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POLYOLEFIN BLEND WITH BARRIER AND MECHANICAL PROPERTIES.

- 57 A polyolefin blend comprising 2 wt.% to 49 wt.% of a first polyethylene PE1 with a density of at least 0.940 g/cm³ according to ISO 1183 and a melt index of at most 500.0 g/10 min according to ISO 1133-1:2011; and from 51 wt.% to 98 wt.% of a second polyethylene PE2 having a density ranging from 0.890 to less than 0.940 g/cm³ according to ISO 1183 and a melt index ranging from 0.1 to 20.0 g/10 min according to ISO 1133-1:2011; wherein the ratio of the melt index of PE1 to PE2 is equal or greater than 1.0; and wherein the polyolefin blend has an oxygen permeability coefficient ranging from 2.04×10^{-16} to 9.18×10^{-16} mol*m/m²*s*Pa as measured by ASTM D3985-17 and/or a water vapor transmission rate of at most 10.42×10^{-16} g/(m².s) as measured by ASTM F1249-20.

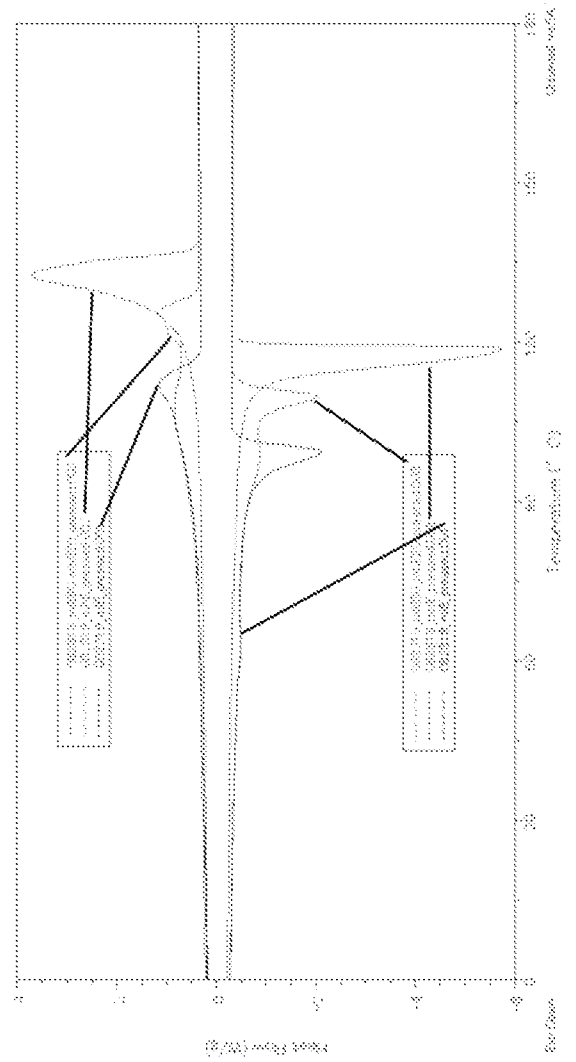


Figure 1

DESCRIPTION

POLYOLEFIN BLEND WITH BARRIER AND MECHANICAL PROPERTIES

Field of the Invention

The invention generally concerns polyolefin blends.

Description of Related Art

A significant part of polyolefin film is used in packaging applications. In several cases, the contents of a package are water vapor sensitive and/or oxygen sensitive. In such case, selection of the most interesting polyolefin to be used for film production is the result of a compromise.

If a low density polyethylene (LDPE) or a linear low density polyethylene (LLDPE) grade is considered, the film will be transparent, quite resistant to slow puncture, but not at all optimum in terms of barrier properties. A thick film would be needed to improve such properties or the storage time should be reduced.

Using a high density polyethylene (HDPE) grade, the barrier properties of the film could be improved and thinner film could be used (interesting as less material is consumed). The interest of HDPE grade in terms of barrier properties is often associated to the content in crystalline phase. However, using a HDPE grade, the transparency of the film will be decreased.

There would be an interest to find a material combining the advantages of HDPE (such as high barrier properties) with those of L(L)DPE (high transparency, strong resistance to slow puncture).

Summary of the Invention

The present invention aims to provides a polyolefin blend having an improved balance of barrier properties (such as oxygen permeability and/or water vapor transmission rate) and mechanical properties (such as modulus of elasticity and/or tensile strength at break and/or elongation at break). The present invention aims to provides a polyolefin blend having an improved balance of barrier properties (such as oxygen permeability and/or water vapor transmission rate) and mechanical properties (such as modulus of elasticity and/or tensile strength at break and/or elongation at break) and optical properties (such as transparency and/or transmittance).

According to a first aspect, the invention provides for a polyolefin blend comprising:

- from 2 wt.% to 49 wt.% of a first polyethylene PE1 based on the total weight of the polyolefin blend; the first polyethylene PE1 being a high-density polyethylene with a density of at least 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of 23°C ; and a melt index (MI2) of at most 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg ; and
- from 51 wt.% to 98 wt.% of a second polyethylene PE2 based on the total weight of the polyolefin blend; the second polyethylene PE2 having a density ranging from 0.890 to less than 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of 23°C ; and a melt index (MI2) ranging from 0.1 to 20.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg ;

wherein the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is equal or greater than 1.0; and wherein the polyolefin blend has an oxygen permeability coefficient (PO_2) ranging from 2.04×10^{-16} to $9.18 \times 10^{-16} \text{ mol}\cdot\text{m/m}^2\cdot\text{s}\cdot\text{Pa}$ as measured by ASTM D3985-17 and/or a water vapor transmission rate (WVTR) of at most $10.42 \times 10^{-6} \text{ g}/(\text{m}^2\cdot\text{s})$ as measured by ASTM F1249-20.

According to a second aspect, the invention provides for a process to produce a polyolefin blend; the process comprising the following steps:

- providing from 2 wt.% to 49 wt.% of a first polyethylene PE1 based on the total weight of the polyolefin blend; the first polyethylene PE1 being a high-density polyethylene with a density of at least 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of 23°C ; and a melt index (MI2) of at most 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg ;
- providing from 51 wt.% to 98 wt.% of a second polyethylene PE2, wherein the second polyethylene PE2 is having a density ranging from 0.890 to less than 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of 23°C ; and a melt index (MI2) ranging from 0.1 to 20.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg ; wherein the first polyethylene PE1 and the second polyethylene PE2 are selected so that the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is equal or greater than 1.0, and

- blending the first and the second polyethylene PE2 to obtain a polyolefin blend having an oxygen permeability coefficient (PO_2) ranging from 2.04×10^{-16} to 9.18×10^{-16} mol·m/m²·s·Pa as measured by ASTM D3985-17 and/or a water vapor transmission rate (WVTR) of at most 10.42×10^{-6} g/(m²·s) as measured by ASTM F1249-20.

With preference, the polyolefin blend is according to the first aspect.

Surprisingly, it was found that it was possible to obtain an improved balance of barrier properties (such as oxygen permeability and/or water vapor transmission rate) and mechanical properties (such as modulus of elasticity and/or tensile strength at break and/or elongation at break) with the polyolefin blend according to the present invention.

In particular, it is possible to obtain a behaviour regarding the barrier properties that are close to a pure HDPE while the HDPE is a minority component in the polyolefin blend. In one non-limiting aspect, the examples in the present application show that about a 2-fold decrease of the oxygen permeability coefficient can be obtained with only 10 wt.% of HDPE based on the total weight of the polyolefin blend by comparison to the oxygen permeability coefficient shown by a pure LLDPE; while at the same time, the polyolefin blend provides for the thermal and mechanical properties close to a pure LLDPE.

This improved balance of properties was unexpected and allows using the polyolefin blends to produce barrier films in simple and cost-effective processes since, for example, there is no need to change the equipment and/or to produce multi-layered PE-PP films to obtain the desired balance of properties.

Also, since the HDPE is a minority component in the polyolefin blend, the optical properties of the blend (such as the transparency) are improved by comparison to a pure HDPE blend.

One or more of the following can be used to better define the polyolefin blend according to the first aspect and/or the process according to the second aspect.

The polyolefin blends

In an embodiment, one or more selected from the first polyethylene PE1 and the second polyethylene PE2 is or comprises a post-consumer resin. Preferably, the total content of the post-consumer resins (PCR_T) in the polyolefin blend ranges is at least 2 wt.% based on the total weight of the polyolefin blend.

In a preferred embodiment, one or more selected from the first polyethylene PE1 and the second polyethylene PE2 is metallocene-catalysed.

In a preferred embodiment, the polyolefin blend has a melt index (MI2) of at most 25.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg; preferably, of at most 20.0 g/10 min; preferably, of at most 15.0 g/10 min; preferably, of at most 10.0 g/10 min; preferably, of at most 9.0 g/10 min; preferably, of at most 8.0 g/10 min; preferably, of at most 7.0 g/10 min; preferably, of at most 6.0 g/10 min; preferably, of at most 5.0 g/10 min.

The polyolefin blend has a melt index (MI2) ranging from 0.1 to 25.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg; preferably, ranging from 0.2 to 20.0 g/10 min; preferably, ranging from 0.3 to 15.0 g/10 min; preferably, ranging from 0.4 to 10.0 g/10 min; preferably, ranging from 0.5 to 9.0 g/10 min; preferably, ranging from 0.8 to 8.0 g/10 min; preferably, ranging from 1.0 to 7.0 g/10 min.

The first polyethylene PE1 and the second polyethylene PE2 are selected so that the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is equal or greater than 1.0; i.e.:

$$\frac{MI2 (PE1)}{MI2(PE2)} \geq 1.0$$

In a preferred embodiment, the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is equal to or greater than 1.1.

With preference, the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is ranging from 1.0 to 1000; preferably, from 1.0 to 500; preferably, from 1.0 to 200; preferably, from 1.0 to 100; preferably, from 1.0 to 80; preferably, from 1.0 to 50; preferably, from 1.0 to 30; preferably, from 1.0 to 25; preferably, from 1.0 to 20; preferably, from 1.1 to 100; preferably, from 1.1 to 50.

In some aspects, at least one selected from the first polyethylene PE1 and the second polyethylene PE2 has an Mw/Mn ranging from 1.5 to 6.0 as determined by GPC.

The polyolefin blend has an oxygen permeability coefficient (PO₂) of at most 9.18×10^{-16} mol·m/m²·s·Pa as measured in accordance with ASTM D3985-17; preferably, at most $8.67 \times$

10^{-16} mol·m/m²·s·Pa; preferably, at most 8.16×10^{-16} mol·m/m²·s·Pa; preferably, at most 7.65×10^{-16} mol·m/m²·s·Pa; preferably, at most 7.14×10^{-16} mol·m/m²·s·Pa.

The polyolefin blend has an oxygen permeability coefficient (PO₂) of at least 2.04×10^{-16} mol·m/m²·s·Pa as measured by ASTM D3985-17; preferably, at least 2.30×10^{-16} mol·m/m²·s·Pa; preferably, at least 2.55×10^{-16} mol·m/m²·s·Pa.

The polyolefin blend has an oxygen permeability coefficient (PO₂) ranging from 2.04×10^{-16} to 9.18×10^{-16} mol·m/m²·s·Pa as measured by ASTM D3985-17; preferably, ranging from 2.30×10^{-16} to 7.65×10^{-16} mol·m/m²·s·Pa; preferably, ranging from 2.55×10^{-16} to 7.14×10^{-16} mol·m/m²·s·Pa.

In a preferred embodiment, the polyolefin blend has a water vapor transmission rate (WVTR) of at most 10.42×10^{-6} g/(m²·s) as measured by ASTM F1249-20; preferably, at most 9.84×10^{-6} g/(m²·s); preferably, at most 9.26×10^{-6} g/(m²·s); preferably, at most 8.68×10^{-6} g/(m²·s); preferably, at most 8.10×10^{-6} g/(m²·s).

With preference, the polyolefin blend has a water vapor transmission rate (WVTR) of at least 1.74×10^{-6} g/(m²·s) as measured by ASTM F1249-20; preferably, at least 2.31×10^{-6} g/(m²·s); preferably, at least 2.89×10^{-6} g/(m²·s); preferably, at least 3.24×10^{-6} g/(m²·s); preferably, at least 3.47×10^{-6} g/(m²·s).

With preference, the polyolefin blend has a water vapor transmission rate (WVTR) ranging from 1.74×10^{-6} to 10.42×10^{-6} g/(m²·s) as measured in accordance with ASTM F1249-20 (i.e. ranging from 0.010 to 0.058 g/100 in²·day); preferably, from 2.08×10^{-6} to 9.84×10^{-6} g/(m²·s) (i.e. ranging from 0.012 to 0.055 g/100 in²·day); preferably, from 2.31×10^{-6} to 9.26×10^{-6} g/(m²·s) (i.e. ranging from 0.013 to 0.052 g/100 in²·day); preferably, from 2.89×10^{-6} to 8.68×10^{-6} g/(m²·s) (i.e. ranging from 0.016 to 0.048 g/100 in²·day); preferably, from 3.47×10^{-6} to 8.10×10^{-6} g/(m²·s) (i.e. ranging from 0.019 to 0.045 g/100 in²·day).

In a preferred embodiment, the polyolefin blend has a modulus of elasticity (*E*) ranging from 180 to 500 MPa, as measured by ISO 527-3 at 23 °C; preferably, ranging from 210 to 300 MPa.

In a preferred embodiment, the polyolefin blend has a tensile strength at break ranging from 15 to 100 MPa as measured in accordance with ASTM D638; preferably, ranging from 20 to 60 MPa.

In a preferred embodiment, the polyolefin blend has an elongation at break ranging from 300

to 800 % as measured in accordance with ASTM D638; preferably, from 500 to 800 %.

In a preferred embodiment, the polyolefin blend has a specific heat capacity (ΔH_m) ranging from 90 to 150 J/g as measured by differential scanning calorimetry (DSC); preferably, from 95 to 140; preferably, from 100 to 135; or from 100 to 130.

In some aspects, the polyolefin blend has a transmittance of at least 10% when measured of at 450 nm on a sample having a thickness of 350 μm ; preferably at least 12%; preferably at least 15%. The transmittance is measured using Evolution™ 350 UV-Vis Spectrophotometer made by ThermoFisher Scientific at 25 °C.

In some aspects, the polyolefin blend comprises from 8 to 30 wt.% of the first polyethylene PE1 based on the total weight of the polyolefin blend, and from 70 to 92 wt.% of the second polyethylene PE2.

The first polyethylene (PE1)

The first polyethylene PE1 is present in the polyolefin blend in a content ranging from 2 to 49 wt.% based on the total weight of the polyolefin blend; preferably, in a content ranging from 5 to 40 wt.%; preferably, in a content ranging from 6 to 35 wt.%; preferably, in a content ranging from 8 to 30 wt.%; preferably, in a content ranging from 8 to 25 wt.%; preferably, in a content ranging from 8 to 22 wt.%. preferably, in a content ranging from 10 to 20 wt.% or from 10 to 30 wt.%.

The first polyethylene PE1 is a high-density polyethylene with a density of at least 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of 23 °C; preferably, of at least 0.942 g/cm^3 ; preferably, of at least 0.945 g/cm^3 ; preferably, of at least 0.948 g/cm^3 ; preferably, of at least 0.950 g/cm^3 .

With preference, the first polyethylene PE1 has a density ranging from 0.940 to 0.970 g/cm^3 as determined according to ISO 1183 at a temperature of 23 °C; preferably, ranging from 0.942 to 0.968 g/cm^3 ; preferably, ranging from 0.945 to 0.965 g/cm^3 ; preferably, ranging from 0.948 to 0.962 g/cm^3 ; preferably, ranging from 0.950 to 0.960 g/cm^3 or from 0.950 to 0.970 g/cm^3 .

The first polyethylene PE1 has a melt index (MI2) of at most 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg; preferably, of at most 400.0 g/10 min; preferably, of at most 300.0 g/10 min; preferably, of at most 200.0 g/10 min; preferably, of at most 100.0 g/10 min; preferably, of at most 90.0 g/10

min; preferably, of at most 85.0 g/10 min; preferably, of at most 80.0 g/10 min; preferably, of at most 75.0 g/10 min; preferably, of at most 70.0 g/10 min.

In a preferred embodiment, the first polyethylene PE1 has a melt index (MI2) ranging from 0.1 to 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg; preferably, ranging from 0.5 to 300.0 g/10 min; preferably, ranging from 0.8 to 200.0 g/10 min; preferably, ranging from 1.0 to 100.0 g/10 min; preferably, ranging from 2.0 to 80.0 g/10 min; preferably, ranging from 3.0 to 70.0 g/10 min; preferably, ranging from 3.5 to 90.0 g/10 min.

Preferably, the first polyethylene PE1 has a melting temperature T_m of at least 120 °C as measured by ISO 11357; preferably, at least 122 °C; more preferably, at least 125 °C.

In some aspects, the first polyethylene PE1 is having a melting temperature of at least 122 °C as measured by ISO 11357, and the melting temperature of the first polyethylene PE1 is greater than the melting temperature of the second polyethylene PE2.

In a preferred embodiment, the first polyethylene PE1 is metallocene-catalysed or is Ziegler-Natta-catalysed; preferably, the first polyethylene PE1 is metallocene-catalysed.

Preferably, the first polyethylene PE1 is a polyethylene copolymer, which is a copolymer of ethylene and at least one C₃-C₂₀ alpha-olefin, preferably propylene and/or 1-hexene.

Preferably, the first polyethylene PE1 has a comonomer content expressed as the number of short chain branches (SCB) per 1,000 total carbons ranging from 0 branch/1000 C up to 3.0 branches/1000 C; preferably, from 0.1 to 2.5 branches/1000 C and more preferably from 0.2 to 2.0 branches/1000 C. Methods for the determination of SCB content are described in more detail herein.

The second polyethylene (PE2)

In an embodiment, the second polyethylene PE2 is one or more selected from linear low-density polyethylene (LLDPE) and low-density polyethylene (LDPE). Preferably, the second polyethylene PE2 is or comprises a linear low-density polyethylene (LLDPE). In a preferred embodiment, the second polyethylene (PE2) comprises LLDPE, wherein the content of LLDPE is at least 70 wt.% of the total weight of the second polyethylene PE2; preferably, at least 80 wt.%; more preferably, at least 90 wt.%.

The second polyethylene PE2 is present in the polyolefin blend in a content of at least 51 wt.% based on the total weight of the polyolefin blend; preferably, in a content of at least 60 wt.%; preferably, in a content of at least 65 wt.%; preferably, in a content of at least 70 wt.%; preferably, in a content of at least 75 wt.%; preferably, in a content of at least 78 wt.%; preferably, in a content of at least 80 wt.%.

The second polyethylene PE2 is present in the polyolefin blend in a content of at most 98 wt.% or at most 95 wt.% based on the total weight of the polyolefin blend; preferably, in a content of at most 94 wt.%; preferably, in a content of at most 92 wt.%; preferably, in a content of at most 90 wt.%.

The second polyethylene PE2 is present in the polyolefin blend in a content ranging from 51 to 98 wt.% or from 51 to 95 wt.% based on the total weight of the polyolefin blend; preferably, in a content ranging from 60 to 94 wt.%; preferably, in a content ranging from 65 to 94 wt.%; preferably, in a content ranging from 70 to 92 wt.%; preferably, in a content ranging from 75 to 92 wt.%; preferably, in a content ranging from 78 to 92 wt.%. preferably, in a content ranging from 80 to 90 wt.% or from 70 to 90 wt.%

In a preferred embodiment, the second polyethylene PE2 has a density ranging from 0.890 to less than 0.940 g/cm³ as determined according to ISO 1183 at a temperature of 23 °C; preferably, ranging from 0.900 to 0.938 g/cm³; preferably, ranging from 0.905 to 0.935 g/cm³; preferably, ranging from 0.910 to 0.932 g/cm³; preferably, ranging from 0.915 to 0.930 g/cm³ or from 0.910 to 0.935 g/cm³.

The second polyethylene PE2 has a melt index (MI2) ranging from 0.1 to 20.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg; preferably, ranging from 0.5 to 16.0 g/10 min; preferably, ranging from 0.8 to 13.0 g/10 min; preferably, ranging from 1.0 to 10.0 g/10 min; preferably, ranging from 1.2 to 8.0 g/10 min; preferably, ranging from 1.0 to 5.0 g/10 min; preferably, ranging from 1.0 to 4.0 g/10 min; preferably, ranging from 0.8 to 8.0 g/10 min.

Preferably, the second polyethylene PE2 has a melting temperature T_m of at most 118 °C as measured by ISO 11357; preferably, of at most 115 °C.

Preferably, the second polyethylene PE2 is metallocene-catalysed or is Ziegler-Natta-catalysed; in some aspects, the second polyethylene PE2 is metallocene-catalysed.

Preferably, the second polyethylene PE2 is a polyethylene copolymer, which is a copolymer of ethylene and at least one C₃-C₂₀ alpha-olefin, preferably propylene and/or 1-hexene.

In a preferred embodiment, the second polyethylene PE2 has a comonomer content expressed as the number of short chain branches (SCB) per 1,000 total carbons ranging from 3.0 branches/1000 C up to 15.0 or 20.0 branches/1000 C preferably from 4.0 to 20.0 branches/1000 C and more preferably from 5.0 to 15.0 branches/1000 C or from 10.0 to 20.0 branches/1000 C. Methods for the determination of SCB content are described in more detail herein.

In some aspects, the ratio of SCB in the second polyethylene PE2 to SCB in the first polyethylene PE1, referred to as SCB ratio, is greater than 1.0, preferably equal to or greater than 1.1, or equal to or greater than 1.2.

According to a third aspect, the present invention provides for an article comprising the polyolefin blend.

In a preferred embodiment, the article is selected from wherein the article of manufacture is a housewares food storage container, cooking utensil, plate, cup, cavity tray, drinking cup, measuring cup, strainer, turkey baster, non - food storage container, filing cabinet, cabinet drawer, general storage device, organizer, tote, sweater box, rigid packaging, deli container, deli container lid, dairy container, dairy container lid, personal care product bottle and jar, furniture, furniture component, building material, building container components, film, sheet, fiber, bag, yarn and fabric blister, or clamshell. In some aspects, the article is selected from a film and/or a sheet.

In an embodiment, the article is a film or a sheet with a thickness ranging from 2 μm to 2.0 mm.

In some aspects, the article is a film, with a thickness ranging from 2 to 500 μm; for example, from 20 to 300 μm or from 30 to 200 μm. Preferably, the film is a stretched film with a thickness ranging from 2 to 10 μm; such as from 3 to 6 μm. The measurements are made using a micrometer.

In some aspects, the article is a film or a sheet with a thickness ranging from 400 μm and 2.5 mm; preferably, from 500 μm to 2.0 mm. The measurements are made using a micrometer.

In an embodiment, the article is a thermoformed sheet with a thickness of at least 1 mm; preferably, ranging from 1 mm to 5 mm.

In an embodiment, the article is selected from an extruded article, a blow-molded article, an injection-molded article or a compression molded article.

According to a fourth aspect, the invention provides for a process to produce the article according to the third aspect, wherein the process comprises the steps of:

- providing from 2 wt.% to 49 wt.% of a first polyethylene PE1 being a high-density polyethylene with a density of at least 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of $23 \text{ }^\circ\text{C}$; and a melt index (MI2) of at most 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of $190 \text{ }^\circ\text{C}$ and under a load of 2.16 kg ;
- providing from 51 wt.% to 98 wt.% of a second polyethylene PE2, wherein the second polyethylene PE2 is having a density ranging from 0.890 to less than 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of $23 \text{ }^\circ\text{C}$; and a melt index (MI2) ranging from 0.1 to 20.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of $190 \text{ }^\circ\text{C}$ and under a load of 2.16 kg ; wherein the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is equal or greater than 1;
- dry blending the first and the second polyethylene PE2; and
- forming the article to obtain an article having an oxygen permeability coefficient (PO_2) ranging from 2.04×10^{-16} to $9.18 \times 10^{-16} \text{ mol}\cdot\text{m/m}^2\cdot\text{s}\cdot\text{Pa}$ as measured by ASTM D3985-17 and/or a water vapor transmission rate (WVTR) of at most $10.42 \times 10^{-6} \text{ g}/(\text{m}^2\cdot\text{s})$ as measured by ASTM F1249-20.

Preferably, the step of forming is performed by extrusion, film casting, film blowing, blow-molding an injection-molding or a compression molding.

According to a fifth aspect, the invention provides for the use of a polyolefin blend according to the first aspect for the manufacture of an article; preferably, an article according to the third aspect. Preferably, the article is a film and/or a sheet.

Brief Description of the Drawings

Figure 1 is a graph showing the DSC performed for S1, S2 and S4.

Figure 2 is a graph showing the DSC performed for S1, S3, S5 and S6.

Figure 3 depicts the tensile test results for the films of the examples.

Figure 4 is the magnified low- ϵ portion of the tensile test results depicted in Figure 3.

Figure 5 represents the oxygen permeability coefficient of the examples.

Figures 6 and 7 concern the visual assessment of the transparency of films produced from the polyolefin blends of the invention compared to pure LLDPE film.

Figure 8 reports the transmittance of films produced from the polyolefin blends of the invention compared to pure LLDPE film.

Detailed Description of the Invention

When describing the polymers, polyolefin blends, articles such as films and/or sheets, uses and processes of the invention, the terms employed are to be construed in accordance with the following definitions, unless a context dictates otherwise.

For the purpose of the invention, the following definitions are given:

As used herein, the term "catalyst" refers to a substance that causes a change in the rate of a polymerization reaction.

As used herein, a "polymer" is a polymeric compound prepared by polymerizing monomers, whether of the same or of a different type. The generic term polymer thus embraces the term homopolymer, usually employed to refer to polymers prepared from only one type of monomer, and the terms copolymer and interpolymer as defined below.

As used herein, a "copolymer", "interpolymer" and like terms mean a polymer prepared by the polymerization of at least two different types of monomers. These generic terms include polymers prepared from two or more different types of monomer, *e.g.* terpolymers, tetrapolymers, etc.

As used herein, "blend", "polymer blend" and like terms refer to a composition of two or more compounds, preferably, two or more polymers or one polymer with at least one other compound.

As used herein, the term "melt blending" involves the use of shear force, extensional force, compressive force, ultrasonic energy, electromagnetic energy, thermal energy or combinations

comprising at least one of the foregoing forces or forms of energy and is conducted in processing equipment wherein the aforementioned forces are exerted by a single screw, multiple screws, intermeshing co-rotating or counter-rotating screws, non-intermeshing co-rotating or counter-rotating screws, reciprocating screws, screws with pins, barrels with pins, rolls, rams, helical rotors, or combinations comprising at least one of the foregoing.

As used herein the terms “polyethylene” (PE) and “ethylene polymer” may be used synonymously. The term “polyethylene” encompasses homopolyethylene as well as copolymer of ethylene which can be derived from ethylene and a comonomer such as one or more selected from the group consisting of C₃-C₂₀ alpha-olefins, such as 1-butene, 1-propylene, 1-pentene, 1-hexene, 1-octene.

The terms “polyethylene resin” as used herein refers to polyethylene fluff or powder that is extruded, and/or melted and/or pelletized and can be produced through compounding and homogenizing of the polyethylene resin as taught herein, for instance, with mixing and/or extruder equipment. As used herein, the term “polyethylene” may be used as a shorthand for “polyethylene resin”.

The term “fluff” or “powder” as used herein refers to polymer material with the hard catalyst particle at the core of each grain and is defined as the polymer material after it exits the polymerization reactor (or the final polymerization reactor in the case of multiple reactors connected in series).

Under normal production conditions in a production plant, it is expected that the melt index (MI₂) will be different for the fluff than for the polyethylene resin. Under normal production conditions in a production plant, it is expected that the density will be slightly different for the fluff, than for the polyethylene resin. Unless otherwise indicated, density and melt index for the polyethylene resin refer to the density and melt index as measured on the polyethylene resin as defined above.

The terms "comprising", "comprises" and "comprised of" as used herein are synonymous with "including", "includes" or "containing", "contains", and are inclusive or open-ended and do not exclude additional, non-recited members, elements or method steps. The terms "comprising", "comprises" and "comprised of" also include the term “consisting of”.

The polyolefin blends of the present invention and methods of making and using the same can “comprise,” “consist essentially of,” or “consist of” particular elements, ingredients, components, compositions, *etc.* disclose throughout the specification. With respect to the transitional phrase “consisting essentially of,” in one non-limiting aspect a basic and novel characteristic of the polyolefin blends of the present invention are their improved balance of barrier properties (such as oxygen permeability and/or water vapor transmission rate), mechanical properties (such as modulus of elasticity and/or tensile strength at break and/or elongation at break), and/or optical properties (such as transparency).

The terms “about” or “approximately” are defined as being close to as understood by one of ordinary skill in the art. In non-limiting embodiment, the terms are defined to be within 10%, preferably within 5%, preferably within 1%, or preferably within 0.5%.

The terms “wt.%,” “vol.%,” or “mol.%,” refers to a weight, volume, or molar percentage of a component, respectively, based on the total weight, the total volume of material, or total moles, that includes the component. In a non-limiting example, 10 grams of component in 100 grams of the material is 10 wt.% of component.

The term “substantially” and its variations are defined to include ranges within 10%, within 5%, within 1%, or within 0.5%.

The use of the words “a” or “an” when used in conjunction with any of the terms “comprising,” “including,” “containing,” or “having” in the claims, or the specification, may mean “one,” but it is also consistent with the meaning of “one or more,” “at least one,” and “one or more than one.”

The recitation of numerical ranges by endpoints includes all integer numbers and, where appropriate, fractions subsumed within that range (e.g. 1 to 5 can include 1, 2, 3, 4 and 5 when referring to, preferably, a number of elements, and can also include 1.5, 2, 2.75 and 3.80, when referring to, preferably, measurements). The recitation of endpoints also includes the recited endpoint values themselves (e.g. from 1.0 to 5.0 includes both 1.0 and 5.0). Any numerical range recited herein is intended to include all sub-ranges subsumed therein.

The terms “virgin polyethylene” are used to denote a polyethylene directly obtained from a polymerization plant. The terms “directly obtained” is meant to include that the polyethylene may optionally be passed through a pelletization step or an additivation step or both.

The terms “Post Consumer Resin”, which may be abbreviated as “PCR”, is used to denote a component of waste.

Throughout the present application, the terms “polyethylene” and “ethylene polymer” may be used synonymously.

The invention provides for a polyolefin blend comprising:

- from 2 wt.% to 49 wt.% of a first polyethylene PE1 based on the total weight of the polyolefin blend; the first polyethylene PE1 being a high-density polyethylene with a density of at least 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of $23 \text{ }^\circ\text{C}$; and a melt index (MI2) of at most 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of $190 \text{ }^\circ\text{C}$ and under a load of 2.16 kg ; and
- from 51 wt.% to 98 wt.% of a second polyethylene PE2 based on the total weight of the polyolefin blend; the second polyethylene PE2 having a density ranging from 0.890 to less than 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of $23 \text{ }^\circ\text{C}$; and a melt index (MI2) ranging from 0.1 to 20.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg ;

wherein the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is equal or greater than 1; and wherein the polyolefin blend has an oxygen permeability coefficient (PO_2) ranging from 2.04×10^{-16} to $9.18 \times 10^{-16} \text{ mol}\cdot\text{m} / \text{m}^2\cdot\text{s}\cdot\text{Pa}$ as measured by ASTM D3985-17 and/or a water vapor transmission rate (WVTR) of at most $10.42 \times 10^{-6} \text{ g}/(\text{m}^2\cdot\text{s})$ as measured by ASTM F1249-20.

The invention also provides for a process to produce a polyolefin blend; the process comprising the following steps:

- providing from 2 wt.% to 49 wt.% of a first polyethylene PE1 being a high-density polyethylene with a density of at least 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of $23 \text{ }^\circ\text{C}$; and a melt index (MI2) of at most 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of $190 \text{ }^\circ\text{C}$ and under a load of 2.16 kg ;
- providing from 51 wt.% to 98 wt.% of a second polyethylene PE2, wherein the second polyethylene PE2 is having a density ranging from 0.890 to less than 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of $23 \text{ }^\circ\text{C}$; and a melt index (MI2) ranging from 0.1 to 20.0 g/10 min as determined according to ISO 1133-1:2011 at a

temperature of 190 °C and under a load of 2.16 kg; wherein the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is equal or greater than 1, and

- blending the first and the second polyethylene PE2 to obtain a polyolefin blend having an oxygen permeability coefficient (PO_2) ranging from 2.04×10^{-16} to 9.18×10^{-16} mol·m / m²·s·Pa as measured by ASTM D3985-17 and/or a water vapor transmission rate (WVTR) of at most 10.42×10^{-6} g/(m²·s) as measured by ASTM F1249-20.

The blend and the process to produce a polyolefin blend will be described jointly.

The Polyolefin Blend

The polyolefin blend is selected from a blend of virgin polyolefins, a blend of post-consumer polyolefins and a blend of one or more virgin polyolefins and one or more post-consumer polyolefins. In some aspects, the polyolefin blend is selected from a blend of virgin polyolefins, i.e. both the first polyethylene PE1 and the second polyethylene PE2 are virgin polyolefins.

The first polyethylene PE1 and/or the second polyethylene PE2 is selected from a virgin polyethylene resin, a polyethylene post-consumer resin and a blend of a virgin polyethylene resin and a polyethylene post-consumer resin. Preferably, one or more selected from the first polyethylene PE1 and the second polyethylene PE2 is or comprises a post-consumer resin.

In some aspects, the total content of the post-consumer resins (PCR_T) in the polyolefin blend ranges is at least 2 wt.% based on the total weight of the polyolefin blend; preferably, at least 10 wt.%; preferably, at least 25 wt.%; preferably, at least 35 wt.%. Preferably, the post-consumer resin is selected to comply with the food-contact requirement as determined by FDA 1771520, that specifies the hexane amount allowed in a polymer for use in food-contact applications.

Preferably, one or more selected from the first polyethylene PE1 and the second polyethylene PE2 is metallocene-catalysed or is Ziegler-Natta-catalysed; in some aspects, one or more selected from the first polyethylene PE1 and the second polyethylene PE2 is metallocene-catalysed.

The polyolefin blend has a melt index (MI2) of at most 25.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg; preferably, of at most 20.0 g/10 min; preferably, of at most 15.0 g/10 min; preferably, of at most 10.0 g/10 min;

preferably, of at most 9.0 g/10 min; preferably, of at most 8.0 g/10 min; preferably, of at most 7.0 g/10 min; preferably, of at most 6.0 g/10 min; preferably, of at most 5.0 g/10 min; preferably, of at most 4.0 g/10 min. The value of MI2 is obtained without a degradation treatment.

The polyolefin blend has a melt index (MI2) of at least 0.1 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg; preferably, at least 0.2 g/10 min; preferably, at least 0.3 g/10 min; preferably, at least 0.4 g/10 min; preferably, at least 0.5 g/10 min; preferably, at least 0.8 g/10 min; preferably, at least 1.0 g/10 min; preferably, at least 1.2 g/10 min; preferably, at least 1.5 g/10 min. The value of MI2 is obtained without a degradation treatment.

The polyolefin blend has a melt index (MI2) ranging from 0.1 to 25.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg; preferably, ranging from 0.2 to 20.0 g/10 min; preferably, ranging from 0.3 to 15.0 g/10 min; preferably, ranging from 0.4 to 10.0 g/10 min; preferably, ranging from 0.5 to 9.0 g/10 min; preferably, ranging from 0.8 to 8.0 g/10 min; preferably, ranging from 1.0 to 7.0 g/10 min; preferably, ranging from 1.2 to 6.0 g/10 min; preferably, ranging from 1.5 to 5.0 g/10 min; preferably, ranging from 1.0 to 4.0 g/10 min. The value of MI2 is obtained without a degradation treatment.

In some aspect wherein the production of a cast film is targeted; the polyolefin blend has a melt index (MI2) ranging from 1.0 to 8.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg; preferably, ranging from 1.5 to 7.0 g/10 min; preferably, ranging from 2.0 to 6.0 g/10 min; preferably, ranging from 3.0 to 5.0 g/10 min. The value of MI2 is obtained without a degradation treatment.

In some aspects wherein the production of a blown film is targeted; the polyolefin blend has a melt index (MI2) ranging from 0.1 to 4.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg; preferably, ranging from 0.5 to 3.0 g/10 min; preferably, ranging from 0.7 to 2.0 g/10 min; preferably, ranging from 0.8 to 1.5 g/10 min. The value of MI2 is obtained without a degradation treatment.

The first polyethylene PE1 and the second polyethylene PE2 are selected so that the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is equal or greater than 1.0; i.e.:

$$\frac{MI2(PE1)}{MI2(PE2)} \geq 1.0$$

In some aspects, the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is equal to or greater than 1.1.

In some aspects, the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is at most 1000; preferably, at most 500; preferably, at most 200; preferably, at most 100; preferably, at most 80; preferably, at most 50, preferably, at most 35, preferably, at most 25, preferably, at most 20.

In some aspects, the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is ranging from 1.0 to 1000; preferably, from 1.0 to 500; preferably, from 1.0 to 200; preferably, from 1.0 to 100; preferably, from 1.0 to 80; preferably, from 1.0 to 50; preferably, from 1.0 to 30; preferably, from 1.0 to 25; preferably, from 1.0 to 20; preferably, from 1.1 to 50.

In some aspects, at least one selected from the first polyethylene PE1 and the second polyethylene PE2 has an Mw/Mn ranging from 1.5 to 6.0 as determined by GPC; preferably from 1.8 to 5.5; preferably from 2.0 to 5.0; preferably from 2.1 to 4.5.

In some aspects, the polyolefin blend comprises from 3 to 45 wt.% of the first polyethylene PE1 based on the total weight of the polyolefin blend, and from 35 to 97 wt.% of the second polyethylene PE2; preferably, from 5 to 40 wt.% of the first polyethylene and from 60 to 95 wt. % of the second polyethylene PE2; preferably, from 8 to 30 wt.% of the first polyethylene and from 70 to 92 wt. % of the second polyethylene PE2; preferably, from 8 to 20 wt.% of the first polyethylene and from 80 to 92 wt. % of the second polyethylene PE2; preferably, from 10 to 20 wt.% of the first polyethylene and from 80 to 90 wt. % of the second polyethylene PE2.

The polyolefin blend has an oxygen permeability coefficient (PO_2) of at most 9.18×10^{-16} mol·m/m²·s·Pa as measured in accordance with ASTM D3985-17 (i.e. at most 180 cm³ (STP) mm / m² day at 1 atm); preferably, at most 8.67×10^{-16} mol·m/m²·s·Pa (i.e. at most 170 cm³ (STP) mm / m² day at 1 atm); preferably, at most 8.16×10^{-16} mol·m/m²·s·Pa (i.e. at most 160 cm³ (STP) mm / m² day at 1 atm); preferably, at most 7.65×10^{-16} mol·m/m²·s·Pa (i.e. at most 150 cm³ (STP) mm / m² day at 1 atm); preferably, at most 7.14×10^{-16} mol·m/m²·s·Pa (i.e. at most 140 cm³ (STP) mm / m² day at 1 atm).

The polyolefin blend has an oxygen permeability coefficient (PO_2) of at least 2.04×10^{-16} mol·m/m²·s·Pa as measured by ASTM D3985-17 (i.e. at least 40 cm³ (STP) mm / m² day at 1 atm); preferably, at least 2.30×10^{-16} mol·m/m²·s·Pa (i.e. at least 45 cm³ (STP) mm / m² day at 1 atm); preferably, at least 2.55×10^{-16} mol·m/m²·s·Pa (i.e. at least 50 cm³ (STP) mm / m² day at 1 atm).

The polyolefin blend has an oxygen permeability coefficient (PO_2) ranging from 2.04×10^{-16} to 9.18×10^{-16} mol·m/m²·s·Pa as measured by ASTM D3985-17; preferably, ranging from 2.30×10^{-16} to 7.65×10^{-16} mol·m/m²·s·Pa; preferably, ranging from 2.55×10^{-16} to 7.14×10^{-16} mol·m/m²·s·Pa.

Preferably, the polyolefin blend has a water vapor transmission rate (WVTR) of at most 10.42×10^{-6} g/(m²·s) as measured by ASTM F1249-20; preferably, at most 9.84×10^{-6} g/(m²·s); preferably, at most 9.26×10^{-6} g/(m²·s); preferably, at most 8.68×10^{-6} g/(m²·s); preferably, at most 8.10×10^{-6} g/(m²·s).

Preferably, the polyolefin blend has a water vapor transmission rate (WVTR) of at least 1.74×10^{-6} g/(m²·s) as measured by ASTM F1249-20; preferably, at least 2.31×10^{-6} g/(m²·s); preferably, at least 2.89×10^{-6} g/(m²·s); preferably, at least 3.24×10^{-6} g/(m²·s); preferably, at least 3.47×10^{-6} g/(m²·s).

In some aspects, the polyolefin blend has a water vapor transmission rate (WVTR) ranging from 1.74×10^{-6} to 10.42×10^{-6} g/(m²·s) as measured in accordance with ASTM F1249-20 (i.e. ranging from 0.010 to 0.058 g/100 in²·day); preferably, from 2.08×10^{-6} to 9.84×10^{-6} g/(m²·s) (i.e. ranging from 0.012 to 0.055 g/100 in²·day); preferably, from 2.31×10^{-6} to 9.26×10^{-6} g/(m²·s) (i.e. ranging from 0.013 to 0.052 g/100 in²·day); preferably, from 2.89×10^{-6} to 8.68×10^{-6} g/(m²·s) (i.e. ranging from 0.016 to 0.048 g/100 in²·day); preferably, from 3.47×10^{-6} to 8.10×10^{-6} g/(m²·s) (i.e. ranging from 0.019 to 0.045 g/100 in²·day).

In some aspects, the polyolefin blend has a modulus of elasticity (E) ranging from 180 to 500 MPa, as measured by ISO 527-3 at 23 °C; preferably, ranging from 210 to 300 MPa.

In some aspects, the polyolefin blend has a tensile strength at break ranging from 15 to 100 MPa as measured in accordance with ASTM D638; preferably, ranging from 20 to 60 MPa.

In some aspects, the polyolefin blend has an elongation at break ranging from 300 to 800 % as measured in accordance with ASTM D638; preferably, from 500 to 800 %.

In some aspects, the polyolefin blend has a transmittance of at least 10% when measured of at 450 nm on a sample having a thickness of 350 μm ; preferably at least 12%; preferably at least 15%. The transmittance is measured using Evolution™ 350 UV-Vis Spectrophotometer made by ThermoFisher Scientific at 25 °C.

Preferably, the polyolefin blend has a specific heat capacity (ΔH_m) ranging from 90 to 150 J/g as measured by differential scanning calorimetry (DSC); preferably, from 95 to 140; preferably, from 100 to 135; or from 100 to 130.

In some aspects, the polyolefin blend has an oxygen permeability coefficient (PO_2) of 2.04×10^{-16} to 9.18×10^{-16} $\text{mol}\cdot\text{m}/\text{m}^2\cdot\text{s}\cdot\text{Pa}$ as measured by ASTM D3985-17 or a water vapor transmission rate (WVTR) of at most 10.42×10^{-6} $\text{g}/(\text{m}^2\cdot\text{s})$ as measured by ASTM F1249-20; in combination with one or more selected from:

- a modulus of elasticity (E) ranging from 180 to 500 MPa, as measured by ISO 527-3 at 23 °C;
- a tensile strength at break ranging from 15 to 100 MPa as measured in accordance with ASTM D638;
- an elongation at break ranging from 300 to 800 % as measured in accordance with ASTM D638;
- a specific heat capacity (ΔH_m) ranging from 90 to 150 J/g as measured by differential scanning calorimetry (DSC);
- a transmittance of at least 10% when measured at 450 nm on a sample having a thickness of 350 μm .

In some aspects, the polyolefin blend has an oxygen permeability coefficient (PO_2) of 2.04×10^{-16} to 9.18×10^{-16} $\text{mol}\cdot\text{m}/\text{m}^2\cdot\text{s}\cdot\text{Pa}$ as measured by ASTM D3985-17 and a water vapor transmission rate (WVTR) of at most 10.42×10^{-6} $\text{g}/(\text{m}^2\cdot\text{s})$ as measured by ASTM F1249-20; in combination with one or more selected from:

- a modulus of elasticity (E) ranging from 180 to 500 MPa, as measured by ISO 527-3 at 23 °C;
- a tensile strength at break ranging from 15 to 100 MPa as measured in accordance with ASTM D638;
- an elongation at break ranging from 300 to 800 % as measured in accordance with ASTM D638;

- a specific heat capacity (ΔH_m) ranging from 90 to 150 J/g as measured by differential scanning calorimetry (DSC);
- a transmittance of at least 10% when measured at 450 nm on a sample having a thickness of 350 μm .

Preferably, the polyolefin blend has an oxygen permeability coefficient (PO_2) of 2.04×10^{-16} to 9.18×10^{-16} $\text{mol}\cdot\text{m}/\text{m}^2\cdot\text{s}\cdot\text{Pa}$ as measured by ASTM D3985-17, a water vapor transmission rate (WVTR) of at most 10.42×10^{-6} $\text{g}/(\text{m}^2\cdot\text{s})$ as measured by ASTM F1249-20; a modulus of elasticity (E) ranging from 180 to 500 MPa, as measured by ISO 527-3 at 23 °C; a tensile strength at break ranging from 15 to 100 MPa as measured in accordance with ASTM D638; an elongation at break ranging from 300 to 800 % as measured in accordance with ASTM D638; and a specific heat capacity (ΔH_m) ranging from 90 to 150 J/g as measured by differential scanning calorimetry (DSC).

Preferably, the polyolefin blend has an oxygen permeability coefficient (PO_2) of 2.04×10^{-16} to 9.18×10^{-16} $\text{mol}\cdot\text{m}/\text{m}^2\cdot\text{s}\cdot\text{Pa}$ as measured by ASTM D3985-17, a water vapor transmission rate (WVTR) of at most 10.42×10^{-6} $\text{g}/(\text{m}^2\cdot\text{s})$ as measured by ASTM F1249-20; a modulus of elasticity (E) ranging from 180 to 500 MPa, as measured by ISO 527-3 at 23 °C; a tensile strength at break ranging from 15 to 100 MPa as measured in accordance with ASTM D638; an elongation at break ranging from 300 to 800 % as measured in accordance with ASTM D638; a specific heat capacity (ΔH_m) ranging from 90 to 150 J/g as measured by differential scanning calorimetry (DSC) and a transmittance of at least 10% when measured at 450 nm on a sample having a thickness of 350 μm .

The First Polyethylene (PE1)

The first polyethylene PE1 is defined to be a high-density polyethylene (HDPE) i.e. a polyethylene having a density of at least 0.940 g/cm^3 .

The first polyethylene PE1 is present in the polyolefin blend in a content of at most 49 wt.% based on the total weight of the polyolefin blend; preferably, in a content of at most 40 wt.%; preferably, in a content of at most 35 wt.%; preferably, in a content of at most 30 wt.%; preferably, in a content of at most 25 wt.%; preferably, in a content of at most 22 wt.%; preferably, in a content of at most 20 wt.%.

The first polyethylene PE1 is present in the polyolefin blend in a content of at least 2 wt.% based on the total weight of the polyolefin blend; preferably, in a content of at least 3 wt.%;

preferably, in a content of at least 4 wt.%; preferably, in a content of at least 5 wt.%; preferably, in a content of at least 6 wt.%; preferably, in a content of at least 8 wt.%; preferably, in a content of at least 10 wt.%.

The first polyethylene PE1 is present in the polyolefin blend in a content ranging from 2 to 49 wt.% based on the total weight of the polyolefin blend; preferably, in a content ranging from 5 to 40 wt.%; preferably, in a content ranging from 6 to 35 wt.%; preferably, in a content ranging from 8 to 30 wt.%; preferably, in a content ranging from 8 to 25 wt.%; preferably, in a content ranging from 8 to 22 wt.%. preferably, in a content ranging from 10 to 20 wt.% or from 10 to 30 wt.%.

The first polyethylene PE1 can be selected from an ethylene homopolymer, a copolymer of ethylene with one or more comonomers selected from C₃-C₂₀ alpha-olefins and any mixture thereof.

In an example of the invention, the first polyethylene PE1 is a homopolymer of ethylene. An ethylene homopolymer according to this invention has less than 0.2 wt.%, preferably, less than 0.1 wt.%, more preferably, less than 0.05 wt.% or preferably, less than 0.005 wt.%, of alpha-olefins other than ethylene in the polymer. In some aspects, no other alpha-olefins are detectable. Accordingly, when the polyethylene is a homopolymer of ethylene, the comonomer content in the polyethylene is less than 0.2 wt.%, preferably, less than 0.1 wt.%, preferably, less than 0.05 wt.% or preferably, less than 0.005 wt.% based on the total weight of the polyethylene.

The first polyethylene PE1 may be a copolymer of ethylene and at least one comonomer, or a mixture of an homopolymer of ethylene and a copolymer of ethylene and at least one comonomer. Suitable comonomers can be selected from the group consisting of aliphatic C₃-C₂₀ alpha-olefins. Examples of suitable aliphatic C₃-C₂₀ alpha-olefins include propylene, 1-butene, 1-pentene, 4-methyl-1-pentene, 1-hexene, 1-octene, 1-decene, 1-dodecene, 1-tetradecene, 1-hexadecene, 1-octadecene and 1-eicosene. Preferably, the comonomer is propylene or 1-hexene. Preferably, the comonomer is selected from propylene and/or 1-hexene.

In an example, the first polyethylene resin PE1 is an ethylene copolymer. The ethylene copolymer comprises at least 0.1 wt.% of one or more comonomers, preferably at least 1 wt.%. The ethylene copolymer comprises up to 10 wt.% of one or more comonomers or preferably

up to 6 wt.%. The content of comonomer is selected by the person skilled in the art to obtain the targeted density and SCB level. Preferably, the ethylene copolymer is a copolymer of propylene and ethylene.

Preferably, the first polyethylene PE1 has a comonomer content expressed as the number of short chain branches (SCB) per 1,000 total carbons ranging from 0 branch/1000 C up to 3.0 branches/1000 C preferably from 0.1 to 2.5 branches/1000 C or preferably from 0.2 to 2.0 branches/1000 C. Methods for the determination of SCB content are described in more detail herein.

The first polyethylene PE1 is a high-density polyethylene with a density of at least 0.940 g/cm³ as determined according to ISO 1183 at a temperature of 23 °C; preferably, of at least 0.942 g/cm³; preferably, of at least 0.945 g/cm³; preferably, of at least 0.948 g/cm³; preferably, of at least 0.950 g/cm³.

In some aspects, the first polyethylene PE1 has a density of at most 0.970 g/cm³ as determined according to ISO 1183 at a temperature of 23 °C; preferably, of at most 0.968 g/cm³; preferably, of at most 0.965 g/cm³; preferably, of at most 0.962 g/cm³; preferably, of at most 0.960 g/cm³.

In some aspects, the first polyethylene PE1 has a density ranging from 0.940 to 0.970 g/cm³ as determined according to ISO 1183 at a temperature of 23 °C; preferably, ranging from 0.942 to 0.968 g/cm³; preferably, ranging from 0.945 to 0.965 g/cm³; preferably, ranging from 0.948 to 0.962 g/cm³; preferably, ranging from 0.950 to 0.960 g/cm³ or from 0.950 to 0.970 g/cm³.

The first polyethylene PE1 has a melt index (MI2) of at most 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg; preferably, of at most 400.0 g/10 min; preferably, of at most 300.0 g/10 min; preferably, of at most 200.0 g/10 min; preferably, of at most 100.0 g/10 min; preferably, of at most 90.0 g/10 min; preferably, of at most 85.0 g/10 min; preferably, of at most 80.0 g/10 min; preferably, of at most 75.0 g/10 min; preferably, of at most 70.0 g/10 min. The value of MI2 is obtained without a degradation treatment.

Preferably, the first polyethylene PE1 has a melt index (MI2) of at least 0.1 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg; preferably, at least 0.5 g/10 min; preferably, at least 0.8 g/10 min; preferably, at least 1.0

g/10 min; preferably, at least 2.0 g/10 min; preferably, at least 3.0 g/10 min; preferably, at least 3.5 g/10 min. The value of MI2 is obtained without a degradation treatment.

Preferably, the first polyethylene PE1 has a melt index (MI2) ranging from 0.1 to 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg; preferably, ranging from 0.5 to 300.0 g/10 min; preferably, ranging from 0.8 to 200.0 g/10 min; preferably, ranging from 1.0 to 100.0 g/10 min; preferably, ranging from 2.0 to 80.0 g/10 min; preferably, ranging from 3.0 to 70.0 g/10 min; preferably, ranging from 3.5 to 90.0 g/10 min. The value of MI2 is obtained without a degradation treatment.

Preferably, the first polyethylene PE1 has a melting temperature T_m of at least 120 °C as measured by ISO 11357; preferably, at least 122 °C; or preferably, at least 125 °C.

In some aspects, the first polyethylene PE1 is having a melting temperature of at least 122 °C as measured by ISO 11357, and the melting temperature of the first polyethylene PE1 is greater than the melting temperature of the second polyethylene PE2. In such a case, the polyolefin blend shows 2 peaks by DSC.

Preferably, the first polyethylene PE1 is metallocene-catalysed or is Ziegler-Natta- catalysed; preferably, the first polyethylene PE1 is metallocene-catalysed.

In some aspects, the first polyethylene PE1 has an M_w/M_n ranging from 1.5 to 6.0 as determined by GPC; preferably from 1.8 to 5.5; preferably from 2.0 to 5.0; preferably from 2.1 to 4.8, or from 2.1 to 4.5; or preferably from 2.5 to 4.8 or from 2.8 to 4.5.

In some aspects, the first polyethylene PE1 is present in the polyolefin blend in a content ranging from 2 wt. % to 49 wt. % based on the total weight of the polyolefin blend; and has a density ranging from 0.945 to 0.965 g/cm³ as determined according to ISO 1183 at a temperature of 23°C; and has a melt index ranging from 1.0 to 100.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg; and has a melting temperature of at least 120°C as measured by ISO 11357; and has a comonomer content expressed as the number of short chain branches (SCB) per 1,000 total carbons ranging from 0 branch/1000 C up to 3.0 branches /1000 C.

In some aspects, the first polyethylene PE1 is present in the polyolefin blend in a content ranging from 2 wt. % to 49 wt. % based on the total weight of the polyolefin blend; and the first polyethylene PE1:

- is a high-density polyethylene with a density ranging from 0.940 to 0.965 g/cm³ as determined according to ISO 1183 at a temperature of 23°C; and
- has a melt index (MI2) ranging from 0.1 to 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg; and
- has a melting temperature of at least 120°C as measured by ISO 11357; and
- is selected from an ethylene homopolymer, a copolymer of ethylene with one or more comonomers selected from C₃-C₂₀ alpha-olefins and any mixture thereof.

In a further aspect, the first polyethylene PE1 is present in the polyolefin blend in a content ranging from 2 wt. % to 49 wt. % based on the total weight of the polyolefin blend; and the first polyethylene PE1:

- is a high-density polyethylene with a density ranging from 0.940 to 0.965 g/cm³ as determined according to ISO 1183 at a temperature of 23°C; and
- has a melt index (MI2) ranging from 0.1 to 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg; and
- has a melting temperature of at least 120°C as measured by ISO 11357; and
- has an Mw/Mn ranging from 1.5 to 6.0; and
- is selected from an ethylene homopolymer, a copolymer of ethylene with one or more comonomers selected from C₃-C₂₀ alpha-olefins and any mixture thereof;
- in some aspects, the first polyethylene PE1 is metallocene-catalysed or is Ziegler-Natta-catalysed.

In a further aspect, the first polyethylene PE1 is present in the polyolefin blend in a content ranging from 2 wt. % to 49 wt. % based on the total weight of the polyolefin blend; and the first polyethylene PE1:

- is a high-density polyethylene with a density ranging from 0.940 to 0.965 g/cm³ as determined according to ISO 1183 at a temperature of 23°C; and
- has a melt index (MI2) ranging from 0.1 to 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg; and
- has a melting temperature of at least 120°C as measured by ISO 11357; and
- has an Mw/Mn ranging from 1.5 to 6.0; and
- is a copolymer of ethylene with one or more comonomers selected from C₃-C₂₀ alpha-olefins and any mixture thereof; and

- has a comonomer content expressed as the number of short chain branches (SCB) per 1,000 total carbons ranging from 0 branch/1000 C up to 3.0 branches /1000 C;
- the first polyethylene PE1 can be a metallocene-catalysed or is Ziegler-Natta- catalysed.

An example of commercially available PE1 suitable for the invention is a metallocene-catalyzed HDPE having MI2 of 4.0 and commercially available at TOTAL under the commercial denomination Lumicene M6040. Other suitable commercially available PE1 suitable for the invention are Lumicene M5220, Lumicene M5220M, Lumicene M5222, Lumicene M4707EP, Lumicene M5510EP, Lumicene M4040EP, Lumicene M6091 commercially available at TOTAL.

The Second Polyethylene (PE2)

The second polyethylene PE2 is one or more selected from medium-density polyethylene (MDPE), linear low-density polyethylene (LLDPE) and low-density polyethylene (LDPE). In an embodiment, the second polyethylene PE2 is one or more selected from linear low-density polyethylene (LLDPE) and low-density polyethylene (LDPE). Preferably, the second polyethylene PE2 is or comprises a linear low-density polyethylene (LLDPE). Preferably, the second polyethylene (PE2) comprises LLDPE, wherein the content of LLDPE is at least 70 wt.% of the total weight of the second polyethylene PE2; preferably, at least 80 wt.%; preferably, at least 90 wt.%.

The second polyethylene PE2 is present in the polyolefin blend in a content of at least 51 wt.% based on the total weight of the polyolefin blend; preferably, in a content of at least 60 wt.%; preferably, in a content of at least 65 wt.%; preferably, in a content of at least 70 wt.%; preferably, in a content of at least 75 wt.%; preferably, in a content of at least 78 wt.%; preferably, in a content of at least 80 wt.%.

The second polyethylene PE2 is present in the polyolefin blend in a content of at most 98 wt.% or at most 95 wt.% based on the total weight of the polyolefin blend; preferably, in a content of at most 94 wt.%; preferably, in a content of at most 92 wt.%; preferably, in a content of at most 90 wt.%.

The second polyethylene PE2 is present in the polyolefin blend in a content ranging from 51 to 98 wt.% or from 51 to 95 wt.% based on the total weight of the polyolefin blend; preferably, in a content ranging from 60 to 94 wt.%; preferably, in a content ranging from 65 to 94 wt.%;

preferably, in a content ranging from 70 to 92 wt.%; preferably, in a content ranging from 75 to 92 wt.%; preferably, in a content ranging from 78 to 92 wt.%. preferably, in a content ranging from 80 to 90 wt.% or from 70 to 90 wt.%

The second polyethylene PE2 has a density of at least 0.890 g/cm³ as determined according to ISO 1183 at a temperature of 23°C; preferably, of at least 0.900 g/cm³; preferably, of at least 0.905 g/cm³; preferably, of at least 0.910 g/cm³; preferably, of at least 0.915 g/cm³.

Preferably, the second polyethylene PE2 has a density of less than 0.940 g/cm³ as determined according to ISO 1183 at a temperature of 23°C; preferably, of at most 0.938 g/cm³; preferably, of at most 0.935 g/cm³; preferably, of at most 0.932 g/cm³; preferably, of at most 0.930 g/cm³.

Preferably, the second polyethylene PE2 has a density ranging from 0.890 to less than 0.940 g/cm³ as determined according to ISO 1183 at a temperature of 23°C; preferably, ranging from 0.900 to 0.938 g/cm³; preferably, ranging from 0.905 to 0.935 g/cm³; preferably, ranging from 0.910 to 0.932 g/cm³; preferably, ranging from 0.915 to 0.930 g/cm³ or from 0.910 to 0.935 g/cm³.

The second polyethylene PE2 has a melt index (MI2) of at most 20.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg; preferably, of at most 16.0 g/10 min; preferably, of at most 13.0 g/10 min; preferably, of at most 10.0 g/10 min; preferably, of at most 9.0 g/10 min; preferably, of at most 8.0 g/10 min; preferably, of at most 7.0 g/10 min; preferably, of at most 6.0 g/10 min; preferably, of at most 5.0 g/10 min; preferably, of at most 4.0 g/10 min. The value of MI2 is obtained without a degradation treatment.

The second polyethylene PE2 has a melt index (MI2) of at least 0.1 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg; preferably, at least 0.5 g/10 min; preferably, at least 0.8 g/10 min; preferably, at least 1.0 g/10 min; preferably, at least 1.2 g/10 min; preferably, at least 1.5 g/10 min. The value of MI2 is obtained without a degradation treatment.

The second polyethylene PE2 has a melt index (MI2) ranging from 0.1 to 20.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg; preferably, ranging from 0.5 to 16.0 g/10 min; preferably, ranging from 0.8 to 13.0 g/10 min; preferably, ranging from 1.0 to 10.0 g/10 min; preferably, ranging from 1.2 to 8.0 g/10

min; preferably, ranging from 1.0 to 5.0 g/10 min; preferably, ranging from 1.0 to 4.0 g/10 min; preferably, ranging from 0.8 to 8.0 g/10 min. The value of MI2 is obtained without a degradation treatment.

Preferably, the second polyethylene PE2 has a melting temperature T_m of at most 118°C as measured by ISO 11357; preferably, of at most 115°C.

Preferably, the second polyethylene PE2 is metallocene-catalysed or is Ziegler-Natta-catalysed; preferably, the second polyethylene PE2 is metallocene-catalysed.

In some aspects, the second polyethylene PE2 has an M_w/M_n ranging from 1.5 to 6.0 as determined by GPC; preferably from 1.8 to 5.5; preferably from 2.0 to 5.0; preferably from 2.0 to 4.8, or from 2.0 to 4.5; or preferably from 2.1 to 4.5 or from 2.1 to 4.0.

The second polyethylene PE2 is a copolymer of ethylene and at least one comonomer. Suitable comonomers can be selected from the group consisting of aliphatic C_3 - C_{20} alpha-olefins. Examples of suitable aliphatic C_3 - C_{20} alpha-olefins include propylene, 1-butene, 1-pentene, 4-methyl-1-pentene, 1-hexene, 1-octene, 1-decene, 1-dodecene, 1-tetradecene, 1-hexadecene, 1-octadecene and 1-eicosene. In some aspects, the comonomer is propylene or 1-hexene. In some aspects, the comonomer is selected from propylene and/or 1-hexene.

The second polyethylene resin PE2 is an ethylene copolymer. The ethylene copolymer comprises at least 0.1 wt.% of one or more comonomers, preferably at least 1 wt.%. The ethylene copolymer comprises up to 10 wt.% of one or more comonomers or preferably up to 6 wt.%. The content of comonomer is selected by the person skilled in the art to obtain the targeted density and SCB level.

Preferably, the second polyethylene PE2 has a comonomer content expressed as the number of short chain branches (SCB) per 1,000 total carbons of at least 3.0 branches /1000 C; preferably, at least 4.0 branches /1000 C; preferably, at least 5.0 branches /1000 C; preferably, at least 6.0 branches /1000 C; preferably, at least 6.0 branches /1000 C; preferably, at least 7.0 branches /1000 C; or, at least 8.0 branches /1000 C; or, at least 9.0 branches /1000 C; or, at least 10.0 branches /1000 C.

Preferably, the second polyethylene PE2 has a comonomer content expressed as the number of short chain branches (SCB) per 1,000 total carbons ranging from 3.0 branches /1000 C up to

20.0 branches /1000 C preferably from 4.0 to 20.0 branches /1000 C or preferably from 5.0 to 15.0 branches /1000 C or from 10.0 to 20.0 branches /1000 C. Methods for the determination of SCB content are described in more detail herein.

In some aspects the ratio of SCB in the second polyethylene PE2 to SCB in the first polyethylene PE1, referred to as SCB ratio, is greater than 1.0, preferably equal to or greater than 1.1, or equal to or greater than 1.2.

In some aspects, the second polyethylene PE2 is present in the polyolefin blend in a content ranging from 51 wt. % to 98 wt. % based on the total weight of the polyolefin blend; and the second polyethylene PE2 is having a density ranging from 0.910 to 0.935 g/cm³ as determined according to ISO 1183 at a temperature of 23°C; a melt index ranging from 0.8 to 8.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg; a melting temperature T_m of at most 118°C as measured by ISO 11357; and optionally, a content of linear low-density polyethylene LLDPE of at least 70 wt.% of the total weight of the second polyethylene PE2.

In some aspects, the second polyethylene PE2 is present in the polyolefin blend in a content ranging from 51 wt. % to 98 wt. % based on the total weight of the polyolefin blend; and the second polyethylene PE2 :

- is one or more selected from linear low-density polyethylene (LLDPE) and low-density polyethylene (LDPE); and
- has a density ranging from 0.890 to less than 0.940 g/cm³ as determined according to ISO 1183 at a temperature of 23°C; and
- has a melt index (MI2) ranging from 0.1 to 20.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg; and
- has a melting temperature of at most 118°C as measured by ISO 11357; and
- is a copolymer of ethylene with one or more comonomers selected from C₃-C₂₀ alpha-olefins and any mixture thereof
- optionally, has a content of linear low-density polyethylene LLDPE of at least 70 wt.% of the total weight of the second polyethylene PE2.

In a further embodiment, the second polyethylene PE2 is present in the polyolefin blend in a content ranging from 51 wt. % to 98 wt. % based on the total weight of the polyolefin blend; and the second polyethylene PE2 :

- is one or more selected from linear low-density polyethylene (LLDPE) and low-density polyethylene (LDPE); and
- has a density ranging from 0.890 to less than 0.940 g/cm³ as determined according to ISO 1183 at a temperature of 23°C; and
- has a melt index (MI2) ranging from 0.1 to 20.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg; and
- has a melting temperature of at most 118°C as measured by ISO 11357; and
- has an Mw/Mn ranging from 1.5 to 6.0; and
- is copolymer of ethylene with one or more comonomers selected from C₃-C₂₀ alpha-olefins and any mixture thereof;
- in some aspects metallocene-catalysed or is Ziegler-Natta- catalysed and/or has a content of linear low-density polyethylene LLDPE of at least 70 wt.% of the total weight of the second polyethylene PE2.

In a further embodiment, the second polyethylene PE2 is present in the polyolefin blend in a content ranging from 51 wt. % to 98 wt. % based on the total weight of the polyolefin blend; and the second polyethylene PE2:

- is one or more selected from linear low-density polyethylene (LLDPE) and low-density polyethylene (LDPE); and
- has a density ranging from 0.890 to less than 0.940 g/cm³ as determined according to ISO 1183 at a temperature of 23°C; and
- has a melt index (MI2) ranging from 0.1 to 20.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg; and
- has a melting temperature of at most 118°C as measured by ISO 11357; and
- has an Mw/Mn ranging from 1.5 to 6.0; and
- is a copolymer of ethylene with one or more comonomers selected from C₃-C₂₀ alpha-olefins and any mixture thereof; and
- has a comonomer content expressed as the number of short chain branches (SCB) per 1,000 total carbons ranging from 3.0 branches /1000 C up to 20.0 branches /1000 C;
- in some aspects, is metallocene-catalysed or is Ziegler-Natta- catalysed and/or has a content of linear low-density polyethylene LLDPE of at least 70 wt.% of the total weight of the second polyethylene PE2.

An example of commercially available PE2 suitable for the invention is a metallocene-catalyzed LLDPE having MI2 of 3.5 and commercially available at TOTAL under the commercial denomination Lumicene M1835. Commercially available PE2 suitable for the invention are Lumicene M1810EP, Lumicene M2310EP, Lumicene M2704EP, Lumicene M1810, Lumicene M2735, FE8000, 1022FN24, LD0304, LA0710 commercially available at TOTAL.

The Article

The present invention also provides for an article comprising the polyolefin blend and a process to produce such article.

Preferably, the article can be selected from a housewares food storage container, cooking utensil, plate, cup, cavity tray, drinking cup, measuring cup, strainer, turkey baster, non - food storage container, filing cabinet, cabinet drawer, general storage device, organizer, tote, sweater box, rigid packaging, deli container, deli container lid, dairy container, dairy container lid, personal care product bottle and jar, furniture, furniture component, building material, building container components, film, sheet, fiber, bag, yarn and fabric blister, or clamshell. In some aspects, the article is selected from a film and/or a sheet.

Preferably, the article is a film or a sheet with a thickness ranging from 2 μm to 2.0 mm.

In some aspects, the article is a film, with a thickness ranging from 2 to 500 μm ; form example, from 20 to 300 μm or from 30 to 200 μm . Preferably, the film is a stretched film with a thickness ranging from 2 to 10 μm ; such as from 3 to 6 μm . The measurements are made using a micrometer.

In some aspects, the article is a films or a sheet with a thickness ranging from 400 μm and 2.5 mm; preferably, from 500 μm to 2.0 mm. The measurements are made using a micrometer.

Preferably, the article is a thermoformed sheet with a thickness of at least 1 mm; preferably, ranging from 1 mm to 5 mm.

Preferably, the article is selected from an extruded article, a blow-molded article, an injection-molded article or a compression molded article.

The invention provides for a process to produce the article according to the third aspect, wherein the process comprises the steps of:

- providing from 2 wt. % to 49 wt. % of a first polyethylene PE1 being a high-density polyethylene with a density of at least 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of 23°C ; and a melt index (MI2) of at most 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg ;
- providing from 51 wt. % to 98 wt. % of a second polyethylene PE2, wherein the second polyethylene PE2 is having a density ranging from 0.890 to less than 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of 23°C ; and a melt index (MI2) ranging from 0.1 to 20.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg ; wherein the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is equal or greater than 1;
- dry blending the first and the second polyethylene PE2; and
- forming the article to obtain an article having an oxygen permeability coefficient (PO_2) ranging from 2.04×10^{-16} to $9.18 \times 10^{-16} \text{ mol}\cdot\text{m} / \text{m}^2\cdot\text{s}\cdot\text{Pa}$ as measured by ASTM D3985-17 and/or a water vapor transmission rate (WVTR) of at most $10.42 \times 10^{-6} \text{ g}/(\text{m}^2\cdot\text{s})$ as measured by ASTM F1249-20..

Preferably, the step of forming is performed by extrusion, film casting, film blowing, blow-molding an injection-molding or a compression molding.

Methods

The melt index (MI2) of polyethylene and blends of polyethylene is determined according to the method of standard ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg .

The density of polyethylene and blends of polyethylene is measured according to the method of standard ISO 1183 at a temperature of 23°C .

The molecular weight M_n (number average molecular weight), M_w (weight average molecular weight), M_z (z average molecular weight) and molecular weight distribution \bar{D} (M_w/M_n) and \bar{D}' (M_z/M_w) are determined by size exclusion chromatography (SEC) and in particular by gel permeation chromatography (GPC). Briefly, a GPC-IR5 from Polymer Char was used: 10 mg polyethylene sample is dissolved at 160°C in 10 mL of trichlorobenzene (technical grade) for 1 hour. Analytical conditions for the GPC-IR from Polymer Char are:

- Injection volume: +/- 0.4 mL;
- Automatic sample preparation and injector temperature: 160 °C;
- Column temperature: 145 °C;
- Detector temperature: 160 °C;
- Column set: 2 Shodex AT-806MS and 1 Styragel HT6E;
- Flow rate: 1 mL/min;
- Detector: IR5 Infrared detector (2800-3000 cm⁻¹);
- Calibration: Narrow standards of polystyrene (commercially available);
- Calculation for polyethylene: Based on Mark-Houwink relation ($\log_{10}(M_{PE}) = 0.965909 \times \log_{10}(M_{PS}) - 0.28264$); cut off on the low molecular weight end at $M_{PE} = 1000$;

The molecular weight averages used in establishing molecular weight/property relationships are the number average (M_n), weight average (M_w) and z average (M_z) molecular weight. These averages are defined by the following expressions and are determined from the calculated M_i :

$$M_n = \frac{\sum_i N_i M_i}{\sum_i N_i} = \frac{\sum_i W_i}{\sum_i W_i / M_i} = \frac{\sum_i h_i}{\sum_i h_i / M_i}$$

$$M_w = \frac{\sum_i N_i M_i^2}{\sum_i N_i M_i} = \frac{\sum_i W_i M_i}{\sum_i M_i} = \frac{\sum_i h_i M_i}{\sum_i M_i}$$

$$M_z = \frac{\sum_i N_i M_i^3}{\sum_i N_i M_i^2} = \frac{\sum_i W_i M_i^2}{\sum_i W_i M_i} = \frac{\sum_i h_i M_i^2}{\sum_i h_i M_i}$$

Here N_i and W_i are the number and weight, respectively, of molecules having molecular weight M_i . The third representation in each case (farthest right) defines how one obtains these averages from SEC chromatograms. h_i is the height (from baseline) of the SEC curve at the i th elution fraction and M_i is the molecular weight of species eluting at this increment.

The molecular weight distribution (MWD) is then calculated as M_w/M_n .

The short chain branching: SCB branch profiles were obtained through size exclusion chromatography using an FTIR detector. Chromatographic conditions are those described

above. However, the sample injection volume was 500 microliters. Samples were introduced to the FTIR detector via a heated transfer line and flow cell (KBr windows, 1 mm optical path, and ca. 70 μL cell volume). The temperatures of the transfer line and flow cell were kept at 143 ± 1 °C and 140 ± 1 °C, respectively. Perkin Elmer FTIR spectrophotometer (PE 2000) equipped with a narrow band mercury cadmium telluride (MCT) detector was used in these studies.

All spectra were acquired using Perkin Elmer Timebase software. Background spectra of the TCB solvent were obtained prior to each run. All IR spectra were measured at 8 cm^{-1} resolution (16 scans). Chromatograms were generated using the root mean square absorbance over the 3000-2700 cm^{-1} spectral region (i.e., FTIR serves as a concentration detector). Molecular weight calculations were made as previously described using a broad molecular weight polyethylene (PE) standard [see Jordens K, Wilkes GL, Janzen J, Rohlfing DC, Welch MB. *Polymer* 2000; 41:7175]. Spectra from individual time slices of the chromatogram are subsequently analyzed for comonomer branch levels using chemometric techniques. All calibration spectra were taken at sample concentrations which far exceeded that needed for good signal to noise (i.e., > 0.08 mg /mL at the detector).

SCB determination was made as follows. Narrow molecular weight ($M_w/M_n \sim 1.1$ to 1.3), solvent gradient fractions of ethylene 1-butene, ethylene 1-hexene, polyethylene homopolymers, and low molecular weight alkanes were used in calibration and verification studies. The total methyl content of these samples ranged from 1.4 to 82.7 methyls per 1000 total carbons. Methyl content of samples was calculated from M_n measured using C-13 NMR spectroscopy. C-13 NMR spectra were obtained on 15 wt.% samples in TCB using a 500 MHz Varian Unity Spectrometer run at 125 °C as previous described in Randall JC, Hsieh ET, *NMR and Macromolecules; Sequence, Dynamic, and Domain Structure*, ACS Symposium Series 247, J. C. Randall, Ed., American Chemical Society, Washington DC, 1984. Methyl content per 1000 carbons by NMR was obtained by multiplying ($\times 1000$) the ratio of total methyl signals to total signal intensity. (Dear inventors, this method for determination of SCB is from another patent. Kindly let us know if it is correct or kindly provide us with an amended method).

The ^{13}C -NMR analysis is performed using a 400 MHz or 500 MHz Bruker NMR spectrometer under conditions such that the signal intensity in the spectrum is directly proportional to the total number of contributing carbon atoms in the sample. Such conditions are well known to the person skilled in the art and include for example sufficient relaxation time, etc. In practice,

the intensity of a signal is obtained from its integral, i.e. the corresponding area. The data is acquired using proton decoupling, 2000 to 4000 scans per spectrum with 10 mm at room temperature through or 240 scans per spectrum with a 10 mm cryoprobe, a pulse repetition delay of 11 seconds and a spectral width of 25000 Hz (+/- 3000 Hz). The sample is prepared by dissolving a sufficient amount of polymer in 1,2,4-trichlorobenzene (TCB, 99%, spectroscopic grade) at 130 °C and occasional agitation to homogenize the sample, followed by the addition of hexadeuterobenzene (C₆D₆, spectroscopic grade) and a minor amount of hexamethyldisiloxane (HMDS, 99.5+ %), with HMDS serving as internal standard. To give an example, about 200 mg to 600 mg of polymer is dissolved in 2.0 mL of TCB, followed by addition of 0.5 mL of C₆D₆ and 2 to 3 drops of HMDS.

Following data acquisition, the chemical shifts are referenced to the signal of the internal standard HMDS, which is assigned a value of 2.03 ppm.

The melting temperature T_m is measured by ISO 11357.

The Oxygen permeability coefficient (PO₂) is measured by ASTM D3985-17

The water vapor transmission rate (WVTR) is measured by ASTM F1249-20. Conditions of the WVTR test include:

- (1) Test: (i) Conditioning for 30 mins; (ii) Flow Rate 100 SCCM (Standard Cubic Centimeter Minutes i.e. $5 * 10^{-7} \text{ m}^3/\text{s}$) (low flow test 10 SCCM so $1.67 * 10^{-7} \text{ m}^3/\text{s}$); (iii) Examination Time 30 minutes; (iv) Minimum of 2 cycles; (v) Test time 15 to 25 hours
- (2) Temperature Setpoint: 37.8°C
- (3) Ambient Temperature: 23°C
- (4) Pressure: 760 mmHg (so 101325 Pa)
- (5) Humidity: 100%
- (6) Film Thickness: 2.49 mil (0.063 mm) to 4.06 mil (0,103 mm)
- (7) Film Size: (Diameter~8cm) 50 cm²

The thickness of a film or a sheet is measured using a Mitutoyo 293-831-30 digital micrometer

The modulus of elasticity (E) is measured by ISO 527-3 at 23 °C.

The tensile strength at break is measured in accordance with ASTM D638.

The elongation at break is measured in accordance with ASTM D638.

Examples

Example 1 : Selection of the polyethylenes and preparation of the samples

Selection of the polyethylenes

- mIE: metallocene-catalyzed LLDPE having a Mw of 133.8 kg/mol a Mw/Mn of 2.2 and a MI2 of 3.5. mIE is commercially available at TOTAL under the commercial denomination Lumicene M1835.
- mhE: metallocene-catalyzed HDPE having a Mw of 123.6 kg/mol a Mw/Mn of 3.3 and a MI2 of 4.0. mhE is commercially available at TOTAL under the commercial denomination Lumicene M6040.
- DMDA: HDPE having a Mw of 69.0 kg/mol a Mw/Mn of 3.3 and a MI2 of 4.4. Dow HDPE is commercially available at Dow Chemical under the commercial denomination DMDA-8965 NT7.

Samples preparation

- Batch mixing: Haake mixer, 150 rpm, 180 °C, 10 min
- Melt-pressing of blends: Carver press, 180 °C, 2500 lbs pressure, 2 min

Example 2: Specific heat capacity and tensile properties

Specific heat capacity was measured by DSC for mIE, mhE and for blends of mIE/mhE and mIE/ DMDA. The results are provided in the below table 1.

Table 1: DSC results

Sample	S1	S2	S3	S4	S5	S6
mIE (wt.%)	100	-	-	80	80	90
mhE (wt.%)	-	100	-	20	-	-
DMDA (wt.%)	-	-	100	-	20	10
T _m (°C)	112	133	127	108/125	110/124	110/120
ΔH _m (J/g)	92	177	169	115	113	103

Note: 2 values indicated for T_m means that 2 peaks are present.

Figure 1 provides the DSC for samples S1, S2 and S4. Figure 2 provides the DSC for S1, S3, S5 and S6.

Tensile tests were performed on samples S1, S3, S5 and S6. Tensile test was performed by Shimadzu tensile tester at 50mm/min after 1 day of aging (by Dr. Bongjoon Lee). Data are averaged over 3 samples and error bars denote the range of the data. The results are reported in the Figure 3 and 4 and in the below table 2

Table 2: Tensile tests results

Sample	S1	S3	S5	S6
mIE (wt.%)	100	-	80	90
DMDA (wt.%)	-	100	20	10
modulus of elasticity (<i>E</i>) (MPa)	204±5	680±1	280±3	253±20
tensile strength at yield σ_y (MPa)	-	20.2±0.2	-	-
elongation at yield ε_y (%)	-	7.58±0.01	-	-
tensile strength at break σ_b (MPa)	34.3±0.4	-	25.6±1.3	32.1±1.0
elongation at break ε_b (%)	756±11	38±6	636±24	727±22

Example 3: The oxygen permeability coefficient (PO₂) evaluations

The oxygen permeability coefficient (PO₂) of the samples was determined according to ASTM D3985-17 under the following conditions :

- Test Specimen Description: 4 in x 4 in square cut from center of test specimen. Specimen inspected for flaws on film surface. When applicable, inside of film is labeled and faced down toward carrier gas.

- Average Thickness: Thickness measured in microns using micrometer. 5 spots (4 edges and center) measured with average used. When using both cells, an average from both samples is taken
- Barometric Pressure: Reported in mBar by barometer placed on top of instrument (typically 1005-1020).
- Partial Pressure of Carrier Gas: Carrier gas is Ultra High Purity Nitrogen. Enters Instrument at 25 psi- verified by pressure gauge.
- Flow Rate of Nitrogen Carrier Gas: Flow rate of 10 + 0.1 cc/min.
- Conditioning: Conditioned in lab at 23 °C ± 2 °C at least 48 prior to testing
- Test Specimen Temperature: measured by the instrument throughout testing with the average reported at the end; typically between 22 and 23 °C (reported to the nearest 0.1 °C)
- Values of OTR, permeance & permeability (if desired): permeance and permeability are not reported. O₂TR value is reported in cc/(m²*day) in ambient air (20.9% O₂) then multiplied by a correction factor of 4.78 to report the values at 100% O₂
- Apparatus Description: Model 8200 Oxygen Permeation Analyzer by Systech Illinois.
- Calibration Factor: A certified calibration film is purchased from Systech Illinois every year and used for calibration. Current calibration film has an O₂TR value of 61.6 cc/(m²*day) at 100% oxygen.
- Area for Permeation: Effective area of 50cm². Samples smaller than 50cm² require a mask and the specific area is recorded for use in calculations
- Time to reach Steady-State: Prior to testing, a 60 minute purge time is observed. Test until stabilization of the OTR is observed.

The results are provided in Figure 5. From the results it can be observed a 2- to 3-fold oxygen permeability coefficient (PO₂) decrease by blending 20 wt% HDPE into LLDPE.

Example 4 : water vapor transmission rate (WVTR) evaluations

The water vapor transmission rate (WVTR) was measured according to ASTM F1249-20.

The sample dimensions required for testing was 4 in x 4 in

For optimal results, the recommended sample thickness is 600 μm or less. As the thickness increases, more variability in results are expected.

- neat mLE, 80-100 μm
- neat mhE (Dow DMDA 8-965 NT7), 47-61 μm
- mLE+Dow DMDA-8965 NT7 (10 wt% blend) , 90-100 μm thick
- mLE+Dow DMDA-8965 NT7 (20 wt% blend) , 79-84 μm thick
- mHE20 (20 wt% blend) + mLE80, 75-98 μm

The results are reported in the below table 3:

Table 3: WVTR tests results

Sample	S1	S3	S5	S6
mLE (wt.%)	100	-	80	90
DMDA (wt.%)	-	100	20	10
WVTR g/(m ² .s) (g/(100in ² *day))	10.31 x 10 ⁻⁶ (0.073)	5.21 x 10 ⁻⁶ (0.029)	3.82 x 10 ⁻⁶ (0.021)	7.41 x 10 ⁻⁶ (0.041)

Example 5: optical properties evaluations

Visual assessment of the transparency of the films produced from S1 (pure metallocene-catalyzed LLDPE) compared to the films produced from the inventive blends S5 and S6 (comprising HDPE) was made and reported in Figures 6 and 7. The samples were pressed at 180 °C for 2 min with 2500 lb force from chunks of polymer taken from the Haake bath mixer. The visual assessment shows an absence of impact or at least of significant impact of the HDPE content on the transparency of the films.

The transmittance was also evaluated using Evolution™ 350 UV-VisSpectrophotometer made by ThermoFisher Scientific at 25 °C. The films pictured were placed directly in the sample holder and scanned from 600 to 300 nm at 0.65 s/nm. An empty cell was scanned first and used at thereference. The S1 (pure metallocene-catalyzed LLDPE) was 400 μm thick while the two samples produced from the inventive blends S5 and S6 (comprising HDPE) were 350 μm thick. The transmission data for the S1 sample was rescaled to 350 μm . The results are reported on Figure 8.

CLAIMS

1. A polyolefin blend comprising:
 - from 2 wt.% to 49 wt.% of a first polyethylene PE1 based on the total weight of the polyolefin blend; the first polyethylene PE1 being a high-density polyethylene with a density of at least 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of $23 \text{ }^\circ\text{C}$; and a melt index (MI2) of at most 500.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of $190 \text{ }^\circ\text{C}$ and under a load of 2.16 kg ; and
 - from 51 wt.% to 98 wt.% of a second polyethylene PE2 based on the total weight of the polyolefin blend; the second polyethylene PE2 having a density ranging from 0.890 to less than 0.940 g/cm^3 as determined according to ISO 1183 at a temperature of $23 \text{ }^\circ\text{C}$; and a melt index (MI2) ranging from 0.1 to 20.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of $190 \text{ }^\circ\text{C}$ and under a load of 2.16 kg ;

wherein the ratio of the melt index of the first polyethylene PE1 to the second polyethylene PE2 is equal or greater than 1.0; and wherein the polyolefin blend has an oxygen permeability coefficient (PO_2) ranging from 2.04×10^{-16} to $9.18 \times 10^{-16} \text{ mol}\cdot\text{m/m}^2\cdot\text{s}\cdot\text{Pa}$ as measured by ASTM D3985-17 and/or a water vapor transmission rate (WVTR) of at most $10.42 \times 10^{-6} \text{ g/(m}^2\cdot\text{s)}$ as measured by ASTM F1249-20.

2. The polyolefin blend according to claim 1, wherein the polyolefin blend has an Oxygen permeability coefficient (PO_2) ranging from 2.55×10^{-16} to $7.14 \times 10^{-16} \text{ mol}\cdot\text{m/m}^2\cdot\text{s}\cdot\text{Pa}$ as measured by ASTM D3985-17.
3. The polyolefin blend according to claim 1 or 2, wherein the polyolefin blend has a water vapor transmission rate (WVTR) of at most $9.26 \times 10^{-6} \text{ g/(m}^2\cdot\text{s)}$, as measured by ASTM F1249-20.
4. The polyolefin blend according to any one of claims 1 to 3, wherein the polyolefin blend has a melt index (MI2) of at most 25 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg .
5. The polyolefin blend according to any one of claims 1 to 4, wherein the ratio of the

melt index of the first polyethylene PE1 to the second polyethylene PE2 ranging from 1.1 to 100.

6. The polyolefin blend according to any one of claims 1 to 5, wherein the polyolefin blend comprises from 8 to 30 wt.% of the first polyethylene PE1 based on the total weight of the polyolefin blend, and from 70 to 92 wt.% of the second polyethylene PE2.
7. The polyolefin blend according to any one of claims 1 to 6, wherein at least one selected from the first polyethylene PE1 and the second polyethylene PE2 has an Mw/Mn ranging from 1.5 to 6.0 as determined by GPC.
8. The polyolefin blend according to any one of claims 1 to 7, wherein at least one selected from the first polyethylene PE1 and the second polyethylene PE2 is a copolymer of ethylene and 1-hexene.
9. The polyolefin blend according to any one of claims 1 to 8, wherein the first polyethylene PE1 comprises one or more of the following:
 - a density ranging from 0.945 to 0.965 g/cm³ as determined according to ISO 1183 at a temperature of 23 °C;
 - a melt index ranging from 1.0 to 100.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg;
 - a melting temperature of at least 120 °C as measured by ISO 11357; and/or
 - a comonomer content expressed as the number of short chain branches (SCB) per 1,000 total carbons ranging from 0 branch/1000 C up to 3.0 branches/1000 C.
10. The polyolefin blend according to any one of claims 1 to 9, the second polyethylene PE2 comprises one or more of the following:
 - a density ranging from 0.910 to 0.935 g/cm³ as determined according to ISO 1183 at a temperature of 23 °C;
 - a melt index ranging from 0.8 to 8.0 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190 °C and under a load of 2.16 kg;
 - a melting temperature T_m of at most 118 °C as measured by ISO 11357; and/or
 - a content of linear low-density polyethylene LLDPE of at least 70 wt.% of the

total weight of the second polyethylene PE2.

11. The polyolefin blend according to any one of claims 1 to 10, wherein one or more selected from the first polyethylene PE1 and the second polyethylene PE2 is metallocene-catalysed.
12. The polyolefin blend according to any one of claims 1 to 11, wherein the second polyethylene PE2 is one or more selected from linear low-density polyethylene (LLDPE) and low-density polyethylene (LDPE).
13. The polyolefin blend according to any one of claims 1 to 12, wherein one or more selected from the first polyethylene PE1 and the second polyethylene PE2 is a post-consumer resin.
14. The polyolefin blend according to any one of claims 1 to 13, wherein the polyolefin blend comprises one or more of:
 - a modulus of elasticity (E) ranging from 180 to 500 MPa, as measured by ISO 527-3 at 23 °C;
 - a tensile strength at break ranging from 15 to 100 MPa as measured in accordance with ASTM D638;
 - an elongation at break ranging from 300 to 800 % as measured in accordance with ASTM D638; and/or
 - a transmittance of at least 10% when measured at 450 nm on a sample having a thickness of 350 μm .
15. The polyolefin blend according to any one of claims 1 to 14, wherein the polyolefin blend has a specific heat capacity (ΔH_m) ranging from 90 to 150 J/g as measured by differential scanning calorimetry (DSC).
16. An article comprising the polyolefin blend according to any one of claims 1 to 15.
17. The article according to claim 16, wherein the article is selected from a housewares food storage container, cooking utensil, plate, cup, cavity tray, drinking cup, measuring

cup, strainer, turkey baster, non - food storage container, filing cabinet, cabinet drawer, general storage device, organizer, tote, sweater box, rigid packaging, deli container, deli container lid, dairy container, dairy container lid, personal care product bottle and jar, furniture, furniture component, building material, building container components, film, sheet, fiber, bag, yarn and fabric blister, or clamshell.

18. The article according to claim 16 or 17, wherein the article is selected from an extruded article, a blow-molded article, an injection-molded article, or a compression molded article.
19. The article according to claim 16, wherein the article is a thermoformed sheet with a thickness of at least 1 mm.
20. The article according to claim 16, wherein the article is a film with a thickness ranging from 2 μm to 2.0 mm.
21. A film comprising the polyolefin blend according to any one of claims 1 to 15.
22. The film according to claim 21, wherein the film has a thickness ranging from m 2 μm to 2.0 mm.
23. The film according to claim 21 or claim 22, wherein the film has an Oxygen permeability coefficient (PO_2) ranging from 2.55×10^{-16} to 7.14×10^{-16} $\text{mol}\cdot\text{m}/\text{m}^2\cdot\text{s}\cdot\text{Pa}$ as measured by ASTM D3985-17.
24. The film according to any one of claims 21 to 23, wherein the film has a water vapor transmission rate (WVTR) of at most 9.26×10^{-6} $\text{g}/(\text{m}^2\cdot\text{s})$, as measured by ASTM F1249-20.
25. The film according to any one of claims 21 to 24, wherein the film has a melt index (MI2) of at most than 25 g/10 min as determined according to ISO 1133-1:2011 at a temperature of 190°C and under a load of 2.16 kg.

26. The film according to any one of claims 21 to 25, wherein the film comprises one or more of:
- a modulus of elasticity (E) ranging from 180 to 500 MPa, as measured by ISO 527-3 at 23 °C;
 - a tensile strength at break ranging from 15 to 100 MPa as measured in accordance with ASTM D638;
 - an elongation at break ranging from 300 to 800 % as measured in accordance with ASTM D638; and/or
 - a transmittance of at least 10% when measured at 450 nm on a sample having a thickness of 350 μm .
27. The film according to any one of claims 21 to 26, wherein the film has a specific heat capacity (ΔH_m) ranging from 90 to 150 J/g as measured by differential scanning calorimetry (DSC).

REVENDICATIONS

LU500086

1. Un mélange de polyoléfines comprenant :

- de 2 % en poids à 49 % en poids d'un premier polyéthylène PE1 sur la base du poids total du mélange de polyoléfines ; le premier polyéthylène PE1 étant un polyéthylène haute densité avec une densité d'au moins $0,940 \text{ g/cm}^3$ telle que déterminée selon ISO 1183 à une température de $23 \text{ }^\circ\text{C}$; et un indice de fusion (MI2) d'au plus $500,0 \text{ g/10 min}$ tel que déterminé selon ISO 1133-1:2011 à une température de $190 \text{ }^\circ\text{C}$ et sous une charge de $2,16 \text{ kg}$; et
- de 51 % en poids à 98 % en poids d'un deuxième polyéthylène PE2 sur la base du poids total du mélange de polyoléfines ; le deuxième polyéthylène PE2 ayant une densité allant de $0,890$ à moins de $0,940 \text{ g/cm}^3$ telle que déterminée selon ISO 1183 à une température de $23 \text{ }^\circ\text{C}$; et un indice de fusion (MI2) allant de $0,1$ à $20,0 \text{ g/10 min}$ tel que déterminé selon ISO 1133-1:2011 à une température de $190 \text{ }^\circ\text{C}$ et sous une charge de $2,16 \text{ kg}$;

dans lequel le rapport de l'indice de fusion du premier polyéthylène PE1 par rapport au deuxième polyéthylène PE2 est égal ou supérieur à $1,0$; et dans lequel le mélange de polyoléfines a un coefficient de perméabilité à l'oxygène (PO_2) allant de $2,04 \times 10^{-16}$ à $9,18 \times 10^{-16} \text{ mol}\cdot\text{m/m}^2\cdot\text{s}\cdot\text{Pa}$ tel que mesuré par ASTM D3985-17 et/ou un taux de transmission de vapeur d'eau (WVTR) d'au plus $10,42 \times 10^{-6} \text{ g}/(\text{m}^2\cdot\text{s})$ tel que mesuré par ASTM F1249-20.

2. Le mélange de polyoléfines selon la revendication 1, dans lequel le mélange de polyoléfines a un coefficient de perméabilité à l'oxygène (PO_2) allant de $2,55 \times 10^{-16}$ à $7,14 \times 10^{-16} \text{ mol}\cdot\text{m/m}^2\cdot\text{s}\cdot\text{Pa}$ tel que mesuré par ASTM D3985-17.
3. Le mélange de polyoléfines selon la revendication 1 ou 2, dans lequel le mélange de polyoléfines a un taux de transmission de vapeur d'eau (WVTR) d'au plus $9,26 \times 10^{-6} \text{ g}/(\text{m}^2\cdot\text{s})$, tel que mesuré par ASTM F1249-20.
4. Le mélange de polyoléfines selon l'une quelconque des revendications 1 à 3, dans lequel le mélange de polyoléfines a un indice de fusion (MI2) d'au plus 25 g/10 min tel que déterminé selon ISO 1133-1:2011 à une température de $190 \text{ }^\circ\text{C}$ et sous une charge de

2,16 kg.

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5. Le mélange de polyoléfines selon l'une quelconque des revendications 1 à 4, dans lequel le rapport de l'indice de fusion du premier polyéthylène PE1 par rapport au deuxième polyéthylène PE2 est compris entre 1,1 et 100.
6. Le mélange de polyoléfines selon l'une quelconque des revendications 1 à 5, dans lequel le mélange de polyoléfines comprend entre 8 et 30 % en poids du premier polyéthylène PE1 sur la base du poids total du mélange de polyoléfines, et entre 70 et 92 % en poids du deuxième polyéthylène PE2.
7. Le mélange de polyoléfines selon l'une quelconque des revendications 1 à 6, dans lequel au moins un élément sélectionné parmi le premier polyéthylène PE1 et le deuxième polyéthylène PE2 a un Mw/Mn allant de 1,5 à 6,0 comme déterminé par GPC.
8. Le mélange de polyoléfines selon l'une quelconque des revendications 1 à 7, dans lequel au moins un élément sélectionné parmi le premier polyéthylène PE1 et le deuxième polyéthylène PE2 est un copolymère d'éthylène et de 1-hexène.
9. Le mélange de polyoléfines selon l'une quelconque des revendications 1 à 8, dans lequel le premier polyéthylène PE1 comprend un ou plusieurs des éléments suivants :
 - une densité allant de 0,945 à 0,965 g/cm³ telle que déterminée selon ISO 1183 à une température de 23 °C ;
 - un indice de fusion allant de 1,0 à 100,0 g/10 min tel que déterminé selon ISO 1133-1:2011 à une température de 190 °C et sous une charge de 2,16 kg ;
 - une température de fusion d'au moins 120 °C telle que mesurée par ISO 11357 ;
et/ou
 - une teneur plus commune exprimée en nombre de ramifications courtes (SCB) pour 1 000 carbones totaux allant de 0 ramification/1 000 C à

3,0 ramifications/1 000 C.

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10. Un mélange de polyoléfines selon l'une quelconque des revendications 1 à 9, le deuxième polyéthylène PE2 comprenant un ou plusieurs des éléments suivants :
- une densité allant de 0,910 à 0,935 g/cm³ telle que déterminée selon ISO 1183 à une température de 23 °C ;
 - un indice de fusion allant de 0,8 à 8,0 g/10 min tel que déterminé selon ISO 1133-1:2011 à une température de 190 °C et sous une charge de 2,16 kg ;
 - une température de fusion T_m d'au plus 118 °C telle que mesurée par ISO 11357 ; et/ou
 - une teneur en polyéthylène basse densité linéaire LLDPE d'au moins 70 % en poids du poids total du deuxième polyéthylène PE2.
11. Le mélange de polyoléfines selon l'une quelconque des revendications 1 à 10, dans lequel un ou plusieurs éléments sélectionnés parmi le premier polyéthylène PE1 et le deuxième polyéthylène PE2 sont catalysés par un métallocène.
12. Le mélange de polyoléfines selon l'une quelconque des revendications 1 à 11, dans lequel le deuxième polyéthylène PE2 est un ou plusieurs éléments sélectionnés parmi le polyéthylène basse densité linéaire (LLDPE) et le polyéthylène basse densité (LDPE).
13. Le mélange de polyoléfines selon l'une quelconque des revendications 1 à 12, dans lequel un ou plusieurs éléments sélectionnés parmi le premier polyéthylène PE1 et le deuxième polyéthylène PE2 est une résine post-consommation.
14. Le mélange de polyoléfines selon l'une quelconque des revendications 1 à 13, dans lequel le mélange de polyoléfines comprend un ou plusieurs éléments parmi :
- un module d'élasticité (*E*) allant de 180 à 500 MPa, tel que mesuré par ISO 527-3 à 23 °C ;

- une résistance à la traction à la rupture allant de 15 à 100 MPa telle que mesurée LU500086 conformément à ASTM D638 ;
- un allongement à la rupture allant de 300 à 800 % tel que mesuré selon ASTM D638 ; et/ou
- une transmittance d'au moins 10 % lorsqu'elle est mesurée à 450 nm sur un échantillon d'une épaisseur de 350 μm .

15. Le mélange de polyoléfines selon l'une quelconque des revendications 1 à 14, dans lequel le mélange de polyoléfines a une capacité thermique spécifique (ΔH_m) allant de 90 à 150 J/g telle que mesurée par calorimétrie différentielle à balayage (DSC).

16. Un article comprenant le mélange de polyoléfines selon l'une quelconque des revendications 1 à 15.

17. L'article selon la revendication 16, dans lequel l'article est sélectionné parmi un récipient de stockage alimentaire de produits ménagers, un ustensile de cuisine, une assiette, une tasse, un plateau à cavité, un gobelet, un verre mesureur, une passoire, une poire à dinde, un récipient de stockage non alimentaire, un classeur, une armoire à tiroirs, un article de stockage général, un organisateur, un fourre-tout, une boîte de pull, un emballage rigide, une boîte de charcuterie, un couvercle de boîte de charcuterie, une boîte de produits laitiers, un couvercle de boîte de produits laitiers, une bouteille et un pot de produits de soins personnels, un meuble, un composant de meuble, un matériau de construction, des composants de conteneur de construction, du film, une feuille, de la fibre, un sac, du fil et un sachet en tissu, ou une coquille.

18. L'article selon la revendication 16 ou 17, dans lequel l'article est choisi parmi un article extrudé, un article moulé par soufflage, un article moulé par injection ou un article moulé par compression.

19. L'article selon la revendication 16, dans lequel l'article est une feuille thermoformée LU500086 d'une épaisseur d'au moins 1 mm.
20. L'article selon la revendication 16, dans lequel l'article est un film d'une épaisseur allant de 2 μm à 2,0 mm.
21. Un film comprenant le mélange de polyoléfines selon l'une quelconque des revendications 1 à 15.
22. Le film selon la revendication 21, dans lequel le film a une épaisseur allant de m 2 μm à 2,0 mm.
23. Le film selon la revendication 21 ou la revendication 22, dans lequel le film a un coefficient de perméabilité à l'oxygène (PO_2) allant de $2,55 \times 10^{-16}$ à $7,14 \times 10^{-16} \text{ mol}\cdot\text{m}/\text{m}^2\cdot\text{s}\cdot\text{Pa}$ tel que mesuré par ASTM D3985-17 .
24. Le film selon l'une quelconque des revendications 21 à 23, dans lequel le film a un taux de transmission de vapeur d'eau (WVTR) d'au plus $9,26 \times 10^{-6} \text{ g}/(\text{m}^2\cdot\text{s})$, tel que mesuré par ASTM F1249-20.
25. Le film selon l'une quelconque des revendications 21 à 24, dans lequel le film a un indice de fusion (MI2) d'au plus 25 g/10 min tel que déterminé selon ISO 1133-1:2011 à une température de 190 °C et sous une charge de 2,16 kg.
26. Le film selon l'une quelconque des revendications 21 à 25, dans lequel le film comprend un ou plusieurs éléments parmi:
- un module d'élasticité (E) allant de 180 à 500 MPa, tel que mesuré par ISO 527-3 à 23 °C ;

- une résistance à la traction à la rupture allant de 15 à 100 MPa telle que mesurée LU500086 conformément à ASTM D638 ;
- un allongement à la rupture allant de 300 à 800 % tel que mesuré selon ASTM D638 ; et/ou
- une transmittance d'au moins 10 % lorsqu'elle est mesurée à 450 nm sur un échantillon d'une épaisseur de 350 μm .

27. Le film selon l'une quelconque des revendications 21 à 26, dans lequel le film a une capacité thermique spécifique (ΔH_m) allant de 90 à 150 J/g telle que mesurée par calorimétrie différentielle à balayage (DSC).

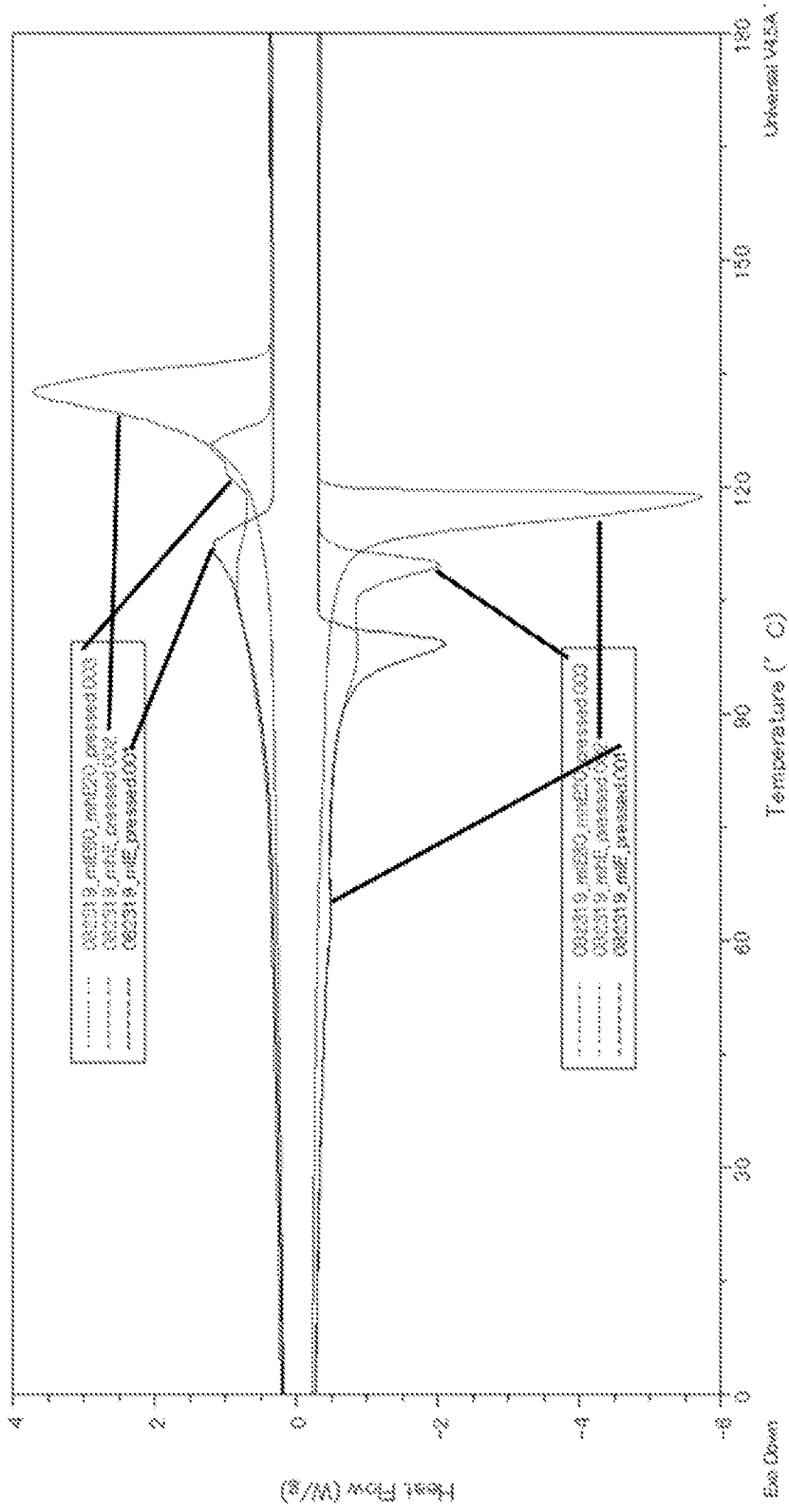


Figure 1

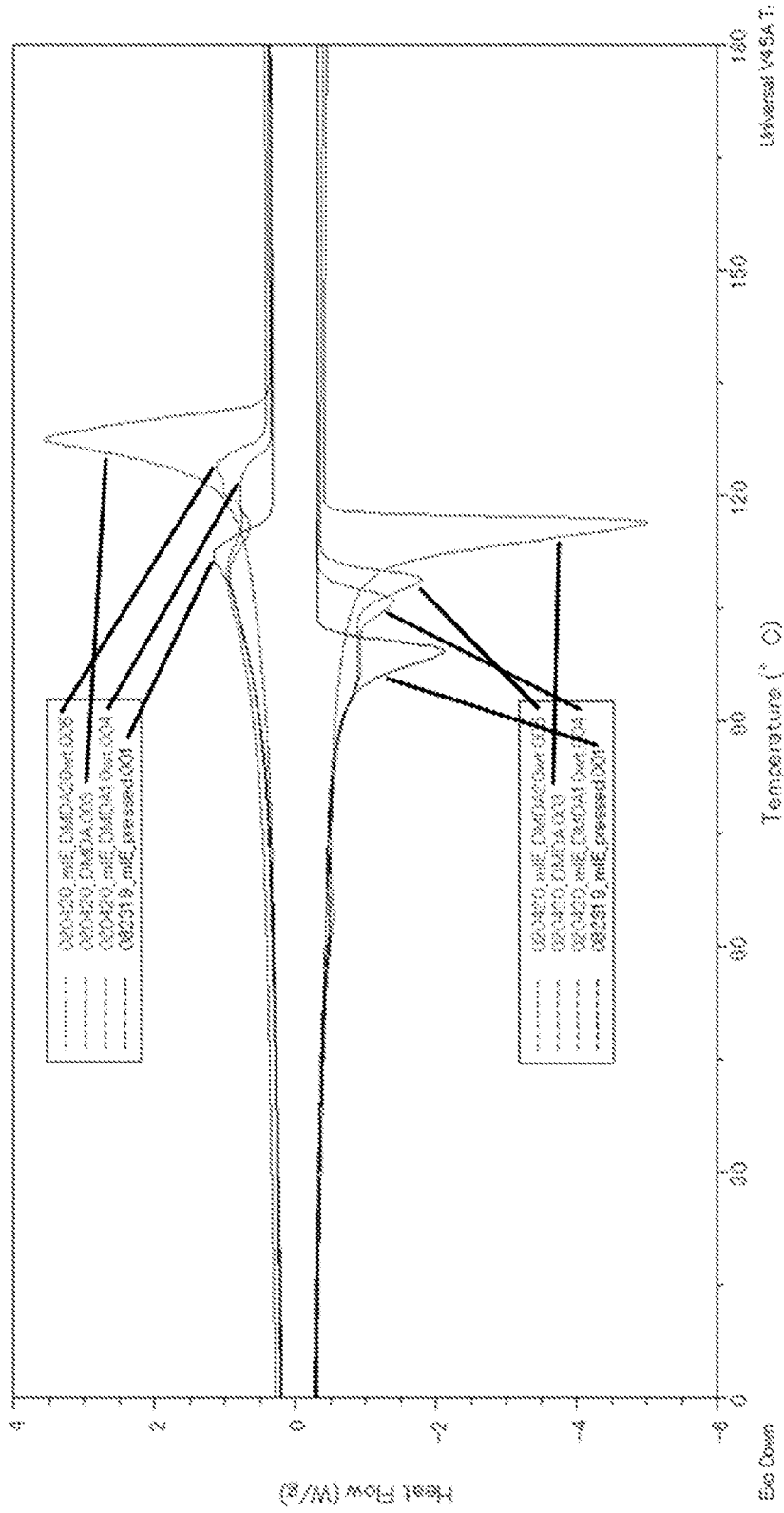


Figure 2

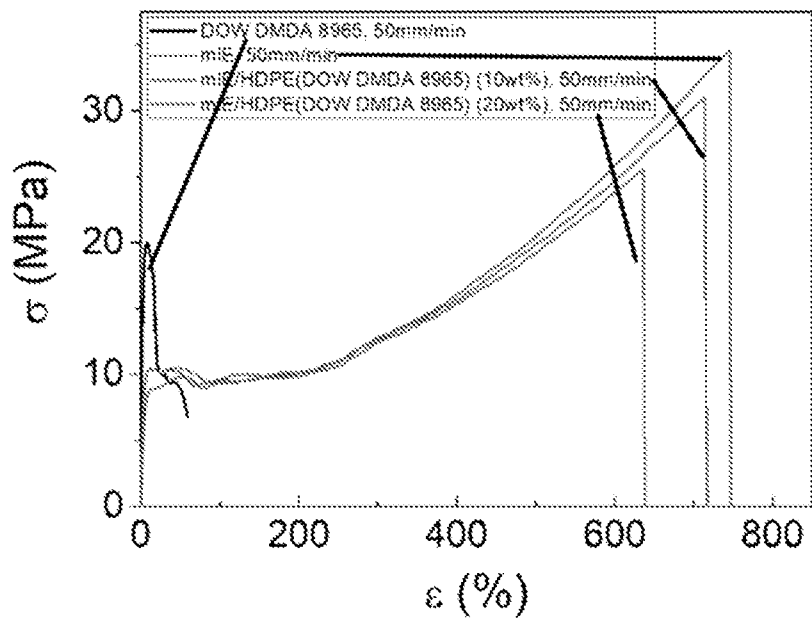


Figure 3

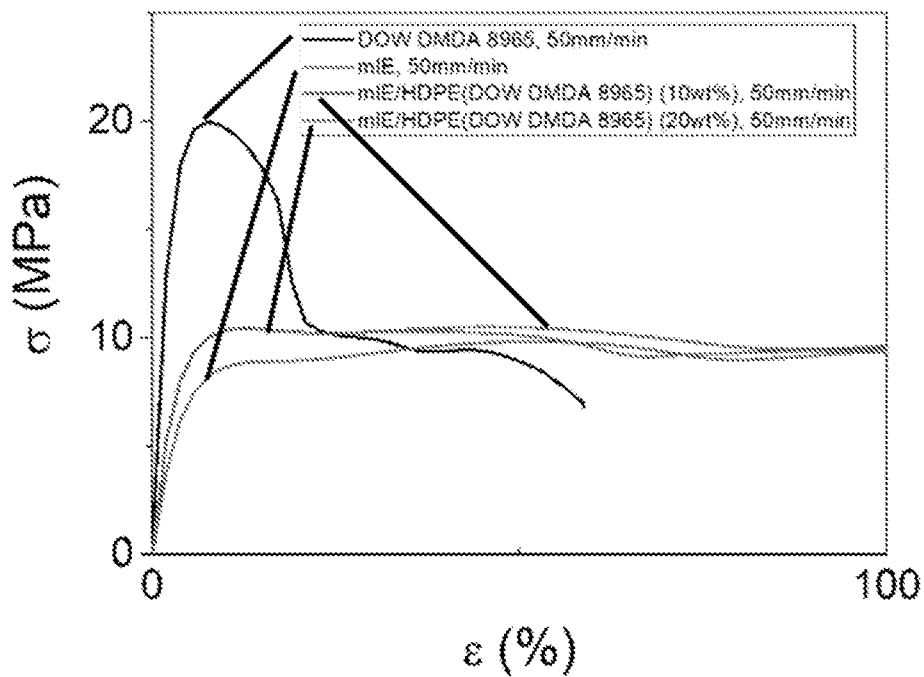


Figure 4

4/5

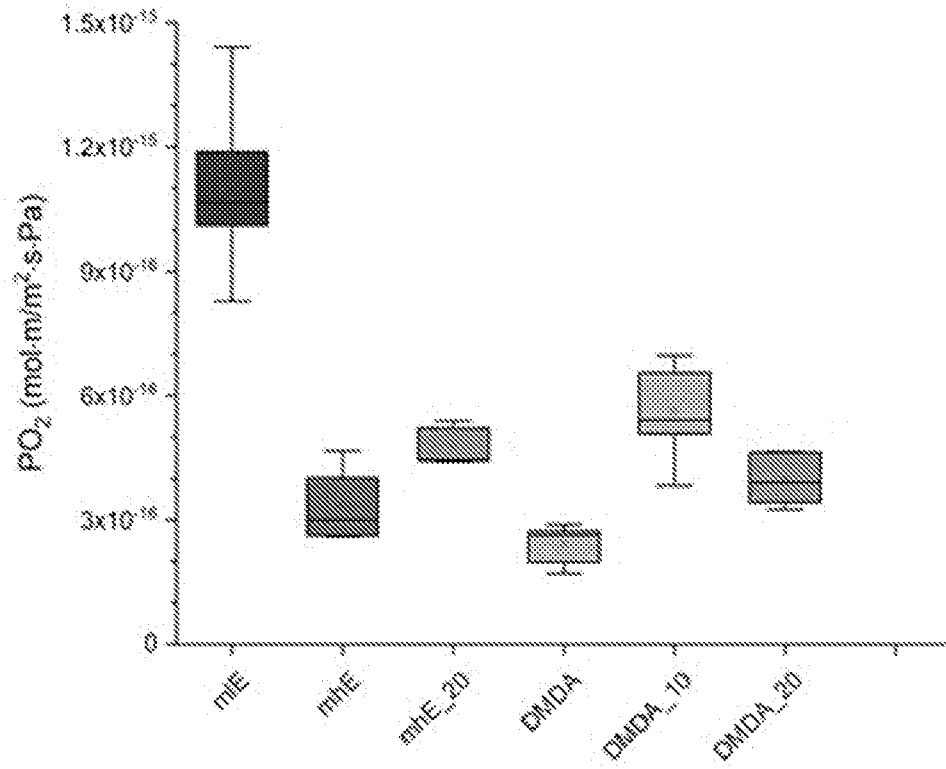


Figure 5

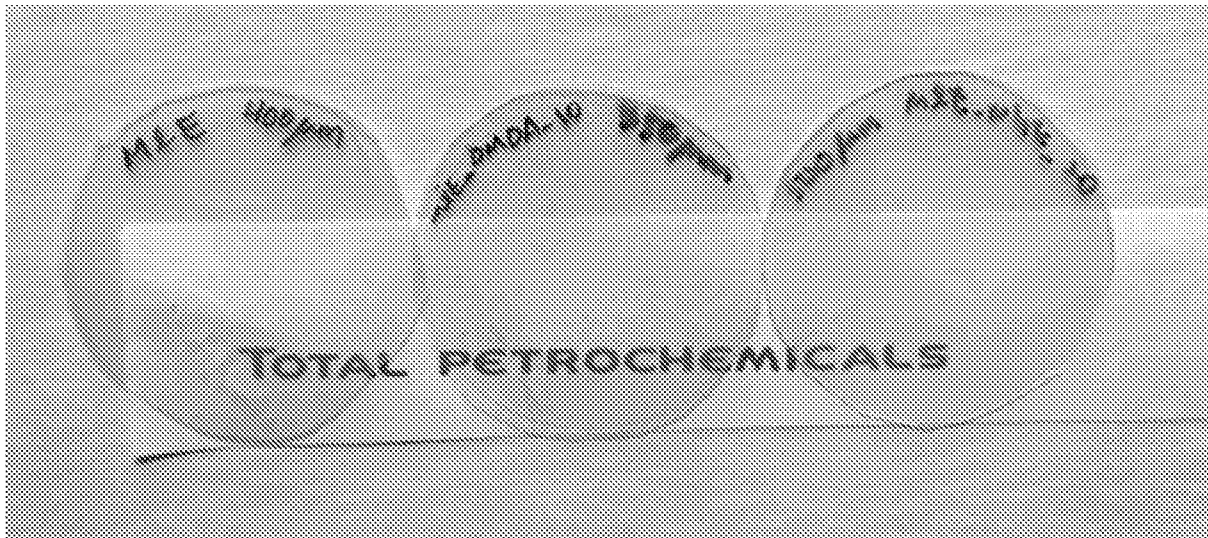


Figure 6

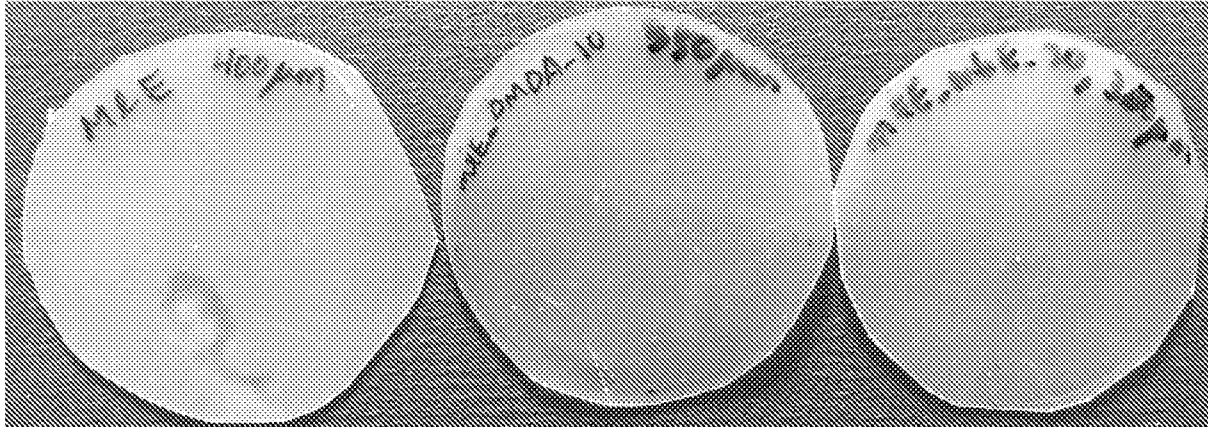
LLDPE**+10% HDPE2****+20% HDPE2**

Figure 7

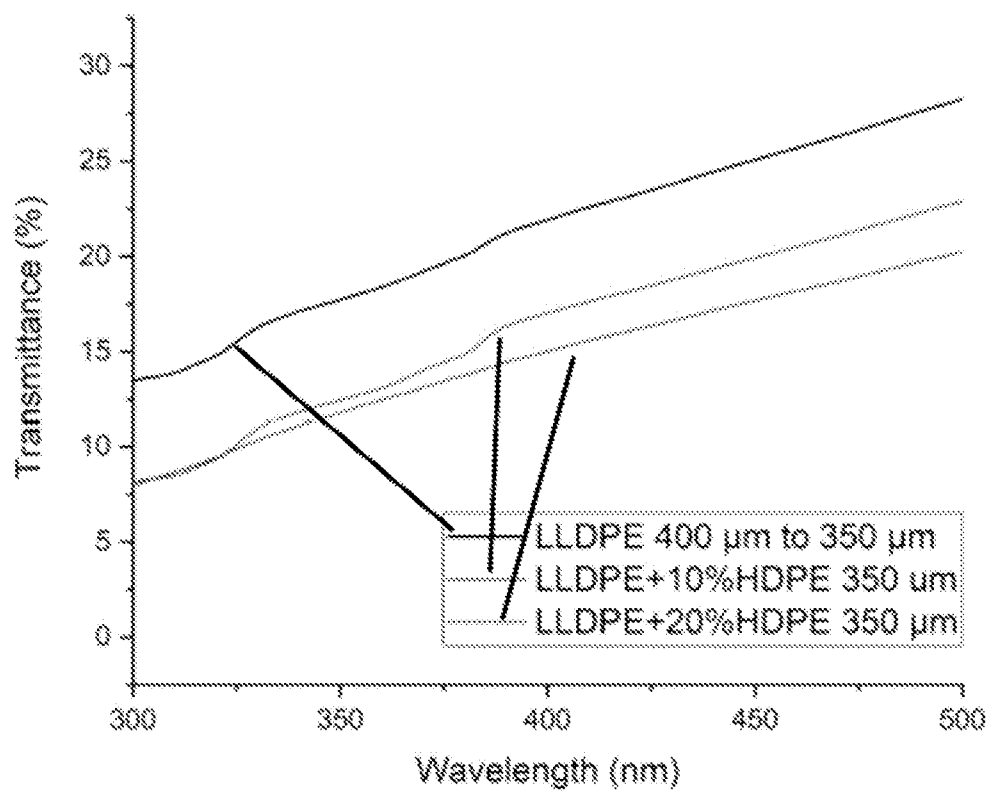


Figure 8