ETHYLENE-BASED POLYMER COMPOSITIONS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 61/222,371, filed July 1, 2009, and fully incorporated herein by reference.

FIELD OF INVENTION

The instant invention relates to an ethylene-based polymer composition, and the method for producing the same.

BACKGROUND OF THE INVENTION

There have been many varieties of polyethylene polymers polymerized over the years, including those made using high pressure free radical chemistry (LDPE), more traditional linear low density polyethylene (LLDPE) typically made using Ziegler-Natta catalysis and metallocene or constrained geometry catalyzed polyethylene, some linear polyethylenes, but also some substantially linear polyethylene containing slight amount of long chain branching. While these polymers have varying positives and negatives, depending on application or end-use, more control over the polymer structure is still desired.

We have now found that post-metallocene catalysts can efficiently polymerize ethylene into polymers and polymer compositions having controlled comonomer distribution profiles, while also controlling unsaturation levels in the polymer.

BRIEF SUMMARY ~~OF THE INVENTION~~

The instant disclosure~~invention~~ provides an ethylene-based polymer composition, and the method for producing the same. In one aspect, there is provided an ethylene-based polymer composition characterized by a Comonomer Distribution Constant in the range of from greater than 45 to less than 400, wherein the composition has less than 120 total unsaturation unit/1,000,000C. In one embodiment, the ~~present invention provides an ethylene-based polymer composition characterized by a~~ Comonomer Distribution Constant may be greater than about 45, more preferably greater than 50, most preferably greater than 95, and as high as 400, preferably as high as 200~~, wherein the inventive ethylene-based polymer composition has less than 120 total unsaturation unit/1,000,000C~~. Preferably, the inventive ethylene-based polymer compositions comprise up to about 3 long chain branches/1000 carbons, more preferably from about 0.01 to about 3 long chain branches/1000 carbons. The inventive ethylene-based polymer compositions can have a ZSVR of at least 2. The inventive ethylene-based polymer compositions can be further characterized by comprising less than 20

vinylidene unsaturation unit/1,000,000C. The inventive ethylene-based polymer compositions can have a bimodal molecular weight distribution (MWD) or a multi-modal MWD. The inventive ethylene-based polymer compositions can have a comonomer distribution profile comprising a mono or bimodal distribution in the temperature range of from 35°C to 120°C, excluding purge. The inventive ethylene-based polymer compositions can comprise a single DSC melting peak. The inventive ethylene-based polymer compositions can comprise a weight average molecular weight (Mw) from about 17,000 to about 220,000.

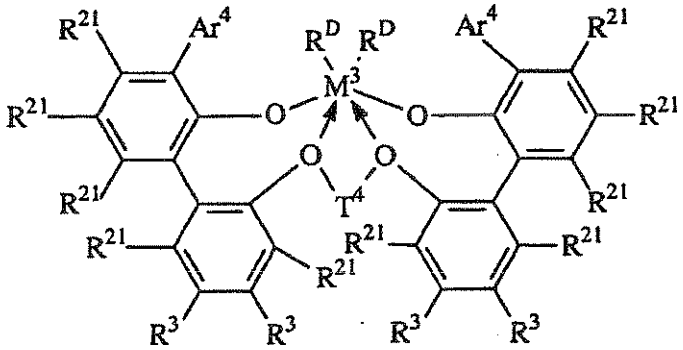
In another aspect, there is provided a fFabricated article comprising the ~~inventive ethylene-based polymer~~ compositions as defined above. ~~are also contemplated,~~ This may be especially in the form of at least one film layer. In another aspect, there is provided a~~Other embodiments include~~ thermoplastic formulations comprising the ~~inventive ethylene-based polymer~~ compositions as defined above and at least one natural or synthetic polymer.

The inventive ethylene-based polymer compositions can be at least partially cross-linked (at least 5% (weight) gel).

In another embodiment, the present disclosure~~invention~~ is a process comprising:

(A) polymerizing ethylene and optionally one or more α-olefins in the presence of a first catalyst to form a semi-crystalline ethylene-based polymer in a first reactor or a first part of a multi-part reactor; and

(B) reacting freshly supplied ethylene and optionally one or more α-olefins in the presence of a second catalyst comprising an organometallic catalyst thereby forming an ethylene-based polymer composition in at least one other reactor or a later part of a multi-part reactor, wherein the catalyst of (A) and (B) can be the same or different and each is a metal complex of a polyvalent aryloxyether corresponding to the formula:



where M^3 is Ti, Hf or Zr, preferably Zr;

Ar^4 is independently in each occurrence a substituted C_{9-20} aryl group, wherein the substituents, independently in each occurrence, are selected from the group consisting of

alkyl; cycloalkyl; and aryl groups; and halo-, trihydrocarbylsilyl- and halohydrocarbyl-substituted derivatives thereof, with the proviso that at least one substituent lacks co-planarity with the aryl group to which it is attached;

T^4 is independently in each occurrence a C_{2-20} alkylene, cycloalkylene or cycloalkenylene group, or an inertly substituted derivative thereof;

R^{21} is independently in each occurrence is hydrogen, halo, hydrocarbyl, trihydrocarbylsilyl, trihydrocarbylsilylhydrocarbyl, alkoxy or di(hydrocarbyl)amino group of up to 50 atoms not counting hydrogen;

R^3 is independently in each occurrence hydrogen, halo, hydrocarbyl, trihydrocarbylsilyl, trihydrocarbylsilylhydrocarbyl, alkoxy or amino of up to 50 atoms not counting hydrogen, or two R^3 groups on the same arylene ring together or an R^3 and an R^{21} group on the same or different arylene ring together form a divalent ligand group attached to the arylene group in two positions or join two different arylene rings together; and

R^D is independently in each occurrence halo or a hydrocarbyl or trihydrocarbylsilyl group of up to 20 atoms not counting hydrogen, or 2 R^D groups together are a hydrocarbylene, hydrocarbadiyl, diene, or poly(hydrocarbyl)silylene group.

In yet another embodiment, the present disclosure~~invention~~ is a method of characterizing an ethylene based polymer for comonomer composition distribution (CDC) , wherein CDC is calculated from comonomer distribution profile by CEF, and CDC is defined as Comonomer Distribution Index divided by Comonomer Distribution Shape Factor multiplying by 100 as shown in Equation 1, Figure 1, and wherein Comonomer distribution index stands for the total weight fraction of polymer chains with the comonomer content ranging from 0.5 of median comonomer content (C_{median}) and 1.5 of C_{median} from 35.0 to 119.0°C, and wherein Comonomer Distribution Shape Factor is defined as a ratio of the half width of comonomer distribution profile divided by the standard deviation of comonomer distribution profile from the peak temperature (Tp), and wherein the method comprises the following steps:

(A) Obtain a weight fraction at each temperature (T) ($w_T(T)$) from 35.0°C to 119.0°C with a temperature step increase of 0.200°C from CEF according to Equation 2, as shown in Figure 2;

(B) Calculate the median temperature (T_{median}) at cumulative weight fraction of 0.500, according to Equation 3, as shown in Figure 3;

We claim:

1. An ethylene-based polymer composition characterized by a Comonomer Distribution Constant in the range of from greater than 45 to less than 400, wherein the composition has less than 120 total unsaturation unit/1,000,000C.

2. The polymer composition of Claim 1 wherein the composition comprises from 0.01 to 3 long chain branches/1000 carbons.

3. The polymer composition of claim 1 having a ZSVR of at least 2.

4. The polymer of claim 3 further characterized by comprising less than 120 vinylidene unsaturation unit/1,000,000C.

5. The polymer composition of Claim 1 wherein the composition has a bimodal molecular weight distribution.

6. The polymer composition of Claim 1 where-in the composition has a multi-modal MWD.

7. A fabricated article comprising the composition of Claim 1.

8. The polymer composition of Claim 1 further comprising a single DSC melting peak.

9. A thermoplastic formulation comprising the composition of Claim 1 and at least one natural or synthetic polymer.

10. The composition of Claim 1, wherein said composition has been at least partially cross-linked (at least 5% gel).

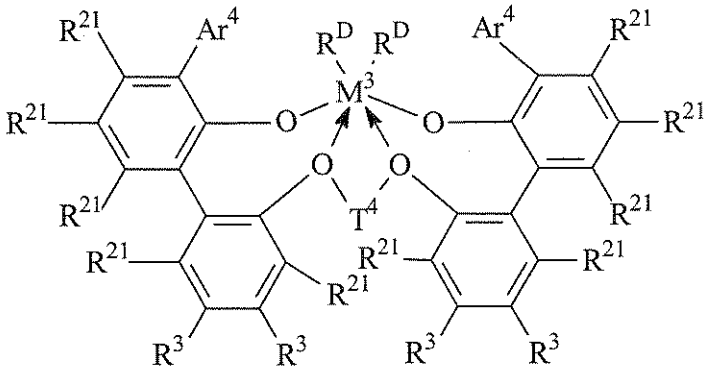
11. The composition of Claim 1, wherein the composition has a comonomer distribution profile comprising a mono or bimodal distribution in the temperature range of from 35°C to 120°C, excluding purge.

12. The polymer composition of Claim 1 comprising Mw from about 17,000 to about 220,000.

13. The polymer composition of Claim 1 produced by ~~A~~a polymerization process comprising:

(A) polymerizing ethylene and optionally one or more α-olefins in the presence of a first catalyst to form a semi-crystalline ethylene-based polymer in a first reactor or a first part of a multi-part reactor; and

(B) reacting freshly supplied ethylene and optionally one or more α-olefins in the presence of a second catalyst comprising an organometallic catalyst thereby forming an ethylene-based polymer composition in at least one other reactor or a later part of said multi-part reactor, wherein the catalyst of (A) and (B) can be the same or different and each is a metal complex of a polyvalent aryloxyether corresponding to the formula:



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