

CLAIMS

1. A method of transitioning a polymerization reaction making an ethylene/alpha-olefin copolymer with a same chromium-based catalyst system in a single gas-phase polymerization reactor operating at a first reactor bed temperature (RBT1), a first average polymer residence time (avgPRT1), and a first ethylene partial pressure (C2P1) and receiving an ethylene (C2) feed, a comonomer (Cx) feed, a hydrogen (H₂) feed, and, optionally, an oxygen (O₂) feed, wherein the feeds are characterized by a first H₂/C₂ gas molar ratio (H₂/C₂-1), a comonomer/ethylene gas molar ratio ("Cx/C₂"), and a first O₂/C₂ gas volume ratio ("[O₂/C₂]₁", vol/vol expressed in parts per million by volume (ppmv)); the method comprising: (a) making, in the reactor under first polymerization conditions comprising H₂/C₂-1, Cx/C₂, [O₂/C₂]₁, RBT1, and C2P1, a first ethylene/alpha-olefin copolymer having a first melt storage modulus G' (G''=3,000 Pa) value (MSM1) measured according to the Melt Storage Modulus Test Method, a first Composition Distribution Breadth Index value (CDBI1), a first density (ρ₁), and a first flow index ("I₂₁1"); followed by (b1), (b2), or (b3): (b1) raising or lowering the reactor bed temperature in the gas-phase polymerization reactor from RBT1 to a second reactor bed temperature (RBT2), which is from 1 to 10 degrees Celsius (° C.) higher or lower than RBT1; or (b2) decreasing or increasing, respectively, the H₂/C₂ gas molar ratio of the hydrogen and ethylene feeds from H₂/C₂-1 to a second H₂/C₂ gas molar ratio (H₂/C₂-2), which is from 0.01 to 0.20 lower or higher than H₂/C₂-1, in such a way that the comonomer/ethylene gas molar ratio value Cx/C₂ is unchanged; or (b3) decreasing or increasing the flow index of the ethylene/alpha-olefin copolymer from (I₂₁)₁ to a second flow index ("I₂₁)₂", which is from 0.1 to 5 grams per 10 minutes (g/10 min.) lower or higher than (I₂₁)₁; wherein steps (a) and any one of (b1) to (b3) are conducted at the same comonomer/ethylene gas molar ratio value Cx/C₂; thereby substantially changing the melt storage modulus G' (G''=3,000 Pa) of the ethylene/alpha-olefin copolymer without using a different alpha-olefin in the Cx feed and without substantially changing its density.
2. The method of claim 1 comprising steps (a) and (b1) and any one of limitations (i) to (iii): (i) wherein in step (b1) the reactor bed temperature RBT1 is increased or decreased to the reactor bed temperature RBT2 and wherein RBT2 is from 1° to 5° C. higher or lower, respectively than RBT1; (ii) wherein the second ethylene/alpha-olefin copolymer has a second melt storage modulus G' (G''=3,000 Pa) (MSM2) of from 500 to 5,000 Pascals (Pa), wherein MSM2 is substantially different than MSM1; and (iii) both (i) and (ii).
3. The method of claim 1 comprising steps (a) and (b2) and any one of limitations (i) to (iii): (i) wherein in step (b2) the H₂/C₂ gas molar ratio of the hydrogen and ethylene feeds is

decreased or increased, respectively, from H₂/C₂-1 to a second H₂/C₂ gas molar ratio (H₂/C₂-2) and wherein H₂/C₂-2 is from 0.01 to 0.20 lower or higher, respectively, than H₂/C₂-1; (ii) wherein the second ethylene/alpha-olefin copolymer has a second melt storage modulus G' (G''=3,000 Pa) (MSM2) of from 500 to 5,000 Pascals (Pa), wherein MSM2 is substantially different than MSM1; and (iii) both (i) and (ii).

4. The method of claim 1 comprising steps (a) and (b3) and any one of limitations (i) to (iii): (i) wherein in step (b3) the flow index (I₂₁)₁ of the first ethylene/alpha-olefin copolymer is increased or decreased to a second flow index ("I₂₁)₂") of the second ethylene/alpha-olefin copolymer, wherein (I₂₁)₁ is from 0.1 to 5 g/10 min. higher or lower, respectively, than (I₂₁)₂; (ii) wherein the second ethylene/alpha-olefin copolymer has a second melt storage modulus G' (G''=3,000 Pa) (MSM2) of from 500 to 5,000 Pascals (Pa), wherein MSM2 is substantially different than MSM1; and (iii) both (i) and (ii).

5. A method of compensating a transitioning polymerization reaction making an ethylene/alpha-olefin copolymer with a same chromium-based catalyst system in a single gas-phase polymerization reactor operating at a first reactor bed temperature (RBT₁), a first average polymer residence time (avgPRT₁), and a first ethylene partial pressure (C₂P₁) and receiving an ethylene (C₂) feed, a comonomer (C_x) feed, a hydrogen (H₂) feed, and, optionally, an oxygen (O₂) feed wherein the feeds are characterized by a first H₂/C₂ gas molar ratio (H₂/C₂-1), a comonomer/ethylene gas molar ratio ("C_x/C₂"), and a first O₂/C₂ gas volume ratio ("[O₂/C₂]₁", vol/vol in ppmv); the method comprising: (a) making, in the reactor under first polymerization conditions comprising H₂/C₂-1, C_x/C₂, [O₂/C₂]₁, RBT₁, and C₂P₁, a first ethylene/alpha-olefin copolymer having a first melt storage modulus G' (G''=3,000 Pa) value (MSM₁) measured according to the Melt Storage Modulus Test Method, a first Composition Distribution Breadth Index value (CDBI₁), a first density (ρ₁), and a first flow index ("I₂₁)₁"; (b1) raising or lowering the reactor bed temperature in the gas-phase polymerization reactor from RBT₁ to a second reactor bed temperature (RBT₂), which is from 1° to 10° C. higher or lower than RBT₁ and (c) decreasing or increasing, respectively, the H₂/C₂ gas molar ratio in such a way that the comonomer/ethylene gas molar ratio value C_x/C₂ is unchanged, wherein steps (a) to (c) are done without changing the alpha-olefin of the C_x feed; thereby making at steady-state conditions after step (c) a second ethylene/alpha-olefin copolymer at a different reactor bed temperature (RBT₂) than the first reactor bed temperature RBT₁, wherein the second ethylene/alpha-olefin copolymer has the same alpha-olefin and has a second melt storage modulus G' (G''=3,000 Pa) (MSM₂) and second density value (ρ₂), wherein MSM₂ is substantially the same as MSM₁ and ρ₂ is substantially the same as ρ₁.

6. The method of claim 5 having any one of limitations (i) to (v): (i) wherein in step (b1) the reactor bed temperature RBT1 is increased to the reactor bed temperature RBT2 and wherein RBT2 is from 1° to 5° C. higher than RBT1; and wherein in step (c) the H₂/C₂ gas molar ratio of the hydrogen and ethylene feeds is decreased from H₂/C₂-1 to a second H₂/C₂ gas molar ratio (H₂/C₂-2) and wherein H₂/C₂-2 is from 0.01 to 0.20 lower than H₂/C₂-1; (ii) wherein melt storage modulus G' (G''=3,000 Pa) (MSM2) for the second ethylene/alpha-olefin copolymer is from 500 to 5,000 Pascals (Pa); (iii) both (i) and (ii); (iv) wherein in step (b1) the reactor bed temperature RBT1 is decreased to the reactor bed temperature RBT2 and wherein RBT2 is from 1° to 5° C. lower than RBT1; and wherein in step (c) the H₂/C₂ gas molar ratio of the hydrogen and ethylene feeds is increased from H₂/C₂-1 to a second H₂/C₂ gas molar ratio (H₂/C₂-2) and wherein H₂/C₂-2 is from 0.01 to 0.20 higher than H₂/C₂-1; and (v) both (ii) and (iv).

7. The method of any one of claims 1 to 6 wherein the Composition Distribution Breadth Index value (CDBI2) and density (ρ₂) of the second ethylene/alpha-olefin copolymer is substantially unchanged from the Composition Distribution Breadth Index value (CDBI1) and density (ρ₁), respectively, of the first ethylene/alpha-olefin copolymer.

8. Use of reactor bed temperature, H₂/C₂ gas molar ratio, or flow index to transition a polymerization reaction using a same chromium-based catalyst system in a single gas-phase polymerization reactor from making a first ethylene/alpha-olefin copolymer having a first melt storage modulus G' (G''=3,000 Pa) (MSM1) to making a second ethylene/alpha-olefin copolymer having a second melt storage modulus G' (G''=3,000 Pa) (MSM2) that is substantially different than MSM1 without changing the alpha-olefin composition and without substantially changing the ethylene/alpha-olefin copolymer's density.

9. The use of claim 8 further using a change in H₂/C₂ gas molar ratio to offset the change in reactor bed temperature in order to compensate the transitioning polymerization reaction by changing the melt storage modulus G' (G''=3,000 Pa) of the second ethylene/alpha-olefin copolymer from MSM2 to MSM1.