hydrogen, alkyl$_{(C\leq6)}$, or substituted alkyl$_{(C\leq6)}$; and R_4, R_5, and R_6 are each independently selected from alkyl$_{(C\leq12)}$, aryl$_{(C\leq12)}$, aralkyl$_{(C\leq12)}$, or a substituted version of any of these groups, or are taken together are alkoxydiyl$_{(C\leq12)}$, alkanediyl$_{(C\leq12)}$, substituted alkoxydiyl$_{(C\leq12)}$ or substituted alkanediyl$_{(C\leq12)}$. In certain embodiments, R_1 is alkyl$_{(C4\text{-}6)}$. In some embodiments, R_1 is tert-butyl. In further embodiments, R_1 is aralkyl$_{(C\leq12)}$. In some embodiments, R_1 1-phenylethyl. In certain embodiments, R_2 is alkyl$_{(C\leq6)}$. In further embodiments, R_2 is methyl. In some embodiments, R_3 is alkyl$_{(C\leq6)}$. In additional embodiments, R_3 is methyl. In certain embodiments, R_4 is aryl$_{(C\leq8)}$. In some embodiments, R_4 is phenyl. In further embodiments, the first organic solvent is 1-phenylethyl alcohol and the second organic solvent is acetophenone. In additional embodiments, the reaction mixture comprises a weight ratio of acetophenone to 1-phenylethyl alcohol of 1 part acetophenone to 99 parts 1-phenylethyl alcohol to 50 parts acetophenone to 50 parts 1-phenylethyl alcohol. In some embodiments, the weight ratio of acetophenone to 1-phenylethyl alcohol is 8 to 92. In certain embodiments, the first organic solvent is acetonitrile. In additional embodiments, the first organic solvent is tert-butyl alcohol. In some embodiments, the first organic solvent is 1-phenylethyl alcohol. In some embodiments, the peroxide is hydrogen peroxide, tert-butyl hydroperoxide, 1-phenylethyl hydroperoxide or cumyl hydroperoxide. In some embodiments, the peroxide is hydrogen peroxide. In further embodiments, the reaction mixture comprises a ratio of alkene$_{(C\leq12)}$ or aralkene$_{(C\leq12)}$ to the peroxide of greater than 1 to 5. In certain embodiments, the ratio of alkene$_{(C\leq12)}$ or aralkene$_{(C\leq12)}$ to the peroxide is greater than 3 to 1. In some embodiments, the ratio of alkene$_{(C\leq12)}$ or aralkene$_{(C\leq12)}$ to the peroxide is greater than 10 to 1. In additional embodiments, the titanium silica catalyst comprises a silica zeolite catalyst which comprises a silica framework in which silicon atoms in the silica framework have been replaced with titanium atoms. In further embodiments, the zeolite is an aluminosilicate MWW zeolite. In some embodiments, the ratio of titanium to silica in the titanium silica catalyst comprises a ratio of 0.5 to 14 titanium atoms for every 100 silicon atoms. In further embodiments, the method further comprises washing the titanium silica catalyst with a templating agent. In additional embodiments, the templating agent is a base. In some embodiments, the templating agent is piperidine, hexamethyleneimine, adamantyl ammonium hydroxide, octyltrimethylammonium hydroxide, heptyltrimethylammonium hydroxide, hexyltrimethylammonium hydroxide, or trimethyladamantylammonium hydroxide. In further embodiments, the method further comprises washing the catalyst with an acid after washing with a templating agent. In additional embodiments, the acid is nitric acid, hydrochloric acid, sulfuric acid, sulfurous acid, phosphoric acid or ammonium chloride. In some embodiments, the titanium silica catalyst is calcined at a

zeolite. In further embodiments, the titanium silica catalyst comprises a ratio of 0.5 to 14 titanium atoms for every 100 silicon atoms. In some embodiments, the method further comprises washing the titanium silica catalyst with a templating agent. In some embodiments, the templating agent is a base. In some embodiments, the templating agent is piperidine, hexamethyleneimine, adamantyl ammonium hydroxide, octyltrimethylammonium hydroxide, heptyltrimethylammonium hydroxide, hexyltrimethylammonium hydroxide, or trimethyladamantylammonium hydroxide. In certain embodiments, the method further comprises washing the catalyst with an acid after washing with a templating agent. In additional embodiments, the acid is nitric acid, hydrochloric acid, sulfuric acid, sulfurous acid, phosphoric acid, or ammonium chloride. In further embodiments, the titanium silica catalyst is calcined at a temperature from about 400 °C to about 800 °C. In some embodiments, the buffer is selected from a buffer of the formula:

$$X_1^+X_2^- \text{ (IV)}$$

wherein X_1^+ is selected from a Group 1 cation, Group 2 cation, ammonium, tetraalkylammonium$_{(C\leq24)}$, tetraarylammonium$_{(C\leq32)}$, tetraaralkylammonium$_{(C\leq36)}$, substituted tetraalkylammonium$_{(C\leq20)}$, substituted tetraarylammonium$_{(C\leq32)}$, substituted tetraaralkylammonium$_{(C\leq36)}$ or heteroarenium$_{(C\leq18)}$; and X_2^- is selected from alkylcarboxylate$_{(C\leq12)}$, alkenylcarboxylate$_{(C\leq12)}$, alkynylcarboxylate$_{(C\leq12)}$, arylcarboxylate$_{(C\leq12)}$, aralkylcarboxylate$_{(C\leq12)}$, heteroarylcarboxylate$_{(C\leq12)}$, heterocycloalkylcarboxylate$_{(C\leq12)}$, phosphate or sulfate. In further embodiments, X_1^+ is ammonium or tetraalkylammonium$_{(C\leq16)}$. In additional embodiments, X_1^+ is ammonium. In some embodiments, X_2^- is alkylcarboxylate$_{(C\leq8)}$. In certain embodiments, X_2^- is acetate. In further embodiments, X_2^- is phosphate. In additional embodiments, X_2^- is dihydrogen phosphate. In some embodiments, the buffer is ammonium acetate or ammonium dihydrogen phosphate. In certain embodiments, the alkene$_{(C\leq12)}$ is propylene or 1-octene. In additional embodiments, the alkene$_{(C\leq12)}$ is propylene. In further embodiments, the method comprises heating the reaction vessel to a temperature between about 20 °C to about 250 °C, such as from about 20 °C to about 150 °C and about 70 °C. In certain embodiments, the method comprises a pressure from about 10 psig (about 170 kPa) to about 1000 psig (about 7000 kPa). In some embodiments, the method comprises a pressure from about 50 psig (about 446 kPa) to about 1000 psig (about 7000 kPa), including from about 100 psig (about 790 kPa) to about 500 psig (about 3500 kPa) and about 300 psig (about 2,170 kPa). In certain embodiments, the method further comprises reacting the alkene$_{(C\leq12)}$ or aralkene$_{(C\leq12)}$ with the titanium silica catalyst for a time period between about 1 minute to about 6 hours, such as about 30 minutes. In some embodiments, the method has a peroxide conversion percentage

layered TiMWW-NAW can also be prepared via hydrothermal synthesis of silica, tetrabutyl orthotitanate and a template in the presence of crystallization agent, like boric acid. The layered TiMWW-AW can then be obtained by refluxing layered TiMWW-NAW with HNO_3 or H_2SO_4 solution. Since boron is detrimental to the catalyst activity, the post treatment method for the synthesis of layered TiMWW catalyst is often used because this treatment of the catalyst removes additional boron.

[0031] Such titanium MWW zeolite catalysts, referred to herein as "TiMWW catalysts," are known to have the following empirical formula: $xTiO_2 \cdot (1-x)SiO_2$, wherein x is a numeral from about 0.0001 and about 0.5. In some embodiments, x is from about 0.01 to about 0.125. In another context, the ratio of Si:Ti in the lattice framework may range from about 9.5:1 to about 99:1, such as from about 9.5:1 to about 60:1. In some applications, titanium rich MWW catalysts are utilized in the present technology.

[0032] The epoxidation process described in the present disclosure may use a catalyst which is either a powder or a large particle size solid. In some embodiments of the present process, the zeolite catalyst may be used as a powder but it is also contemplated that the zeolite catalyst can be used if spray dried, pelletized or extruded. Additionally, the zeolite catalyst may further comprise a binder before the catalyst is shaped, spray dried, molded or extruded into a particular desired form. Additionally, the catalyst in some embodiments is either in a suspension or a fixed-bed form.

[0033] In another embodiment, a layered TiMWW catalyst is used to epoxide the alkene. The layered TiMWW catalyst may be used with a template to prepare the catalyst. Some templating agents that may be used are piperidine, hexamethyleneimine, adamantyl ammonium hydroxide, octyltrimethylammonium hydroxide, heptyltrimethylammonium hydroxide, hexyltrimethylammonium hydroxide, or trimethyladamantylammonium hydroxide. In some embodiments, the templating agent is hexamethyleneimine or piperidine. In one embodiment, the templating agent is piperidine. After reaction of the TiMWW catalyst with the templating agent, in some embodiments, the catalyst is washed with an acid. In some aspects, the acids that the catalyst can be washed with include nitric acid, hydrochloric acid, sulfuric acid, sulfurous acid, phosphoric acid or ammonium chloride. In some embodiments, the TiMWW catalyst and the layered TiMWW catalyst have the XRD spectra as is shown the Figure.

[0034] In some embodiments, the epoxidation catalyst further comprises adding a palladium complex. In some embodiments, the palladium complex allows the reaction of molecular

CLAIMS

1. A method for producing propylene oxide comprising contacting propylene with a titanium silica zeolite catalyst, hydrogen peroxide, an ammonium buffer selected from the group consisting of ammonium acetate and ammonium dihydrogen phosphate, and an R_1-OH solvent in a reaction mixture, the reaction mixture further comprising acetophenone, wherein the R1-OH solvent is 1-phenylethyl alcohol and wherein the reaction mixture comprises a ratio of acetophenone to 1-phenylethyl alcohol of 1:99 to 50:50, and the peroxide selectivity rate is greater than about 40%.

2. The method of claim 1, wherein the R_1-OH solvent further comprises from about 0.1-50% by weight of water.

3. The method of claim 1, wherein the titanium silica catalyst comprises a silica zeolite catalyst which comprises a silica framework in which silicon atoms in the silica framework have been replaced with titanium atoms and the zeolite is an aluminosilicate MWW zeolite.

4. The method of claim 1, wherein the ratio of titanium to silica in the titanium silica catalyst comprises a ratio of 0.5 to 5 titanium atoms for every 100 silicon atoms.

5. The method of claim 3, further comprising washing the titanium silica catalyst with a templating agent.

6. The method of claim 5, wherein the templating agent is piperidine, hexamethyleneimine, adamantyl ammonium hydroxide, octyltrimethylammonium hydroxide, heptyltrimethylammonium hydroxide, hexyltrimethylammonium hydroxide, or trimethyladamantylammonium hydroxide.

7. The method of claim 5, further comprising washing the catalyst with an acid after washing with a templating agent.

8. The method of claim 7, wherein the acid is nitric acid, hydrochloric acid, sulfuric acid, sulfurous acid, phosphoric acid or ammonium chloride.

9. The method of claim 1, wherein the method comprises heating the reaction mixture to a temperature between 20 °C and 250 °C.

10. The method of claim 1, wherein the method further comprises reacting the alkene$_{(C\leq12)}$ or aralkene$_{(C\leq12)}$ with the titanium silica catalyst for a time period between 1 minute and 6 hours.

11. The method of claim 1, wherein the method further comprises a pressure from 68.9476 kPa to 6894.76 kPa.

12. The method of claim 1, wherein the titanium silica zeolite catalyst comprises a ratio of 0.5-14 titanium atoms for every 100 silicon atoms.