CLAIMS

What is claimed is:

1. A catalyst composition comprising:

    (a) titanium, wherein a part of the titanium is present as a titanium dioxide phase and at least 0.1 wt. % of the titanium dioxide phase is in a brookite form; and

    (b) a silica support comprising a pore volume greater than 1.0 cm^3/g,

    wherein the titanium has been deposited on the silica support wherein the catalyst composition has a powder X-ray diffraction spectra comprising peaks at about 25.3, 25.7, 30.8, 36.1, and 48.0 °2θ.

2. The catalyst composition of claim 1, wherein the brookite form of the titanium dioxide phase is present in an amount from about 0.1 wt. % to about 50 wt. % of the titanium dioxide phase relative to the total titanium dioxide phase.

3. The catalyst composition of claim 1, wherein the silica support comprises amorphous silica having:

    (a) a surface area greater than 800 m^2/g.

4. The catalyst composition of claim 1, wherein the amount of the total titanium dioxide phase is from about 1 wt. % to about 8 wt. % of the catalyst composition.

5. The catalyst composition of claim 1, further comprising a plurality of $organosilicate_{(C1-24)}$ groups on the surface of the catalyst composition.

6. The catalyst composition of claim 5, wherein the $organosilicate_{(C1-24)}$ group is $-OSi(CH_3)_3$.

7. A method for producing the catalyst composition of claim 1 comprising:

    (a) obtaining a silica support, wherein the silica support comprises amorphous silica having a surface area greater than 800 m^2/g and pore volume greater than 1.0 cm^3/g;

    (b) drying the silica support to produce a dried silica support;

(c) depositing a titanium-containing reagent on the dried silica support to produce a titanium-treated silica support;

(d) calcining the titanium-treated silica support to produce a titanated silica support; and

(e) washing the titanated silica support with water or an $alcohol_{(C1-12)}$ to form a washed titanated silica support;

wherein at least 0.1 wt. % of the titanium dioxide phase relative to the total titanium dioxide phase is in a brookite form.

8. The method of claim 7, wherein the silica support is dried at a temperature from about 100 °C to about 850 °C for a time period from about 1 hour to about 48 hours.

9. The method of claim 7, wherein the titanium-containing reagent is titanium(IV) alkoxide, titanium(IV) halide, or a mixed titanium(IV) alkoxide halide.

10. The method of claim 9, wherein the titanium(IV) halide is $TiCl_4$.

11. The method of claim 10, wherein the $TiCl_4$ is deposited to the dried silica support as a liquid, as a gas, or as part of a solution, wherein the solution further comprises an aromatic or aliphatic solvent.

12. The method of claim 7, wherein the titanium-containing reagent is deposited in the vapor phase at temperature from about 25 °C to about 800 °C.

13. The method of claim 7, wherein the titanium-treated silica support is calcined at a temperature from about 300 °C to 800 °C.

14. The method of claim 7, wherein the method further comprises drying the washed titanated silica support.

15. The method of claim 7, wherein the method further comprises reacting the washed titanated silica support with a silylating agent.

16. A method for producing an epoxide comprising:

(a) admixing an $olefin_{(C2-12)}$ and an oxidizing agent to form a reaction mixture; and

(b) contacting the olefin$_{(C2-12)}$ and oxidizing agent with a catalyst composition of claim 1 under conditions sufficient to produce an epoxide$_{(C2-12)}$.

17. The method of claim 16, wherein the oxidizing agent is an organic hydroperoxide.

18. The method of claim 17, wherein the organic hydroperoxide is tert-butyl hydroperoxide, cumene hydroperoxide, or ethylbenzene hydroperoxide.

19. The method of claim 16, wherein the olefin is propylene.