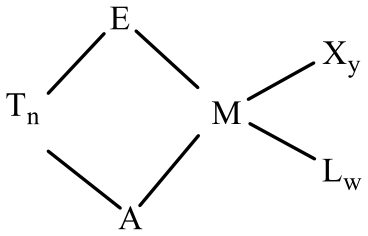
CLAIMS:

We claim:

1. A catalyst compound represented by Formula (**I**):



(**I**)

wherein:

M is a group 3-5 metal atom, a lanthanide metal atom, or an actinide metal atom of the Periodic Table of Elements;

E is a substituted polycyclic arenyl ligand bonded to M and is substituted by at least one ferrocenyl substituent bonded to an aromatic six-membered ring of the polycyclic arenyl ligand;

A is a monoanionic ligand bonded to M;

n is 0 or 1;

T is bonded to A and E, and is a bridging group containing a group 13, 14, 15, or 16 element of the Periodic Table of Elements, and is present when n is one and absent when n is zero;

each instance of X is independently a univalent anionic ligand, or two Xs are joined and bound to M to form a metallocycle ring, or two Xs are joined to form a chelating ligand, a diene ligand, or an alkylidene ligand;

each instance of L is independently a Lewis base, or two Ls are joined and bound to M to form a bidentate Lewis base;

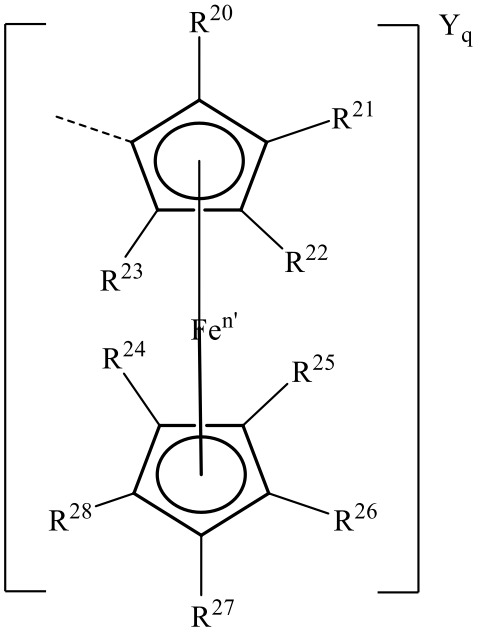
an X may be joined to an L to form a monoanionic bidentate group;

y is 1, 2, or 3;

w is 0, 1, or 2; and

y+w is 4 or less.

2. The catalyst compound of claim 1, wherein the at least one ferrocenyl substituent is represented by Formula (**Ia**):



(**Ia**)

wherein Fe is Fe(II) or Fe(III) and each of R^{20}, R^{21}, R^{22}, R^{23}, R^{24}, R^{25}, R^{26}, R^{27}, and R^{28} is independently hydrogen, hydrocarbyl, or any adjacent R^{20}, R^{21}, R^{22}, R^{23}, R^{24}, R^{25}, R^{26}, R^{27}, and R^{28} may optionally be joined to form one or more hydrocarbyl rings or heterocyclic rings each having 5, 6, 7, or 8 ring atoms;

the dashed line indicates a bond to the polycyclic arenyl ligand of E of Formula (**I**);

n' is the charge on Fe wherein n' is zero when Fe is Fe(II), and n' is +1 when Fe is Fe(III); and

Y, when present, is a non-coordinating anion with a charge of -1 and is present when q is 1 and n' is +1, and is absent when q is 0 and n' is 0.

3. The catalyst compound of claim 2, wherein Y is selected from the group consisting of tetrakis(3,5-bis(trifluoromethyl)phenyl borate, tetrafluoroborate, antimonyhexafluoride, phosphoroushexafluoride, tetrakis(perfluorophenylborate), and tetraphenylborate.

4. The catalyst compound of claim 2, wherein each of R^{20}, R^{21}, R^{22}, R^{23}, R^{24}, R^{25}, R^{26}, R^{27}, and R^{28} of Formula (**Ia**) is hydrogen.

5. The catalyst compound of any of claims 1 to 4, wherein E is selected from the group consisting of substituted indenyl, fluorenyl, cyclopenta[*b*]naphthalenyl, cyclopenta[*a*]naphthalenyl, tetrahydro-*s*-indacenyl, and tetrahydro-*as*-indacenyl.

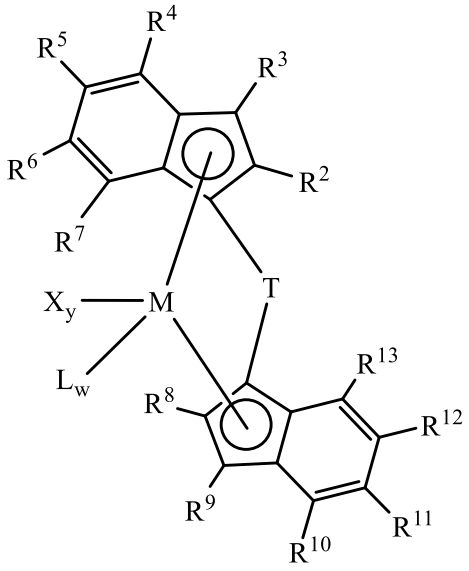
6. The catalyst compound of claim 1, wherein the at least one ferrocenyl substituent of

Formula (**Ia**) is located at a 4-position of E.

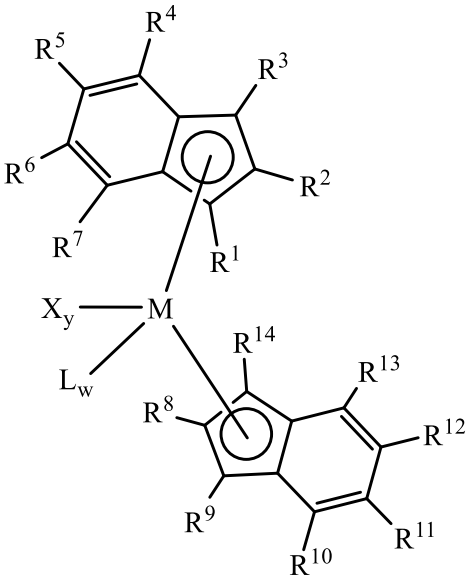
7. The catalyst compound of claim 1, wherein A is selected from the group consisting of substituted or unsubstituted cyclopentadienyl, indenyl, fluorenyl, cyclopenta[*b*]naphthalenyl, cyclopenta[*a*]naphthalenyl, tetrahydro-*s*-indacenyl, and tetrahydro-*as*-indacenyl.

8. The catalyst compound of claim 1, wherein A is a monoanionic ligand represented by formula $JR"_{m-1-n}$, wherein J is a heteroatom with a coordination number of three from group 15 or a heteroatom with a coordination number of two from group 16 of the Periodic Table of Elements; each instance of R" is independently hydrocarbyl; and m is the coordination number of the heteroatom J such that "m-1-n" indicates the number of R" substituents bonded to J, and n is 0 or 1.

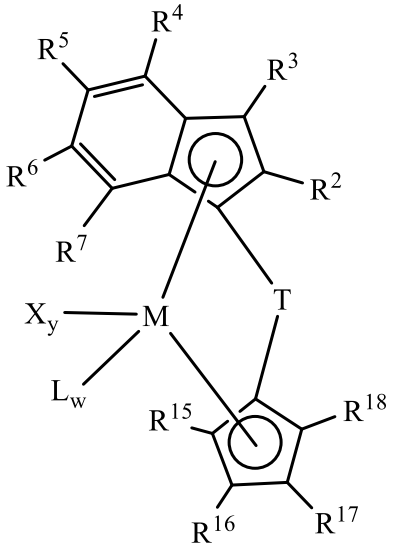
9. The catalyst compound of claim 1, wherein the catalyst compound is represented by Formulas (**IIa**), (**IIb**), (**IIIa**), (**IIIb**), (**IVa**), or (**IVb**):



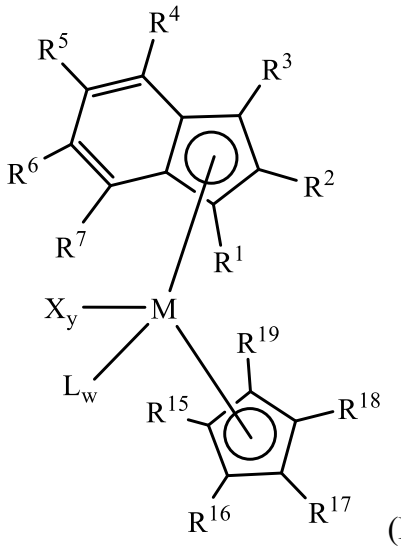
(**IIa**)



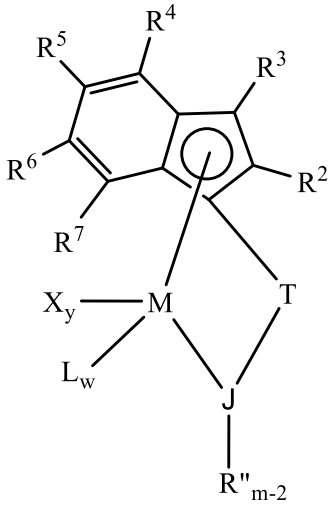
(**IIb**)



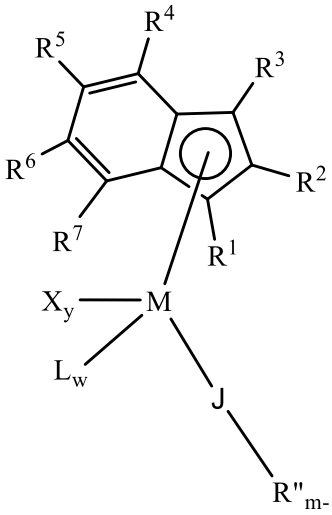
(**IIIa**)



(**IIIb**)



(**IVa**)



(**IVb**)

wherein:

M, T, L, X, y, and w are as described as for Formula (**I**);

each of R^4, R^5, R^6 and R^7 is independently a hydrogen, a substituted or unsubstituted hydrocarbyl, a heteroatom or heteroatom-containing group, or a ferrocenyl substituent provided that at least one of R^4, R^5, R^6 or R^7 is a ferrocenyl substituent, and optionally adjacent R^4, R^5, R^6, and R^7 that are not ferrocenyl may be joined to form one or more substituted hydrocarbyl rings or heterocyclic rings each having 5, 6, 7, or 8 ring atoms;

each of R^{10}, R^{11}, R^{12} and R^{13} of Formula (**IIa**) and Formula (**IIb**) is independently a hydrogen, substituted or unsubstituted hydrocarbyl, a heteroatom or heteroatom-containing group, or ferrocenyl substituent, and any adjacent R^{10}, R^{11}, R^{12} and R^{13} that are not ferrocenyl

may be joined to form one or more substituted or unsubstituted hydrocarbyl rings or heterocyclic rings each having 5, 6, 7, or 8 ring atoms;

each of (when present) R^1, R^2, R^3, R^8, R^9, R^{14}, R^{15}, R^{16}, R^{17}, R^{18}, and R^{19} of Formula (**IIa**), Formula (**IIb**), Formula (**IIIa**), Formula (**IIIb**), Formula (**IVa**), and/or Formula (**IVb**) is independently a hydrogen, substituted or unsubstituted hydrocarbyl, a heteroatom or heteroatom-containing group, and any two adjacent R^1, R^2, R^3, R^8, R^9, R^{14}, R^{15}, R^{16}, R^{17}, R^{18}, and R^{19} may optionally be joined to form one or more substituted or unsubstituted. hydrocarbyl rings or heterocyclic rings each having 5, 6, 7, or 8 ring atoms;

J of Formula (**IVa**), and/or Formula (**IVb**) is a heteroatom with a coordination number of three from group 15 or with a coordination number of two from group 16 of the Periodic Table of Elements; and

each R" is independently substituted or unsubstituted hydrocarbyl, and m is the coordination number of the heteroatom J such that "m-2" and “m-1” indicates the number of R" substituents bonded to J.

10. The catalyst compound of claims 8 and 9, wherein J of Formula (**IVa**), and Formula (**IVb**) is nitrogen and each instance of R” is selected from the group consisting of tert-butyl, neopentyl, cyclohexyl, cyclooctyl, cyclodecyl, cyclododeceyl, adamantan-1-yl, adamantan-2-yl, norborn-1-yl, norborn-2-yl, benzyl, and ethylphenyl.

11. The catalyst compound of any of claims 1 to 10, wherein each instance of X of Formula (**I**), Formula (**IIa**), Formula (**IIb**), Formula (**IIIa**), Formula (**IIIb**), Formula (**IVa**), and Formula (**IVb**) is independently selected from the group consisting of methyl, benzyl, trimethylsilyl, methylene(trimethylsilyl), neopentyl, ethyl, propyl, butyl, phenyl, hydrido, chloro, fluoro, bromo, iodo, trifluoromethanesulfonate, dimethylamido, diethylamido, dipropylamido, and diisopropylamido.

12. The catalyst compound of any of claims 1 to 11, wherein each instance of L of Formula (**I**), Formula (**IIa**), Formula (**IIb**), Formula (**IIIa**), Formula (**IIIb**), Formula (**IVa**), and Formula (**IVb**) is independently selected from the group consisting of Et_2O, MeOtBu, Et_3N, $PhNMe_2$, $MePh_2N$, tetrahydrofuran, and methyl acetate.

13. The catalyst compound of any of claims 1 to 12, wherein M of Formula (**I**), Formula (**IIa**), Formula (**IIb**), Formula (**IIIa**), Formula (**IIIb**), Formula (**IVa**), and Formula (**IVb**) is Zr,

Hf, or Ti.

14. The catalyst compound of any of claims 1 to 13, wherein n is 1 and T of Formula (**I**), Formula (**IIa**), Formula (**IIIa**), and Formula (**IVa**) is selected from the group consisting of CH_2, CH_2CH_2, $C(CH_3)_2$, CPh_2, $SiMe_2$, $SiPh_2$, SiMePh, $Si(CH_2)_3$, $Si(CH_2)_4$, and $Si(CH_2)_5$.

15. The catalyst compound of claim 9, wherein the catalyst compound of Formula (**IIa**), Formula (**IIIa**), or Formula (**IVa**) is selected from the group consisting of:
rac-dimethylsilanediyl-bis(η^5-4-ferrocenyl-2-methylinden-1-yl)zirconium dichloride,
rac-dimethylsilanediyl-bis(η^5-4-ferrocenyl-2-methylinden-1-yl)zirconium dimethyl,
rac-dimethylsilanediyl-bis(η^5-4-ferrocenyl-2-methylinden-1-yl)hafnium dichloride,
rac-dimethylsilanediyl-bis(η^5-4-ferrocenyl-2-methylinden-1-yl)hafnium dimethyl,
rac-dimethylsilanediyl-bis(η^5-2-butyl-4-ferrocenylinden-1-yl)zirconium dichloride,
rac-dimethylsilanediyl-bis(η^5-2-butyl-4-ferrocenylinden-1-yl)zirconium dimethyl,
rac-dimethylsilanediyl-bis(η^5-2-butyl-4-ferrocenylinden-1-yl)hafnium dichloride,
rac-dimethylsilanediyl-bis(η^5-2-butyl-4-ferrocenylinden-1-yl)hafnium dimethyl,
rac-dimethylsilanediyl-bis(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methylinden-1-yl)zirconium dichloride,
rac-dimethylsilanediyl-bis(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methylinden-1-yl)zirconium dimethyl,
rac-dimethylsilanediyl-bis(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methylinden-1-yl)hafnium dichloride,
rac-dimethylsilanediyl-bis(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methylinden-1-yl)hafnium dimethyl,
rac-dimethylsilanediyl-bis(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)zirconium dichloride,
rac-dimethylsilanediyl-bis(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)zirconium dimethyl,
rac-dimethylsilanediyl-bis(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)hafnium dichloride,
rac-dimethylsilanediyl-bis(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)hafnium dimethyl;

(dimethylsilanediyl)(η^5-2-butyl-4-ferrocenylinden-1-yl)(κ^1-*tert*-butylamido)dimethyltitanium,
(dimethylsilanediyl)(η^5-2-butyl-4-ferrocenylinden-1-yl)(κ^1-*tert*-butylamido)dimethylzirconium,
(dimethylsilanediyl)(η^5-2-butyl-4-ferrocenylinden-1-yl)(κ^1-*tert*-butylamido)dimethylhafnium,
(dimethylsilanediyl)(η^5-2-butyl-4-ferrocenylinden-1-yl)(κ^1-*tert*-butylamido)titanium dichloride,
(dimethylsilanediyl)(η^5-2-butyl-4-ferrocenylinden-1-yl)(κ^1-*tert*-butylamido)zirconium dichloride,
(dimethylsilanediyl)(η^5-2-butyl-4-ferrocenylinden-1-yl)(κ^1-*tert*-butylamido)hafnium dichloride,
(dimethylsilanediyl)(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methyl-1*H*-inden-1-yl)-(κ^1-*tert*-butylamido)dimethyltitanium,
(dimethylsilanediyl)(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methyl-1*H*-inden-1-yl)-(κ^1-*tert*-butylamido)dimethylzirconium,
(dimethylsilanediyl)(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methyl-1*H*-inden-1-yl)-(κ^1-*tert*-butylamido)dimethylhafnium,
(dimethylsilanediyl)(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methyl-1*H*-inden-1-yl)-(κ^1-*tert*-butylamido)titanium dichloride,
(dimethylsilanediyl)(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methyl-1*H*-inden-1-yl)-(κ^1-*tert*-butylamido)zirconium dichloride,
(dimethylsilanediyl)(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methyl-1*H*-inden-1-yl)-(κ^1-*tert*-butylamido)hafnium dichloride,
(dimethylsilanediyl)(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(κ^1-*tert*-butylamido)dimethyltitanium,
(dimethylsilanediyl)(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(κ^1-*tert*-butylamido)dimethylzirconium,
(dimethylsilanediyl)(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(κ^1-*tert*-butylamido)dimethylhafnium,
(dimethylsilanediyl)(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(κ^1-*tert*-butylamido)titanium dichloride,
(dimethylsilanediyl)(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(κ^1-*tert*-butylamido)zirconium dichloride,

(dimethylsilanediyl)(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(κ^1-*tert*-butylamido)hafnium dichloride;

dimethylsilanediyl(η^5-4-ferrocenyl-2-methylinden-1-yl)(tetramethylcyclopentadienyl)zirconium dichloride,

dimethylsilanediyl(η^5-4-ferrocenyl-2-methylinden-1-yl)(tetramethylcyclopentadienyl)zirconium dimethyl,

dimethylsilanediyl(η^5-4-ferrocenyl-2-methylinden-1-yl)(tetramethylcyclopentadienyl)hafnium dichloride,

dimethylsilanediyl(η^5-4-ferrocenyl-2-methylinden-1-yl)(tetramethylcyclopentadienyl)hafnium dimethyl,

dimethylsilanediyl(η^5-4-ferrocenyl-2-isopropylinden-1-yl)(tetramethylcyclopentadienyl)zirconium dichloride,

dimethylsilanediyl(η^5-4-ferrocenyl-2-isopropylinden-1-yl)(tetramethylcyclopentadienyl)zirconium dimethyl,

dimethylsilanediyl(η^5-4-ferrocenyl-2-isopropylinden-1-yl)(tetramethylcyclopentadienyl)hafnium dichloride,

dimethylsilanediyl(η^5-4-ferrocenyl-2-isopropylinden-1-yl)(tetramethylcyclopentadienyl)hafnium dimethyl,

dimethylsilanediyl(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methylinden-1-yl)(tetramethylcyclopentadienyl)zirconium dichloride,

dimethylsilanediyl(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methylinden-1-yl)(tetramethylcyclopentadienyl)zirconium dimethyl,

dimethylsilanediyl(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methylinden-1-yl)(tetramethylcyclopentadienyl)hafnium dichloride,

dimethylsilanediyl(η^5-6-*tert*-butyl-4-ferrocenyl-5-methoxy-2-methylinden-1-yl)(tetramethylcyclopentadienyl)hafnium dimethyl,

dimethylsilanediyl(η^5-4-ferrocenyl-2-methyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(tetramethylcyclopentadienyl)zirconium dichloride,

dimethylsilanediyl(η^5-4-ferrocenyl-2-methyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(tetramethylcyclopentadienyl)zirconium dimethyl,

dimethylsilanediyl(η^5-4-ferrocenyl-2-methyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(tetramethylcyclopentadienyl)hafnium dichloride,

dimethylsilanediyl(η^5-4-ferrocenyl-2-methyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(tetramethylcyclopentadienyl)hafnium dimethyl,
dimethylsilanediyl(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(tetramethylcyclopentadienyl)zirconium dichloride,
dimethylsilanediyl(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(tetramethylcyclopentadienyl)zirconium dimethyl,
dimethylsilanediyl(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(tetramethylcyclopentadienyl)hafnium dichloride, and
dimethylsilanediyl(η^5-4-ferrocenyl-2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(tetramethylcyclopentadienyl)hafnium dimethyl.

16. A catalyst system comprising an activator and the catalyst compound of any of claims 1 to 15.

17. The catalyst system of claim 16, further comprising a support material.

18. The catalyst system of claim 16, wherein the activator comprises a non-coordinating anion activator and/or an alkylalumoxane.

19. A process for producing an ethylene alpha-olefin copolymer, the process comprising:

polymerizing ethylene and at least one C_3-C_{20} alpha-olefin by introducing the ethylene and the at least one C_3-C_{20} alpha-olefin with a catalyst system of Claim 16, in one or more continuous stirred tank reactors or loop reactors, in series or in parallel, at a reactor pressure of 0.05 MPa to 1,500 MPa and a reactor temperature of 30°C to 230°C to form the ethylene alpha-olefin copolymer.

20. The process of claim 19, wherein the ethylene alpha-olefin copolymer has:

a comonomer content of C_3-C_{20} alpha-olefin units of about 10 wt% to about 35 wt%, and

a z-average molecular weight (Mz) of about 200,000 g/mol to about 5,000,000 g/mol.

21. A process for producing a propylene homopolymer or a propylene copolymer, the process comprising:

polymerizing propylene and optionally a comonomer selected from the group

consisting of C_2, C_4-C_{20} alpha-olefin, and combinations thereof by introducing the propylene and the optional comonomer with a catalyst system of Claim 16, in one or more continuous stirred tank reactors or loop reactors, in series or in parallel, at a reactor pressure of 0.05 MPa to 1,500 MPa and a reactor temperature of 30°C to 230°C to form the propylene homopolymer or the propylene copolymer.

22. The process of claim 21, wherein the process produces the propylene homopolymer and the propylene homopolymer has:

a z-average molecular weight (Mz) of about 200,000 g/mol to about 800,000 g/mol,

a polydispersity index (PDI) value of about 1 to about 3, and

a melt temperature (Tm) of about 135°C to about 150°C.

23. The process of claim 21, wherein the process produces the propylene homopolymer and the propylene homopolymer has:

a meso dyad content of about 90% to about 99%,

an [mmmm] pentad content of about 80% to about 97%, and

less than 125 2,1-regio defects per 10,000 propylene units.