**CLAIMS:**

What is claimed is:

1. A method for producing an olefin polymer comprising:

contacting $C_3$-$C_{40}$ olefin, ethylene, and diene with a catalyst system comprising activator and a catalyst compound represented by formula (I):

$$T_yCp'_mMG_nX_q \qquad (I)$$

wherein:

Cp' is a tetrahydro-*s*-indacenyl group which is optionally substituted or unsubstituted, provided that when Cp' is tetrahydro-*s*-indacenyl: 1) the 3 and/or 4 positions are not aryl or substituted aryl, 2) the 3 position is not directly bonded to a group 15 or 16 heteroatom, 3) there are no additional rings fused to the tetrahydroindacenyl ligand, 4) T is not bonded to the 2-position, and 5) the 5, 6, or 7-position is geminally disubstituted;

M is a group 3, 4, 5, or 6 transition metal;

T is a bridging group;

y is 0 or 1, indicating the absence or presence of T;

G is a heteroatom group represented by the formula $JR^i_{z-y}$ where J is N, P, O or S,

$R^i$ is a $C_1$ to $C_{100}$ hydrocarbyl group, and z is 2 when J is N or P, and z is 1 when J is O or S;

X is a leaving group;

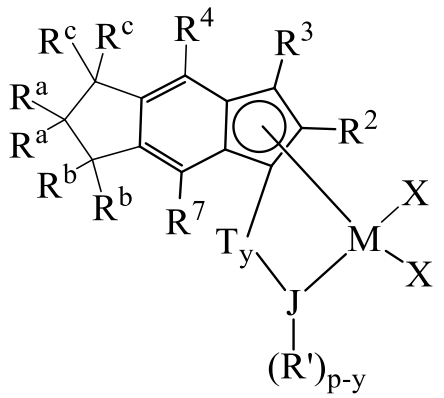
m = 1; n = 1, 2 or 3; q = 1, 2 or 3; and the sum of m+n+q is equal to the oxidation state of the transition metal; and

obtaining a $C_3$-$C_{40}$ olefin-ethylene-diene terpolymer comprising from 1 to 35 mol% of ethylene, from 98.9 to 65 mol% $C_3$-$C_{40}$ olefin, and from 0.1 to 10 mol% diene,

wherein the polymer produced has:

1) a propylene tacticity index ratio [m/r] of greater than 0.4 and less than 1.2;
2) a crystallinity of from 0% to 3%;
3) a melt flow rate at 230°C from 0.2 g/10 min to 100 g/10 min; and
4) a glass transition temperature of from -2°C to -25°C.

2. The method of claim 1, wherein the catalyst compound is represented by formula (II):



(II)

where M is a group 4 metal;

J is N, O, S or P;

p is 2 when J is N or P, and is 1 when J is O or S;

each $R^a$ is independently $C_1$-$C_{10}$ alkyl;

each $R^b$ and $R^c$ is independently hydrogen or a $C_1$-$C_{10}$ alkyl;

each $R^2$, $R^3$, $R^4$, and $R^7$ is independently hydrogen, or a $C_1$-$C_{50}$ substituted or unsubstituted hydrocarbyl, halocarbyl, silylcarbyl or germylcarbyl, provided that: 1) $R^3$ and/or $R^4$ are not aryl or substituted aryl, 2) $R^3$ is not directly bonded to a group 15 or 16 heteroatom, and 3) adjacent $R^4$, $R^c$, $R^a$, $R^b$, or $R^7$ do not join together to form a fused ring system;

each R' is independently a $C_1$-$C_{100}$ substituted or unsubstituted hydrocarbyl, halocarbyl, silylcarbyl or germylcarbyl;

T is a bridging group and y is 0 or 1 indicating the absence (y=0) or presence (y=1) of T;

each X is, independently, a leaving group, or two Xs are joined and bound to the metal atom to form a metallocycle ring, or two Xs are joined to form a chelating ligand, a diene ligand, or an alkylidene.

3. The method of claim 2, wherein both $R^a$ are methyl and all $R^b$ and $R^c$ are hydrogen.

4. The method of claim 2, wherein $R^2$ is methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl or an isomer thereof and $R^3$, $R^4$, $R^2$, and $R^7$ are hydrogen.

5. The method of claim 2, wherein $R^2$ is methyl.

6. The method of claim 1, wherein y is 1.

7. The method of claim 1, wherein y is 1 and T is $(CR^8R^9)_x$, $SiR^8R^9$, or $GeR^8R^9$ where x is 1 or 2, $R^8$ and $R^9$ are independently selected from hydrogen or substituted or unsubstituted hydrocarbyl, halocarbyl, silylcarbyl and germylcarbyl and $R^8$ and $R^9$ are optionally bonded together to form a ring structure.

8. The method of claim 1, wherein M is Ti.

9. The method of claim 1, wherein J is N.

10. The method of claim 2, wherein R' is methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, phenyl or an isomer thereof.

11. The method of claim 2, wherein R' is t-butyl, neopentyl, cyclohexyl, cyclooctyl, cyclododecyl, adamantyl, or norbornyl.

12. The method of claim 1, wherein each X is, independently, selected from hydrocarbyl radicals having from 1 to 20 carbon atoms, aryls, hydrides, amides, alkoxides, sulfides, phosphides, halides, amines, phosphines, ethers, or a combination thereof.

13. The method of claim 1, wherein each X is independently selected from halides, aryls or $C_1$ to $C_5$ alkyl groups.

14. The method of claim 1, wherein the catalyst is one or more of:
dimethylsilylene(2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(t-butylamido)$M(R)_2$;
dimethylsilylene(6,6-dimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(t-butylamido)$M(R)_2$;

dimethylsilylene(2,7,7-trimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(t-butylamido)M(R)$_2$;
dimethylsilylene(7,7-dimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(t-butylamido)M(R)$_2$;
dimethylsilylene(2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(cyclododecylamido)M(R)$_2$;
dimethylsilylene(6,6-dimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(cyclododecylamido)M(R)$_2$;
dimethylsilylene(2,7,7-trimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(cyclododecylamido)M(R)$_2$;
dimethylsilylene(7,7-dimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(cyclododecylamido)M(R)$_2$;
dimethylsilylene(2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(cyclohexylamido)M(R)$_2$;
dimethylsilylene(6,6-dimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(cyclohexylamido)M(R)$_2$;
dimethylsilylene(2,7,7-trimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(cyclohexylamido)M(R)$_2$;
dimethylsilylene(7,7-dimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(cyclohexylamido)M(R)$_2$;
dimethylsilylene(2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(adamantylamido)M(R)$_2$;
dimethylsilylene(6,6-dimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(adamantylamido)M(R)$_2$;
dimethylsilylene(2,7,7-trimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(adamantylamido)M(R)$_2$;
dimethylsilylene(7,7-dimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(adamantylamido)M(R)$_2$;
dimethylsilylene(2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(neopentylamido)M(R)$_2$;
dimethylsilylene(6,6-dimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(neopentylamido)M(R)$_2$;

dimethylsilylene(2,7,7-trimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(neopentylamido)M(R)$_2$;
dimethylsilylene(7,7-dimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(neopentylamido)M(R)$_2$;
dimethylsilylene(2-methyl-6,6-diethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(t-butylamido)M(R)$_2$;
dimethylsilylene(6,6-diethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(t-butylamido)M(R)$_2$;
dimethylsilylene(2-methyl-7,7-diethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(t-butylamido)M(R)$_2$;
dimethylsilylene(7,7-diethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(t-butylamido)M(R)$_2$;
dimethylsilylene(2-methyl-6,6-diethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(cyclododecylamido)M(R)$_2$;
dimethylsilylene(6,6-diethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(cyclododecylamido)M(R)$_2$;
dimethylsilylene(2-methyl-7,7-diethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(cyclododecylamido)M(R)$_2$;
dimethylsilylene(7,7-dimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(cyclododecylamido)M(R)$_2$;
diethylsilylene(2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(t-butylamido)M(R)$_2$;
diethylsilylene(6,6-dimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(t-butylamido)M(R)$_2$;
diethylsilylene(2,7,7-trimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(t-butylamido)M(R)$_2$;
diethylsilylene(7,7-dimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(t-butylamido)M(R)$_2$;
dimethylsilylene(2-methyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(cyclohexylamido)M(R)$_2$;
dimethylsilylene(2-methyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(cyclododecylamido)M(R)$_2$;
dimethylsilylene(2-methyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(adamantylamido)M(R)$_2$; and
dimethylsilylene(2-methyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(t-butylamido)M(R)$_2$;

where M is selected from a group consisting of Ti, Zr, and Hf and R is selected from halogen or $C_1$ to $C_5$ alkyl.

15. The method of claim 1, wherein the catalyst is one or more of: dimethylsilylene(2,7,7-trimethyl-3,6,7,8-tetrahydro-*as*-indacen-3-yl)(t-butylamido)titanium dimethyl; or dimethylsilylene(2,6,6-trimethyl-1,5,6,7-tetrahydro-*s*-indacen-1-yl)(t-butylamido)titanium dimethyl.

16. The method of claim 1, wherein the activator is represented by the formula:

$$(Z)_d^+ (A^{d-})$$

wherein: Z is (L-H) or a reducible Lewis acid, wherein L is a neutral Lewis base, H is hydrogen, and (L-H) is a Bronsted acid; and $A^{d-}$ is a boron containing non-coordinating anion having the charge d-, wherein d is 1, 2, or 3.

17. The method of claim 1, wherein the activator comprises one or more of: N,N-dimethylanilinium tetrakis(perfluoronaphthyl)borate, N,N-dimethylanilinium tetrakis(perfluorobiphenyl)borate, N,N-dimethylanilinium tetrakis(perfluorophenyl)borate, N,N-dimethylanilinium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate, triphenylcarbenium tetrakis(perfluoronaphthyl)borate, triphenylcarbenium tetrakis(perfluorobiphenyl)borate, triphenylcarbenium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate, triphenylcarbenium tetrakis(perfluorophenyl)borate, $[Me_3NH^+][B(C_6F_5)_4]$, 1-(4-(tris(pentafluorophenyl)borate)-2,3,5,6-tetrafluorophenyl) pyrrolidinium; , 1-(4-(tris(pentafluorophenyl)borate)-2,3,5,6-tetrafluorophenyl) pyrrolidinium, sodium tetrakis(pentafluorophenyl)borate, potassium tetrakis(pentafluorophenyl)borate, 4-(tris(pentafluorophenyl)borate)-2,3,5,6-tetrafluoropyridinium, sodium tetrakis(perfluorophenyl)aluminate, potassium tetrakis(pentafluorophenyl), and N,N-dimethylanilinium tetrakis(perfluorophenyl)aluminate.

18. The method of claim 1, wherein the activator is N,N-dimethylanilinium tetrakis(pentafluorophenyl)borate or N,N-dimethylanilinium tetrakis (perfluoronaphthyl)borate.

19. The method of claim 1, wherein the $C_3$-$C_{40}$ olefin is a $C_3$-$C_{20}$ α-olefin.

20. The method of claim 1, wherein the $C_3$-$C_{20}$ α-olefin is one or more of propylene, 1-butene, 1-pentene, 1-hexene, 1-heptene, 1-octene, 1-nonene, 1-decene, 1-undecene, 1-dodecene and isomers thereof.

21. The method of claim 1, wherein the $C_3$-$C_{20}$ α-olefin is propylene.

22. The method of claim 1, wherein the diene is one or more of 5-ethylidene-2-norbornene; 1,4-hexadiene; 5-methylene-2-norbornene; 1,6-octadiene; 5-methyl-l,4-hexadiene; 3,7-dimethyl-1,6-octadiene; dicyclopentadiene; and combinations thereof.

23. The method of claim 1, wherein the diene is 5-ethylidene-2-norbornene.

24. The method of claim 1, wherein the catalyst has an efficiency greater than 10,000 g polymer/g catalyst.

25. The method of claim 1, wherein the polymer produced has a propylene tacticity index ratio [m/r] of greater than 0.4 and less than 1.2.

26. The method of claim 1, wherein the contacting occurs at a temperature of from 0°C to 300°C, at a pressure from 0.35 MPa to 16 MPa.

27. The method of claim 1, wherein the polymer produced has a g’ value of 0.90 or greater.

28. The method of claim 1, wherein the polymer produced has a number average molecular weight value of from 40,000 g/mol to 250,000 g/mol.

29. The method of claim 1, wherein the polymer produced has a weight average molecular weight value of from 50,000 g/mol to 500,000 g/mol.

30. The method of claim 1, wherein the polymer produced has a z-average molecular weight value of from 150,000 g/mol to 800,000 g/mol.

31. The method of claim 1, wherein the polymer produced has an Mw/Mn of from 1.5 to 3.