distribution defined by the equation: MWD = $M_{w(GPC)}$ / $M_{n(GPC)}$, $M_{w(GPC)}$ is a weight average molecular weight of the bimodal polyethylene composition, $M_{n(GPC)}$ is a number average molecular weight of the bimodal polyethylene composition, and $M_{p(GPC)}$, $M_{w(GPC)}$, and $M_{n(GPC)}$ are measured using GPC. Additionally, the bimodal polyethylene composition has a ratio of the (Mz(GPC)) to the Mw(GPC) from 8.5 to 10.5.

[0004a] In one aspect, there is provided a bimodal polyethylene composition having:

a density (ρ) from 0.952 g/cm^3 to 0.957 g/cm^3 when measured according to ASTM D792-08, Method B;

a high load melt index (I_{21}) from 1.0 to 10 dg/min when measured according to ASTM D1238 at 190 °C and a 21.6 kg load;

a peak molecular weight ($M_{p(GPC)}$) defined by the equation: $M_{p(GPC)} < -2{,}805.3 \times MWD + 102{,}688$, wherein MWD is a molecular weight distribution defined by the equation: MWD = $M_{w(GPC)}$ / $M_{n(GPC)}$, $M_{w(GPC)}$ is a weight average molecular weight of the bimodal polymer composition, and $M_{n(GPC)}$ is a number average molecular weight of the bimodal polymer composition, and wherein $M_{p(GPC)}$, $M_{w(GPC)}$, and $M_{n(GPC)}$ are measured using gel permeation chromatography (GPC); wherein $M_{p(GPC)}$ is defined and determined as set out in the description;

a z-average molecular weight ($M_{z(GPC)}$) greater than 3,200,000 to 5,000,000 g/mol as measured using GPC; and

a ratio of the ($M_{z(GPC)}$) to the $M_{w(GPC)}$ is from 8.5 to 10.5;

wherein the $M_{n(GPC)}$ is greater than 28,000 g/mol;

wherein the $M_{p(GPC)}$ is 55,000 g/mol to 65,000 g/mol;

wherein the bimodal polyethylene composition is a polymerized reaction product of an ethylene monomer and at least one C_3-C_{12} α-olefin comonomer; and

wherein the term bimodal refers to compositions having two primary fractions: a first ethylene-based polymer fraction, which is a low molecular weight fraction, and a second ethylene-based polymer fraction, which is a high molecular weight fraction.

[0004b] In another aspect, there is provided an article manufactured using the bimodal polyethylene composition as defined herein.

[0004c] In another aspect, there is provided a method for producing the bimodal polyethylene composition as defined herein, comprising polymerizing via gas-phase polymerization ethylene and at least one C_3-C_{12} α-olefin comonomer in the presence of a main catalyst and a trim catalyst in a single reactor to produce the bimodal polyethylene composition.

[0005] These and additional features provided by the present disclosure will be more fully understood in view of the following detailed description, in conjunction with the drawings.

DETAILED DESCRIPTION

[0006] Embodiments of the present disclosure are directed to bimodal polyethylene compositions and articles comprising bimodal polyethylene compositions that have improved performance and processability. Embodiments of the present disclosure are directed to a bimodal polyethylene composition, which may have a density (ρ) from 0.952 g/cm^3 to 0.957 g/cm^3 when measured according to ASTM D792-08, Method B, a high load melt index (I_{21}) from 1.0 to 10 dg/min when measured according to ASTM D1238 at 190 °C and a 21.6 kg load, and a z-average molecular weight ($M_{z(GPC)}$) greater than 3,200,000 g/mol as measured using gel permeation chromatography (GPC). The bimodal polyethylene composition may also have a peak molecular weight ($M_{p(GPC)}$) defined by the equation: $M_{p(GPC)} < -2{,}805.3 \times MWD + 102{,}688$, wherein MWD is a molecular weight distribution defined by the equation: $MWD = M_{w(GPC)} / M_{n(GPC)}$, $M_{w(GPC)}$ is a weight average molecular weight of the bimodal polyethylene composition, $M_{n(GPC)}$ is a number average molecular weight of the bimodal polyethylene composition, and $M_{p(GPC)}$, $M_{w(GPC)}$, and $M_{n(GPC)}$ are measured using GPC.

[0007] The term "polymer" refers to polymeric compounds prepared by polymerizing monomers, whether of the same or a different type. The generic term polymer thus embraces the term "homopolymer," which is usually employed to refer to polymers prepared from only one type of monomer, and the term "copolymer," which is usually employed to refer to polymers prepared from two or more different monomers.

[0008] The term "interpolymer" refers to polymers prepared by polymerizing at least two different types of monomers. The generic term interpolymer thus includes copolymers and other polymers prepared by polymerizing more than two different types of monomers, such as terpolymers.

[0009] The terms "polyethylene" and "ethylene-based polymer" refer to polymers comprising greater than 50 percent (%) by mole of units that have been derived from ethylene monomer. This

CLAIMS

1. A bimodal polyethylene composition having:

a density (ρ) from 0.952 g/cm^3 to 0.957 g/cm^3 when measured according to ASTM D792-08, Method B;

a high load melt index (I_{21}) from 1.0 to 10 dg/min when measured according to ASTM D1238 at 190 °C and a 21.6 kg load;

a peak molecular weight ($M_{p(GPC)}$) defined by the equation: $M_{p(GPC)} < -2{,}805.3 \times MWD + 102{,}688$, wherein MWD is a molecular weight distribution defined by the equation: $MWD = M_{w(GPC)} / M_{n(GPC)}$, $M_{w(GPC)}$ is a weight average molecular weight of the bimodal polymer composition, and $M_{n(GPC)}$ is a number average molecular weight of the bimodal polymer composition, and wherein $M_{p(GPC)}$, $M_{w(GPC)}$, and $M_{n(GPC)}$ are measured using gel permeation chromatography (GPC); wherein $M_{p(GPC)}$ is defined and determined as set out in the description;

a z-average molecular weight ($M_{z(GPC)}$) greater than 3,200,000 to 5,000,000 g/mol as measured using GPC; and

a ratio of the ($M_{z(GPC)}$) to the $M_{w(GPC)}$ is from 8.5 to 10.5;

wherein the $M_{n(GPC)}$ is greater than 28,000 g/mol;

wherein the $M_{p(GPC)}$ is 55,000 g/mol to 65,000 g/mol;

wherein the bimodal polyethylene composition is a polymerized reaction product of an ethylene monomer and at least one C_3-C_{12} α-olefin comonomer; and

wherein the term bimodal refers to compositions having two primary fractions: a first ethylene-based polymer fraction, which is a low molecular weight fraction, and a second ethylene-based polymer fraction, which is a high molecular weight fraction.

2. The bimodal polyethylene composition of claim 1, wherein the $M_{w(GPC)}$ is greater than 380,000 g/mol.

3. The bimodal polyethylene composition of any one of claims 1 to 2 having:

a secant modulus (E_s) defined by the equation: $E_s > -2{,}622 + 2{,}822 \times \rho + 2.5 \times MFR_5$, wherein MFR_5 is a ratio of the high load melt index (I_{21}) to a melt index (I_5) of the bimodal polyethylene composition measured according to ASTM D1238 at 190 °C and a 5.0 kg load;

a secant modulus (E_s) defined by the equation: $E_s > -4{,}570.6 + 4{,}883 \times \rho + 3.1 \times MWD$; or both;

wherein the secant modulus is a 2% Secant flexural modulus measured according to ASTM D790.

4. The bimodal polyethylene composition of any one of claims 1 to 3, wherein the $M_{w(GPC)}$ is from 380,000 g/mol to 500,000 g/mol.

5. The bimodal polyethylene composition of any one of claims 1 to 4, wherein the MFR_5 is from 20 to 32, wherein MFR_5 is a ratio of the high load melt index (I_{21}) to a melt index (I_5) of the bimodal polyethylene composition measured according to ASTM D1238 at 190 °C and a 5.0 kg load.

6. The bimodal polyethylene composition of any one of claims 1 to 5, wherein the $M_{n(GPC)}$ is from 28,000 g/mol to 40,000 g/mol.

7. The bimodal polyethylene composition of any one of claims 1 to 6, wherein a secant modulus (E_s) of the bimodal polyethylene composition is greater than 965 MPa;
wherein the secant modulus is a 2% Secant flexural modulus measured according to ASTM D790.

8. The bimodal polyethylene composition of any one of claims 1 to 7 having an environmental stress-cracking resistance F_{50} greater than 150 hours when measured according to ASTM D1693, Procedure B, 10% Igepal.

9. The bimodal polyethylene composition of any one of the preceding claims wherein the bimodal polyethylene composition is a polymerized reaction product of an ethylene monomer and 1-butene, 1-hexene, or both.

10. The bimodal polyethylene composition of any one of claims 1 to 8 wherein the bimodal polyethylene composition is a polymerized reaction product of an ethylene monomer and 1-butene, 1-octene, or both.

11. The bimodal polyethylene composition of any one of claims 1 to 8 wherein the bimodal polyethylene composition is a polymerized reaction product of an ethylene monomer and 1-hexene, 1-octene, or both.

12. The bimodal polyethylene composition of claims 9 or 11 wherein the bimodal polyethylene composition is a polymerized reaction product of an ethylene monomer and 1-hexene.

13. An article manufactured using the bimodal polyethylene composition of any one of claims 1 to 12.

14. The article of claim 13, wherein the article is a blow molded article.

15. A method for producing the bimodal polyethylene composition of any one of claims 1 to 12, comprising polymerizing via gas-phase polymerization ethylene and at least one C_3-C_{12} α-

olefin comonomer in the presence of a main catalyst and a trim catalyst in a single reactor to produce the bimodal polyethylene composition.