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 ~~the~~ each secondary building unit~~s~~ comprise aluminum hydroxide,

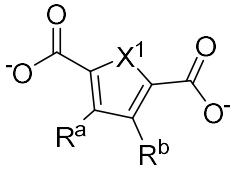
wherein the organic ligands comprise one or more ~~metals or metal-containing complexes,~~

~~wherein the organic ligands comprise one or more linear ditopic moieties, v-shaped ditopic moieties, trigonal tritopic moieties, square or rectangular tetratopic moieties, or tetrahedral tetratopic moieties, wherein the moieties comprise 5-membered or 6-membered rings substituted with at least two carboxylate groups, and~~

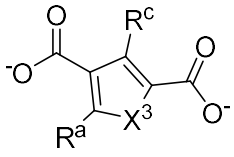
~~wherein the secondary building units are connected to the organic ligands through the oxygen atoms of the carboxylate groups in the organic ligands.~~

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

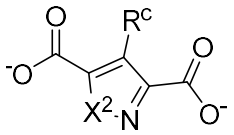
~~3. The MOF of claim 1 or 2, wherein the organic ligands comprise one or more~~ moieties of Formula (I)-(XII):



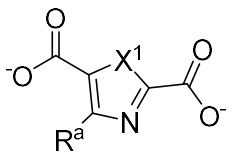
(I), wherein X^1 is NH, O or S, and each of R^a and R^b is independently H or alkyl;



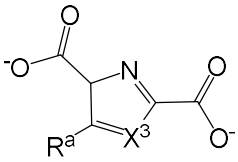
(II), wherein X^3 is NH, O or S, and each of R^a and R^c is independently H or alkyl;

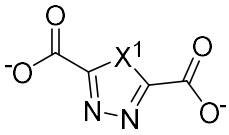


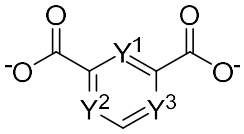
(III), wherein X^2 is NH, O or S, and R^c is H or alkyl;

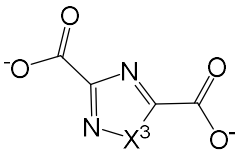


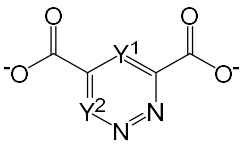
(IV), wherein X^1 is NH, O or S, and R^a is H or alkyl;

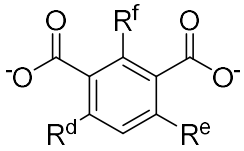
 (V), wherein X^3 is NH, O or S, and R^a is H or alkyl;

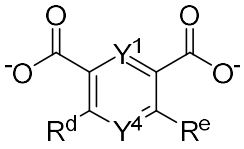
 (VI), wherein X^1 is NH, O or S;

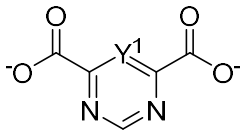
 (VII), wherein Y^1, Y^2 and Y^3 are independently CH or N;

 (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;

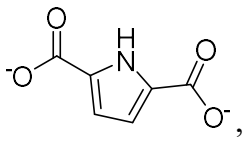
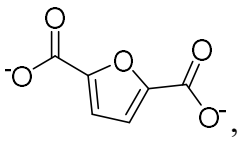
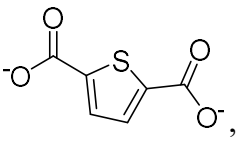
 (XI), wherein one of Y^1 and Y^4 is N, and the remaining of Y^4 and Y^1 is CH, or both Y^1 and Y^4 are N, and each of R^d and R^e are independently H or alkyl; and

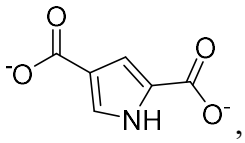
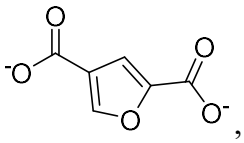
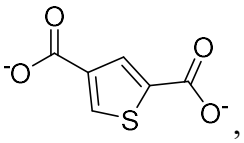
 (XII), wherein Y^1 is CH or N.

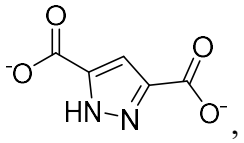
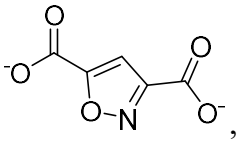
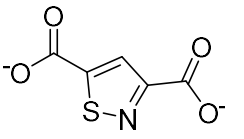
[Claim 2]. The MTV-MOF of claim 1, wherein the secondary building units form 1D rod-like chains or distinct multinuclear metal clusters.

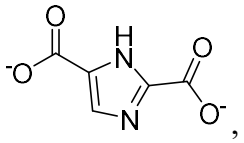
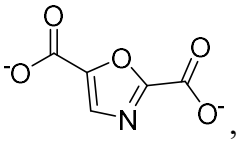
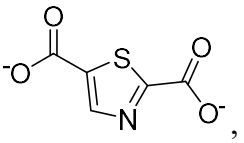
[Claim ~~3~~4]. The MTV-MOF of claim ~~2~~1 or 2, wherein R^a, R^b, R^c, R^d, R^e and R^f are each H.

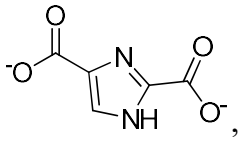
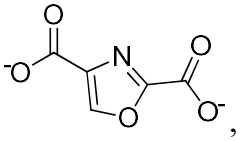
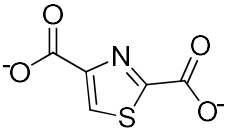
[Claim ~~4~~5]. The MTV-MOF of any one of claims 1 to 43, wherein the organic ligands comprise one or more moieties of the following:

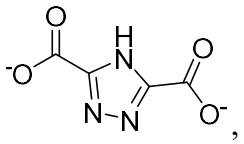
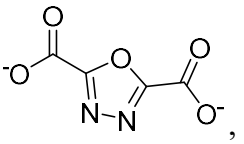
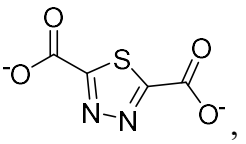
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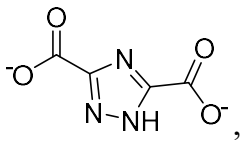
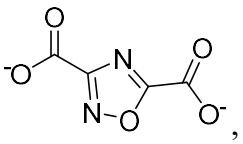
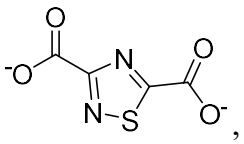
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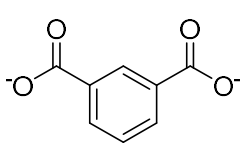
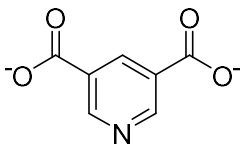
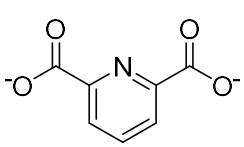
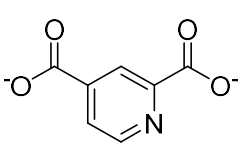
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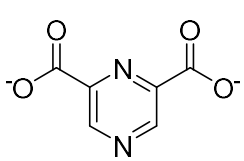
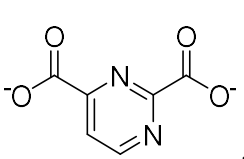
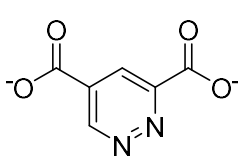
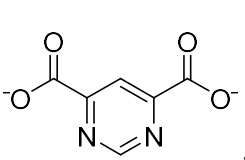
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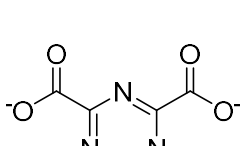
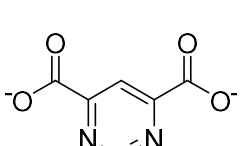
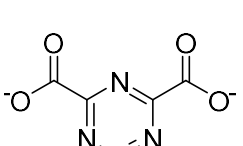
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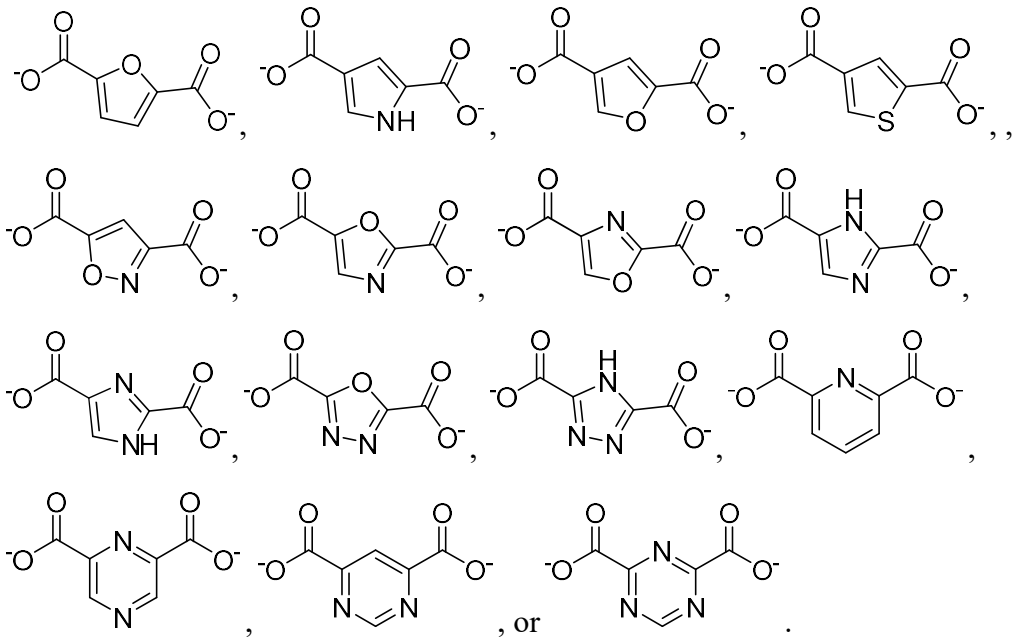
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[Claim 65]. The MTV-MOF of any one of claims 1 to 54, wherein the MOF is a ~~single-linker~~ metal-organic framework with a single organic ligand.

[Claim 76]. The MTV-MOF of claim 65, wherein each organic ligand comprises:



~~8The MOF of any one of claims 1 to 7, wherein each secondary building unit comprises aluminum hydroxide.~~

[Claim 97]. The MTV-MOF of any one of claims 1 to 7, wherein the MOF is MOF-313, MOF-314, or MOF-323.

[Claim 108]. The MTV-MOF of any one of claims 1 to 54, wherein the MTV-MOF ~~is a multivariate metal-organic framework (MTV-MOF)~~comprises two or more organic ligands.

[Claim 119]. The MTV-MOF of claim 108, wherein the organic ligands comprise~~s~~ a plurality of moieties of Formula (I)-(XII).

[Claim 1210]. The MTV-MOF of claim 119, wherein the organic ligands comprise~~s~~ two moieties of Formula (I)-(XII).

~~13. The MOF of any one of claims 1 to 5, wherein the MOF is Al(OH)(2,5-FDC)$_w$(2,4-TDC)$_v$, wherein w + v = 1; or Al(OH)(3,5-PynDC)$_m$(IPA)$_n$, wherein m + n = 1.~~

~~14. The MOF of any one of claims 1 to 13, wherein each secondary building unit comprises zirconium, nickel, iron, copper, manganese, aluminum, magnesium, calcium, strontium, barium, titanium, zinc, indium, cadmium, hafnium, lead, cobalt, or chromium, or a complex thereof.~~

~~15. The MOF of any one of claims 1 to 13, wherein each secondary building unit comprises aluminum or an aluminum-containing complex.~~

[Claim ~~16~~11]. The MTV-MOF of any one of claims 1 to ~~15~~10, wherein the secondary building units form 1D rod-like chains, and the organic ligands comprise one or more v-shaped ditopic moieties~~.~~

~~17. The MOF of claim 16,~~ 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 ~~18~~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 ~~17~~11;

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

collecting water from the vapor.

[Claim ~~19~~13]. The method of claim ~~18~~12, wherein the water is collected from the vapor using a condenser.

[Claim ~~20~~14]. A water harvesting system, comprising an adsorbent layer comprising one or more MTV-MOFs of any one of claims 1 to ~~17~~11.

[Claim ~~21~~15]. The system of claim ~~20~~14, further comprising a condenser adjacent to the adsorbent layer.

[Claim ~~22~~16]. The system of claim ~~20~~14, wherein the system is a passive water harvesting system.

[Claim ~~23~~17]. A MTV-MOF of any one of claims 1 to ~~17~~ 11 for use in water harvesting or water purification.

[Claim ~~24~~18]. A MTV-MOF of any one of claims 1 to ~~16~~ 11 for use in heat pumps, dehumidifiers, adsorption refrigerators, solar cooling systems, dryers, organic light emitting devices, or secondary battery devices.

[Claim ~~25~~19]. A method of using the MTV-MOF of any one of claims 1 to ~~16~~11, comprising containing in, storing in and/or extracting from the MTV-MOF a predetermined gas or fluid.

[Claim ~~26~~20]. The method of claim ~~24~~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.