	45%	0.008
Composition 5	0%	0%	0%	0%	10%	0.008
Comparative	0%	0%	0%	0%	10%	0.014
Composition 6	0%	0%	0%	40%	20%	0.015
Comparative	0%	0%	0%	0%	40%	0.030
Composition 7	0%	0%	0%	0%	20%	0.049
Comparative	30%	30%	0%	0%	20%	0.045
Composition 8	0%	0%	0%	0%	60%	0.045
Comparative	0%	0%	0%	0%	0%	0.003
Composition 9	30%	30%	0%	0%	0%	0.016
Comparative	30%	30%	0%	0%	0%	0.007

Table 6

Table 7

		Delta n	Haze	
	Weldability			
Loss Factor @ 27.12 MHz				48.9 0.006
Elvax 250				0.007
Elvax 265				0.008
Elvax 360				0.009
Taisox EVA 7360M				87.2 0.010
Hanwha EVA 1157				
Elvax460		10%		
Exceed 1018		10%		
DOWLEX 2107G		20%		
DOW LDPE PG 7008		20%		
AFF PL 1845G		20%		
AFF PL 1850G		20%		
AFF KC 8852G		20%		
ENGAGE 8452		30%		
ENGAGE 8411		30%		
Comparative Composition 13	---	90%		
Comparative Composition 14	---	45%	45%	
Comparative Composition 15	---	90%	90%	
Comparative Composition 16	---	40%	40%	
Comparative Composition 17	---	80%	80%	
Comparative Composition 18	---	80%	80%	
Comparative Composition 19	---	80%	80%	
Comparative Composition 20	---	80%	80%	
Comparative Composition 21	---	80%	80%	
Comparative Composition 22	---	70%	70%	
Comparative Composition 23	---	70%	70%	
Comparative Composition 24	---	60%	60%	
Comparative Composition 25	---	60%	60%	
Comparative Composition 26	---	60%	60%	
Comparative Composition 27	---	60%	60%	
Comparative Composition 28	---	40%	40%	
Comparative Composition 29	---	60%	60%	
Comparative Composition 30	---	40%	40%	
Comparative Composition 31	70%	---	---	30% * 0.039

### Test Methods

Test methods include the following:

#### Density

Samples that are measured for density are prepared according to ASTM D4703.

- 5 Measurements are made within one hour of sample pressing using ASTM D792, Method B.

#### Melt Index

Melt index ( $I_2$ ) is measured in accordance with ASTM D1238, Condition 190 °C/2.16 kg, and is reported in grams eluted per 10 minutes.

- 10 Melt flow rate is measured in accordance with ASTM D1238, Condition 230 °C/2.16 kg, and is reported in grams eluted per 10 minutes.

#### Differential Scanning Calorimetry (DSC)

- DSC can be used to measure the melting and crystallization behavior of a polymer over a wide range of temperature. For example, the TA Instruments Q1000 DSC, equipped with an RCS (refrigerated cooling system) and an autosampler is used to perform this analysis. During testing, a nitrogen purge gas flow of 50 ml/min is used. Each sample is melt pressed into a thin film at about 175 °C; the melted sample is then air-cooled to room temperature (~25 °C). A 3-10 mg, 6 mm diameter specimen is extracted from the cooled polymer, weighed, placed in a light aluminum pan (ca 50 mg), and crimped shut. Analysis is then performed to determine its thermal properties.

- The thermal behavior of the sample is determined by ramping the sample temperature up and down to create a heat flow versus temperature profile. First, the sample is rapidly heated to 180 °C and held isothermal for 3 minutes in order to remove its thermal history. Next, the sample is cooled to -40 °C at a 10 °C/minute cooling rate and held isothermal at -40 °C for 3 minutes. The sample is then heated to 150 °C (this is the “second heat” ramp) at a 10 °C/minute heating rate. The cooling and second heating curves are recorded. The cool curve is analyzed by setting baseline endpoints from the beginning of crystallization to -20 °C. The heat curve is analyzed by setting baseline endpoints from -20 °C to the end of melt. The values determined are peak melting temperature ( $T_m$ ), peak crystallization temperature ( $T_c$ ), heat of fusion ( $H_f$ ) (in Joules per gram), and the calculated % crystallinity for samples using appropriate equation, for example for the ethylene/alpha-olefin interpolymer using the following Equation 1.

$$\% \text{ Crystallinity} = ((H_f)/(292 \text{ J/g})) \times 100 \quad \text{Equation 1}$$

The heat of fusion ( $H_f$ ) and the peak melting temperature are reported from the second heat curve. Peak crystallization temperature is determined from the cooling curve.

5 Conventional Gel Permeation Chromatography (GPC)

The GPC system consists of either a Polymer Laboratories Model PL-210 or a Polymer Laboratories Model PL-220 instrument equipped with a refractive index (RI) concentration detector. The column and carousel compartments are operated at 140°C. Three Polymer Laboratories 10- $\mu\text{m}$  Mixed-B columns are used with the solvent 1,2,4-trichlorobenzene. The samples are prepared at a 10 concentration of 0.1 g of polymer in 50 milliliters of solvent. The solvent used to prepare the samples contains 200 ppm of the antioxidant butylated hydroxytoluene (BHT). Samples are prepared by agitating lightly for four hours at 160 °C. The injection volume used is 200 microliters and the flow rate is 1.0 ml/min. Calibration of the GPC column set is performed with twenty one narrow molecular weight distribution polystyrene standards purchased from Polymer Laboratories.

15 The polystyrene standard peak molecular weights ( $M_{PS}$ ) are converted to polyethylene molecular weight ( $M_{PE}$ ) using Equation 1A. The equation is described in Williams and Ward, J. Polym. Sci., Polym. Letters, 6, 621 (1968)):

$$M_{PE} = A \times (M_{PS})^B \quad \text{Equation 1A}$$

Where A has a value of 0.4316 and B is equal to 1.0.

20 A third order polynomial is determined to build the logarithmic molecular weight calibration as a function of elution volume.

Polyethylene equivalent molecular weight calculations were performed using PolymerChar “GPC One” software. The number average molecular weight ( $M_n$ ), weight average molecular weight ( $M_w$ ), and z-average molecular weight ( $M_z$ ) was calculated by inputting the GPC results in 25 equations 2 to 4:

$$\overline{M_n} = \frac{\sum^i R I_i}{\sum^i (R I_i / M_{PE,i})} \quad \text{Equation 2}$$

$$\overline{Mw} = \frac{\sum^i (RI_i * M_{PE,i})}{\sum^i (RI_i)} \quad \text{Equation 3}$$

$$\overline{Mz} = \frac{\sum^i (RI_i * M_{PE,i}^2)}{\sum^i (RI_i * M_{PE,i})} \quad \text{Equation 4}$$

Where  $RI_i$  and  $M_{PE,i}$  are the concentration detector baseline corrected response and conventional calibrated polyethylene molecular weight for the  $i^{th}$  slice of the concentration response, elution volume paired data set. The precision of the weight-average molecular weight  $\Delta Mw$  is < 2.6 %.

The MWD is expressed as the weight average molecular weight (Mw) divided by the number average molecular weight (Mn).

The GPC column set is calibrated by running 21 narrow molecular weight distribution polystyrene standards. The molecular weight (MW) of the standards ranges from 580 to 8,400,000, and the standards are contained in 6 “cocktail” mixtures. Each standard mixture has at least a decade of separation between individual molecular weights. The standard mixtures are purchased from Polymer Laboratories. The polystyrene standards are prepared at 0.025 g in 50 mL of solvent for molecular weights equal to or greater than 1,000,000 and 0.05 g in 50 mL of solvent for molecular weights less than 1,000,000. The polystyrene standards were dissolved at 80 °C with gentle agitation for 30 minutes. The narrow standards mixtures are run first and in order of decreasing highest molecular weight component to minimize degradation.

#### *Injection Molding*

All of the sample plaques and sample chips were molded using a Krauss Maffei KM 110-390/390 CL Injection Molding Machine, equipped with a single shot mold base.

The haze/clarity chip samples (60 x 60 x 2 mm plaques) were molded with Axxicon Mold Inserts.

- B-insert. 60 x 60 x 2 mm plaque
- A-insert. Aim Mirror insert. Polished NO/N1 (SPI-SPE 1-2) according ISO 1302

The Tensile samples (ASTM D 638 Type I Tensile bar) were molded with Axxicon Mold Inserts.

- B-insert. ASTM D 638 Type I Tensile. 165(6.5") x 13(0.5") x 3.2(0.125") mm
- A-insert. Aim Mirror insert. Polished NO/N1 (SPI-SPE 1-2) according ISO 1302

*Tape extrusion:*

The compounded blend in pellets form was extruded with a Haake single extruder (3/4" diameter and 25 L/D) attached with a tape/slot die. The typical extrusion condition was applied (~50 RPM and Temperature profile from 140 0C to 190 0C). The extrudate was taken off on a chill rolls system with 3 rolls configurations. The temperature of the chill roll was controlled at about 15 0C. 5 The finished tape films are collected on a wind-up system and the dimension of the tapes are 3.5~4" wide and 10 or 15 mils thick.

*RF welding:*

The extruded tape films are Radio-Frequency welded with a Callanan RF Welder. The power 10 output of the Callanan RF Welder is 2KW and the operation/generator frequency is 27.12 MHz. Seal bar/die dimension is (1/2"X8"). The films are sealed in machine direction. During the RF welding process, the films to be welded are placed between the seal bar and bottom metal plate. The seal bar is brought down to the bottom metal plate via a pneumatic cylinder at 30 psi pressure, and the films are pressed between the bar and the plate when an RF frequency is applied.

15 The power level setting can be adjusted from 0% to 100%. The typical setting is 80%-90% in this invention. The typical weld time in this invention is 2 to 4 sec.

In order to tune RF welder, the Clayton setting is adjusted to optimize the resonant frequency 20 of the work piece. The maximum power can be coupled, out of the generator, when the resonant frequency of the work piece is nearly resonant at the output frequency of generator (27.12 MHz). In this invention, the Clayton setting is set between 20-22.

*Weld Strength/Peel measurement:*

The welded films are cut into 1" wide stripes in CD direction. These stripes are then pulled in CD direction using a Instron. The Peak Load during pulling is recorded as the weld strength.

*Dielectric Spectroscopy (DES)*

25 Dielectric spectroscopy measurements were performed over a frequency range of  $1 \times 10^6$  Hz to  $3 \times 10^9$  Hz using an Agilent 4991A RF Impedance/Material Analyzer controlled by a personal computer (NOVOCONTROL Technologies GmbH & Co. KG). All measurements were performed at room temperature under dry nitrogen. Approximately 11 mm diameter circles were punched out of the sheets using a cork borer. Samples were measured with a micrometer for thickness and scanned 30 between two gold-coated electrodes 10 mm in diameter. As all samples had similar densities and

thicknesses, individual masses were not recorded. Rather, it was assumed that the average mass of a given sample would be included in the coefficient of the  $\Delta H_{absorbed}$  parameter.

*Haze:*

The clarity and haze of sample chips of 2 mm thickness were measured using BYK Gardner

5 Haze-gard as specified in ASTM D1746 and ASTM D1003.

The present invention may be embodied in other forms without departing from the spirit and the essential attributes thereof, and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indicating the scope of the invention.

## CLAIMS

We Claim:

1. A polymeric blend composition comprising:

(a) a first component selected from the group consisting of an ethylene/alpha-olefin copolymer and a propylene/ethylene copolymer; wherein said ethylene/alpha-olefin copolymer has density in the range of from 0.857 to 0.902 g/cm<sup>3</sup>, a melt index (I<sub>2</sub>) in the range of from 0.2 to 30 g/10 minutes, a DCS melting point temperature (second heat) in the range of from 40 to 99° C, a heat of fusion in the range of from 18 to 108 Jg<sup>-1</sup>, and a crystallinity in the range of from 6 to 37 weight percent; and wherein propylene/ethylene copolymer has a melt flow rate in the range of from 1 to 30 g/10 minutes, a DCS melting point temperature (second heat) in the range of from 55 to 85° C, a heat of fusion in the range of from 10 to 40 Jg<sup>-1</sup>, and a crystallinity in the range of from 6 to 21 weight percent;

(b) less than 40 percent by weight of a second component comprising an ethylene vinyl acetate copolymer comprising from 9 to 40 percent by weight of units derived from vinyl acetate, and wherein said ethylene vinyl acetate copolymer has a melt index (I<sub>2</sub>) in the range of from 0.2 to 20 g/10 minutes;

wherein Δ<sub>n</sub> is less than 0.003, and wherein Δ<sub>n</sub> is the absolute value of the difference between the refractive index of (a) and (b); and wherein dielectric loss factor of the polymeric blend composition is in the range of equal to or greater than 0.024.

- 20 2. An injection molded article comprising the polymeric blend composition of Claim 1.
3. A film comprising the polymeric blend composition of Claim 1.
4. A sheet comprising the polymeric blend composition of Claim 1.
5. A tape comprising the polymeric blend composition of Claim 1.

6. A multilayer structure comprising the film of Claim 3 or the sheet of Claim 4 or the tape of Claim 5.

7. Any of preceding claims, wherein said polymeric blend composition has a haze of less than 36 percent.

5 8. An article comprising;

a substrate, and

a film associated with at least a surface of said substrate, wherein said film comprises the polymeric blend composition of Claim 1, and wherein said film is coated or laminated to said at least one surface.

**INTERNATIONAL SEARCH REPORT**

International application No.

**PCT/CN2013/084292**

**A. CLASSIFICATION OF SUBJECT MATTER**

C08L23/06(2006.01) i; C08L 23/16(2006.01) i; C08L31/06(2006.01)i

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

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

C08L 23/-; C08L 31/-

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)

CNTXT,CNABS;VEN:ethylene, ethene, olefin, copolymer, copolymerization, propylene, propene, refractive, dielectric loss, weldability, weldable, ELVAX, AFFINITY, ENGAGE, HANWHA, TAISOX, DOW, VERSIFY

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002198322A1 (HYUNDAI MOTOR CO LTD) 26 December 2002 (2002-12-26) see the whole document	1-8
A	CN 1765967A (SUMITOMO CHEM CO LTD) 03 May 2006 (2006-05-03) see the whole document	1-8
A	CN 102239206A (DOW GLOBAL TECHNOLOGIES INC) 09 November 2011 (2011-11-09) see the whole document	1-8
A	CN 102139552A (LING HE ET AL.) 03 August 2011 (2011-08-03) see the whole document	1-8
A	CN 102482523A (HEWLETT-PACKARD DEV CO LP) 30 May 2012 (2012-05-30) see the whole document	1-8
A	CN 103172918A (SHANGHAI GENIUS ADVANCED MATERIAL CO LTD) 26 June 2013 (2013-06-26) see the whole document	1-8

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
- “&” document member of the same patent family

Date of the actual completion of the international search  <b>04 June 2014</b>	Date of mailing of the international search report  <b>01 July 2014</b>
Name and mailing address of the ISA/  <b>STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA(ISA/CN) 6,Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088 China</b>	Authorized officer  <b>WANG,Jinfeng</b>
Facsimile No. (86-10)62019451	Telephone No. (86-10)62084498

**INTERNATIONAL SEARCH REPORT**

International application No.

**PCT/CN2013/084292****C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6258862B1 (SOLVAY) 10 July 2001 (2001-07-10) see the whole document	1-8

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/CN2013/084292**

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