CLAIMS

We claim:

1. A catalyst system comprising a transition metal compound and an activator, the activator having the formula (1):

$$[R^1R^2R^3AH]^+[Y]^-, \quad (1)$$

wherein:

$[Y]^-$ is a non-coordinating anion (NCA),

A is nitrogen or phosphorus,

R^1 and R^2 are hydrocarbyl groups or heteroatom-containing hydrocarbyl groups and together form a first, 3- to 10-membered non-aromatic ring with A, wherein any number of adjacent ring members may optionally members of at least one second, aromatic or aliphatic ring or aliphatic and/or aromatic ring system of two or more rings, wherein said at least one second ring or ring system is fused to said first ring, and wherein any atom of the first and/or at least one second ring or ring system is a carbon atom or a heteroatom and may be substituted independently by one or more substituents selected from the group consisting of a hydrogen atom, halogen atom, C_1 to C_{10} alkyl, C_5 to C_{15} aryl, C_6 to C_{25} arylalkyl, and C_6 to C_{25} alkylaryl, and

R^3 is a hydrogen atom or C_1 to C_{10} alkyl, or R^3 is a C_1 to C_{10} alkylene group that connects to said first ring and/or to said at least one second ring or ring system.

2. The catalyst system of claim 1, wherein A is nitrogen, R^1 and R^2 together are a $-(CH_2)_a-$ group with a being 3, 4, 5, or 6, and R^3 is C_1 to C_5 alkyl.

3. The catalyst system of claim 1 or 2, wherein $[Y]^-$ is $[B(R^4)_4]^-$, with R^4 being an unsubstituted aryl group or a substituted aryl group, of which the one or more substituents are identical or different and are selected from the group consisting of C_1 to C_{10} alkyl, C_5 to C_{15} aryl, a halogen atom, preferably fluorine, halogenated C_1 to C_{10} alkyl, halogenated C_5 to C_{15} aryl, halogenated C_6 to C_{25} alkylaryl, and halogenated C_6 to C_{25} arylalkyl groups, and wherein R^4 is preferably perfluorinated aryl, more preferably pentafluorophenyl, heptafluoronaphthyl or perfluorobiphenyl.

4. The catalyst system of any claims 1-3, wherein the transition metal compound is a metallocene, preferably a dialkylsiladiylbis(indenyl) metallocene, wherein the metal is a group 4 metal and the indenyl is unsubstituted or substituted by one or more substituents selected from the group consisting of a halogen atom, C_1 to C_{10} alkyl, C_5 to C_{15} aryl, C_6 to C_{25}

arylalkyl, and C_6 to C_{25} alkylaryl, and the metallocene is more preferably selected from the group consisting of a rac-dimethylgermylbis(indenyl)hafnocene or -zirconocene, a rac-dimethylsilyl bis(indenyl) hafnocene or -zirconocene, a rac-dimethylsilyl bis(2-methyl-4-phenylindenyl) hafnocene or -zirconocene, a rac-dimethylsilyl bis(2-methyl-indenyl) hafnocene or -zirconocene, a rac-dimethylsilyl bis(2-methyl-4-naphthylindenyl) hafnocene or -zirconocene, or a rac-ethylenyl bis(indenyl) hafnocene or -zirconocene, wherein the hafnocene and zirconocene has at least two leaving groups X_1 and X_2 which are, independently, hydrogen, halogen, hydride radicals, hydrocarbyl radicals, substituted hydrocarbyl radicals, halocarbyl radicals, substituted halocarbyl radicals, silylcarbyl radicals, substituted silylcarbyl radicals, germylcarbyl radicals, or substituted germylcarbyl radicals; or both X are joined and bound to the metal atom to form a metallacycle ring containing from about 3 to about 20 carbon atoms; or both together can be an olefin, diolefin or aryne ligand.

5. The catalyst system of any claims 1-4, wherein the transition metal compound and/or the activator are supported on a solid support, wherein the support comprises silica or alumina.

6. A process for polymerizing one or more olefins, comprising contacting under polymerization conditions one or more olefin monomers with a catalyst system according to any claims 1-5.

7. Use of a compound of formula (1) as defined in any of claims 1-5, as activator of a transition metal compound in a catalyst system for the polymerization of one or more olefins.

8. A process for polymerizing one or more olefins, comprising contacting under polymerization conditions one or more olefin monomers with a catalyst system comprising a transition metal compound and an activator having the following formula (2):

$$[R_nAH]^+[Y]^-, \qquad (2)$$

wherein

$[Y]^-$ is a non-coordinating anion (NCA),

A is nitrogen, phosphorus or oxygen,

n is 3 if A is nitrogen or phosphorus,

n is 2 if A is oxygen,

the groups R are identical or different and are a C_1 to C_3 alkyl group,

at a given reaction temperature the weight average molecular weight (Mw) of the

~~polymer formed increases or at least does not substantially decrease with increasing monomer conversion.~~

~~9. The process of any of claims 6-8, or the use of claim 7, wherein the one or more olefins are alpha-olefins, and preferably propylene, optionally in combination with another alpha-olefin.~~

~~10. The process of any of claims 6, 8, or 9, or the use of claim 7 or 9, wherein the activator is a combination of at least two different compounds of formula (1) as defined in any of claims 1-5 and/or formula (2) as defined in claim 8.~~

~~11. The process of any of claims 6, 8, or 9, or any use of claims 7-10, wherein $[R_nAH]^+$ is trimethylammonium, and $[Y]^-$ is tetrakis(pentafluorophenyl)borate, tetrakis(heptafluoronaphthyl)borate or tetrakis (perfluorobiphenyl)borate.~~

~~12. The process or use of claim 11, wherein the transition metal compound is a metallocene selected from the group consisting of a rac-dimethylgermylbis(indenyl)hafnocene or -zirconocene, a rac-dimethylsilyl bis(indenyl) hafnocene or -zirconocene, a rac-dimethylsilyl bis(2-methyl-4-phenylindenyl) hafnocene or -zirconocene, a rac-dimethylsilyl bis(2-methyl-indenyl) hafnocene or -zirconocene, a rac-dimethylsilyl bis(2-methyl-4-naphthylindenyl) hafnocene or -zirconocene, or an ethylenyl bis(indenyl) hafnocene or -zirconocene, wherein the hafnocene and zirconocene has at least two leaving groups X_1 and X_2 which are as defined in claim 4.~~

~~13. The process of any of claims 6, 8-12, or the use of any of claims 7 or 9-12, wherein the monomer conversion is from 5 to 50%, preferably 5 to 98%.~~

~~14. A copolymer composition comprising units derived from propylene and ethylene, where the copolymer comprises from about 0.1 to about 20 wt% units derived from ethylene, and~~

~~i. the density of the copolymer composition is less than about 0.900 g/cc;~~

~~ii. the heat of fusion of the copolymer composition is less than about 75 J/g;~~

~~iii. the melting point of the composition satisfies the relation $T_m > -6.2*e + 125$, where e is the ethylene content of the composition in wt% and Tm is the melting point in degrees Celsius;~~

~~iv. the copolymer is prepared using one or more metallocene catalysts; and~~

~~v. the copolymer composition has a T_{75} – T_{25} value of less than 35, where T_{25} is the temperature in degrees Celsius at which 25% of the eluted polymer is obtained and T_{75} is the temperature in degrees Celsius at which 75% of the eluted polymer is obtained via temperature rising elution fractionation (TREF).~~

~~15. The copolymer composition of claim 14, wherein the copolymer comprises from about 2 to about 20 wt% units derived from ethylene, or from about 3 to about 16 wt% units derived from ethylene, or from about 5 to about 14 wt% units derived from ethylene.~~

~~16. The copolymer composition of any of claims 14 or 15, wherein the density of the composition is less than about 0.970 g/cc.~~

~~17. The copolymer composition of any of claims 14-16, wherein the density of the composition is from about 0.860 to about 0.900 g/cc.~~

~~18. The copolymer composition of any of claims 14-17, wherein the molecular weight of the copolymer is from about 20,000 to about 400,000 g/mol.~~

~~19. The copolymer composition of any of claims 14-18, wherein the soluble fraction, F_a, of the copolymer satisfies the following relation:~~

~~$F_a < 7*e + 35$,~~

~~where e is the ethylene content of the composition in wt%.~~

~~20. The copolymer of any of claims 14-19, wherein the T_{75} – T_{25} value of the copolymer is less than 30, where T_{25} is the temperature in degrees Celsius at which 25% of the eluted polymer is obtained and T_{75} is the temperature in degrees Celsius at which 75% of the eluted polymer is obtained via TREF.~~

~~21.~~1. A process for the production of one or more copolymer compositions comprising contacting propylene and one or more comonomers with a catalyst system under polymerization conditions including conducting the polymerization in a homogenous solution at a temperature of from about 80°C to about 200°C and a monomer conversion of from 5 to 90%, where:

a. the catalyst system comprises a transition metal compound and an activator, the

activator having the formula:

~~$[R_nAH][Y]^+$~~; $[R_nAH][Y]^-$,

where the R groups may be identical or different and are a C_1 to C_3 alkyl group; A is nitrogen~~, phosphorus, or oxygen~~; n is 3 ~~if A is nitrogen or phosphorus and n is 2 if A is oxygen~~; and ~~$[Y]^+$~~ $[Y]^-$ is a non-coordinating anion represented by $[B(R^4)_4]^-$, with R^4 being an aryl group or a substituted aryl group, of which the one or more substituents are identical or different and are selected from the group consisting of alkyl, aryl, a halogen atom, halogenated aryl, and haloalkylaryl groups; and

wherein the transition metal compound is a dialkylsilylbis(indenyl) metallocene, wherein the metal is a Group 4 metal and the indenyl is unsubstituted or substituted by one or more substituents selected from the group consisting of a halogen atom, C_1 to C_{10} alkyl, C_5 to C_{15} aryl, C_6 to C_{25} arylalkyl, C_6 to C_{25} alkylaryl, and wherein the metallocene has two leaving groups, X_1 and X_2, which are both halogen or C_1 to C_3 alkyl; and

b. the copolymer composition comprises units derived from propylene and ethylene, where the copolymer comprises from about 0.1 to about 20 wt% units derived from ethylene, and:

i. the density of the copolymer composition is less than about ~~0.900~~ 0.970 g/cc;

ii. the heat of fusion of the copolymer composition is less than about 75 J/g;

iii. the melting point of the composition satisfies the relation $T_m > -6.2*e + 125$, where e is the ethylene content of the composition in wt% and Tm is the melting point in degrees Celsius;

iv. the copolymer is prepared using one ~~or more~~ dialkylsilylbis (indenyl) metallocene ~~catalysts~~; and

v. the copolymer composition has a $T_{75} - T_{25}$ value of less than 35, where T_{25} is the temperature in degrees Celsius at which 25% of the eluted polymer is obtained and T_{75} is the temperature in degrees Celsius at which 75% of the eluted polymer is obtained via temperature rising elution fractionation (TREF);

wherein the Mw of the polymer formed increases or at least does not substantially decrease with increasing monomer conversion at a given reaction temperature.

~~22. The process of claim 21, wherein the density of the composition is less than about 0.970 g/cc.~~

2. The process of claim 1, wherein the copolymer comprises from about 2 to about 20 wt% units derived from ethylene.

3. The process of claim 2, wherein the copolymer comprises from about 3 to about 16 wt% units derived from ethylene.

4. The process of claim 3, wherein the copolymer comprises from about 5 to about 14 wt% units derived from ethylene.

5. The process of claim 1, wherein the density of the copolymer composition is less than about 0.940 g/cc.

~~23.~~6. The process of ~~any of claims 21-22~~ claim 5, wherein the density of the copolymer composition is from about 0.860 to about 0.900 g/cc.

7. The process of claim 1, wherein the molecular weight of the copolymer is from about 20,000 to about 400,000 g/mol.

8. The process of claim 1, wherein the molecular weight distribution of the copolymer is from about 2.0 to about 2.4.

~~24.~~9. The process of ~~any of claims 21-23~~ claim 1, wherein the soluble fraction, F_a, of the copolymer satisfies the following relation:

$$F_a < 7*e + 35,$$

where e is the ethylene content of the composition in wt%.

~~25. The process of any of claims 21-24, wherein the transition metal compound is a dialkylsilylbis(indenyl) metallocene, wherein the metal is a group 4 metal and the indenyl is unsubstituted or substituted by one or more substituents selected from the group consisting of a halogen atom, C_1 to C_{10} alkyl, C_5 to C_{15} aryl, C_6 to C_{25} arylalkyl, C_6 to C_{25} alkylaryl, and wherein the metallocene has two leaving groups, X_1 and X_2, which are both halogen or C_1 to C_3 alkyl.~~

10. The process of claim 1, wherein the soluble fraction, F_a, of the copolymer satisfies the following relation:

$$F_a < 7*e + 38,$$

where e is the ethylene content of the composition in wt%.

11. The process of claim 1, wherein the soluble fraction, F_a, of the copolymer satisfies the following relation:

$$F_a < 7*e + 40,$$

where e is the ethylene content of the composition in wt%.

12. The process of claim 1, wherein the copolymer composition has a $T_{75} - T_{25}$ value of less than 30, 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 via temperature rising elution fractionation (TREF).

13. The process of claim 12, wherein the copolymer composition has a $T_{75} - T_{25}$ value of less than 25.

14. The process of claim 13, wherein the copolymer composition has a $T_{75} - T_{25}$ value of less than 20.

15. The process of claim 1, wherein the activator has the formula $[Me_3NH][Y]^+$, where Me denotes a methyl group.

16. The process of claim 15, wherein $[Y]^-$ is tetrakis(pentafluorophenyl)borate, tetrakis(heptafluorophenyl)borate, or tetrakis(perfluorophenyl)borate.