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

~~In a first aspect, t~~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, 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 use of the metal-doped hydroxyapatite as a catalyst may facilitate the efficient conversion of an alcohol such as ethanol to an aldehyde such as acetaldehyde. This may provide an alternate route for producing acetaldehyde, which is a precursor for high-value chemicals such as pyridine derivatives, pentaerythritol, crotanaldehyde, acetic acid and vinyl acetate, from ethanol. Further advantageously, the use of a metal-doped hydroxyapatite as a catalyst to convert ethanol to acetaldehyde may circumvent the use of costly and

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

~~In a second aspect, t~~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, 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

at atmospheric pressure. This may circumvent the problem of conventional methods where the reaction must be performed under high pressures.

Definitions

The following words and terms used herein shall have the meaning indicated:

The term "conversion" refers to a chemical reaction process in which chemical transformation takes place, that is, the product differs chemically from the starting materials.

The term "conversion" also refers to the percentage of reactants converted to products inside a chemical reactor. It describes, as ratios, how much of a reactant has reacted (X – conversion, normally between zero and one), how much of a

Claims

1. A use of a metal-doped hydroxyapatite as a catalyst for converting an alcohol to an 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.

~~2. The use according to claim 1, wherein the dopant of the metal-doped hydroxyapatite is selected from the group consisting of a metal, a metal oxide and mixtures thereof.~~

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

~~4. The use according to claim 3, wherein the metal is a group 3, group 4, group 5, group 6, group 10, group 11 or group 12 transition metal.~~

~~5.~~ 2. The use according to claim ~~4~~1, wherein the transition metal is silver, gold, vanadium or chromium.

~~6.~~ 3. The use according to claim ~~5~~2, wherein the transition metal is silver.

~~3.~~4. The use according to ~~claim 2~~any one of the preceding claims, wherein the metal oxide is an oxide of a transition metal.

~~4.~~5. The use according to claim ~~3~~4, wherein the oxide of a transition metal is an oxide of a group 3, group 4, group 5, group 6, group 10, group 11 or group 12 transition metal.

~~9.~~6. The use according to claim ~~6~~5, wherein the oxide of a transition metal is an oxide of silver oxide, gold oxide, vanadium oxide or chromium oxide.

~~10.~~7. The use according to claim ~~9~~6, wherein the oxide of a transition metal is an oxide of silver.

~~11.~~8. 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%.

~~12.~~9. The use according to claim ~~11~~8, wherein the hydroxyapatite is doped with the metal, metal oxide or mixtures thereof, at an atomic percentage up to 6 at%.

~~13.~~10. The use according to any of the preceding claims, wherein the hydroxyapatite is a stoichiometric hydroxyapatite or a non-stoichiometric hydroxyapatite.

~~14.~~11. The use according to claim ~~13~~10, wherein the hydroxyapatite is a stoichiometric hydroxyapatite.

~~15.~~12. The use according to claim ~~13~~10, wherein the non-stoichiometric hydroxyapatite has a Ca/P molar ratio in the range of 1.45 to 1.70.

~~16.~~13. The use according to claim ~~15~~12, wherein the non-stoichiometric hydroxyapatite has a Ca/P molar ratio in the range of 1.50 to 1.65.

~~17.~~14. The use according to any of the preceding claims, wherein the converting step comprises oxidising the alcohol to the aldehyde.

~~18.~~15. The use according to claim ~~17~~14, wherein the oxidising step comprises an oxidative dehydrogenation reaction of the alcohol to the aldehyde.

~~19. The use according to any of the preceding claims, wherein the alcohol is a lower alcohol of 1 to 6 carbon atoms.~~

~~20.~~16. The use according to any one of the preceding claims ~~19~~, wherein the alcohol is ethanol.

~~21.~~17. The use according to any of the preceding claims, wherein the aldehyde is a lower aldehyde of 1 to 6 carbon atoms.

~~22.~~18. The use according to claim ~~21~~17, wherein the aldehyde is acetaldehyde.

~~23.~~19. 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 ~~22~~18, 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.

~~24.~~ 20. The method according to claim ~~23~~19, wherein the contacting step is performed at a temperature in the range of 150 °C to 350 °C.

~~25.~~ 21. The method according to claims ~~23~~—19 or 20~~24~~, wherein the contacting step is performed at a temperature in the range of 200 °C to 275 °C.

~~26.~~ 22. The method according to any of claims ~~23~~19 to ~~25~~21, wherein the contacting step is performed at a pressure in the range of 1 atm to 20 atm.

~~27.~~ 23. The method according to claim ~~26~~22, wherein the contacting step is performed at 1 atm.

~~28.~~ 24. The method according to any of claims ~~23~~ 19 to ~~27~~23, wherein the contacting step is performed at a weight hourly space velocity (WHSV) in the range of 1 h^{-1} to 10 h^{-1}.

~~29.~~ 25. The method according to claim ~~28~~24, wherein the contacting step is performed at a weight hourly space velocity (WHSV) in the range of 4 h^{-1} to 7 h^{-1}.

~~30.~~ 26. The method according to any of claims ~~23~~ 19 to ~~29~~25, wherein the contacting step comprises the step of oxidising the alcohol to the aldehyde.

~~31.~~ 27. The method according to claim ~~30~~26, wherein the oxidising step comprises an oxidative dehydrogenation reaction of the alcohol to aldehyde.

~~32. The method according to any of claims 23 to 31, wherein the alcohol is a lower alcohol of 1 to 6 carbon atoms.~~

~~33.~~ 28. The method according to any one of claims 19 to ~~32~~27, wherein the alcohol is ethanol.

~~34.~~ 29. The method according to any of claims ~~23~~ 19 to ~~33~~28, wherein the aldehyde is a lower aldehyde of 1 to 6 carbon atoms.

~~35.~~30. The method according to claim ~~34~~29, wherein the aldehyde is acetaldehyde.