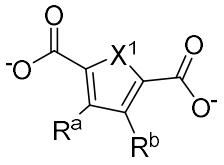
CLAIMS

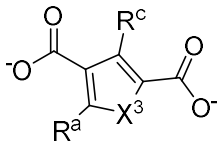
What is claimed is:

Claim 1. A multivariate metal-organic framework (MTV-MOF), comprising repeating cores, wherein the cores comprise secondary building units connected to organic ligands, wherein each secondary building unit comprise aluminum hydroxide,

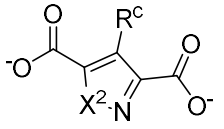
wherein the organic ligands comprise one or more moieties of Formula (I)-(XII):



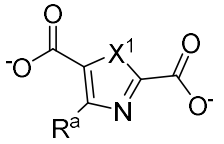
(I), wherein X^1 is NH, O or S, and each of R^a and R^b is independently H or alkyl;



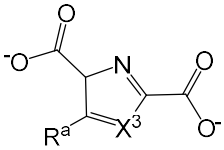
(II), wherein X^3 is NH, O or S, and each of R^a and R^c is independently H or alkyl;



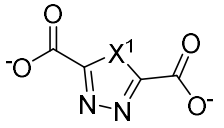
(III), wherein X^2 is NH, O or S, and R^c is H or alkyl;



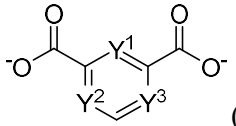
(IV), wherein X^1 is NH, O or S, and R^a is H or alkyl;



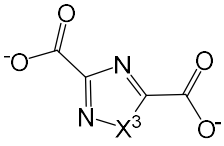
(V), wherein X^3 is NH, O or S, and R^a is H or alkyl;



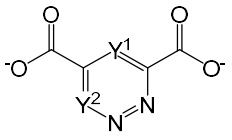
(VI), wherein X^1 is NH, O or S;



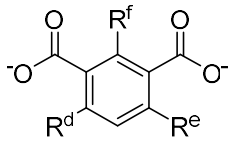
(VII), wherein Y^1, Y^2 and Y^3 are independently CH or N;



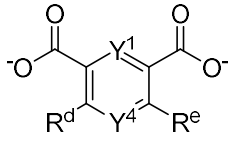
(VIII), wherein X^3 is NH, O or S;



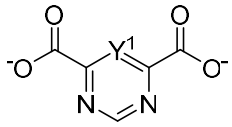
(IX), wherein Y^1 and Y^2 are independently CH or N;



(X), wherein each of R^d, R^e and R^f is independently H or alkyl;



(XI), wherein one of Y^1 and Y^4 is N, and the remaining of Y^4 and Y^1 is CH, or both Y^1 and Y^4 are N, and each of R^d and R^e are independently H or alkyl; and



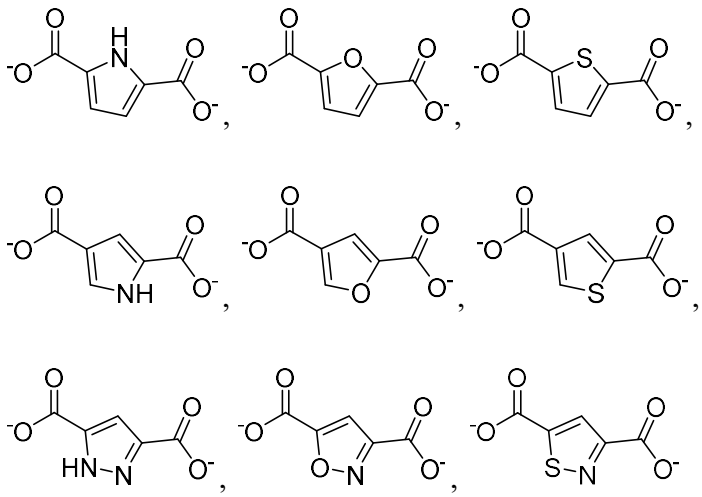
(XII), wherein Y^1 is CH or N,

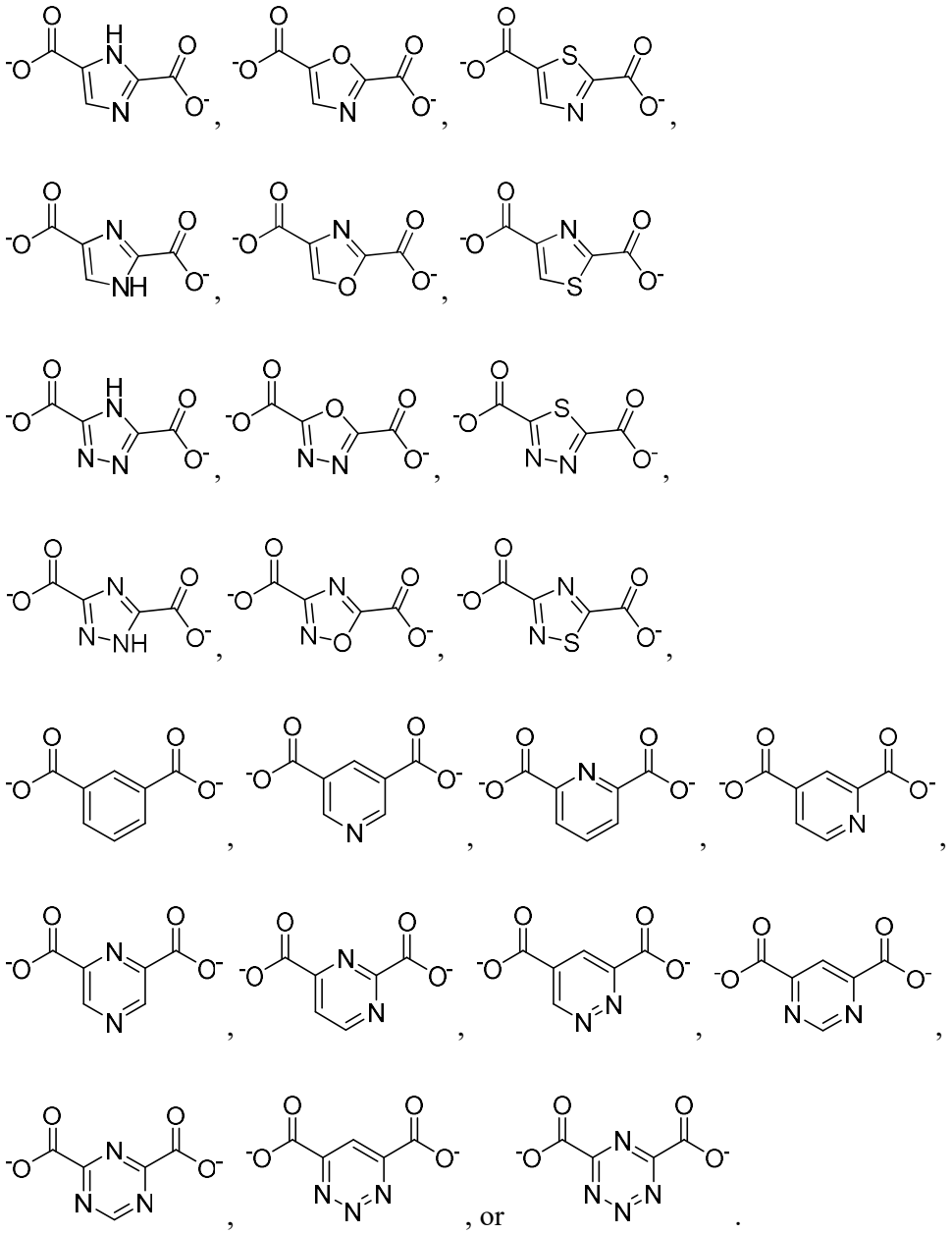
wherein the secondary building units are connected to the organic ligands through the oxygen atoms of the carboxylate groups in the organic ligands.

Claim 2. The MTV-MOF of claim 1, wherein the secondary building units form 1D rod-like chains or distinct multinuclear metal clusters.

Claim 3. The MTV-MOF of claim 1 or 2, wherein R^a, R^b, R^c, R^d, R^e and R^f are each H.

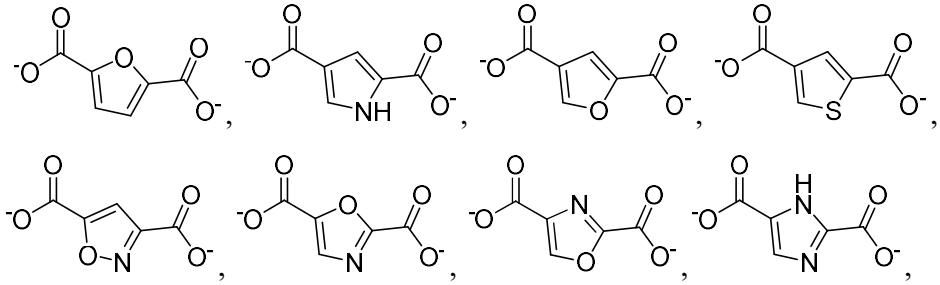
Claim 4. The MTV-MOF of any one of claims 1 to 3, wherein the organic ligands comprise one or more moieties of the following:

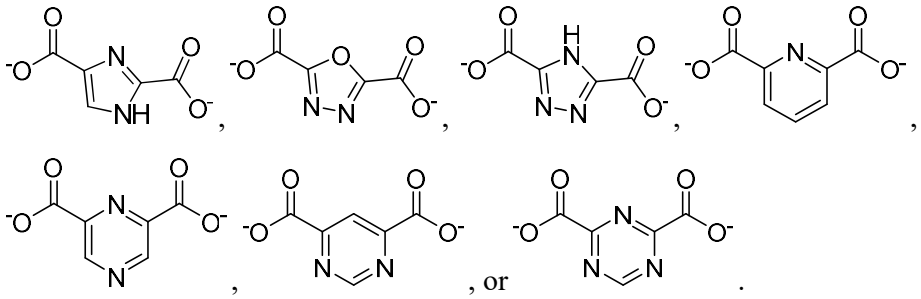




Claim 5. The MTV-MOF of any one of claims 1 to 4, wherein the MOF is a metal-organic framework with a single organic ligand.

Claim 6. The MTV-MOF of claim 5, wherein each organic ligand comprises:





Claim 7. The MTV-MOF of any one of claims 1 to, wherein the MOF is MOF-313, MOF-314, or MOF-323.

Claim 8. The MTV-MOF of any one of claims 1 to 4, wherein the MTV-MOF comprises two or more organic ligands.

Claim 9. The MTV-MOF of claim 8, wherein the organic ligands comprise a plurality of moieties of Formula (I)-(XII).

Claim 10. The MTV-MOF of claim 9, wherein the organic ligands comprise two moieties of Formula (I)-(XII).

Claim 11. The MTV-MOF of any one of claims 1 to 10, wherein the secondary building units form 1D rod-like chains, and the organic ligands comprise one or more v-shaped ditopic moieties wherein the secondary building units are preferably connected to the organic ligands through the oxygen atoms of the carboxylate groups in the organic ligands via a cis-edge-shared octahedra geometry or a trans-edge-shared octahedra geometry.

Claim 12. A method of water harvesting, comprising:

adsorbing water from ambient atmosphere using a water-harvesting system, wherein the water-harvesting system comprises one or more MTV-MOFs of any one of claims 1 to 11;

desorbing vapor from the one or more MTV-MOFs; and

collecting water from the vapor.

Claim 13. The method of claim 12, wherein the water is collected from the vapor using a condenser.

Claim 14. A water harvesting system, comprising an adsorbent layer comprising one or more MTV-MOFs of any one of claims 1 to 11.

Claim 15. The system of claim 14, further comprising a condenser adjacent to the adsorbent layer.

Claim 16. The system of claim 14, wherein the system is a passive water harvesting system.

Claim 17. A MTV-MOF of any one of claims 1 to 11 for use in water harvesting or water purification.

Claim 18. A MTV-MOF of any one of claims 1 to 11 for use in heat pumps, dehumidifiers, adsorption refrigerators, solar cooling systems, dryers, organic light emitting devices, or secondary battery devices.

Claim 19. A method of using the MTV-MOF of any one of claims 1 to 11, comprising containing in, storing in and/or extracting from the MTV-MOF a predetermined gas or fluid.

Claim 20. The method of claim 19, wherein the gas or fluid is CO_2, H_2O, H_2, CH_4, C_2H_4, or C_2H_2, or any combinations thereof.