ETHYLENE-BASED POLYMER COMPOSITION FOR FILMS WITH IMPROVED TOUGHNESS

REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of U.S. Provisional Application No. 62/017525, filed June 26, 2014, and incorporated herein by reference.

BACKGROUND OF THE INVENTION

Various polymerization techniques, using different catalyst systems, have been employed to produce ethylene-based polymer compositions suitable for films. Ethylene-based polymer compositions are described in the following references: US5844045 (see also US5869575 and US6448341), US6566446, US5677383 (see also US6111023), US5977251, US2015/0148490, US2015/0148491 and WO2014/058639. However, there remains a need for compositions that can be used to form films with improved toughness, while maintaining a good balance of other film physical properties, such as MD tear, puncture, and optics. These needs have been met by the following invention.

SUMMARY

The instant disclosure provides a composition comprising a first composition, comprising at least one ethylene-based polymer, and wherein the first composition comprises a MWCDI value greater than 0.9, and a melt index ratio (I10/I2) that meets the following equation: $I10/I2 \geq 7.0 - 1.2 \times \log(I2)$.

In one aspect, there is provided a composition comprising a first composition, comprising at least one ethylene-based polymer, wherein the first composition further comprises a second ethylene-based polymer; and wherein the first composition comprises a Molecular Weighted Comonomer Distribution Index (MWCDI) value greater than 0.9, and a melt index ratio (I10/I2) that meets the following equation: $I10/I2 \geq 7.0 - 1.2 \times \log(I2)$.

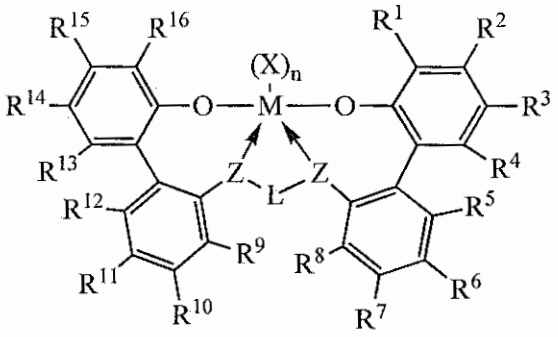
In another aspect, there is provided an article comprising at least one component formed from the composition as defined herein.

The disclosure also provides a process to form a composition comprising at least two ethylene-based polymers, said process comprising the following:

polymerizing ethylene, and optionally at least one comonomer, in solution, in the presence of a catalyst system comprising a metal-ligand complex of Structure I, to form a first ethylene-based polymer; and

polymerizing ethylene, and optionally at least one comonomer, in the presence of a catalyst system comprising a Ziegler/Natta catalyst, to form a second ethylene-based polymer; and

wherein Structure I is as follows:



(I),

wherein:

M is titanium, zirconium, or hafnium, each independently being in a formal oxidation state of +2, +3, or +4; and

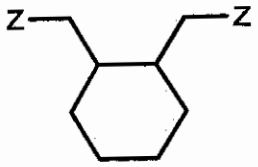
n is an integer from 0 to 3, and wherein when n is 0, X is absent; and

each X independently is a monodentate ligand that is neutral, monoanionic, or dianionic; or two Xs are taken together to form a bidentate ligand that is neutral, monoanionic, or dianionic; and

X and n are chosen, in such a way, that the metal-ligand complex of formula (I) is, overall neutral; and

each Z independently is O, S, N(C_1-C_{40})hydrocarbyl, or P(C_1-C_{40})hydrocarbyl; and

wherein the Z-L-Z fragment is comprised of formula (1):



(1);

R^1 through R^{16} are each, independently, selected from the group consisting of the following: a substituted or unsubstituted (C_1-C_{40})hydrocarbyl, a substituted or unsubstituted (C_1-C_{40})heterohydrocarbyl, $Si(R^C)_3$, $Ge(R^C)_3$, $P(R^P)_2$, $N(R^N)_2$, OR^C, SR^C, NO_2, CN, CF_3, $R^CS(O)$-, $R^CS(O)_2$-, $(R^C)_2C$=N-, $R^CC(O)O$-, $R^COC(O)$-, $R^CC(O)N(R)$-, $(R^C)_2NC(O)$-, halogen atom, hydrogen atom; and wherein each R^C is independently a (C1-C30)hydrocarbyl; R^P is a (C1-C30)hydrocarbyl; and R^N is a (C1-C30)hydrocarbyl; and

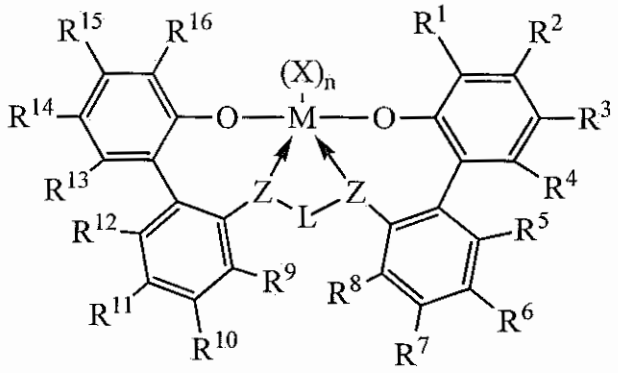
wherein, optionally, two or more R groups (from R^1 through R^{16}) can combine together into one or more ring structures, with such ring structures each, independently, having from 3 to 50 atoms in the ring, excluding any hydrogen atom.

In another aspect, there is provided a process to form a composition as defined herein, said process comprising the following:

polymerizing ethylene, and optionally at least one comonomer, in solution, in the presence of a catalyst system comprising a metal-ligand complex of Structure I, to form a first ethylene-based polymer; and

polymerizing ethylene, and optionally at least one comonomer, in the presence of a catalyst system comprising a Ziegler/Natta catalyst, to form a second ethylene-based polymer; and

wherein Structure I is as follows:



(I),

wherein:

M is titanium, zirconium, or hafnium, each independently being in a formal oxidation state of +2, +3, or +4; and

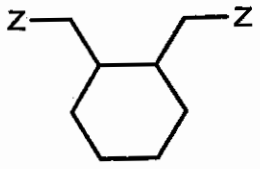
n is an integer from 0 to 3, and wherein when n is 0, X is absent; and

each X, independently, is a monodentate ligand that is neutral, monoanionic, or dianionic; or two Xs are taken together to form a bidentate ligand that is neutral, monoanionic, or dianionic; and

X and n are chosen, in such a way, that the metal-ligand complex of formula (I) is, overall neutral; and

each Z, independently, is O, S, N(C_1-C_{40})hydrocarbyl, or P(C_1-C_{40})hydrocarbyl; and

wherein the Z-L-Z fragment is comprised of formula (1):



(1);

R^1 through R^{16} are each, independently, selected from the group consisting of the following: a substituted or unsubstituted (C_1-C_{40})hydrocarbyl, a substituted or unsubstituted

$(C_1\text{-}C_{40})$heterohydrocarbyl, $Si(R^C)_3$, $Ge(R^C)_3$, $P(R^P)_2$, $N(R^N)_2$, OR^C, SR^C, NO_2, CN, CF_3, $R^CS(O)$-, $R^CS(O)_2$-, $(R^C)_2C$=N-, $R^CC(O)O$-, $R^COC(O)$-, $R^CC(O)N(R)$-, $(R^C)_2NC(O)$-, halogen atom, hydrogen atom; and wherein each R^C is independently a (C1-C30)hydrocarbyl; R^P is a (C1-C30)hydrocarbyl; and R^N is a (C1-C30)hydrocarbyl; and

wherein, optionally, two or more R groups (from R^1 through R^{16}) can combine together into one or more ring structures, with such ring structures each, independently, having from 3 to 50 atoms in the ring, excluding any hydrogen atom.

CLAIMS

1. A composition comprising a first composition, comprising at least one ethylene-based polymer, wherein the first composition further comprises a second ethylene-based polymer; and wherein the first composition comprises a Molecular Weighted Comonomer Distribution Index (MWCDI) value greater than 0.9, and a melt index ratio (I10/I2) that meets the following equation: $I10/I2 \geq 7.0 - 1.2 \times \log (I2)$.

2. The composition of claim 1, wherein the first composition has a MWCDI value less than, or equal to, 10.0.

3. The composition of claim 1 or claim 2, wherein the ethylene-based polymer is an ethylene/α-olefin interpolymer.

4. The composition of claim 1, wherein the second ethylene-based polymer is an ethylene/α-olefin interpolymer.

5. The composition of claim 4, wherein the ethylene/α-olefin interpolymer is a heterogeneously branched ethylene/α-olefin interpolymer.

6. The composition of any one of the previous claims, wherein the first composition has a Zero-Shear Viscosity Ratio (ZSVR) value from 1.2 to 3.0.

7. The composition of any one of the previous claims, wherein the first composition has a melt index ratio I10/I2 less than, or equal to, 9.2.

8. The composition of any one of the previous claims, wherein the first composition has a vinyl unsaturation level greater than 10 vinyls per 1,000,000 total carbons.

9. The composition of any one of the previous claims, wherein the composition further comprises another polymer.

10. The composition of claim 9, wherein the polymer is selected from the following: a LLDPE, a LDPE, a HDPE, a propylene-based polymer, or a combination thereof.

11. An article comprising at least one component formed from the composition of any one of the previous claims.

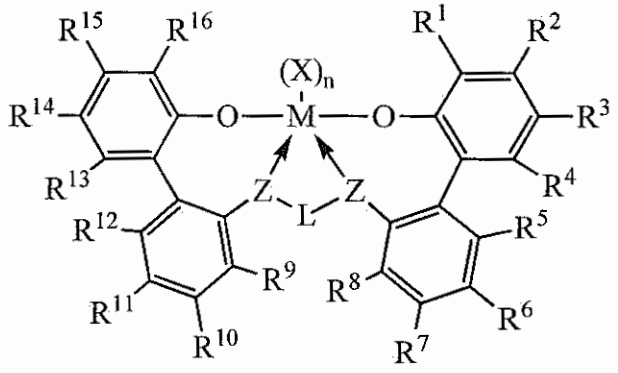
12. The article of claim 11, wherein the article is a film or coating.

13. A process to form a composition as claimed in claim 1, said process comprising the following:

polymerizing ethylene, and optionally at least one comonomer, in solution, in the presence of a catalyst system comprising a metal-ligand complex of Structure I, to form a first ethylene-based polymer; and

polymerizing ethylene, and optionally at least one comonomer, in the presence of a catalyst system comprising a Ziegler/Natta catalyst, to form a second ethylene-based polymer; and

wherein Structure I is as follows:



(I),

wherein:

M is titanium, zirconium, or hafnium, each independently being in a formal oxidation state of +2, +3, or +4; and

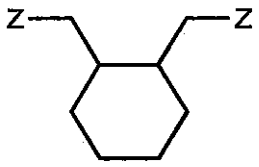
n is an integer from 0 to 3, and wherein when n is 0, X is absent; and

each X, independently, is a monodentate ligand that is neutral, monoanionic, or dianionic; or two Xs are taken together to form a bidentate ligand that is neutral, monoanionic, or dianionic; and

X and n are chosen, in such a way, that the metal-ligand complex of formula (I) is, overall neutral; and

each Z, independently, is O, S, N(C_1-C_{40})hydrocarbyl, or P(C_1-C_{40})hydrocarbyl; and

wherein the Z-L-Z fragment is comprised of formula (1):



(1);

R^1 through R^{16} are each, independently, selected from the group consisting of the following: a substituted or unsubstituted $(C_1\text{-}C_{40})$hydrocarbyl, a substituted or unsubstituted $(C_1\text{-}C_{40})$heterohydrocarbyl, $Si(R^C)_3$, $Ge(R^C)_3$, $P(R^P)_2$, $N(R^N)_2$, OR^C, SR^C, NO_2, CN, CF_3, $R^CS(O)$-, $R^CS(O)_2$-, $(R^C)_2C$=N-, $R^CC(O)O$-, $R^COC(O)$-, $R^CC(O)N(R)$-, $(R^C)_2NC(O)$-, halogen atom, hydrogen atom; and wherein each R^C is independently a (C1-C30)hydrocarbyl; R^P is a (C1-C30)hydrocarbyl; and R^N is a (C1-C30)hydrocarbyl; and

wherein, optionally, two or more R groups (from R^1 through R^{16}) can combine together into one or more ring structures, with such ring structures each, independently, having from 3 to 50 atoms in the ring, excluding any hydrogen atom.

14. The process of claim 13, wherein the composition comprises a MWCDI value greater than 0.9.