Claims

1. A clay composition comprising intercalated modified and calcined smectite clay for use as an olefin polymerization catalyst support activator comprising:
   (a) pillars comprising aluminum and:
      (i) at least one rare earth or lanthanide group metal; or
      (ii) at least one rare earth or lanthanide group metal and gallium; and
   (b) said clay comprising at least one ion-exchanged metal selected from the group consisting of magnesium, and zinc; and
   wherein said clay is characterized by a basal d_{001} spacing equal to or greater than 18.5 angstroms and equal to or less than ~~about~~ 100 angstroms.

2. The clay composition of claim 1 wherein the pillars comprise at least one of cerium or lanthanum.

3. The clay composition of any one of claims 1-2 comprising at least one deposited metal selected from the group consisting of catalytically active transition metals of Groups 3-10 of the Periodic Table and optionally at least one organoaluminum compound.

4. A process for producing a clay composition for use as an olefin polymerization catalyst support-activator comprising intercalated modified and calcined smectite clay, the process comprising steps:
   (A) contacting an aqueous slurry comprising smectite clay with an aqueous pillaring agent comprising at least one of aluminum, zirconium or chromium and: (i) at least one rare earth or lanthanide group metal; or (ii) at least one rare earth or lanthanide group metal and gallium; to form a solids-containing phase and an aqueous phase;
   (B) separating the solids-containing phase from the aqueous phase formed in (A);
   (C) contacting the separated solids obtained in (B) at least once with an aqueous Met_mX_n composition comprising at least one Met_mX_n compound, wherein Met_m is at least one metal ion selected from the group consisting of magnesium and zinc, and X_n comprises at least one anionic species; and m and n = numerals that together

satisfy the valence requirement for the combination of Met_m and X_n, to form a mixture comprising a solids-containing phase and an aqueous phase;

(D) separating the aqueous phase formed in (C) in order to form a new solids-containing phase;

(E) drying the separated, solids-containing phase from (D) in order to obtain dry solids and reducing said dry solids to a dry, particulate form; and

(F) calcining the dry, particulate from (E) to form a dry, pillared, solid catalyst support-activator in particulate form.

5. The process of claim 4 comprising in step (B), repeatedly extracting with water the solids-containing phase separated from the aqueous phase formed in step (A) and separating the water from the solids until the separated water is free or substantially free of: (i) residual anions originally present in the aqueous pillaring agent; or (ii) unconsumed pillaring agent or byproduct thereof; or (iii) both (i) and (ii);

in step (D), contacting and mixing the new solids-containing phase with a new portion of aqueous Met_mX_n composition, wherein Met and X_n are the same or different chemical species as selected in (C) and mixing and separating the resulting mixture comprising a solids-containing phase and an aqueous phase; and optionally repeating step (D) at least one additional time, wherein following the last mixing and contacting with the Met_mX_n composition, water-washing by introducing distilled or de-ionized water to the separated solids-containing phase to form a solids-containing composition, mixing and separating the composition into a solids-containing phase and an aqueous phase; and

repeating the water-washing until the aqueous phase is free or substantially free of X_n ions in order to obtain a washed solids-containing phase;

wherein free or substantially free is confirmed by a conductance value of less than 20,000 μS/cm or a negative $AgNO_3$ test result, or both.

6. The process of claim 4 or claim 5, wherein X_n comprises at least one anionic species independently selected from the group consisting of a halide selected from the group consisting of chloride, iodide, fluoride and bromide; bromate; chlorate; perchlorate;

sulfate; sulfamate; carbonate; hydrogen-carbonate; carbamate; nitrite; nitrate; oxalate; phosphate; selenate; sulfamate; azide; alkoxide; amide, including NR_2 or $R[CON(R)]_a$, wherein R is independently H or a C_1-C_{20} unsubstituted or substituted hydrocarbyl group and a=1-4; and carboxylate, including $R[CO_2]_b$, wherein R is independently H or a C_1-C_{20} unsubstituted or substituted hydrocarbyl group and b=1-4.

7. The process of any one of claims 4 to 6 wherein Met_mX_n is selected from the group consisting of MgF_2, $MgCl_2$, $Mg(OAc)_2$, $Mg(NO_3)_2$, $ZnCl_2$, $ZnSO_4$, and mixtures thereof.

8. The process of claim 7 wherein Met_mX_n is $MgCl_2$ or $ZnCl_2$ or a mixture of $MgCl_2$ and $ZnCl_2$.

9. The process of any one of claims 4 to 8 wherein following separation of the solids-containing phase in (B), the solids-containing phase is extracted at least once with water.

10. The process of claim 9 wherein water extraction is repeated until upon separation from the solids, the separated water is free or substantially free of: (i) residual anions originally present in the aqueous pillaring agent; or (ii) unconsumed pillaring agent or byproduct thereof; or (iii) both (i) and (ii); wherein free or substantially free is confirmed by a conductance value of less than 20,000 µS/cm or a negative $AgNO_3$ test result, or both.

11. The process of claim 7 or claim 8 wherein contacting with Met_mX_n is carried out from 2 to ~~about~~ 10 times, and wherein Met_mX_n used in more than one contacting step is the same or different as Met_mX_n used in a prior contacting step, and including a separating step as in (D) between one or more contacting step.

12. The process of any one of claims 7-11, wherein the pillaring agent is selected from the group consisting of a basic aluminum complex, a basic zirconium complex, a basic chromium complex and mixtures thereof.

13. The process of any one of claims 7-12, wherein calcining is conducted at a temperature in the range of ~~about~~ 110°C to ~~about~~ 800°C for ~~about~~ 1 hr. to ~~about~~ 10 hrs.

14. An intercalated modified and calcined smectite clay catalyst support-activator for a metallocene olefin polymerization catalyst in the absence of an aluminoxane or borate activator, said catalyst support activator comprising:

intercalated modified and calcined smectite clay comprising:

(a) pillars comprising aluminum and:

(i) at least one rare earth or lanthanide group metal; or

(ii) at least one rare earth or lanthanide group metal and gallium; and

(b) said clay comprising at least one ion-exchanged metal selected from the group consisting of magnesium and zinc; and

wherein said clay is characterized by a basal d_{001} spacing equal to or greater than 18.5 angstroms and equal to or less than ~~about~~ 100 angstroms.