Honours Projects for 2014

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This document will give you an idea of the type of research we are undertaking within my group. If you have any further queries, please do not hesitate to contact me (details above).

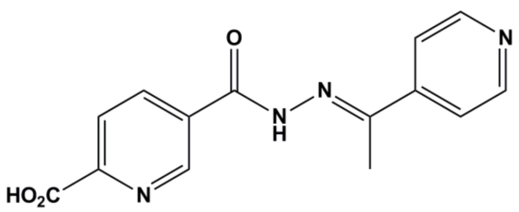
More information on my research can be seen at: ***www.chem.monash.edu.au/staff/turner.html***

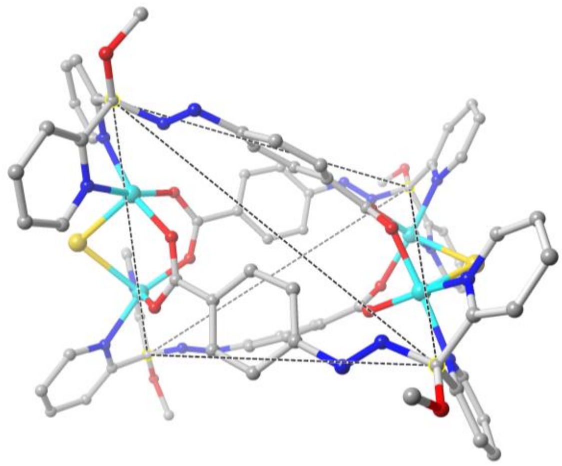
Metal-Organic Frameworks and Polyhedra

The formation of either polymeric materials or discrete complexes that comprise a framework of metal ions connected by organic bridges is highly topical. A notable emphasis of this research is an attempt to control the topology or shape of the framework in a predictable manner with the aim of creating porous or hollow materials/polyhedral.

This project will examine a series of organic bridges, or ligands, that contain functional groups that are potentially able to form hydrogen bonds with anions in addition to their coordinating ability. By using ligands that associate strongly with the anions we can attempt to assemble networks by using the anions as templates around which the ligands gather. In this manner we can alter the topology of our coordination networks by changing which anion we use during the synthetic procedure. This project will utilize a variety of non-symmetric ligands that incorporate a hydrogen-bonding hydrazinyl unit between the coordinating ends. Reactions with metals occur under self-assembly conditions which frequently yield fascinating – if sometimes unpredictable – structures, whose properties will be explored.

The project will involve synthesis of both the organic ligands and their metal-complexes and structural analysis by diffraction, primarily using the Australian Synchrotron. We have recently made a novel Cu-tetrahedron (see below) and a plethora of coordination polymers – your contribution is waiting to happen!





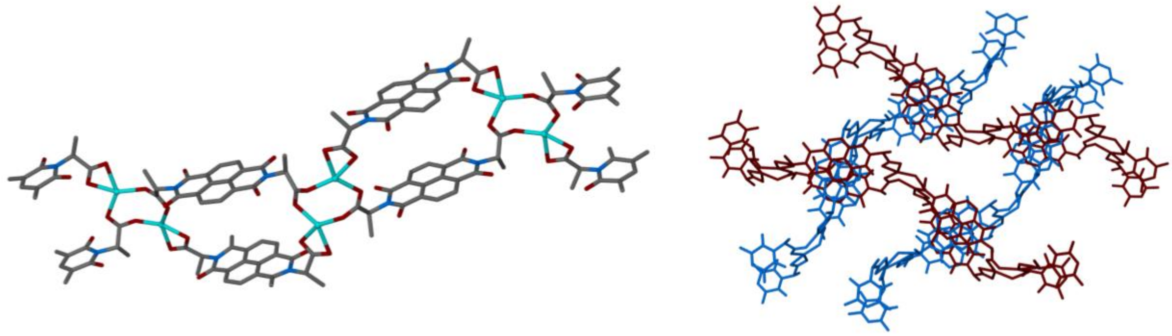
An example of a target ligand and a previously synthesised metal-organic tetrahedron using a similar organic bridge.

Chiral Framework Materials for Separation

Coordination polymers, or ‘metal-organic frameworks’, are materials in which organic molecules bridge between metal-ions to form a 3D network. This project will use amino-acid-based ligands that have the potential to form materials that contain empty, chiral channels. The target materials are porous frameworks in which solvents, gases or other small organic molecules can be placed with a particular emphasis on separation of enantiomers, by selective adsorption, or strong and reversible binding of gaseous guests. It is anticipated that the fluorescence behavior of the material will be dependent on the guests that are held within the lattice thereby the material will act as a sensor.

Honours Projects for 2014

A series of ligands will be synthesised that are based on a naphthalene diimide (NDI) core. By varying the nature of the coordinating group we can vary the topology and properties of the resulting coordination polymers. The project will involve the organic synthesis of the ligands, synthesis and structural studies of coordination polymers (typically involving the Australian Synchrotron) and investigations into their guest storage properties (in collaboration with CSIRO). Our previous results are very promising (see below) and there is massive scope to create your own array of new, porous materials.

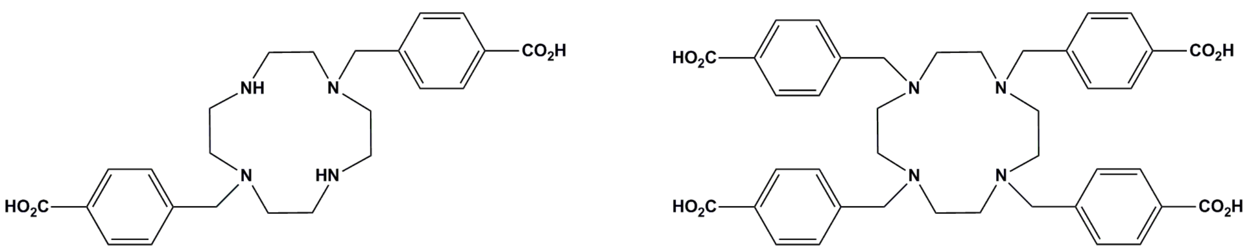


An Mn-based network containing NDI ligands (left) which form an interpenetrated structure with potentially guest-accessible, chiral channels (right).

Amine-Based Porous Materials for CO_2 Capture (with Prof. Stuart Batten)

This project forms part of a multi-institution, multi-disciplinary effort to synthesise and study porous metal-organic materials that are capable of strong and selective CO_2 gas uptake. Traditional solution-phase methods for CO_2 scrubbing rely on aqueous amine solutions. The aim of this project is to incorporate free amines into framework materials that can provide strong, selective and reversible binding of CO_2.

This project will attempt to incorporate amine-containing macrocycles into coordination polymers (porous frameworks constructed using metal ions and organic bridging ligands). You will be using a wide range of different macrocycles and coordinating groups with a ‘modular’ approach to ligand construction. The project will involve the synthesis of both the organic ligands and the final materials, structural analysis of the materials (using the Australian synchrotron) and, hopefully, analysis of the gas storage properties of the wonderfully porous materials that you make!



Examples of the types of ligands that will be targeted during this project. The size and substitution of the macrocycle and the types of coordinating groups will be varied.