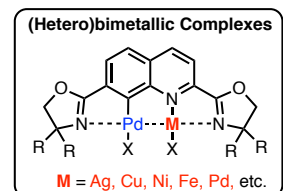


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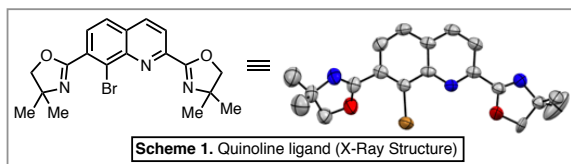
TITLE: **Development of Unique Functional Group Interconversions**PI: **Alejandro Bugarin**; Department of Chemistry and Physics, Florida Gulf Coast University**Progress of Research and Impact:**

Development of new strategies to generate synthetically useful molecules is of paramount importance, in both material sciences and synthesis. At the same time, discovery of specialized catalysts capable of performing new transformations or improving known reactions' scope, while using eco-friendly conditions/protocols and simple technologies is fundamental in our search for sustainable materials. In particular, the search for more effective routes to improve many synthetic processes to achieve widespread applications. Our research efforts are focused on the development of novel *heterobimetallic catalysts* capable of activating simple molecules (e.g., alkyl halides, alkynes, alkenes, allenes, etc.). In this regard, we are centered on addressing a long-standing problem afflicting organometallic chemists, reactivity and control of both regioselectivity and stereoselectivity of transition metal catalysts. This new direction grant was awarded to examine direct site selectivity and reactivity of our new designed heterobimetallic catalysts. During the past year, our progress has been promising in that our catalytic system shows great reactivity towards many molecules (e.g., activation of alkyl halides), leading to facile functional group interconversion.

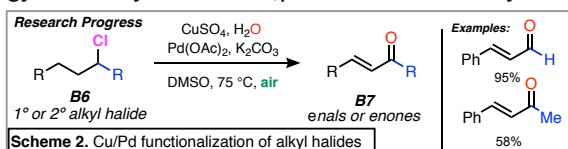


Due to unexpected circumstances my research group moved from UTA to FGCU. Fortunately, the ACS Petroleum Research Foundation granted us the following. First, a year extension of the award and second the transfer of the remaining funds from UTA to FGCU, for what we are very thankful. Thanks to this, we are still working on the project. Therefore, our progress from last year is summarized in the following paragraphs.

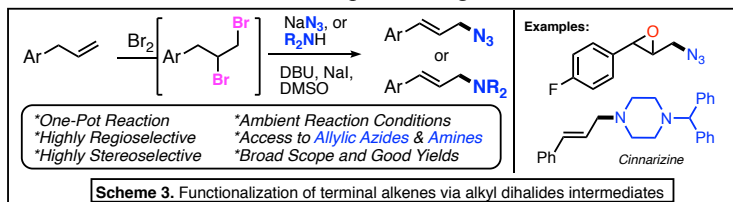
**(1) Synthesis of tetradentate ligands:** We are happy to report that 4-different pincer-like ligands, derived from quinoline, were synthesized and more are in the pipeline. Symmetric and chiral ligands composed the list, whereas aminoacids were employed as chiral sources. For example, the ligand in Scheme 1 was prepared and fully characterized, even with X-ray analysis. Everyone in my research group is very excited to have obtained X-ray structures of ligands, some bearing bromo substituents and others iodo. Currently, we are characterizing metal-complexes with copper, silver, and/or palladium. Thus far,  $^1\text{H}$  NMR confirms the formation of the heterobimetallic complex, albeit X-ray structures are still to be acquired. A manuscript is current under preparation for publication with undergraduate authors. In addition, we are currently checking turn over number (TON) and catalyst loading of several transformations. Future plans involve an interesting variety of bimetallic complexes, (e.g. Pd-Cu, Pd-Ag, etc.) and chiral ligands, to be employed as tunable catalysts in miscellaneous transformations.



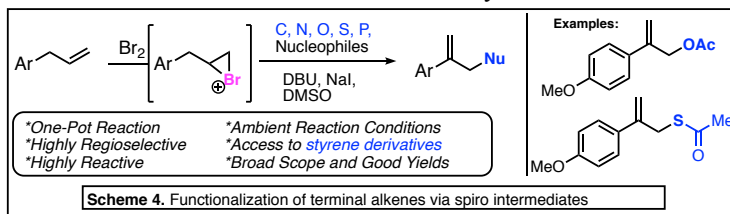
**(2) Alkyl halides into  $\alpha,\beta$ -unsaturated carbonyls:** This research project commenced with the proof of concept reaction, conversion of commercially available 1-chloro-3-phenylpropane in the presence of two distinct catalyst. Fortunately, we were able to develop a direct strategy for the synthesis of  $\alpha,\beta$ -unsaturated carbonyls with water and air, via hydration or hydrolysis of the alkyl halides, followed by oxidation of the resulting alcohols to create enals (from primary alkyl halides) and enones (from secondary alkyl halides), with yields up to 95% (Scheme 2, to be published soon).



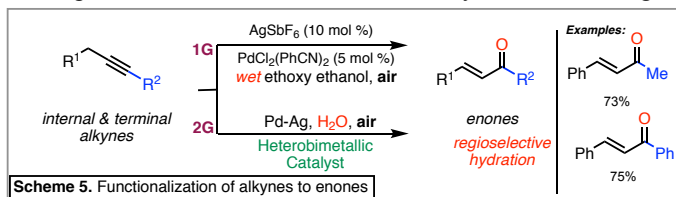
**(3) Alkenes into allylic azide/amines:** Since alkyl halides proved to be excellent substrates, for enals/enones formation, we hypothesized that alkyl dihalides will also work. However, after performing our transformation under standard conditions, we observed the formation of an allylic system instead (Scheme 3). Optimization of the reaction conditions and substrate scope investigation led to a transition metal free reaction with excellent yield and scope (more than 25 adducts), even the well-known calcium channel blocker *cinnarizine* was synthesized in one-pot reaction (Scheme 3). The manuscript now appears in *Org. Biomol. Chem.* Importantly, this work was performed mainly by undergraduate students.



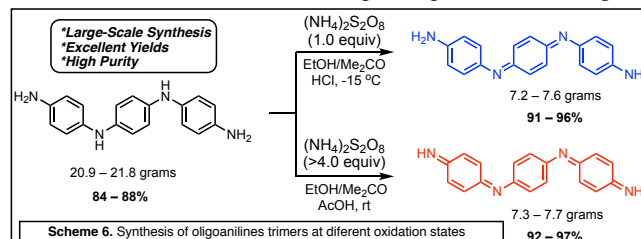
**(4) Alkenes into styrene derivatives:** By carefully selecting the reactions conditions and substrates, from the preceding subproject, we discovered that terminal alkenes can be direct converted into styrene derivatives. These adducts are easily functionalized with nitrogen, oxygen, carbon, and sulfur nucleophiles (Scheme 4, [manuscript under preparation](#)). Our future plans are to utilize and investigate the potential of this styrene derivatives as monomers of miscellaneous polymers, perhaps with special properties.



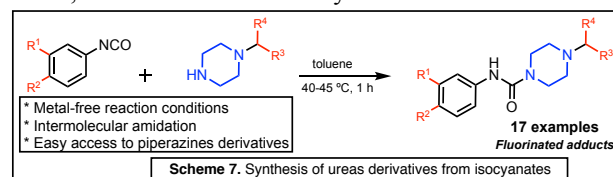
**(5) Alkynes into enones:** At the same time, we are investigating the catalytic functionalization of simple alkyne hydrocarbons, by reaction them with water and air in the presence of transition metals. The synthetic advantage of this method is construction of new C–O, C=O, and C–H bonds in one synthetic step, under mild reaction conditions, and rapid conversion to C=C bonds with high regioselectivity. Our preliminary data should help to develop an efficient strategy to convert several different alkynes into  $\alpha,\beta$ -unsaturated ketones (enones) in a single operation using both the first-generation tandem catalytic system (ligandless: Scheme 5, top) and the second generation using our heterobimetallic catalysts (e.g., pincer Pd–Ag complex: Scheme 5, bottom). Our current results are encouraging for the first generation, where good yields and excellent regioselective hydration were observed, [manuscript under preparation](#). However, we are yet to try the second-generation catalytic system.



**(6) Aryl halides into oligoaniline trimers:** In our continued effort to develop unique functional group interconversions, we developed a large-scale synthesis of oligoanilines trimers from readily available starting materials. The manuscript now appears in *Synthesis*. We are very proud to note that our article was selected by the editors to be the cover art of the issue (Scheme 6). Thus, highlighting the significance and impact of this work, which should have vast applications in miscellaneous areas.



**(7) Isocyanates into urea derivatives:** During our studies, we also converted isocyanates to ureas derivatives under mild conditions (Scheme 7). The different adduct were fully characterized and evaluated against different bacteria and fungi. The work was published a few months back in *Biorg. Chem.*



Finally, and to further expand the power of facile functional group interconversion, we are currently working on a couple of chemical transformations that take make use of *water and air as the environmentally friendly reagents*.

### Summation:

It is well known that petroleum derivatives are everywhere in our society from chemicals to wearables. Although most of them are useful and of utmost importance to our community, some of them present real threat to the environment as pollutants. Therefore, development of synthetic alternatives to compensate or mitigate this issue is crucial to ensure a better future. Herein, we have accomplished a couple of **unprecedented functional group interconversions**, all of them are straightforward and new synthetic transformation. All aiming to reduce chemical waste and energy consumption, while developing new catalytic systems that encompass atom-economic transformations.

Overall, the ACS PRF ND grant provided economical support and a research platform, which offered a high-quality research training for graduate and undergraduate students, while allowing the PI to develop several research projects and to finish others. In addition, the impact to students could be measure with all that they have learned and improved during their research experiences. In general, they acquired the necessary synthetic skills and handling of scientific instrumentation required for compounds' analysis and characterization.