CLAIMS

1. A catalyst composition comprising:

an activator-support comprising a fluorided-chlorided silica-coated alumina;

a metallocene compound; and

optionally, a co-catalyst.

2. The composition of claim 1, wherein:

the fluorided-chlorided silica-coated alumina comprises from about 10 to about 80 wt. % silica, based on the weight of the silica-coated alumina;

the fluorided-chlorided silica-coated alumina comprises from about 2 to about 15 wt. % F, based on the weight of the fluorided-chlorided silica-coated alumina; and

the fluorided-chlorided silica-coated alumina comprises from about 1 to about 10 wt. % Cl, based on the weight of the fluorided-chlorided silica-coated alumina.

3. The composition of claim 1, wherein the catalyst composition comprises an activator-support comprising a fluorided-chlorided silica-coated alumina, a metallocene compound, and a co-catalyst, wherein the co-catalyst comprises an aluminoxane compound, an organoboron or organoborate compound, an ionizing ionic compound, an organoaluminum compound, an organozinc compound, an organomagnesium compound, an organolithium compound, or any combination thereof.

4. The composition of claim 3, wherein the co-catalyst comprises an organoaluminum compound, wherein the organoaluminum compound comprises trimethylaluminum, triethylaluminum, tri-n-propylaluminum, tri-n-butylaluminum, triisobutylaluminum, tri-n-hexylaluminum, tri-n-octylaluminum, diisobutylaluminum hydride, diethylaluminum ethoxide, diethylaluminum chloride, or any combination thereof.

5. The composition of claim 1, wherein the fluorided-chlorided silica-coated alumina is produced by a process comprising:

(a) calcining a silica-coated alumina at a peak calcining temperature to produce a calcined silica-coated alumina;

(b) contacting the calcined silica-coated alumina with a chlorine-containing compound and calcining at a peak chloriding temperature to produce a chlorided silica-coated alumina; and

(c) contacting the chlorided silica-coated alumina with a fluorine-containing compound and calcining at a peak fluoriding temperature to produce the fluorided-chlorided silica-coated alumina.

6. The composition of claim 1, wherein:

a catalyst activity of the catalyst composition is greater than about 1000 grams of polyethylene per gram of fluorided-chlorided silica-coated alumina per hour, under slurry polymerization conditions, with a triisobutylaluminum co-catalyst, using isobutane as a diluent, and with a polymerization temperature of 95 °C and a reactor pressure of 400 psig; and

a catalyst activity of the catalyst composition is greater than about 1000 grams of polypropylene per gram of fluorided-chlorided silica-coated alumina per hour, under slurry polymerization conditions, with a triisobutylaluminum co-catalyst, and a polymerization temperature of 70 °C and a reactor pressure of 450 psig.

7. The composition of claim 1, wherein:

a catalyst activity of the catalyst composition is greater than that of a catalyst system containing a chlorided silica-coated alumina, under the same polymerization conditions; and

a catalyst activity of the catalyst composition is greater than that of a catalyst system containing a fluorided silica-coated alumina, under the same polymerization conditions.

8. The composition of claim 1, wherein a catalyst activity of the catalyst composition is greater than that of a catalyst system containing a chlorided-fluorided silica-coated alumina, under the same polymerization conditions.

9. An olefin polymerization process, the process comprising contacting a catalyst composition with an olefin monomer and an optional olefin comonomer in a polymerization reactor system under polymerization conditions to produce an olefin polymer, wherein the catalyst composition comprises an activator-support comprising a fluorided-chlorided silica-coated alumina, a metallocene compound, and an optional co-catalyst.

10. The process of claim 9, wherein the polymerization reactor system comprises a batch reactor, slurry reactor, gas-phase reactor, solution reactor, high pressure reactor, tubular reactor, autoclave reactor, or any combination thereof.

11. The process of claim 9, wherein the olefin monomer comprises ethylene or propylene.

12. The process of claim 9, wherein the catalyst composition is contacted with ethylene and an olefin comonomer comprising 1-butene, 1-hexene, 1-octene, or a mixture thereof.

13. A process to produce a fluorided-chlorided silica-coated alumina, the process comprising:

(a) calcining a silica-coated alumina at a peak calcining temperature to produce a calcined silica-coated alumina;

(b) contacting the calcined silica-coated alumina with a chlorine-containing compound and calcining at a peak chloriding temperature to produce a chlorided silica-coated alumina; and

(c) contacting the chlorided silica-coated alumina with a fluorine-containing compound and calcining at a peak fluoriding temperature to produce the fluorided-chlorided silica-coated alumina.

14. The process of claim 13, wherein:

the peak calcining temperature is in a range from about 400 to about 1000 °C;

the peak chloriding temperature is less than or equal to the peak calcining temperature; and

the peak fluoriding temperature is less than or equal to the peak calcining temperature.

15. The process of claim 13, wherein:

the peak calcining temperature is in a range from about 400 to about 1000 °C;

the peak chloriding temperature is in a range from about 300 to about 700 °C and is less than or equal to the peak calcining temperature; and

the peak fluoriding temperature is in a range from about 300 to about 700 °C and is less than or equal to the peak calcining temperature.

16. The process of claim 13, wherein:

the fluorine-containing compound comprises HF, F_2, perfluorohexane, perfluoroacetic anhydride, tetrafluoroethane, ammonium fluoride, ammonium bifluoride, or a combination thereof;

the chlorine-containing compound comprises HCl, Cl_2, carbon tetrachloride, tetrachloroethylene, or a combination thereof; or

both.

17. The process of claim 13, wherein:

the contacting of the calcined silica-coated alumina and the chlorine-containing compound is in the vapor phase; and

the contacting of the chlorided silica-coated alumina and the fluorine-containing compound is in the vapor phase.

18. The process of claim 13, wherein:

the contacting of the calcined silica-coated alumina and the chlorine-containing compound is in the liquid phase; and

the contacting of the chlorided silica-coated alumina and the fluorine-containing compound is in the liquid phase.

19. The process of claim 13, wherein:

the silica-coated alumina comprises from about 10 to about 80 wt. % silica, based on the weight of the silica-coated alumina;

the fluorided-chlorided silica-coated alumina comprises from about 2 to about 15 wt. % F, based on the weight of the fluorided-chlorided silica-coated alumina; and

the fluorided-chlorided silica-coated alumina comprises from about 3 to about 10 wt. % Cl, based on the weight of the fluorided-chlorided silica-coated alumina.

20. A fluorided-chlorided silica-coated alumina produced by the process of claim 13, wherein the fluorided-chlorided silica-coated alumina has:

a pore volume in a range from about 0.9 to about 2.0 mL/g; and

a surface area in a range from about 200 to about 700 m^2/g.

CLAIMS

We claim:

1. A catalyst composition comprising:
an activator-support comprising a fluorided-chlorided silica-coated alumina;

a metallocene compound; and

optionally, a co-catalyst; wherein:

a catalyst activity of the catalyst composition is greater than that of a catalyst system containing a fluorided silica-coated alumina, under the same polymerization conditions.

2. The composition of claim 1, wherein:
the fluorided-chlorided silica-coated alumina comprises from about 10 to about 80 wt. % silica, based on the weight of the silica-coated alumina;

the fluorided-chlorided silica-coated alumina comprises from about 2 to about 15 wt. % F, based on the weight of the fluorided-chlorided silica-coated alumina; and

the fluorided-chlorided silica-coated alumina comprises from about 1 to about 10 wt. % Cl, based on the weight of the fluorided-chlorided silica-coated alumina.

3. The composition of claim 1, wherein the catalyst composition comprises an activator-support comprising a fluorided-chlorided silica-coated alumina, a metallocene compound, and a co-catalyst, wherein the co-catalyst comprises an aluminoxane compound, an organoboron or organoborate compound, an ionizing ionic compound, an organoaluminum compound, an organozinc compound, an organomagnesium compound, an organolithium compound, or any combination thereof.

4. The composition of claim 3, wherein the co-catalyst comprises an organoaluminum compound, wherein the organoaluminum compound comprises trimethylaluminum, triethylaluminum, tri-n-propylaluminum, tri-n-butylaluminum, triisobutylaluminum, tri-n-hexylaluminum, tri-n-octylaluminum, diisobutylaluminum hydride, diethylaluminum ethoxide, diethylaluminum chloride, or any combination thereof.

5. The composition of claim 1, wherein the fluorided-chlorided silica-coated alumina is produced by a process comprising:
(a) calcining a silica-coated alumina at a peak calcining temperature to produce a calcined silica-coated alumina;

(b) contacting the calcined silica-coated alumina with a chlorine-containing compound and calcining at a peak chloriding temperature to produce a chlorided silica-coated alumina; and

(c) contacting the chlorided silica-coated alumina with a fluorine-containing compound and calcining at a peak fluoriding temperature to produce the fluorided-chlorided silica-coated alumina.

6. The composition of claim 1, wherein:

a catalyst activity of the catalyst composition is greater than about 1000 grams of polyethylene per gram of fluorided-chlorided silica-coated alumina per hour, under slurry polymerization conditions, with a triisobutylaluminum co-catalyst, using isobutane as a diluent, and with a polymerization temperature of 95° C. and a reactor pressure of 400 psig; and

a catalyst activity of the catalyst composition is greater than about 1000 grams of polypropylene per gram of fluorided-chlorided silica-coated alumina per hour, under slurry polymerization conditions, with a triisobutylaluminum co-catalyst, and a polymerization temperature of 70° C. and a reactor pressure of 450 psig.

7. The composition of claim 1, wherein:

a catalyst activity of the catalyst composition is greater than that of a catalyst system containing a chlorided silica-coated alumina, under the same polymerization conditions.

8. The composition of claim 1, wherein a catalyst activity of the catalyst composition is greater than that of a catalyst system containing a chlorided-fluorided silica-coated alumina, under the same polymerization conditions.

9. An olefin polymerization process, the process comprising contacting a catalyst composition with an olefin monomer and an optional olefin comonomer in a polymerization reactor system under polymerization conditions to produce an olefin polymer, wherein the catalyst composition comprises an activator-support comprising a fluorided-chlorided silica-coated alumina, a metallocene compound, and an optional co-catalyst; wherein:

a catalyst activity of the catalyst composition is greater than that of a catalyst system containing a fluorided silica-coated alumina, under the same polymerization conditions.

10. The process of claim 9, wherein the polymerization reactor system comprises a batch reactor, slurry reactor, gas-phase reactor, solution reactor, high pressure reactor, tubular reactor, autoclave reactor, or any combination thereof.

11. The process of claim 9, wherein the olefin monomer comprises ethylene or propylene.

12. The process of claim 9, wherein the catalyst composition is contacted with ethylene and an olefin comonomer comprising 1-butene, 1-hexene, 1-octene, or a mixture thereof.

13. A process to produce a fluorided-chlorided silica-coated alumina, the process comprising:

(a) calcining a silica-coated alumina at a peak calcining temperature to produce a calcined silica-coated alumina;

(b) contacting the calcined silica-coated alumina with a chlorine-containing compound and calcining at a peak chloriding temperature to produce a chlorided silica-coated alumina; and

(c) contacting the chlorided silica-coated alumina with a fluorine-containing compound and calcining at a peak fluoriding temperature to produce the fluorided-chlorided silica-coated alumina; wherein:

an activity of a catalyst composition containing the fluorided-chlorided silica-coated alumina is greater than that of a catalyst system containing a chlorided-fluorided silica-coated alumina, under the same polymerization conditions.

14. The process of claim 13, wherein:

the peak calcining temperature is in a range from about 400 to about 1000° C.;

the peak chloriding temperature is less than or equal to the peak calcining temperature; and

the peak fluoriding temperature is less than or equal to the peak calcining temperature.

15. The process of claim 13, wherein:

the peak calcining temperature is in a range from about 400 to about 1000° C.;

the peak chloriding temperature is in a range from about 300 to about 700° C. and is less than or equal to the peak calcining temperature; and

the peak fluoriding temperature is in a range from about 300 to about 700° C. and is less than or equal to the peak calcining temperature.

16. The process of claim 13, wherein:

the fluorine-containing compound comprises HF, F_2, perfluorohexane, perfluoroacetic anhydride, tetrafluoroethane, ammonium fluoride, ammonium bifluoride, or a combination thereof; and

the chlorine-containing compound comprises HCl, Cl_2, carbon tetrachloride, tetrachloroethylene, or a combination thereof.

17. The process of claim 13, wherein:

the contacting of the calcined silica-coated alumina and the chlorine-containing compound is in the vapor phase; and

the contacting of the chlorided silica-coated alumina and the fluorine-containing compound is in the vapor phase.

18. The process of claim 13, wherein:

the contacting of the calcined silica-coated alumina and the chlorine-containing compound is in the liquid phase; and

the contacting of the chlorided silica-coated alumina and the fluorine-containing compound is in the liquid phase.

19. The process of claim 13, wherein:

the silica-coated alumina comprises from about 10 to about 80 wt. % silica, based on the weight of the silica-coated alumina;

the fluorided-chlorided silica-coated alumina comprises from about 2 to about 15 wt. % F, based on the weight of the fluorided-chlorided silica-coated alumina; and

the fluorided-chlorided silica-coated alumina comprises from about 3 to about 10 wt. % Cl, based on the weight of the fluorided-chlorided silica-coated alumina.

20. A fluorided-chlorided silica-coated alumina produced by the process of claim 13, wherein the fluorided-chlorided silica-coated alumina has:

a pore volume in a range from about 0.9 to about 2.0 mL/g; and

a surface area in a range from about 200 to about 700 m^2/g.