Claims

1. A process for producing an alkylated aromatic compound, the process comprising contacting an aromatic starting material and hydrogen with a plurality of catalyst particles under hydroalkylation conditions to produce an effluent comprising the alkylated aromatic compound, the catalyst comprising a composite of a solid acid, an inorganic oxide different from the solid acid and a hydrogenation metal, wherein the distribution of the hydrogenation metal in at least 60 wt% of the catalyst particles is such that:

the average concentration of the hydrogenation metal in the rim portion of a given catalyst particle is Crim;

the average concentration of the hydrogenation metal in the outer portion of a given catalyst particle is Couter; and

the average concentration of the hydrogenation metal in the center portion of the given catalyst particle is Ccenter; and

at least one of the following conditions is met:

(i) Crim/Ccenter $\geq$ 2.0; and

(ii) Couter/Ccenter $\geqslant$ 2.0.

2. The process of claim 1, wherein the solid acid comprises a molecular sieve.

3. The process of claim 1 or claim 2, wherein in at least 80 wt% of the catalyst particles, at least one of the following conditions is met: (i) Crim/Ccenter $\geq$ 2.0; and (ii) Couter/Ccenter $\geqslant$ 2.0.

4. The process of any of the preceding claims, wherein at least one of the following conditions is met: (a) Crim/Ccenter $\geq$ 10.0; and (b) Couter/Ccenter $\geqslant$ 10.0.

5. The process of any of the preceding claims, wherein at least 50 wt% of the hydrogenation metal is supported on the inorganic oxide.

6. The process of any of the preceding claims, wherein the solid acid is a MWW type molecular sieve.

7. The process of claim 6, wherein the solid acid comprises at least one of the following molecular sieves: MCM-22, PSH-3, SSZ-25, ERB-1, ITQ-1, ITQ-2, MCM-36, MCM-49, and MCM-56.

8. The process of any of the preceding claims, wherein the inorganic oxide comprises at least one of alumina, silica, titania, and zirconia.

9. The process of any of the preceding claims, wherein the hydrogenation metal comprises at least one of Pd, Pt, Ru, Ni, Zr, ~~Ru,~~ Ir, Rh, Os and Co.

10. The process of any of the preceding claims, wherein the catalyst particles are made by a catalyst fabrication process comprising:

(I) forming a mixture comprising the solid acid and the inorganic oxide;

(II) forming a pellet from the mixture;

(III) depositing a source material of the hydrogenation metal onto the pellet; and

(IV) calcining the pellet after step (III) at a temperature in the range from 400°C to 1000°C.

11. The process of claim 10, wherein the source material of the hydrogenation metal comprises $PdCl_2$, and the depositing step comprises impregnating the pellet with an aqueous $PdCl_2$ dispersion having a pH in the range from 0 to 4.

12. The process of claim 10 or 11, wherein the catalyst fabrication process further comprises, after step (IV):

(V) activating the calcined pellet in the presence of H_2.

13. The process of any of the preceding claims, wherein the aromatic starting material is benzene and the alkylated aromatic compound is cyclohexylbenzene.

14. A process for making phenol and/or cyclohexanone, the process comprising:

(1) producing cyclohexylbenzene according to claim 13;

(2) oxidizing at least a portion of the cyclohexylbenzene to produce cyclohexylbenzene hydroperoxide; and

(3) cleaving at least a portion of the cyclohexylbenzene hydroperoxide to obtain phenol and cyclohexanone.

15. A catalyst, the catalyst comprising a composite of a solid acid, an inorganic oxide different from the solid acid and a hydrogenation metal, wherein the distribution of the hydrogenation metal in at least 60 wt% of the catalyst particles is such that:

the average concentration of the hydrogenation metal in the rim portion of a given catalyst particle is Crim;

the average concentration of the hydrogenation metal in the outer portion of a given catalyst particle is Couter; and

the average concentration of the hydrogenation metal in the center portion of the given catalyst particle is Ccenter; and

at least one of the following conditions is met:

(i) Crim/Ccenter $\geq$ 2.0; and

(ii) Couter/Ccenter $\geqslant$ 2.0.

16. The catalyst of claim 15, wherein at least one of the following conditions is met: (a) Crim/Ccenter $\geq$ 10.0; and (b) Couter/Ccenter $\geqslant$ 10.0.

17. The catalyst of claim 15 or 16, wherein at least 50 wt% of the hydrogenation metal is supported on the inorganic oxide.

18. The catalyst of any of claims 15 to 17, wherein at least 75 wt% of the hydrogenation metal is supported on the inorganic oxide.

19. The catalyst of any of claims 15 to 18, wherein the inorganic oxide is present in the composite in the form of islets, and the islets are substantially uniformly distributed within the composite.

20. The catalyst of claim 19, wherein the inorganic oxide islets have an average size of at most 40 μm.

21. The catalyst of any of claims 15 to 20, wherein the solid acid is a MWW type molecular sieve.

22. The catalyst of claim 21, wherein the solid acid comprises at least one of the following molecular sieves: MCM-22, PSH-3, SSZ-25, ERB-1, ITQ-1, ITQ-2, MCM-36, MCM-49, and MCM-56.

23. The catalyst of any of claims 15 to 22, wherein the inorganic oxide comprises at least one of alumina, silica, titania, and zirconia.

24. The catalyst of any of claims 15 to 23, wherein the hydrogenation metal comprises at least one of Pd, Pt, Ru, Ni, Zr, ~~Ru,~~ Ir, Rh, Os and Co.

25. The catalyst of claim 24, wherein at least 90 wt% of the hydrogenation metal has an oxidation state of zero.