

Claims

1. A hybrid iron nanoparticle catalyst comprising:
 - i) 30 to 70 wt. % of nanoparticles comprising iron and at least one of a metal M selected from the group consisting of alkali metals, alkaline earth metals, transition metals of groups 3 to 7 or 9 to 11 of the Periodic Table of Elements lanthanides, and combinations of M thereof; and
 - ii) 70 to 30 wt. % of an aluminosilicate or silicoaluminophosphate zeolite, based on the total weight of the catalyst,wherein said nanoparticle has a diameter of 2 to 50 nm, and the total wt.% of the nanoparticles and zeolite is 100 wt.%.
2. The catalyst of claim 1, wherein said metal M comprises 10 to 50 wt. % based on the weight of the iron nanoparticle.
3. The catalyst of any of the preceding claims, wherein the nanoparticles adopt a spinel crystalline phase, or a spinel crystalline phase having the formula FeM_2O_4 .
4. The catalyst of any of the preceding claims, wherein the zeolite is an aluminosilicate zeolite, a pentasil zeolite or faujasite zeolite, or the zeolite is selected from the group consisting of zeolite X, ZSM-5, zeolite Y, ZSM-12, ZSM-22, and HY zeolite.
5. The catalyst of any of the preceding claims, wherein the mole ratio of alumina to silica in the zeolite is about 1:2 to 1:90.
6. The catalyst of any of the preceding claims, wherein the zeolite is a silicoaluminophosphate zeolite, SAPO 11 or SAPO 34.
7. The catalyst of any of the preceding claims, wherein the weight ratio of the zeolite to the iron nanoparticle is about 1:0.5 to 1:10.
8. The catalyst of any of the preceding claims, wherein the iron nanoparticles further comprise an oxide of a halogen.
9. The catalyst of claim 8, wherein the oxide of the halogen is present in an amount of about 0.1 to 50 wt. %, based on the weight of the nanoparticles.
10. The catalyst of any of the preceding claims, wherein the iron nanoparticles further comprise a transition metal of groups 3 to 7 and 9 to 11 of the Periodic Table of Elements.
11. The catalyst of claim 10, wherein the molar ratio of iron to the transition metal is 1:1 to 50:1.
12. The catalyst of any of the preceding claims, wherein the iron nanoparticles further comprises a SiO_2 matrix.
13. A method of preparing a hybrid nanoparticle iron catalyst, the method comprising

- i) mixing an iron salt with an aqueous surfactant to form a mixture;
- ii) adding a basic salt solution comprising a salt of an element selected from the group consisting of alkali metals, alkaline earth metals, transition metals of groups 3 to 7 or 9 to 11 of the Periodic Table of Elements, lanthanides, and combinations of elements thereof, to the mixture of step (i) to form a precipitate;
- iii) heating the precipitate of step (ii) in the presence of air and oxygen; and
- iv) mixing the precipitate of step (iii) with an aluminosilicate or a silicoaluminophosphate zeolite to yield a hybrid iron catalyst.
14. The method of claim 13, wherein said salt of the element comprises hydroxide, carbonate or bicarbonate anions.
15. The method of any of claims 13-14, wherein the molar ratio of the iron to the element of the basic salt is 1:2 to 1:25.
16. The method of any of claims 13-15, wherein the heating step is carried out at a temperature of 300°C to 600°C or for 1 to 10 hours.
17. The method of any of claims 13-16, wherein the iron salt is an iron (II) or iron (III) salt or the iron salt comprises an anion selected from the group consisting of nitrate, chloride, fluoride, bromide, iodide, phosphate, pyrophosphate and perchlorate.
18. The method of any of claims 13-17, wherein the surfactant is an ionic surfactant, or the surfactant comprises an anion selected from the group consisting of: halides, sulfonates, sulfates, phosphates and carboxylates.
19. The method of any of claims 13-18, wherein the molar ratio of iron to the surfactant is 1:0.5 to 1:15.
20. The method of any of claims 13-19, further comprising, prior to step (iii), the steps of:
- collecting the precipitated nanoparticle catalyst; and
- drying said precipitated nanoparticle catalyst in air.
21. The method of claim 20, wherein the collection of the precipitated nanoparticle catalyst is by centrifugation and/ or filtration.
22. The method of any of claims 13-21, further comprising, prior to step (ii), adding a solution of a salt of a transition metal to the mixture of step (i).
23. The method of any of the claims 13-21, further comprising:
- prior to step ii), introducing a solution of a silicate to the mixture of step (i).
24. The method of claim 23, wherein the silicate comprises alkoxy groups of 2 to 15 carbon atoms.

25. The method of any of claims 23-24, wherein the molar ratio of iron to said silicate is 1:1 to 1:50.
26. The catalyst of any of claims 1-9, prepared according to the method of any of claims 11-19, or the catalyst of any of claims 10-11, prepared according to the method of any of claims 21-22, or the catalyst of claim 12, prepared according to the method of any of claims 23-25.
27. A process for the production of light olefins, the process comprising the step of:
- i) heating the catalyst of any of claims 1-12 or 26 in the presence of a gas comprising one or more oxides of carbon and hydrogen to activate said catalyst; and
 - ii) contacting said activated catalyst of step (i) with a gas stream comprising one or more oxides of carbon and hydrogen to partially or fully convert said one or more oxides of carbon to said light olefins, said light olefins comprising between 2 to 4 carbon atoms,
- wherein methane is substantially absent from said light olefins, or constitutes less than 20% of said light olefins.
28. The process of claim 27, wherein the step (i) is carried out at a temperature of 200°C–350°C, or wherein step (ii) is carried out at a temperature of 200°C-450°C, or wherein step (i) is carried out at a pressure of 5-30 bar, or wherein step (ii) is carried out at a pressure of 5 to 50 bar.
29. The process of any of claims 27-28, wherein the space velocity of the gas stream in step (ii) is 1500 ml/g.h to 5000 ml/g.h.
30. The process of any of claims 27-29, wherein the molar ratio of hydrogen to the one or more oxides of carbon in the gas is 4:1 to 1:3.
31. The process of any of claims 27-30, further comprising, prior to step (i), reducing the catalyst of any of claims 1-12 or 26 by contacting said catalyst with a stream of hydrogen gas.
32. The process of any of claims 27-31, wherein the oxide of carbon in the gas stream of step (ii) is substantially carbon dioxide.