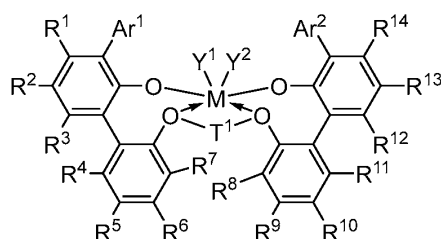


CLAIMS

1. A process comprising:
 contacting ethylene and butene under polymerization conditions at a temperature greater than 125°C with a catalyst system comprising
- (i) a first polymerization catalyst having the structure of Formula (III)

Formula (III)



wherein

M is titanium, zirconium, or hafnium;

each Y¹ and Y² is independently selected from the group consisting of (C₁-C₄₀)hydrocarbyl, (C₁-C₄₀)trihydrocarbylsilylhydrocarbyl, halogen, alkoxide, or amine, or two Y groups together are a divalent hydrocarbylene, hydrocarbadiyl or trihydrocarbylsilyl group;

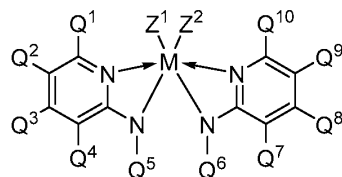
each Ar¹ and Ar² independently is selected from the group consisting of (C₆-C₄₀)aryl, substituted (C₆-C₄₀)aryl, (C₃-C₄₀)heteroaryl, and substituted (C₃-C₄₀)heteroaryl;

T¹ independently at each occurrence is a saturated C₂-C₄ alkyl that forms a bridge between the two oxygen atoms to which T¹ is bonded; and

each R¹, R², R³, R⁴, R⁵, R⁶, R⁷, R⁸, R⁹, R¹⁰, R¹¹, R¹², R¹³, and R¹⁴ independently is selected from the group consisting of hydrogen, a halogen, (C₁-C₄₀)hydrocarbyl, substituted (C₁-C₄₀)hydrocarbyl, (C₁-C₄₀)heterohydrocarbyl, substituted (C₁-C₄₀)heterohydrocarbyl, (C₆-C₄₀)aryl, substituted (C₆-C₄₀)aryl, (C₃-C₄₀)heteroaryl, and substituted (C₃-C₄₀)heteroaryl, and nitro (NO₂);

- (ii) a second polymerization catalyst having the structure of Formula (I)

Formula (I)



wherein

M is titanium, zirconium, or hafnium,

each Z¹ and Z² is independently selected from the group consisting of (C₁-C₄₀)hydrocarbyl, (C₁-C₄₀)trihydrocarbylsilylhydrocarbyl, halogen, alkoxide, or amine, or two Z groups together are a divalent hydrocarbylene, hydrocarbadiyl or trihydrocarbylsilyl group;

each Q¹ and Q¹⁰ independently is selected from the group consisting of (C₆-C₄₀)aryl, substituted (C₆-C₄₀)aryl, (C₃-C₄₀)heteroaryl, and substituted (C₃-C₄₀)heteroaryl;

each Q², Q³, Q⁴, Q⁷, Q⁸, and Q⁹ independently is selected from the group consisting of hydrogen, (C₁-C₄₀)hydrocarbyl, substituted (C₁-C₄₀)hydrocarbyl, (C₁-C₄₀)heterohydrocarbyl, substituted (C₁-C₄₀)heterohydrocarbyl, halogen, and nitro (NO₂);

each Q⁵ and Q⁶ independently is selected from the group consisting of (C₁-C₄₀)alkyl, substituted (C₁-C₄₀)alkyl, and [(Si)₁-(C+Si)₄₀] substituted organosilyl;

each N independently is nitrogen;

optionally, two or more of the Q¹⁻⁵ groups combine together to form a ring structure, with such ring structure having from 5 to 16 atoms in the ring excluding any hydrogen atoms; and

optionally, two or more of the Q⁶⁻¹⁰ groups can combine together to form a ring structure, with such ring structure having from 5 to 16 atoms in the ring excluding any hydrogen atoms; and

optionally, two or more of the Q^{6-10} groups can combine together to form a ring structure, with such ring structure having from 5 to 16 atoms in the ring excluding any hydrogen atoms;

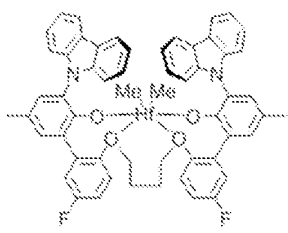
(iii) a chain shuttling agent; and

forming an ethylene/butene multi-block copolymer having LCB/1000C greater than or equal to 0.06.

2. The process of claim 1 comprising contacting the ethylene and butene under polymerization conditions at a temperature from 130°C to 170°C with a catalyst system comprising

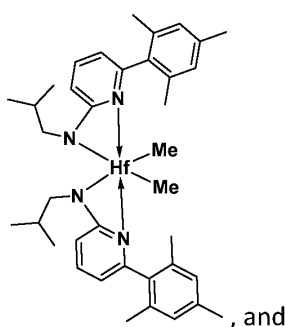
(i) a first polymerization catalyst having a structure of catalyst 1

catalyst 1



(ii) a second polymerization catalyst having a structure of catalyst 2

catalyst 2



(iii) a chain shuttling agent that is diethyl zinc; and

forming an ethylene/butene multi-block copolymer having a rheology ratio (RR) and a viscosity at 0.1 radians per second ($V_{0.1}$) wherein RR fulfills Equation (A)

$$RR \geq [(-3.0 \times 10^{-8}) \times (V_{0.1})^2] + [0.001 \times (V_{0.1})] + 0.85. \text{ Equation (A)}$$

3. The process of claim 2, comprising forming an ethylene/butene multi-block copolymer having a viscosity at 100 rad/s (V_{100}) wherein RR fulfills Equation (B)

$$RR \geq [(2.0 \times 10^{-6}) \times (V_{100})^2] + [0.003 \times (V_{100})] + 0.6. \text{ Equation (B)}$$

4. A composition comprising:

an ethylene/butene multi-block copolymer having LCB/1000C greater than or equal to 0.06.

5. The composition of claim 4 wherein the ethylene/butene multi-block copolymer comprises from 10 mol % to 30 mol % of butene.

6. The composition of claim 5 wherein the ethylene/butene multi-block copolymer has a rheology ratio (RR) and a viscosity at 0.1 radians per second ($V_{0.1}$) wherein RR fulfills Equation (A)

$$RR \geq [(-3.0 \times 10^{-8}) \times (V_{0.1})^2] + [0.001 \times (V_{0.1})] + 0.85.$$

7. The composition of claim 6 wherein the ethylene/butene multi-block copolymer has a viscosity at 100 rad/s (V_{100}) wherein RR fulfills Equation (B)

$$RR \geq [(2.0 \times 10^{-6}) \times (V_{100})^2] + [0.003 \times (V_{100})] + 0.6.$$

8. The composition of claim 7, wherein the ethylene/butene multi-block copolymer has a rheology ratio (RR) from 1.2 to 10.0.

9. The composition of claim 8 wherein the ethylene/butene multi-block copolymer comprises hard segments and soft segments, the soft segments having melting temperature (SS-T_m) from -5°C to 30°C.