Claims

1. A metal organic framework (MOF) having a UTSA-16 structure, where the composition comprises:

a first metal selected from one or more of the group consisting of Cr, Mn, Fe, Ni, Cu, and Co present in an amount of up to 80 mol% of the total metal in the MOF; and

from 20 to 80 mol% of the total metal in the MOF is a second metal selected from one or more of the group consisting of Cd, Mn, and Zn.

2. The MOF according to Claim 1, wherein the second metal is Zn.

3. The MOF according to Claim 1 or 2, wherein the second metal is present in an amount of from 50 to 75 mol% of the total metal present in the MOF.

4. The MOF according to any one of the preceding claims, wherein the first metal is selected from Fe and Co, optionally wherein the first metal is Co.

5. The MOF according to any one of the preceding claims, wherein the first metal is present in an amount of from 25 to 50 mol% of the total metal present in the MOF.

6. The MOF according to any one of the preceding claims, wherein the second metal preferentially occupies a tetrahedral metal site within the MOF.

7. The MOF according to any one of the preceding claims, wherein the majority of the first metal, when present, occupies an octahedral metal site within the MOF.

8. The MOF according to any one of the preceding claims, wherein the first metal, when present, and second metal preferentially occupy an octahedral metal site and a tetrahedral metal site within the MOF, respectively.

9. The MOF according to any one of the preceding claims, wherein the MOF has a saturated CO_2 uptake of from 3.39 to 5.0 mmol/g, optionally wherein the MOF has a saturated CO_2 uptake of from 3.39 to 4.5 mmol/g, such as from 3.39 to 3.50 mmol/g.

10. The MOF according to any one of the preceding claims, wherein the MOF has a breakthrough CO_2 working capacity of up to 2.2 mmol/g, such as from 1.0 to 1.8 mmol/g, such as from 1.65 to 1.70 mmol/g.

11. The MOF according to any one of the preceding claims, wherein:
the first metal is Co;
the second metal is Zn; and
the MOF has a saturated CO_2 uptake of from 3.39 to 5.0 mmol/g.

12. The MOF according to any one of the preceding claims, wherein:
the first metal is Co;
the second metal is Zn;
the MOF has a saturated CO_2 uptake of from 3.39 to 5.0 mmol/g; and
the first metal, when present, and second metal preferentially occupy an octahedral metal site and a tetrahedral metal site within the MOF, respectively.

13. A method of forming a MOF according to any one of the preceding claims, wherein the method comprises the step of aging a mixture comprising from a first metal precursor, a second metal precursor, a base, citric acid, a first solvent and a second solvent for a period of time at a temperature of from 15 to 200 °C, wherein:
the first metal precursor is selected from one or more of the group consisting of Cr, Mn, Fe, Ni, Cu, and Co;
the second metal precursor selected from one or more of the group consisting of Cd, Mn, and Zn; and
the metal in the first metal precursor is present in an amount of up to 80 mol% of the total amount of metal in the mixture; and
the metal in the second metal precursor is present in an amount of from 20 to 80 mol% of the total amount of metal in the mixture.

14. The method according to Claim 13, wherein the temperature is from 20 to 150 °C,
optionally wherein the temperature is from 40 to 120 °C, such as temperature of from 60 to 80 °C.

15. The method according to Claim 14, wherein the temperature used results in one or both solvents being refluxed.

16. The method according to any one of Claims 13 to 15, wherein:
(a) the first solvent is water and the second solvent is an alkyl alcohol (e.g. the alkyl alcohol is methanol, a propanol or, more particularly, ethanol); and/or
(b) the base is a metal hydroxide (e.g. the base is KOH); and/or

(c) the method is performed under ambient atmospheric conditions (e.g. standard pressure).

17. The method according to any one of Claims 13 to 16, wherein the first and second metal precursors are a metal salt, where the metal is in a cationic form, which is balanced by one or more counterions selected from one or more of halide (e.g. chloride), nitrate, sulfate, hydroxide, oxide, acetate anion, and hydrates thereof

18. The method according to any one of Claims 13 to 17, wherein:

(a) the second metal precursor is $Zn(OAc)_2$ or a hydrate thereof (e.g. $Zn(OAc)_2 \cdot 2H_2O$); and/or

(b) the metal in the second metal precursor is present in an amount of from 25 to 100 mol%, such as from 50 to 75 mol% of the total metal present in the mixture.

19. The method according to any one of Claims 13 to 18, wherein:

(a) the first metal precursor is $Fe(OAc)_2$, $Co(OAc)_2$ or hydrates thereof (e.g. $Co(OAc)_2 \cdot 4H_2O$); and/or

(b) the metal in the first metal precursor is present in an amount of from 25 to 50 mol%, such as from 50 to 75 mol%, such as from 25 to 50 mol% of the total metal present in the mixture.

20. A method of capturing CO_2 comprising the step of exposing a material comprising a MOF as described in any one of Claims 1 to 12 to an environment containing CO_2.