THERMOPLASTIC COMPOSITIONS COMPRISING BIMODAL POLYETHYLENE AND ARTICLES MANUFACTURED THEREFROM

TECHNICAL FIELD

[0001] Embodiments of the present disclosure are generally directed to thermoplastic compositions and, in particular, thermoplastic compositions comprising bimodal polyethylene and articles manufactured therefrom.

BACKGROUND

[0002] When manufacturing insulation and jacket layers for wires and cables, both the performance (*e.g.*, mechanical properties, environmental stress-cracking resistance, *etc.*) and the processability of the thermoplastic compositions used for the manufacture of the insulation and jacket layers are critical in order to ensure both success in fabrication and long-term durability during service. While some thermoplastic compositions may have superior mechanical properties, such as elongation at break, these superior mechanical properties are typically achieved by sacrificing processability, environmental stress-cracking resistance, or both. In contrast, other thermoplastic compositions may achieve superior processability by sacrificing mechanical properties, environmental stress-cracking resistance, or both. Accordingly, there is an ongoing need for thermoplastic compositions that balance mechanical properties and processability while also maintaining environmental stress-cracking resistance.

SUMMARY

[0003] The present disclosure address these needs by providing a bimodal polyethylene comprising a high molecular weight component and a low molecular weight component. In some examples, the bimodal polyethylene has a density of from 0.933 grams per centimeter (g/cm^3) to 0.960 g/cm^3, a melt index (I_2) of from 0.3 decigrams per minute (dg/min) to 0.9 dg/min, and a melt flow ratio (MFR_{21}) greater than or equal to 70.0. In some examples, the high molecular weight component has a density of from 0.917 g/cm^3 to 0.927 g/cm^3, and a high load melt index (I_{21}) of from 0.85 dg/min to 4.00 dg/min. In some examples, the bimodal polyethylene includes from 40 weight percent (wt.%) to 60 wt.% of the high molecular weight component.

[0003a] In one aspect, there is provided a bimodal polyethylene comprising a high molecular weight component and a low molecular weight component, wherein the bimodal polyethylene has: a density of from 0.933 g/cm^3 to 0.960 g/cm^3 when measured according to ASTM D792-13, Method B; a melt index (I_2) of from 0.3 dg/min to 0.9 dg/min when measured

according to ASTM D1238-10 at 190 °C and a 2.16 kg load; and a melt flow ratio (MFR_{21}) greater than 70.0, wherein the melt flow ratio (MFR_{21}) is a ratio of a high load melt index (I_{21}) of the bimodal polyethylene to the melt index (I_2), and the high load melt index (I_{21}) is measured according to ASTM D1238-10 at 190 °C and a 21.6 kg load, wherein: the high molecular weight component has a density of from 0.917 g/cm^3 to 0.929 g/cm^3 when measured according to ASTM D792-13, Method B; the high molecular weight component has a high load melt index (I_{21}) of from 0.85 dg/min to 4.00 dg/min when measured according to ASTM D1238-10 at 190 °C and a 21.6 kg load; the high molecular weight component has a shear thinning index (SHI) of from 10.0 to 20.0, wherein the shear thinning index (SHI) is a ratio of a complex viscosity of the bimodal polyethylene measured at 0.1 radians per second (η*0.1) to a complex viscosity of the bimodal polyethylene measured at 100 radians per second (η*100), and the complex viscosities of the bimodal polyethylene are determined at 190 °C using Dynamic Mechanical Spectroscopy (DMS); and the bimodal polyethylene comprises from 40 wt.% to 60 wt.% of the high molecular weight component**.**

[0003b] In another aspect, there is provided a method for producing the bimodal polyethylene as defined herein, the method comprising polymerizing ethylene and at least one 1-alkene comonomer in the presence of a catalyst in a multi-reactor system to produce the bimodal polyethylene.

[0003c] In another aspect, there is provided a thermoplastic composition comprising from 1 wt.% to 99 wt.% of the bimodal polyethylene as defined herein; and one or more additives.

[0003d] In another aspect, there is provided an article manufactured using the thermoplastic composition as defined herein.

[0004] These and additional features provided by the examples of the present disclosure will be more fully understood in view of the following detailed description.

CLAIMS

1. A bimodal polyethylene comprising a high molecular weight component and a low molecular weight component, wherein the bimodal polyethylene has:

a density of from 0.933 g/cm^3 to 0.960 g/cm^3 when measured according to ASTM D792-13, Method B;

a melt index (I_2) of from 0.3 dg/min to 0.9 dg/min when measured according to ASTM D1238-10 at 190 °C and a 2.16 kg load; and

a melt flow ratio (MFR_{21}) greater than 70.0, wherein the melt flow ratio (MFR_{21}) is a ratio of a high load melt index (I_{21}) of the bimodal polyethylene to the melt index (I_2), and the high load melt index (I_{21}) is measured according to ASTM D1238-10 at 190 °C and a 21.6 kg load, wherein:

the high molecular weight component has a density of from 0.917 g/cm^3 to 0.929 g/cm^3 when measured according to ASTM D792-13, Method B;

the high molecular weight component has a high load melt index (I_{21}) of from 0.85 dg/min to 4.00 dg/min when measured according to ASTM D1238-10 at 190 °C and a 21.6 kg load;

the high molecular weight component has a shear thinning index (SHI) of from 10.0 to 20.0, wherein the shear thinning index (SHI) is a ratio of a complex viscosity of the bimodal polyethylene measured at 0.1 radians per second ($\eta^*0.1$) to a complex viscosity of the bimodal polyethylene measured at 100 radians per second (η^*100), and the complex viscosities of the bimodal polyethylene are determined at 190 °C using Dynamic Mechanical Spectroscopy (DMS); and

the bimodal polyethylene comprises from 40 wt.% to 60 wt.% of the high molecular weight component.

2. The bimodal polyethylene of claim 1, wherein the bimodal polyethylene has a high load melt index (I_{21}) greater than 35.0 dg/min when measured according to ASTM D1238-10 at 190 °C and a 21.6 kg load.

3. The bimodal polyethylene of either claim 1 or 2, wherein the bimodal polyethylene has a density of from 0.933 g/cm^3 to 0.945 g/cm^3; and a short chain branching distribution of a high molecular weight region of the bimodal polyethylene ($SCBD_2$) of the bimodal polyethylene is greater than or equal to 4.0 average number of branches/1000 carbons.

4. The bimodal polyethylene of either claim 1 or 2, wherein the bimodal polyethylene has a density of from 0.945 g/cm^3 to 0.960 g/cm^3; and a short chain branching distribution of a high molecular weight region of the bimodal polyethylene ($SCBD_2$) of the bimodal polyethylene is greater than or equal to 3.0 average number of branches/1000 carbons.

5. A method for producing the bimodal polyethylene of any of claims 1 to 4, the method comprising polymerizing ethylene and at least one 1-alkene comonomer in the presence of a catalyst in a multi-reactor system to produce the bimodal polyethylene.

6. The method of claim 5, wherein the ethylene and the at least one 1-alkene comonomer is polymerized via gas-phase polymerization in a dual reactor system.

7. The method of either claim 5 or 6, wherein the dual reactor system comprises a first gas-phase reactor and a second gas-phase reactor arranged in series; and the high molecular weight component is produced in the first reactor, and the low molecular weight component is produced in the second reactor.

8. The method of any of claims 5 to 8, wherein the at least one 1-alkene comonomer comprises 1-hexene; the catalyst comprises a Ziegler-Natta catalyst; or both.

9. A thermoplastic composition comprising from 1 wt.% to 99 wt.% of the bimodal polyethylene of any of claims 1 to 4; and one or more additives.

10. The thermoplastic composition of claim 9, wherein the one or more additives comprise carbon black.

11. An article manufactured using the thermoplastic composition of either claim 9 or 10.

12. The article of claim 11, wherein the article is a coated conductor comprising a conductive core; and a coating layer at least partially covering the conductive core, wherein the coating layer comprises the thermoplastic composition of either claim 9 or 10.

13. The article of either claim 11 or 12, wherein the thermoplastic composition has a cyclic shrinkage less than or equal to 2.40%; a surface smoothness less than 45 μ-in; or both.

14. The article of any of claims 11 to 13, wherein the thermoplastic composition has an environmental stress-cracking resistance (ESCR) (F_0) greater than 2,500 hours when measured according to IEC 60811-406 without oven conditioning.