

WHAT IS CLAIMED IS:

1. A silica-alumina composite material that is suitable for use in making a hydroprocessing catalyst base, comprising a modified first silica-alumina, wherein the first silica-alumina is modified to comprise silica and alumina domains and a silica-alumina interphase; and a second silica-alumina; wherein the first silica-alumina and the second silica-alumina differ in one or more characteristics selected from the ratio of silica to alumina, surface area, pore size, pore volume, silica domain size, or alumina domain size.
2. The material of claim 1, wherein the modified first silica-alumina is modified by contacting a first silica-alumina with a strong acid, preferably nitric acid, under extrusion conditions.
3. The material of any one of claims 1 or 2, wherein the first silica-alumina and the second silica-alumina comprise amorphous silica-alumina or are both amorphous silica-alumina.
4. The material of any one of claims 1-3, wherein the second silica-alumina is a modified second silica-alumina comprising silica and alumina domains and a silica-alumina interphase.
5. The material of claim 4, wherein the modified second silica-alumina is modified by contacting a second silica-alumina with a strong acid, preferably nitric acid, under extrusion conditions.
6. The material of any one of claims 1-5, wherein the material further comprises a molecular sieve and/or an alumina support.
7. The material of claim 6, wherein the molecular sieve comprises a Y zeolite, preferably a Y zeolite having a unit cell size of between 24.15 Å and 24.45 Å, and, optionally, further comprising a beta zeolite.
8. The material of any one of claims 1-7, wherein the material comprises
1-90 wt.%, or 10-80 wt.%, or 20-70 wt.%, or 30-60 wt.%, or 30-50 wt.% of the first silica-alumina;
1-90 wt.%, or 10-80 wt.%, or 20-70 wt.%, or 25-60 wt.%, or 25-50 wt.% of the second silica-alumina;
0-60 wt.%, or 2-50 wt.%, or 5-40 wt.%, or 5-30 wt.%, or 5-20 wt.%, or 5-15 wt.% molecular sieve; and
0-40 wt.%, or 5-40 wt.%, or 10-30 wt.%, or 15-30 wt.% alumina.
9. The material of any one of claims 1-8, wherein the first silica-alumina and/or the second silica-alumina comprise one or more of the following:

an alumina content in units of wt.% in the range of 10-98, or 10-80, or 20-80, or 30-80, or 30-70, or 40-70, or 50-70, or 50-80, or 60-80, or 10-50, or 10-40, or 20-40, or 40-98, or 50-98, or 60-98, or 70-98, or 80-98;

a surface area by nitrogen adsorption in units of m^2/g in the range of 300-700, or 300-650, or 300-600, or 320-600, or 320-550, or 320-500, or 350-700, or 350-650, or 350-600, or 350-600, or 350-550, or 350-500, or 400-700, or 400-650, or 400-600, or 400-550, or 450-700, or 450-650, or 450-600, or 450-550;

a pore volume by nitrogen adsorption in units of m^3/g in the range of 0.7-2.50, or 0.7-2.2, or 0.7-2.0, or 0.7-1.8, or 0.7-1.6, or 0.7-1.4, or 0.7-1.2, or 0.7-1.0, or 0.7-0.9, or 0.75-2.50, or 0.75-2.2, or 0.75-2.0, or 0.75-1.8, or 0.75-1.6, or 0.75-1.4, or 0.75-1.2, or 0.75-1.0, or 0.75-0.9, or 0.85-2.50, or 0.85-2.2, or 0.85-2.0, or 0.85-1.8, or 0.85-1.6, or 0.85-1.4, or 0.85-1.2, or 0.85-1.0, or 0.85-0.9, or 0.9-2.50, or 0.9-2.2, or 0.9-2.0, or 0.9-1.8, or 0.9-1.6, or 0.9-1.4, or 0.9-1.2, or 0.9-1.0, or 1.0-2.50, or 1.0-2.2, or 1.0-2.0, or 1.0-1.8, or 1.0-1.6, or 1.0-1.4, or 1.0-1.2, or 1.0-2.50, or 1.1-2.2, or 1.1-2.0, or 1.1-1.8, or 1.1-1.6, or 1.1-1.4, or 1.1-1.2, or 1.2-2.5, or 1.2-2.0, or 1.2-1.8, or 1.2-1.6, or 1.2-1.4, or 1.3-2.5, or 1.3-2.0, or 1.3-1.8, or 1.3-1.6, or 1.3-1.4, or 1.4-2.5, or 1.4-2.0, or 1.4-1.8, or 1.4-1.6;

a diameter at 50% pore volume D_{50} in units of nm in the range of 3-35, or 3-20, or 3-15, or 3-10, or 3-8, or 3-7, or 4-25, or 4-20, or 4-15, or 4-10, or 4-8, or 4-7, or 5-25, or 5-20, or 5-15, or 5-10, or 5-8, or 5-7, or 6-25, or 6-20, or 6-15, or 6-10, or 6-8, or 8-25, or 8-20, or 8-15, or 8-10, or 10-25, or 10-20, or 10-15, or 10-13, or 12-25, or 12-20, or 12-15, or 14-25, or 14-20, or 14-18, or 16-25, or 16-20, or 16-18.

10. The material of any one of claims 1-9, wherein the material comprises one or more of the following:

a particle density in units of g/mL in the range of 0.6-0.10, or 0.64-1.0, or 0.68-1.0, or 0.72-1.0, or 0.76-1.0, or 0.8-1.0, or 0.84-1.0, or 0.88-1.0, or 0.6-0.96, or 0.64-0.96, or 0.68-0.96, or 0.72-0.96, or 0.76-0.96, or 0.8-0.96, or 0.84-0.96, or 0.88-0.96, or 0.6-0.92, or 0.64-0.92, or 0.68-0.92, or 0.72-0.92, or 0.76-0.92, or 0.8-0.92, or 0.84-0.92, or 0.6-0.88, or 0.64-0.88, or 0.68-0.88, or 0.72-0.88, or 0.76-0.88, or 0.8-0.88, or 0.6-0.84, or 0.64-0.84, or 0.68-0.84, or 0.72-0.84, or 0.76-0.84, or 0.8-0.84, or 0.6-0.8, or 0.64-0.8, or 0.68-0.8, or 0.72-0.8, or 0.76-0.8, or 0.6-0.76, or 0.64-0.76, or 0.68-0.76, or 0.72-0.76;

a surface area by nitrogen adsorption in units of m^2/g in the range of 300-700, or 300-650, or 300-600, or 320-600, or 320-550, or 320-500, or 350-700, or 350-650, or 350-600, or 350-600, or 350-550, or 350-500, or 400-700, or 400-650, or 400-600, or 400-550, or 450-700, or 450-650, or 450-600, or 450-550;

a pore volume by nitrogen adsorption in units of m^3/g in the range of 0.7-2.50, or 0.7-2.2, or 0.7-2.0, or 0.7-1.8, or 0.7-1.6, or 0.7-1.4, or 0.7-1.2, or 0.7-1.0, or 0.7-0.9, or 0.75-2.50, or 0.75-2.2, or 0.75-2.0, or 0.75-1.8, or 0.75-1.6, or 0.75-1.4, or 0.75-1.2, or 0.75-1.0, or 0.75-0.9, or 0.85-2.50, or 0.85-2.2, or 0.85-2.0, or 0.85-1.8, or 0.85-1.6, or 0.85-1.4, or 0.85-1.2, or 0.85-1.0, or 0.85-0.9, or 0.9-2.50, or 0.9-2.2, or 0.9-2.0, or 0.9-

1.8, or 0.9-1.6, or 0.9-1.4, or 0.9-1.2, or 0.9-1.0, or 1.0-2.50, or 1.0-2.2, or 1.0-2.0, or 1.0-1.8, or 1.0-1.6, or 1.0-1.4, or 1.0-1.2, or 1.0-2.50, or 1.1-2.2, or 1.1-2.0, or 1.1-1.8, or 1.1-1.6, or 1.1-1.4, or 1.1-1.2, or 1.2-2.5, or 1.2-2.0, or 1.2-1.8, or 1.2-1.6, or 1.2-1.4, or 1.3-2.5, or 1.3-2.0, or 1.3-1.8, or 1.3-1.6, or 1.3-1.4, or 1.4-2.5, or 1.4-2.0, or 1.4-1.8, or 1.4-1.6;

a diameter at 50% pore volume D_{50} in units of nm in the range of 3-35, or 3-20, or 3-15, or 3-10, or 3-8, or 3-7, or 4-25, or 4-20, or 4-15, or 4-10, or 4-8, or 4-7, or 5-25, or 5-20, or 5-15, or 5-10, or 5-8, or 5-7, or 6-25, or 6-20, or 6-15, or 6-10, or 6-8, or 8-25, or 8-20, or 8-15, or 8-10, or 10-25, or 10-20, or 10-15, or 10-13, or 12-25, or 12-20, or 12-15, or 14-25, or 14-20, or 14-18, or 16-25, or 16-20, or 16-18.

11. A hydroprocessing catalyst comprising

the material of any one of claims 1-10 in the range of about 40 to less than 100 wt.%, or 40-99 wt.%, or 50-99 wt.%, or 60-99 wt.%, or 70-99 wt.%;

a noble metal in the range of 0.1 to 5 wt.%, or 0.1-4 wt.%, or 0.1-3 wt.% or 0.1-2 wt.%, or 0.1-1 wt.%;

a base metal in the range of 0-40 wt.%, or 5-40 wt.%, or 5-30 wt.%, or 10-40 wt.%, or 10-30 wt.%, or 10-20 wt.%, or 20-40 wt.%, or 20-30 wt.%; wherein the total base metal content is optionally in the range of 0-40 wt.%, or 5-40 wt.%, or 5-30 wt.%, or 10-40 wt.%, or 10-30 wt.%, or 10-20 wt.%, or 20-40 wt.% or 20-30 wt.%; and

a promoter in the range of 0-30 wt.%, or 0-20 wt.%, or 0-10 wt.%, or 5-30 wt.%, or 5-20 wt.%, or 10-30 wt.%, or 10-20 wt.%;

12. A method of making a silica-alumina composite material that is suitable for use as, or in making, a hydroprocessing catalyst base, the method comprising

combining a first silica-alumina and a second silica-alumina, optionally with a molecular sieve and/or an alumina support, to form a base composition;

wherein the first silica-alumina and the second silica-alumina differ in one or more characteristics selected from the ratio of silica to alumina, surface area, pore size, pore volume, silica domain size, or alumina domain size;

adding a dilute strong acid aqueous solution, preferably nitric acid, to the base composition to form an extrudable composition; and

extruding, drying, and calcining the extrudable composition to form the silica-alumina composite material.

13. The method of claim 12, wherein the first silica-alumina and the second silica-alumina comprise amorphous silica-alumina or are amorphous silica-aluminas.
14. The method of claim 12, wherein the base composition comprises the first silica-alumina, the second silica-alumina, a Y zeolite and an alumina, optionally, further comprising a beta zeolite.
15. The method of any one of claims 12-14, wherein the base composition comprises
1-90 wt.%, or 10-80 wt.%, or 20-70 wt.%, or 30-60 wt.%, or 30-50 wt.% of the first silica-alumina;
1-90 wt.%, or 10-80 wt.%, or 20-70 wt.%, or 25-60 wt.%, or 25-50 wt.% of the second silica-alumina;
0-60 wt.%, or 2-50 wt.%, or 5-40 wt.%, or 5-30 wt.%, or 5-20 wt.%, or 5-15 wt.% molecular sieve; and
0-40 wt.%, or 5-40 wt.%, or 10-30 wt.%, or 15-30 wt.% alumina.
16. The method of any one of claims 12-15, wherein the first silica-alumina and/or the second silica-alumina comprise one or more of the following:

an alumina content in units of wt.% in the range of 10-98, or 10-80, or 20-80, or 30-80, or 30-70, or 40-70, or 50-70, or 50-80, or 60-80, or 10-50, or 10-40, or 20-40, or 40-98, or 50-98, or 60-98, or 70-98, or 80-98;

a surface area by nitrogen adsorption in units of m^2/g in the range of 300-700, or 300-650, or 300-600, or 320-600, or 320-550, or 320-500, or 350-700, or 350-650, or 350-600, or 350-600, or 350-550, or 350-500, or 400-700, or 400-650, or 400-600, or 400-550, or 450-700, or 450-650, or 450-600, or 450-550;

a pore volume by nitrogen adsorption in units of m^2/g in the range of 0.7-2.50, or 0.7-2.2, or 0.7-2.0, or 0.7-1.8, or 0.7-1.6, or 0.7-1.4, or 0.7-1.2, or 0.7-1.0, or 0.7-0.9, or 0.75-2.50, or 0.75-2.2, or 0.75-2.0, or 0.75-1.8, or 0.75-1.6, or 0.75-1.4, or 0.75-1.2, or 0.75-1.0, or 0.75-0.9, or 0.85-2.50, or 0.85-2.2, or 0.85-2.0, or 0.85-1.8, or 0.85-1.6, or 0.85-1.4, or 0.85-1.2, or 0.85-1.0, or 0.85-0.9, or 0.9-2.50, or 0.9-2.2, or 0.9-2.0, or 0.9-1.8, or 0.9-1.6, or 0.9-1.4, or 0.9-1.2, or 0.9-1.0, or 1.0-2.50, or 1.0-2.2, or 1.0-2.0, or 1.0-1.8, or 1.0-1.6, or 1.0-1.4, or 1.0-1.2, or 1.0-2.50, or 1.1-2.2, or 1.1-2.0, or 1.1-1.8, or 1.1-1.6, or 1.1-1.4, or 1.1-1.2, or 1.2-2.5, or 1.2-2.0, or 1.2-1.8, or 1.2-1.6, or 1.2-1.4, or 1.3-2.5, or 1.3-2.0, or 1.3-1.8, or 1.3-1.6, or 1.3-1.4, or 1.4-2.5, or 1.4-2.0, or 1.4-1.8, or 1.4-1.6;

a diameter at 50% pore volume D_{50} in units of nm in the range of 3-35, or 3-20, or 3-15, or 3-10, or 3-8, or 3-7, or 4-25, or 4-20, or 4-15, or 4-10, or 4-8, or 4-7, or 5-25, or 5-20, or 5-15, or 5-10, or 5-8, or 5-7, or 6-25, or

- 6-25, or 6-20, or 6-15, or 6-10, or 6-8, or 8-25, or 8-20, or 8-15, or 8-10, or 10-25, or 10-20, or 10-15, or 10-13, or 12-25, or 12-20, or 12-15, or 14-25, or 14-20, or 14-18, or 16-25, or 16-20, or 16-18.
17. The method of any one of claims 12-16, wherein the silica-alumina composite material comprises one or more of the following:
- a particle density in units of g/mL in the range of 0.6-0.1.0, or 0.64-1.0, or 0.68-1.0, or 0.72-1.0, or 0.76-1.0, or 0.8-1.0, or 0.84-1.0, or 0.88-1.0, or 0.6-0.96, or 0.64-0.96, or 0.68-0.96, or 0.72-0.96, or 0.76-0.96, or 0.8-0.96, or 0.84-0.96, or 0.88-0.96, or 0.6-0.92, or 0.64-0.92, or 0.68-0.92, or 0.72-0.92, or 0.76-0.92, or 0.8-0.92, or 0.84-0.92, or 0.6-0.88, or 0.64-0.88, or 0.68-0.88, or 0.72-0.88, or 0.76-0.88, or 0.8-0.88, or 0.6-0.84, or 0.64-0.84, or 0.68-0.84, or 0.72-0.84, or 0.76-0.84, or 0.8-0.84, or 0.6-0.8, or 0.64-0.8, or 0.68-0.8, or 0.72-0.8, or 0.76-0.8, or 0.6-0.76, or 0.64-0.76, or 0.68-0.76, or 0.72-0.76;
- a surface area by nitrogen adsorption in units of m²/g in the range of 300-700, or 300-650, or 300-600, or 320-600, or 320-550, or 320-500, or 350-700, or 350-650, or 350-600, or 350-600, or 350-550, or 350-500, or 400-700, or 400-650, or 400-600, or 400-550, or 450-700, or 450-650, or 450-600, or 450-550;
- a pore volume by nitrogen adsorption in units of m²/g in the range of 0.7-2.50, or 0.7-2.2, or 0.7-2.0, or 0.7-1.8, or 0.7-1.6, or 0.7-1.4, or 0.7-1.2, or 0.7-1.0, or 0.7-0.9, or 0.75-2.50, or 0.75-2.2, or 0.75-2.0, or 0.75-1.8, or 0.75-1.6, or 0.75-1.4, or 0.75-1.2, or 0.75-1.0, or 0.75-0.9, or 0.85-2.50, or 0.85-2.2, or 0.85-2.0, or 0.85-1.8, or 0.85-1.6, or 0.85-1.4, or 0.85-1.2, or 0.85-1.0, or 0.85-0.9, or 0.9-2.50, or 0.9-2.2, or 0.9-2.0, or 0.9-1.8, or 0.9-1.6, or 0.9-1.4, or 0.9-1.2, or 0.9-1.0, or 1.0-2.50, or 1.0-2.2, or 1.0-2.0, or 1.0-1.8, or 1.0-1.6, or 1.0-1.4, or 1.0-1.2, or 1.0-2.50, or 1.1-2.2, or 1.1-2.0, or 1.1-1.8, or 1.1-1.6, or 1.1-1.4, or 1.1-1.2, or 1.2-2.5, or 1.2-2.0, or 1.2-1.8, or 1.2-1.6, or 1.2-1.4, or 1.3-2.5, or 1.3-2.0, or 1.3-1.8, or 1.3-1.6, or 1.3-1.4, or 1.4-2.5, or 1.4-2.0, or 1.4-1.8, or 1.4-1.6;
- a diameter at 50% pore volume D₅₀ in units of nm in the range of 3-35, or 3-20, or 3-15, or 3-10, or 3-8, or 3-7, or 4-25, or 4-20, or 4-15, or 4-10, or 4-8, or 4-7, or 5-25, or 5-20, or 5-15, or 5-10, or 5-8, or 5-7, or 6-25, or 6-20, or 6-15, or 6-10, or 6-8, or 8-25, or 8-20, or 8-15, or 8-10, or 10-25, or 10-20, or 10-15, or 10-13, or 12-25, or 12-20, or 12-15, or 14-25, or 14-20, or 14-18, or 16-25, or 16-20, or 16-18.
18. A silica-alumina composite material made by the method of any one of claims 12-17.
19. A method for hydroprocessing a hydrocarbonaceous feedstock, comprising contacting a hydroprocessing catalyst with the hydrocarbonaceous feedstock and hydrogen under hydroprocessing conditions, the

hydroprocessing catalyst comprising at least one metal deposited on the material of any one of claims 1-10 or 18, or wherein the hydroprocessing catalyst is the catalyst of claim 11.

20. The method of claim 19, wherein the method comprises a hydrocracking process operated under hydrocracking conditions in which the catalyst provides increased catalytic activity and comparable heavy diesel and total distillate yield compared with a hydroprocessing catalyst that differs only in that it comprises one of the first silica-alumina or the second silica-alumina but not both.