CLAIMS

We claim:

1. A mixed-metal organic framework system, comprising:

a mixed-metal organic framework having an empirical or chemical formula of two or more distinct metallic elements and bridged by a linker, the mixed-metal organic framework comprising a plurality of disalicylate linkers, wherein each linker comprises one or more aromatic rings, each aromatic ring comprising a carboxylate functional group and an alcohol functional group, the carboxylate functional group and the alcohol functional groups are adjacent to one another on each aromatic ring, and each aromatic ring is positioned at a greatest distance from the other; and

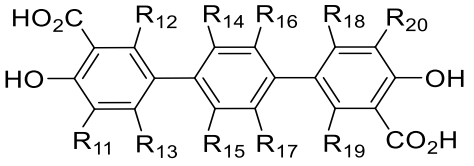
a ligand.

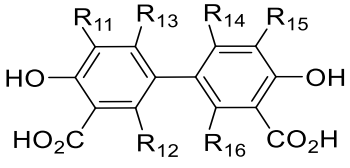
2. A mixed-metal organic framework of the formula: $M^1_xM^2_{(2-x)}(A)(B)$ where M^1 and M^2 are each independently different metal cations, A is a disalicylate organic linker, and B is a ligand.

3. The mixed-metal organic framework of claim 2, wherein M^1 and M^2 are both independently a divalent metal cation.

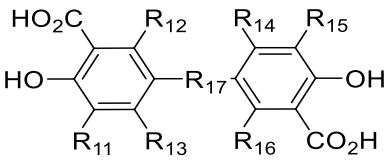
4. The mixed-metal organic framework of claim 2, wherein M^1 and M^2 are selected independently from Ca^{2+}, Mg^{2+}, Fe^{2+}, Cr^{2+}, V^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Zn^{2+}, Cu^{2+}.

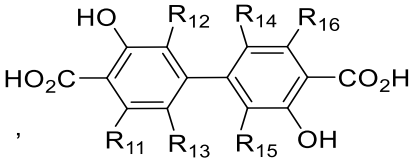
5. The mixed-metal organic framework of claim 2, wherein A is a plurality of linkers selected independently from a group consisting of:



,


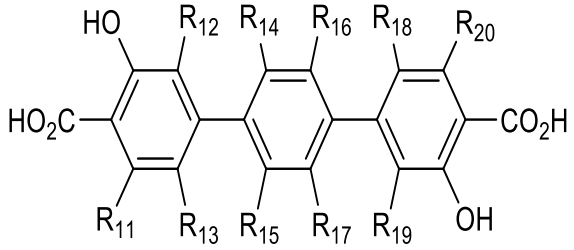
,



,


,

and



,

wherein R_{11}, R_{12}, R_{13}, R_{14}, R_{15}, R_{16}, R_{17}, R_{18}, R_{19}, and R_{20} are each independently selected from H, halogen, hydroxyl, methyl, and halogen substituted methyl; and

R_{17} is selected from the group consisting of substituted or unsubstituted aryl, vinyl, alkynyl, substituted or unsubstituted heteroaryl, divinyl benzene, and diacetyl benzene.

6. The mixed-metal organic framework of claim 1, wherein the mixed metal organic framework provides an X-ray diffraction pattern that can be indexed to a hexagonal unit cell.

7. The mixed-metal organic framework of claim 6, where the unit cell is selected from spacegroups 168 to 194.

8. The mixed-metal organic framework of claim 1, further comprising a metal rod structure.

9. The mixed-metal organic framework of claim 8 having a hexagonal pore oriented parallel to the metal rod structure.

10. The mixed-metal organic framework of claim 1, wherein the mixed-metal organic framework displays a (3,5,7)-c **msi** net.

11. The mixed-metal organic framework of claim 1, wherein the mixed-metal organic framework displays a (3,5,7)-c **msg** net.

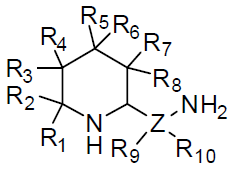
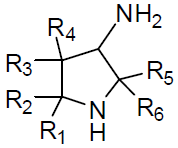
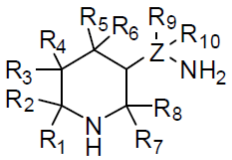
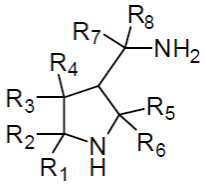
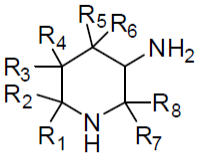
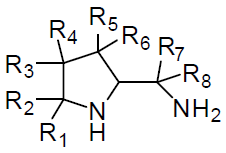
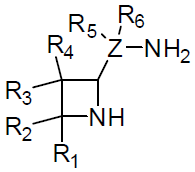
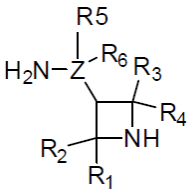
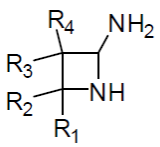
12. The mixed-metal organic framework of claim 1, wherein the mixed-metal organic framework expresses peak maxima in the X-ray diffraction pattern at 30 °C after drying at 250 °C under N_2 for 30 minutes at:

d(Å)
18.65 ±0.5
10.79 ±0.5
9.35 ±0.5
7.07 ±0.5
6.51 ±0.5
6.24 ±0.5
5.84 ±0.5
5.41 ±0.5
5.19 ±0.5

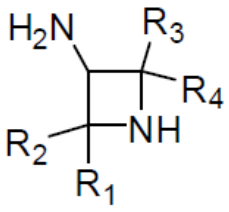
13. The metal-organic framework of claim 6, wherein an *a* axis of the unit cell and a *b* axis of the unit cell are each greater than 18 Å, and a *c* axis is greater than 6 Å.

14. The metal-organic framework system of claim 1, wherein the ligand is a diamine.

15. The metal-organic framework system of claim 14, wherein the diamine is independently selected from:

and



wherein Z is independently selected from carbon, silicon, germanium, sulfur and selenium; and R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, and R_{10}, are each independently selected from H, halogen, methyl, halogen substituted methyl and hydroxyl.

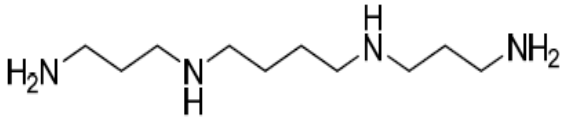
16. The mixed-metal organic framework system of claim 14, wherein the diamine ligand is selected from one of: dimethylethylenediamone (mmen) or 2-(aminomethyl)piperidine 2-ampd.

17. The mixed-metal organic framework system of claim 1, wherein the ligand is a tetramine.

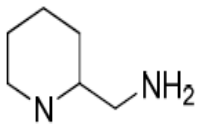
18. The mixed-metal organic framework system of claim 17, wherein the tetramine is selected from one of 3-4-3 tetramine (spermine) or 2-2-2 tetramine.

19. The mixed-metal organic framework system of claim 1, wherein the ligand is a triamine.

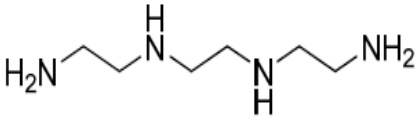
20. The metal-mixed organic framework system of claim 1, wherein the ligand is selected from:



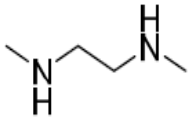
3-4-3 Tetramine



2-ampd



2-2-2 Tetramine



dimethylethylenediamine ("mmen")

21. A method of synthesizing the mixed-metal organic framework system of claim 1 comprising the steps of:

1) contacting a solution comprising 2 or more sources of 2 or more distinct metallic elements and an organic linker capable of bridging metal cations,

2) heating the mixture to produce the mixed-metal organic framework of any of the preceding claims; and

3) contacting the mixed-metal organic framework with a ligand.

22. The method of claim 21, wherein the metallic elements are selected independently from Ca, Mg, Fe, Cr, V, Mn, Co, Ni, Zn, Cu.

23. The method of claim 21, wherein the solution comprises an elemental metal or a salt of the metal in which the counter anion comprises a nitrate, acetate, carbonate, oxide, hydroxide, fluoride, chloride, bromide, iodide, phosphate, or acetylacetonate.