Claims

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

~~from 0 to 80 mol% of the total metal in the MOF is~~ 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 ~~100~~ 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 Claim 2, wherein the second metal is present in an amount of from 25 to 100 mol% of the total metal present in the MOF.~~

4~~3~~. The MOF according to Claim ~~3~~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~~5~~. The MOF according to any one of the preceding claims, wherein the first metal is selected from Fe and Co, optionally ~~.~~

~~6. The MOF according to Claim 5,~~ wherein the first metal is Co.

7~~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~~8~~. The MOF according to any one of the preceding claims, wherein the second metal preferentially occupies a tetrahedral metal site within the MOF.

7~~9~~. 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~~10~~. 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.

~~11~~9. The MOF according to any one of the preceding claims, wherein the MOF has a saturated CO_2 uptake of from 3.39 ~~up~~ to 5.0 mmol/g, optionally wherein the MOF has a saturated CO_2 uptake of from ~~2.5~~3.39 to 4.5 mmol/g, such as from 3.39 to 3.50 mmol/g.

~~12~~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 from 0 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 100 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 ~~,~~

~~15. The method according to Claim 14,~~ wherein the temperature is from 40 to 120 °C, such as temperature of from 60 to 80 °C.

~~16~~15. The method according to Claim ~~15~~14, wherein the temperature used results in one or both solvents being refluxed.

~~17~~16. The method according to any one of Claims 13 to ~~16~~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).

~~18~~17. The method according to any one of Claims 13 to ~~17~~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

~~19~~18. The method according to any one of Claims 13 to ~~18~~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.

~~20~~19. The method according to any one of Claims 13 to ~~19~~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.

~~21~~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.