CLAIMS

1. A catalyst for catalytic reforming of naphtha, comprising:

A) a noble metal comprising one or more of platinum, palladium, rhodium, ruthenium, osmium, and iridium;

B) a lanthanide-series metal comprising one or more elements of atomic numbers 57-71 of the periodic table; and

C) a support; wherein an average bulk density of the catalyst is 0.300 - 0.620 gram per cubic centimeter, an atomic ratio of the lanthanide-series metal:noble metal is less than 1.3:1, and the lanthanide-series metal is distributed at a concentration of the lanthanide-series metal in a 100 micron surface layer of the catalyst less than two times a concentration of the lanthanide-series metal at a central core of the catalyst.

2. The catalyst according to claim 1, wherein the lanthanide-series metal comprises cerium and an atomic ratio of cerium:noble metal is 0.50:1.00 - 1.29:1.00.

3. The catalyst according to claim 1, wherein the lanthanide-series metal comprises cerium and an atomic ratio of cerium:noble metal is 0.94:1.00 - 1.26:1.00.

4. The catalyst according to claim 1, wherein the lanthanide-series metal comprises cerium and an atomic ratio of cerium:noble metal is 1.00:1.00 - 1.26:1.00.

5. The catalyst according to claim 1, wherein the lanthanide-series metal comprises cerium and the noble metal comprises platinum.

6. The catalyst according to claim 5, wherein an atomic ratio of cerium:platinum is 0.94:1.00 - 1.29:1.00.

7. The catalyst according to claim 5, wherein an atomic ratio of cerium:platinum is 0.94:1.00 - 1.26:1.00.

8. The catalyst according to claim 5, wherein an atomic ratio of cerium:platinum is 1.00:1.00 - 1.26:1.00.

9. The catalyst according to claim 1, 2, 3, 4, or 5, wherein the average bulk density of the catalyst is 0.555 - 0.580 gram per cubic centimeter.

10. The catalyst according to claim 1, 2, 3, 4, or 5 wherein the catalyst further comprises a group 14 metal of the periodic table.

CLAIMS

The invention claimed is:

1. A catalyst for catalytic reforming of naphtha, comprising:

A) a noble metal comprising one or more of platinum, palladium, rhodium, ruthenium, osmium, and iridium;

B) a lanthanide-series metal comprising one or more elements of atomic numbers 57-71 of the periodic table; and

C) a support; wherein an average bulk density of the catalyst is about 0.300-about 0.620 gram per cubic centimeter, an atomic ratio of the lanthanide-series metal:noble metal is less than about 1.3:1, and the lanthanide-series metal is distributed at a concentration of the lanthanide-series metal in a 100 micron surface layer of the catalyst greater than one times but less than or equal to 1.75 times a concentration of the lanthanide-series metal at a central core of the catalyst.

2. The catalyst according to claim 1, wherein the lanthanide-series metal comprises cerium and an atomic ratio of cerium:noble metal is about 0.50:1.00-about 1.29:1.00.

3. The catalyst according to claim 1, wherein the lanthanide-series metal comprises cerium and an atomic ratio of cerium:noble metal is about 0.94:1.00-about 1.26:1.00.

4. The catalyst according to claim 1, wherein the lanthanide-series metal comprises cerium and an atomic ratio of cerium:noble metal is about 1.00:1.00-about 1.26:1.00.

5. The catalyst according to claim 1, wherein the lanthanide-series metal comprises cerium and the noble metal comprises platinum.

6. The catalyst according to claim 5, wherein an atomic ratio of cerium:platinum is about 0.94:1.00-about 1.29:1.00.

7. The catalyst according to claim 5, wherein an atomic ratio of cerium:platinum is about 0.94:1.00-about 1.26:1.00.

8. The catalyst according to claim 5, wherein an atomic ratio of cerium:platinum is about 1.00:1.00-about 1.26:1.00.

9. The catalyst according to claim 1, wherein the average bulk density of the catalyst is about 0.555-about 0.580 gram per cubic centimeter.

10. The catalyst according to claim 1, wherein the catalyst further comprises a group 14 metal of the periodic table.

11. The catalyst according to claim 1, further comprises tin.

12. The catalyst according to claim 11, wherein the catalyst comprises no more than about 5%, by weight, tin.

13. The catalyst according to claim 1, further comprises a halide.

14. The catalyst according to claim 13, wherein the halide comprises chloride with an atomic ratio of chloride:cerium of about 14:1-about 20:1.

15. The catalyst according to claim 1, wherein the support comprises an alumina.

16. A catalyst for catalytic reforming of naphtha, comprising:

A) platinum;

B) cerium;

C) chloride; and

D) a support; wherein an average bulk density of the catalyst is about 0.300-about 0.620 gram per cubic centimeter, an atomic ratio of cerium:platinum is less than 1.3:1, an mole ratio of chloride:cerium of about 14:1-about 20:1, and cerium is distributed at a concentration in a 100 micron surface layer of the catalyst greater than one times but less than or equal to 1.75 times a concentration of cerium at a central core of the catalyst.

17. The catalyst according to claim 16, wherein the atomic ratio of cerium:platinum is about 0.94:1.00-about 1.26:1.00.

18. The catalyst according to claim 16, wherein the catalyst further comprises a group 14 metal of the periodic table.

19. A reforming process, comprising:

A) charging a hydrocarbon feedstock and a hydrogen-rich gas to a reforming zone; and

B) contacting the hydrocarbon feedstock and the hydrogen rich gas in a reactor in the reforming zone wherein the catalyst comprises:

1) a noble metal comprising one or more of platinum, palladium, rhodium, ruthenium, osmium, and iridium;

2) a lanthanide-series metal comprising one or more elements of atomic numbers 57-71 of the periodic table; and

3) a support; wherein an average bulk density of the catalyst is about 0.300-about 0.620 gram per cubic centimeter, an atomic ratio of the lanthanide-series metal:noble metal is less than about 1.3:1, and the lanthanide-series metal is distributed at a concentration of the lanthanide-series metal in a 100 micron surface layer of the catalyst greater than one times but less than or equal to 1.75 times a concentration of the lanthanide-series metal at a central core of the catalyst.

20. The reforming process according to claim 19, further comprising continuously regenerating the catalyst.