CLAIMS

What is claimed is:

1. A process for the production of an ethylene alpha-olefin copolymer, the process comprising:

polymerizing ethylene and at least one alpha-olefin by contacting the ethylene and the at least one alpha-olefin with a metallocene catalyst in at least one gas phase reactor at a reactor pressure of from 0.7 to 70 bar and a reactor temperature of from 20°C to 150°C to form an ethylene alpha-olefin copolymer;

wherein the alpha-olefin is selected from the group comprising hexene, octene, or combinations thereof;

wherein the ethylene alpha-olefin copolymer has:

a melt index (I_2) of from 0.1 to 100 dg/min,

a MWD of from 1.5 to 5.0,

a $T_{75} - T_{25}$ value of greater than 20, wherein T_{25} is the temperature at which 25% of the eluted polymer is obtained and T_{75} is the temperature at which 75% of the eluted polymer is obtained in a TREF experiment;

a M_{60}/M_{90} value of greater than 1, wherein M_{60} is the molecular weight of the polymer fraction that elutes at 60°C and M_{90} is the molecular weight of the polymer fraction that elutes at 90°C in a TREF-LS experiment;

a density D of 0.927 g/cc or less;

wherein the ethylene alpha-olefin copolymer has a peak melting temperature $T_{max\ second\ melt}$ satisfying the following relation:

$$T_{max\ second\ melt} > D*398 - 245; \text{ and}$$

wherein the metallocene is selected from the group consisting of:

bis(n-propylcyclopentadienyl)hafnium X_n,

bis(n-butylcyclopentadienyl)hafnium X_n,

bis(n-pentylcyclopentadienyl)hafnium X_n,

(n-propyl cyclopentadienyl)(n-butylcyclopentadienyl)hafnium X_n,

bis[(2-trimethylsilylethyl)cyclopentadienyl]hafnium X_n,

bis(trimethylsilyl cyclopentadienyl)hafnium X_n,

dimethylsilylbis(n-propylcyclopentadienyl)hafnium X_n,

dimethylsilylbis(n-butylcyclopentadienyl)hafnium X_n,

bis(1-n-propyl-2-methylcyclopentadienyl)hafnium X_n, and

(n-propylcyclopentadienyl)(1-n-propyl-3-n-butylcyclopentadienyl)hafnium X_n;

wherein X_n is selected from the group consisting of halogen ions, hydrides, C_{1-12} alkyls, C_{2-12} alkenyls, C_{6-12} aryls, C_{7-20} alkylaryls, C_{1-12} alkoxys, C_{6-16} aryloxys, C_{7-18} alkylaryloxys, C_{1-12} fluoroalkyls, C_{6-12} fluoroaryls, and C_{1-12} heteroatom-containing hydrocarbons and substituted derivatives thereof.

2. The process of claim 1, wherein the ethylene alpha-olefin copolymer has a peak melting temperature $T_{max\ second\ melt}$ satisfying the following relation:

$$T_{max\ second\ melt} > D*398 - 242.$$

3. The process of any one of the preceding claims, wherein the process further comprises contacting the metallocene catalyst with at least one support material.

4. The process of any one of the preceding claims, wherein the process further comprises contacting the metallocene catalyst with at least one activator.

5. The process of claim 5, wherein the activator is an alumoxane.

6. The process of any one of the preceding claims, wherein the ethylene alpha-olefin copolymer has a density from 0.900 to 0.927 g/cc.

7. The process of any one of claims 1-6, wherein the ethylene alpha-olefin copolymer has a density from 0.900 to 0.918 g/cc.

8. The process of any one of claims 1-6, wherein the ethylene alpha-olefin copolymer has a density from 0.918 to 0.927 g/cc.

9. The process of any one of the preceding claims, wherein the copolymer has a melt flow ratio from 5 to 50.

10. The process of any one of the preceding claims, wherein a compositional distribution of the copolymer is 50% or less.

11. The process of any one of the preceding claims, wherein the gas phase reactor is operated in a condensing mode.

12. The process of any one of the preceding claims, wherein the M_{60}/M_{90} value is greater than 1.5.

13. The process of any one of the preceding claims, wherein the ethylene alpha-olefin copolymer has a T_{75}-T_{25} value of greater than 25.

14. The process of any one of the preceding claims, wherein the ethylene alpha-olefin copolymer has a T_{75}-T_{25} value of greater than 30.

15. The process of any one of the preceding claims, wherein the ethylene alpha-olefin copolymer has a M_{60}/M_{90} value of greater than 2.

16. The process of any one of the preceding claims, wherein the ethylene alpha-olefin copolymer has a M_{60}/M_{90} value of greater than 3.

17. The process of any one of the preceding claims, wherein the ethylene alpha-olefin copolymer has a M_{60}/M_{90} value of greater than 3.5.

18. The process of any one of the preceding claims, wherein the copolymer has a hexane extractable content of 2.5 percent or less when tested in accordance with the FDA method stated in 21 C.F.R. § 177.1520.

19. An ethylene alpha-olefin copolymer obtained by contacting ethylene, at least one alpha-olefin, and a metallocene catalyst in at least one gas-phase reactor, the copolymer comprising:

a melt index (I_2) of from 0.1 to 100 dg/min,

a MWD of from 1.5 to 5.0,

a $T_{75} - T_{25}$ value of greater than 20, wherein T_{25} is the temperature at which 25% of the eluted polymer is obtained and T_{75} is the temperature at which 75% of the eluted polymer is obtained in a TREF experiment;

a M_{60}/M_{90} value of greater than 1, wherein M_{60} is the molecular weight of the polymer fraction that elutes at 60°C and M_{90} is the molecular weight of the polymer fraction that elutes at 90°C in a TREF-LS experiment;

a density D of 0.927 g/cc or less;

wherein the alpha-olefin selected from the group consisting of hexene, octene, and combinations thereof;

wherein the ethylene alpha-olefin copolymer has a peak melting temperature $T_{max\ second\ melt}$ satisfying the following relation:

$$T_{max\ second\ melt} > D*398 - 245;\ \text{and}$$

wherein the metallocene catalyst is selected from the group consisting of:

bis(n-propylcyclopentadienyl)hafnium X_n,

bis(n-butylcyclopentadienyl)hafnium X_n,

bis(n-pentylcyclopentadienyl)hafnium X_n,

(n-propyl cyclopentadienyl)(n-butylcyclopentadienyl)hafnium X_n,

bis[(2-trimethylsilylethyl)cyclopentadienyl]hafnium X_n,

bis(trimethylsilyl cyclopentadienyl)hafnium X_n,

dimethylsilylbis(n-propylcyclopentadienyl)hafnium X_n,

dimethylsilylbis(n-butylcyclopentadienyl)hafnium X_n,

bis(1-n-propyl-2-methylcyclopentadienyl)hafnium X_n, and

(n-propylcyclopentadienyl)(1-n-propyl-3-n-butylcyclopentadienyl)hafnium X_n;

wherein X_n is selected from the group consisting of halogen ions, hydrides, C_{1-12} alkyls, C_{2-12} alkenyls, C_{6-12} aryls, C_{7-20} alkylaryls, C_{1-12} alkoxys, C_{6-16} aryloxys, C_{7-18} alkylaryloxys, C_{1-12} fluoroalkyls, C_{6-12} fluoroaryls, and C_{1-12} heteroatom-containing hydrocarbons and substituted derivatives thereof, a density D of 0.927 g/cc or less;

a melt flow index from 0.1 to 80 g/10 min;

a molecular weight distribution from 1.5 to 5.0; and

a peak melting temperature $T_{max\ second\ melt}$ satisfying the following relation:

$T_{max\ second\ melt} > D*398 - 245$.

20. The copolymer of claim 19, wherein the copolymer has a peak melting temperature $T_{max\ second\ melt}$ satisfying the following relation:

$T_{max\ second\ melt} > D*398 - 242$.

21. The copolymer of claims 19 or 20, wherein the copolymer has a density from 0.900 to 0.927 g/cc.

22. A film comprising the copolymer of any of claims 19-21.

23. The film of claim 22, wherein the film has an MD tear strength of 134 kN/m or greater, and a dart drop impact of 192.5 kN/m or greater.

24. The film of claim 22, wherein the film has an MD tear strength of 154 kN/m or greater.

25. The film of claim 22, wherein the film has an MD tear strength of 192.5 kN/m or greater.

26. The film of any one of claims 22-25, wherein the film has a 1% MD secant modulus of 200 MPa or greater.

27. The film of any one of claims 22-26, wherein the film has a heat seal initiation temperature of 85°C or less.

28. The film of any one of claims 22-27, wherein the film has an MD tear strength of 77 kN/m or greater.

29. The film of any one of claims 22-28, wherein the film has a heat seal initiation temperature of 80°C or less.

30. The film of any one of claims 22-29, wherein the film has an 1% secant modulus of 137.8 MPa or greater.

31. The film of any one of claims 22-30, wherein the film has a hexane extractables content of 2% or less.

32. The film of any one of claims 22-30, wherein the film has a hexane extractables content of 1.6% or less.

33. The film of any one of claims 22-30, wherein the film has a hexane extractables content of 1.4% or less.

34. The film of any one of claims 22-33, wherein the film has a hot tack force at 90°C of 6 N/25 mm or greater.

35. The film of any one of claims 22-33, wherein the film has a hot tack force at 85°C of 6 N/25 mm or greater.

36. The film of any one of claims 22-33, wherein the film has a hot tack force at 80°C of 6 N/25 mm or greater.

37. The film of any one of claims 22-36, wherein the film further comprises at least one other polymer, preferably, a high pressure low density polyethylene.

38. The film of any one of claims 22-37, wherein the film comprises two or more layers.

39. The film of any one of claims 22-38, wherein the copolymer has a hexane extractable content of 2.5 percent or less when tested in accordance with the FDA method stated in 21 C.F.R. § 177.1520.

40. The film of any one of claims 22-38, wherein the copolymer has a hexane extractable content of 2.0 percent or less when tested in accordance with the FDA method stated in 21 C.F.R. § 177.1520.

41. The film of any one of claims 22-38, wherein the copolymer has a hexane extractable content of 1.5 percent or less when tested in accordance with the FDA method stated in 21 C.F.R. § 177.1520.

What is claimed is:

1. A process for the production of an ethylene alpha-olefin copolymer comprising:

polymerizing ethylene and at least one alpha-olefin by contacting the ethylene and the at least one alpha-olefin with a metallocene catalyst in at least one gas phase reactor at a reactor pressure of from 0.7 to 70 bar and a reactor temperature of from 20° C. to 150° C. to form an ethylene alpha-olefin copolymer, wherein the ethylene alpha-olefin copolymer is characterized by having

a) a melt index (I_2) of from 0.1 to 100 dg/min,

b) a MWD of from 1.5 to 5.0,

c) a $T_{75}-T_{25}$ value of greater than 20,

wherein T_{25} is the temperature at which 25% of the eluted polymer is obtained and T_{75} is the temperature at which 75% of the eluted polymer is obtained in a TREF experiment;

d) a M_{60}/M_{90} value of greater than 1.5,

wherein M_{60} is the molecular weight of the polymer fraction that elutes at 60° C. and M_{90} is the molecular weight of the polymer fraction that elutes at 90° C. in a TREF-LS experiment; and

e) a density of from 0.9129 g/cc to 0.9137 g/cc.

2. The process of claim **1**, wherein the ethylene alpha-olefin copolymer has a $T_{75}-T_{25}$ value of greater than 25.

3. The process of claim **1**, wherein the ethylene alpha-olefin copolymer has a $T_{75}-T_{25}$ value of greater than 30.

4. The process of claim **1**, wherein the ethylene alpha-olefin copolymer has a M_{60}/M_{90} value of greater than 2.

5. The process of claim **1**, wherein the ethylene alpha-olefin copolymer has a M_{60}/M_{90} value of greater than 3.

6. The process of claim **1**, wherein the ethylene alpha-olefin copolymer has a M_{60}/M_{90} value of greater than 3.5.

7. The process of claim **1**, wherein the metallocene is selected from the group consisting of:

bis(n-propylcyclopentadienyl)hafnium X_n,

bis(n-butylcyclopentadienyl)hafnium X_n,

bis(n-pentylcyclopentadienyl)hafnium X_n,

(n-propyl cyclopentadienyl)(n-butylcyclopentadienyl) hafnium X_n,

bis[(2-trimethylsilylethyl)cyclopentadienyl]hafnium X_n,

bis(trimethylsilyl cyclopentadienyl)hafnium X_n,

dimethylsilylbis(n-propylcyclopentadienyl)hafnium X_n,

dimethylsilylbis(n-butylcyclopentadienyl)hafnium X_n,

bis(1-n-propyl-2-methylcyclopentadienyl)hafnium X_n, and

(n-propylcyclopentadienyl)(1-n-propyl-3-n-butylcyclopentadienyl)hafnium X_n,

wherein X_n is selected from the group consisting of halogen ions, hydrides, C_{1-12} alkyls, C_{2-12} alkenyls, C_{6-12} aryls, C_{7-20} alkylaryls, C_{1-12} alkoxys, C_{6-16} aryloxys, C_{7-18} alkylaryloxys, C_{1-12} fluoroalkyls, C_{6-12} fluoroaryls, and C_{1-12} heteroatom-containing hydrocarbons and substituted derivatives thereof, and

wherein n is 0 or an integer from 1 to 4.

8. The process of claim **1**, wherein the process further comprises contacting the metallocene catalyst with at least one support material.

9. The process of claim **1**, wherein the process further comprises contacting the metallocene catalyst with at least one activator.

10. The process of claim **9**, wherein the activator is an alumoxane.

11. The process of claim **1**, wherein the ethylene alpha-olefin copolymer has a melt flow ratio (I_{21}/I_2) of from 5 to 50.

12. The process of claim **1**, wherein the alpha-olefin comprises hexene, octene, or combinations thereof.

13. The process of claim **1**, wherein the gas phase reactor is operated in a condensing mode.

14. The process of claim **1**, wherein the reactor temperature is from 65° C. to 110° C.