selectivity, and conversion rates of greater than 80 % are known to result in the formation of mainly carbon oxide by-products. Above 200 °C, the conversion selectivity to acetaldehyde decreases as the reaction temperature increases. These drawbacks make the conversion of ethanol to acetaldehyde on an industrial scale inefficient and costly.

Therefore, there is a need to provide an alternative catalyst to carry out the selective and efficient conversion of alcohols such as ethanol to aldehydes such as acetaldehyde. Further, there is a need for a method for selectively ad efficiently converting alcohols such as ethanol to aldehydes such as acetaldehyde.

Summary

There is provided a use of a metal-doped hydroxyapatite as a catalyst for converting an alcohol to an aldehyde. In an embodiment, the metal-doped hydroxyapatite may be silver-doped stoichiometric hydroxyapatite. In other embodiments, the alcohol may be ethanol and the aldehyde may be acetaldehyde.

In an aspect, there is provided the use of a metal-doped hydroxyapatite as a catalyst for converting an alcohol to an aldehyde at a temperature in the range of about 150 °C to about 350 °C, wherein the dopant of the metal-doped hydroxyapatite is selected from the group consisting of a metal, a metal oxide and mixtures thereof, wherein the metal is a transition metal selected from the group consisting of group 5 transition metals, group 11 transition metals and chromium and the alcohol is selected from the group consisting of methanol, ethanol, propan-1-ol, butan-1-ol, pentan-1-ol, 3-methylbutan-1-ol, 2-methylbutan-1-ol, 2,2-dimethylpropan-1-ol, hexan-1-ol,

the catalyst by dispersing it on a support such as HAP.

There is also provided a method for converting an alcohol to an aldehyde, comprising the step of contacting the alcohol with a metal-doped hydroxyapatite catalyst as mentioned above. In other embodiments, the alcohol may be ethanol and the aldehyde may be acetaldehyde.

In another aspect, there is provided a method for converting an alcohol to an aldehyde, comprising the step of contacting the alcohol with a metal-doped hydroxyapatite catalyst according to the use as defined above at a temperature in the range of about 150 °C to about 350 °C, to form the aldehyde, wherein the dopant of the metal-doped hydroxyapatite is selected from the group consisting of a metal, a metal oxide and mixtures thereof, wherein the metal is a transition metal selected from the group consisting of group 5 transition metals, group 11 transition metals and chromium and the alcohol is selected from the group consisting of methanol, ethanol, propan-1-ol, butan-1-ol, pentan-1-ol, 3-methylbutan-1-ol, 2-methylbutan-1-ol, 2,2-dimethylpropan-1-ol, hexan-1-ol, 2-methylpentan-1-ol, 3-methylpentan-1-ol, 4-methylpentan-1-ol, 2,2-dimethylbutan-1-ol, 2,3-dimethylbutan-1-ol, 3,3-dimethylbutan-1-ol and 2-ethylbutan-1-ol.

Advantageously, the disclosed method for converting an alcohol such as ethanol to an aldehyde such as acetaldehyde may allow the conversion to be performed at low temperatures below 300 ^{o}C. This may circumvent the problem faced by conventional methods of converting ethanol to acetaldehyde, where high reaction temperatures are required, consequently resulting in the increased production of by-products and a decrease in reaction yield and efficiency.

Further advantageously, the disclosed method for converting ethanol to acetaldehyde may allow the conversion to be performed

Claims

1. A use of a metal-doped hydroxyapatite as a catalyst for converting an alcohol to an aldehyde at a temperature in the range of about 150 °C to about 350 °C, wherein the dopant of the metal-doped hydroxyapatite is selected from the group consisting of a metal, a metal oxide and mixtures thereof, wherein the metal is a transition metal selected from the group consisting of group 5 transition metals, copper, silver and chromium and the alcohol is selected from the group consisting of methanol, ethanol, propan-1-ol, butan-1-ol, pentan-1-ol, 3-methylbutan-1-ol, 2-methylbutan-1-ol, 2,2-dimethylpropan-1-ol, hexan-1-ol, 2-methylpentan-1-ol, 3-methylpentan-1-ol, 4-methylpentan-1-ol, 2,2-dimethylbutan-1-ol, 2,3-dimethylbutan-1-ol, 3,3-dimethylbutan-1-ol and 2-ethylbutan-1-ol.

2. The use according to claim 1, wherein the transition metal is silver, vanadium or chromium.

3. The use according to claim 2, wherein the transition metal is silver.

4. The use according to any one of the preceding claims, wherein the metal oxide is an oxide of a transition metal.

5

5. The use according to claim 4, wherein the oxide of a transition metal is an oxide of silver oxide, vanadium oxide or chromium oxide.

6. The use according to claim 5, wherein the oxide of a transition metal is an oxide of silver.

7. The use according to any of the preceding claims, wherein the hydroxyapatite is doped with the metal, metal oxide or mixtures thereof, at an atomic percentage up to 10 at%.

8. The use according to claim 7, wherein the hydroxyapatite is doped with the metal, metal oxide or mixtures thereof, at an atomic percentage up to 6 at%.

9. The use according to any of the preceding claims, wherein the hydroxyapatite is a stoichiometric hydroxyapatite or a non-stoichiometric hydroxyapatite.

10. The use according to claim 9, wherein the hydroxyapatite is a stoichiometric hydroxyapatite.

11. The use according to claim 9, wherein the non-stoichiometric hydroxyapatite has a Ca/P molar ratio in the range of 1.45 to 1.70.

12. The use according to claim 11, wherein the non-stoichiometric hydroxyapatite has a Ca/P molar ratio in the range of 1.50 to 1.65.

13. The use according to any of the preceding claims, wherein the converting step comprises oxidising the alcohol to the aldehyde.

14. The use according to claim 13, wherein the oxidising step comprises an oxidative dehydrogenation reaction of the alcohol to the aldehyde.

15. The use according to any one of the preceding claims, wherein the alcohol is ethanol.

16. The use according to any of the preceding claims, wherein the aldehyde is a lower aldehyde of 1 to 6 carbon atoms.

17. The use according to claim 16, wherein the aldehyde is acetaldehyde.

18. A method for converting an alcohol to an aldehyde, comprising the step of contacting the alcohol with a metal-doped hydroxyapatite catalyst according to the use of any of claims 1 to 17 at a temperature in the range of about 150 °C to about 350 °C, to form the aldehyde, wherein the dopant of the metal-doped hydroxyapatite is selected from the group consisting of a metal, a metal oxide and mixtures thereof, wherein the metal is a transition metal selected from the group consisting of group 5 transition metals, copper, silver and chromium and the alcohol is selected from the group consisting of methanol, ethanol, propan-1-ol, butan-1-ol, pentan-1-ol, 3-methylbutan-1-ol, 2-methylbutan-1-ol, 2,2-dimethylpropan-1-ol, hexan-1-ol, 2-methylpentan-1-ol, 3-methylpentan-1-ol, 4-methylpentan-1-ol,

2,2-dimethylbutan-1-ol, 2,3-dimethylbutan-1-ol, 3,3-dimethylbutan-1-ol and 2-ethylbutan-1-ol.

19. The method according to claim 18, wherein the contacting step is performed at a temperature in the range of 200 °C to 275 °C.

20. The method according to claim 18 or 20, wherein the contacting step is performed at a pressure in the range of 1 atm to 20 atm.

21. The method according to claim 20, wherein the contacting step is performed at 1 atm.

22. The method according to any of claims 19 to 21, wherein the contacting step is performed at a weight hourly space velocity (WHSV) in the range of 1 h^{-1} to 10 h^{-1}.

23. The method according to claim 22, wherein the contacting step is performed at a weight hourly space velocity (WHSV) in the range of 4 h^{-1} to 7 h^{-1}.

24. The method according to any of claims 19 to 23, wherein the contacting step comprises the step of oxidising the alcohol to the aldehyde.

25. The method according to claim 24, wherein the oxidising step comprises an oxidative dehydrogenation reaction of the alcohol to aldehyde.

26. The method according to any one of claims 18 to 25, wherein the alcohol is ethanol.

27. The method according to any of claims 18 to 26, wherein the aldehyde is a lower aldehyde of 1 to 6 carbon atoms.

28. The method according to claim 27, wherein the aldehyde is acetaldehyde.

5