Novel Metal Organic Frameworks with Superior Physical Properties

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BACKGROUND

While there is a huge existing field of metal organic framework (MOF) and coordination polymer (CP) materials, there are essentially zero crystalline systems which allow for zero-valent metals to be present as the primary structural building unit. Most MOFs and CPs utilize anionic ligands and metal centers in an oxidized state. This forms the basis of strong ‘reticular’ bonds which impart both stability and, in the case of MOFs, permanent porosity on these solid state materials. The fact that metals in MOFs or CPs are oxidized, does not allow for reactivity or chemistry that is known for zero-valent metals. To stabilize zero-valent metals in a MOF or CP, this invention uses multi-topic isocyanide ligands, which form bonds to both low (and zero) valent metal centers as well as metal centers in higher oxidation states. The ability to stabilize many metal oxidation states is a hallmark of isocyanide coordination chemistry. In addition, the ability of isocyanides to participate simultaneously as s donors and p acceptors allows them to form one of the strongest metal ligand bonds.

TECHNOLOGY DESCRIPTION

Researchers from UCSD have developed a novel multtopic isocyanide ligands that allows formation of superior 3D and 2D metal-organic networks. Finely tuned steric profile of the ligand allows for coordinative unsaturation at the transition metal centers. Moreover, the inclusion of sterically encumbering m-mesityl substituents on the central biphenyl linker forces the thermodynamically favorable formation of a 2D infinite sheets. This allows for the controlled solid-state preparation of Cu(I) tris-isocyanide nodes with a labile solvent ligand in a manner mirroring solution-phase chemistry of monomeric complexes.

MOFs generated from the novel isocyanide ligands exhibit exquisite stability under variety of different conditions including strong acidic and basic media. Unlike previously reported MOF, these novel isocyanide copper frameworks have remarkably high thermal stability, allowing for applications up to 500°C.

This invention allows low-valent, especially zero-valent, transition metals to be assembled in an extended network solid material. These materials can also contain open metal coordination sites, which can enable catalysis and/or strong adsorption of gas/guest molecules into the material. These materials can be thought of as “polymerized” low-valent organometallic complexes. As molecular species, low-valent organometallic complexes, can catalyze an enormous range of catalytic transformations in solution relevant to industry, organic synthesis and energy applications. This invention allows such highly useful and reactive low-valent organometallic complexes to be assembled into a robust solid state material.

APPLICATIONS

Gas storage, gas separation, Catalysis relevant to alternative energy, organic synthesis, electrocatalysis, petrochemical processes and polymerization.

ADVANTAGES

- MOFs with tunable pore size
- MOFs and CPs with high stability in protic and aprotic solvents
- MOFs and CPs with high thermal stability (temperatures up to 500°C)
- 2D metal-organic structures with catalytic properties of solution phase chemistry
- Polymer structures with metal atoms “trapped” in mixed oxidation states

INTELLECTUAL PROPERTY INFO

Provisional patent application filed in June 2016

RELATED MATERIALS

PATENT STATUS

Patent Pending