CLAIMS:

1. A method of synthesizing a metal-organic framework system comprising a metal-organic framework and a plurality of ligands appended to the metal-organic framework, the method comprising the steps of:

providing a metal-organic framework comprising a plurality of one or more distinct metallic elements and a plurality of linkers, the metal-organic framework comprising at least one open metal site; and

appending a ligand in a vapor-phase to the metal-organic framework at the open metal site to form the metal-organic framework system.

2. A method of making a metal-organic framework system comprising the steps of:

making a metal-organic framework comprising a plurality of one or more distinct metallic elements and a plurality of linkers, wherein the metal-organic framework comprises a plurality of open metal sites, and wherein a linker bridges at least one of the plurality of the open metal sites to another;

evaporating a plurality of ligands to produce a vapor-phase; and

in the vapor-phase, binding the at least one of the plurality of ligands to the at least one of the open metal sites of the metal-organic framework to form the metal-organic framework system.

3. The method of claim 2, further comprising the step of suspending the metal-organic framework in a solvent.

4. The method of claim 3, further comprising the step of filtering the solvent from the metal-organic framework.

5. The method of claim 2, wherein the plurality of ligand is heated to form the vapor-phase.

6. The method of claim 2, wherein an inert gas passes through the vapor-phase.

7. The method of claim 6, wherein the inert gas is nitrogen.

8. A method of recycling metal-organic framework system comprising the steps of:

detaching a plurality of first appended ligands from the metal-organic framework system

to provide a metal-organic framework, wherein the metal-organic framework structure remains intact, the metal-organic framework comprising a plurality of one or more distinct metallic elements and a plurality of linkers; and

appending at least one of a plurality of second appended ligands to the metal-organic framework to produce a recycled metal-organic framework system.

9. The method of claim 8, further comprising the step of sequential soaking of the metal-organic framework system and metal-organic framework to provide a recycled metal-organic framework system.

10. The method of claim 8, further comprising the step of washing the metal-organic framework system in solvent to remove the plurality of first appended ligands.

11. The method of claim 8, further comprising the step of appending the at least one plurality of second appended ligands to the metal-organic framework in a vapor-phase.

12. The method of claim 8, wherein the plurality of first appended ligands are spent diamine-appended ligands

13. The method of claim 8, wherein the plurality of second appended ligands are the plurality of first appended ligands recycled.

14. The method of claim 8, wherein the plurality of first appended ligands are different than the plurality of second appended ligands.

15. The method of claim 8, wherein the metal-organic framework system comprises a diamine appended to the metal organic framework.

16. The method of claim 8, wherein each of the plurality of one or more distinct metallic elements are bridged by one or more of the plurality of linkers to form the metal site.

17. The method of claim 16, wherein the plurality of one or more distinct metallic elements comprise magnesium, zinc, nickel, copper, and/or a combination thereof.

18. The method of claim 17, wherein the distinct metallic element is Mg.

19. The method of claim 1, wherein the ligand is an amine.

20. The method of claim 2, wherein the plurality of ligands is an alcohol.

21. The method of claim 2, wherein the linker is a multidentate organic ligand comprising a first binding site and a second binding site that are bridged together with a third binding site.

22. The method of claim 21, wherein the first binding site and second binding site of the multidentate organic ligand each comprise a salicylate moiety and the third binding site comprises a diamine moiety.

23. The method of claim 22, wherein the multidentate organic linker is 5, 5'-(((1*E*,2E*)*-ethane-1,2-diylidene)bis-(azaneylylidene))bis(2-hydrozybenzoic acid).