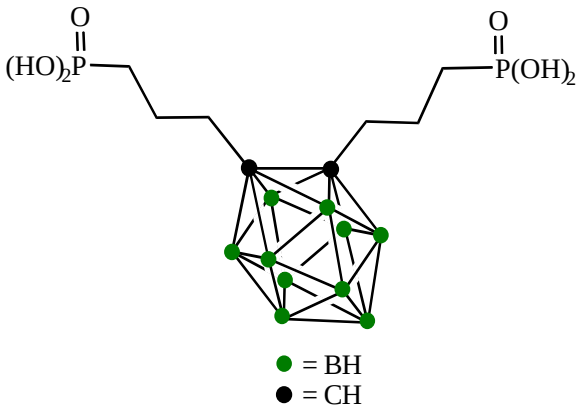
Chemical Research

I am a synthetic chemist, I enjoy mixing chemicals and making new architecturally interesting molecules and solid state materials. I became interested in inorganic chemistry because of one element Boron! (And Jim Spencer's enthusiasm as well, of course.) The cage structures and complexity of the boron hydrides, have fascinated my fellow Boron chemists for more than 40 years and me for more than a decade. Only one element away from carbon, yet its reactivity is so dramatically different.

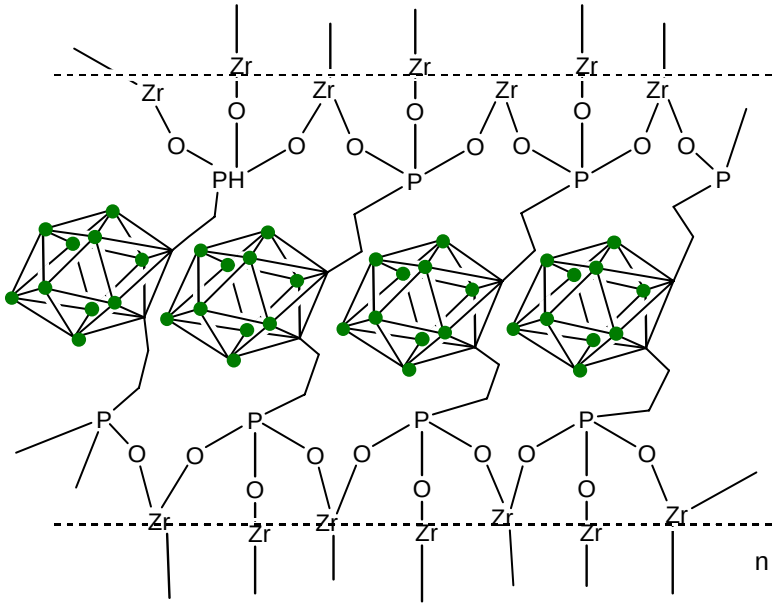
At the moment, I have four applications to which I am applying my synthetic skills, new drugs for boron neutron capture therapy (BNCT) and new architecturally interesting materials, new carbohydrate ligands and the development of laboratories for teaching. Often the two are one in the same.

New Architecturally Interesting Materials

The focus of my attention at the moment is in the synthesis of *ortho*-carborane (and *meta*-carborane) cages substituted at the carbon with a long chain hydrocarbon chain containing a phosphonate end group similar to the one shown on the right. Eventually, I will be interested in the kinds of compounds these substituted carboranes will make with metal centers. This project has two stages, the first is to make the ligands ("hangers") and the second to understand their interactions with different metal centers.

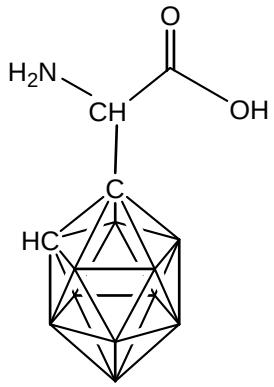


The second stage however may prove to be trickier. As unstable as boranes are, their metal complexes while more stable, are often more difficult to characterize. I am confident that I will be able to isolate both discreet compounds as well as complex layered materials such as the one shown here. The structures and properties of these materials are of interest on their own merit and also as applications in drug therapy, electronics and magnetics.



Another part of this project that is already well on its way is the synthesis of the organic counterparts to these hangers (i.e. compounds without the carborane such as straight organic chains and chains with proton donating substituents). Once these are fully characterized, similar Zirconium layered materials will be made from them. Initially, I became interested in these through a collaboration with the United States Naval Academy. The Navy is interested in these compounds as potential Fuel Cell Separators. I have almost completed this phase of the work and am steps away from final compounds suitable for testing. Once they are made and characterized, I will ship them off to my contacts at the USNA for electrochemical testing.

BNCT



My short-term goal is to find a high-yield preparation to the amino acid derivative shown here. Long term goals include incorporating it into peptide backbones. By far the most challenging step here is the initial synthesis of this amino acid. It has been reported in the literature but no synthetic method has thus far been reported.

M**etal Carbohydrate Chemistry**

Through a collaboration with Dr. Mary Scientist, I am currently pursuing the metal complexes of his 3-deoxyaldosulose bis(thiosemicarbazones). These have proven trickier than I imagined as they are complicated by solubility issues. Our goal here is to synthesize a variety of complexes with different metals and with some good old fashioned luck, grow a crystal or two here and there! While the ligands themselves, show antiviral and antimicrobial activity, it is expected that the metal complexes will be important medically as chemotherapy drugs.

Development of Laboratories for Teaching

Students learn best when they can relate learning to their world. As a temporary person at UMM I had a student interested in biodiesel, he wanted to drive a big truck but wanted to do it in a responsible way. So, he and I set about synthesizing biodiesel and developed it into a laboratory for organic chemistry. As a professor at AU one of our althetic fields was found to have an Arsenic problem so student and I developed yet another lab to answer the questions will this arsenic get into our drinking water? Sometimes the best ideas come from the simplest questions. I plan to continue working with interested undergraduates and graduate students to develop laboratory experiments that help bring chemistry to the real world.