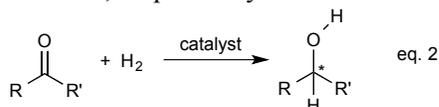


Development of Transition Metal Complexes for Breaking Unreactive Chemical Bonds

John P. Lee

Want to make some new metal-containing molecules! The field of organometallic chemistry is the place where we combine the rules of organic chemistry while breaking rules using inorganic chemistry. The use of organometallic transition metal complexes has had a significant impact in the field of organic chemistry as these complexes act as catalysts, and nearly all organic syntheses of any complexity include at least one metal-catalyzed reaction. Indeed, since 2001 three separate Nobel Prizes have been awarded for work in this field involving organometallic complexes with precious metals used as catalysts in organic chemistry. One area in catalysis that is currently being pursued is the selective activation and functionalization of bonds that are not supposed to be broken under standard laboratory conditions, so called inert chemical bonds, such as the C-H bond of hydrocarbons. Specifically, we are interested in the atom economical oxidation of C-H bonds of aromatic molecules and alkanes to vinyl arenes and alcohols, respectively.



This summer we will be working on two projects involving the metal cobalt. Fundamental work is needed in the exploration of Earth-abundant transition metals as catalysts for new organic transformations. Thus, specifically we will look at the chemistry of cobalt(III) utilizing the aromatic cyclopentadienyl anion, Cp (Example X-ray crystal structures shown in Figures 1-2), and taking advantage of the NMR active nucleus ^{59}Co . Long-term interest in this chemistry lies in the development of catalysts for the 1) oxidation of methane to methanol (eq. 1) and 2) asymmetric hydrogenation of prochiral ketones to chiral alcohols (eq. 2). With increasing environmental concerns in regard to CO_2 and the rapid depletion of fossil fuel reserves it is imperative that we develop new methods that can convert raw materials (e.g., methane, benzene and hydrogen) into more useful chemicals.

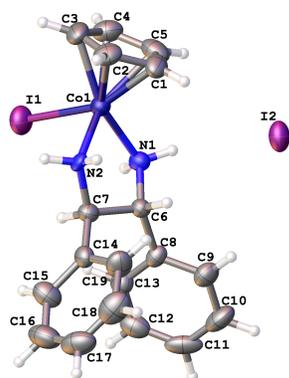


Figure 1

spectroscopy, spectroscopy, crystal X-ray diffraction. In encouraged to present your American Chemical Society in 2017.

Students in my group have gone on to pursue a PhD in chemistry at UTK and Texas A&M, pursue professional degrees in medicine and pharmacy at UT Memphis and have found positions in industry immediately after graduation. These students have presented at regional and national meetings of the American Chemical Society and in some cases had their results published in peer-reviewed journals such as *Polyhedron* and *Journal of Coordination Chemistry*.

Both catalytic reactions of interest represent a greener and more atom economical use of our existing fossil fuel resources and reaction by-products. In addition to working on current challenges in the field of inorganic chemistry, you will learn synthetic inorganic and organometallic chemistry, which includes air-free chemistry in a nitrogen filled glove box and Schlenk techniques. A significant amount of the Department's instrumentation will be used for characterization,

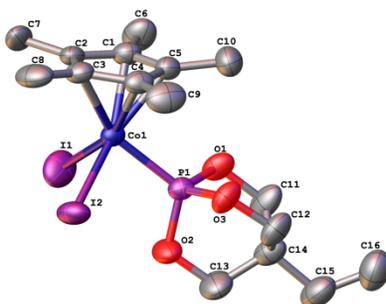


Figure 2

which includes: $^1\text{H}/^{13}\text{C}/^{31}\text{P}/^{59}\text{Co}$ NMR infrared and UV-vis electrochemistry, and single-addition, you will be work at the Regional meeting held in Charlotte, NC