Research Interests

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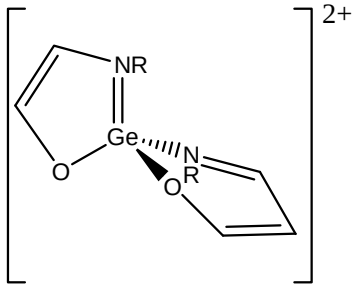
Germanium Complexes

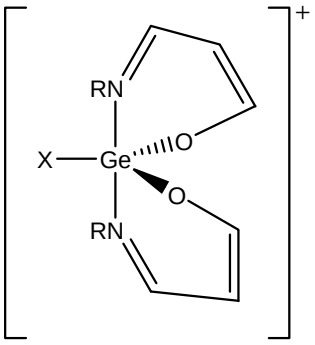
Complexes of germanium are attracting interest because of their low toxicity to humans and their antimicrobial properties. I am interested in studying compounds containing germanium, Ge, a main group element below silicon (Si) on the periodic table, for three important reasons. First, the number of reported germanium compounds is less than other elements in the same period which include carbon, silicon and tin (Sn). A structure search of Ge, Si and Sn complexes with a minimum of 2 bonds to nitrogen and 2 bonds to oxygen resulted in 57 structures, 195 structures and 291 structures, respectively. Second, the potential for germanium compounds to act as catalysts, reagents that increase the rate of a chemical reaction, has only recently been explored (Chmura, 2007). Third, since germanium is a semiconductor, I am interested in using these compounds to prepare germanium nanoparticles or thin films (Baribeau, J. M, 2006). Consequently, there are several important reasons to pursue the preparation, characterization, and reactivity of germanium compounds.

Germanium compounds have been observed to form bonds to 4, 5, or 6 other atoms (**Figure 1**). These compounds with oxygen, nitrogen, and/or chloride groups, with the general formula, $Ge(NR)_{2-x},(OR)_{4-x},Cl_{2-x}$, have been prepared (Jindal and Singh (2007, 2008)) but not characterized by X-ray crystallography so their exact structure (4, 5, or 6 bonds) is unknown.

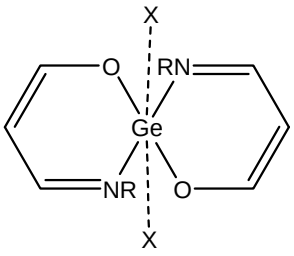
Figure 1: Different possibilities for bonding in germanium compounds containing nitrogen, oxygen and chloride atoms bonded to the germanium. R is a carbon containing group, X is chloride or oxide (OR).



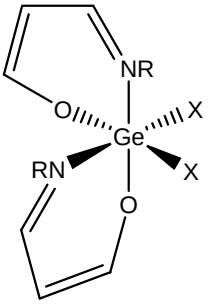
An example of bonding to 4 atoms



An example of bonding to 5 atoms



or



Two examples of bonding to 6 atoms

The second and third reasons for preparing the compounds are to evaluate their usefulness in the preparation of other materials. One important aspect is the evaluation of the germanium complexes as catalysts, reagents that make reactions happen faster and therefore often more efficiently. Currently, tin, the element below germanium on the periodic table, is used as a catalyst for many reactions. Tin is inexpensive but it is toxic to humans and other animals. Consequently, in preparations of materials for use in humans such as pharmaceuticals or polymeric replacement parts, tin should be avoided. Germanium is known to have a low toxicity and so studies to replace the use of tin catalysts are of considerable interest. In addition, germanium is used extensively in the semiconductor industry. The ability to control the size and shape of germanium metal particles is important to the continuing development of faster, lighter computers. The germanium compounds we are preparing can be decomposed and the germanium metal structures can be analyzed to determine their size and shape.

Students involved in these projects will learn inert atmosphere techniques, possibly use ^{1}H, ^{13}C and ^{31}P NMR spectroscopy, IR spectroscopy, UV-VIS spectroscopy, photoluminescence spectroscopy, ICP analysis, X-ray diffraction, and transmission electron microscopy to characterize the materials, and make presentations locally and regionally.

References

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