IRIDIUM-CATALYZED C-H BOND ACTIVATION AND BORYLATION OF SMALL ORGANIC MOLECULES

ABSTRACT
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THESIS

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Jagriti Chaturvedi
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Co-Supervisor
Dr. Buddhadeb Chattopadhyay
Assistant Professor
Centre of Biomedical Research (CBMR)
SGPGIMS Campus, Raebareli Road
Uttar Pradesh, Lucknow-226014, India

Supervisor
Dr. Gajanan Pandey
Professor
Department of Applied Chemistry
School for Physical Sciences
Babasaheb Bhimrao Ambedkar University
Lucknow-226025, India

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Abstract

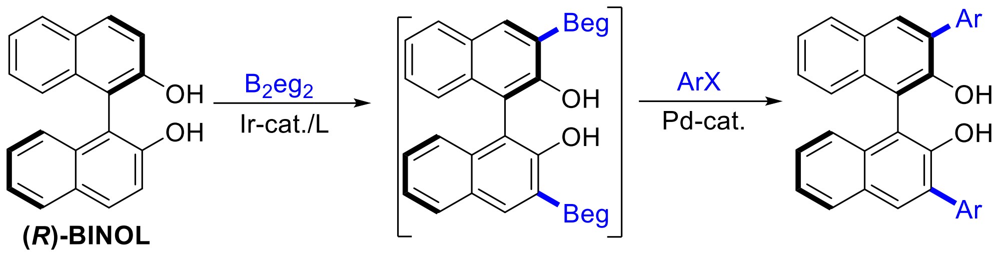
The pursuit for the discovery of new and powerful synthetic methods from simple starting materials to access high-valued organic materials has been at the forefront of synthetic organic chemistry research for more than a century. While traditional synthetic strategies mostly rely on the innate reactivity of functional groups, the introduction of transition metal-catalysts renders innovative strategies to construct covalent bonds, thus offering a great opportunity to derivatize various important molecules with little functionality to synthetically versatile motifs. In this context, transition metal-catalyzed C-H bond activation and subsequent borylation sparked significant interest as a prevalent reaction in synthesis owing to the high synthetic usefulness of the organoboron compounds. Organoboron compounds are a class of multifunctional reagents for the preparation of carbon-carbon and carbon-heteroatom bonds in modern synthetic chemistry. The most challenging task in these C-H borylation reactions is controlling the site selectivity. However, because of the huge efforts of many pioneering research groups, the selectivity problem has now outreached a notable level for both the proximal and distal C-H bond borylation reactions. The work complied in this thesis mainly aims to deliberate and summarize the different strategies and findings related to the invention of the directed proximal *ortho*, distal *meta*/*para*, aliphatic (racemic and enantioselective) borylation reactions.

This thesis is divided into four chapter.

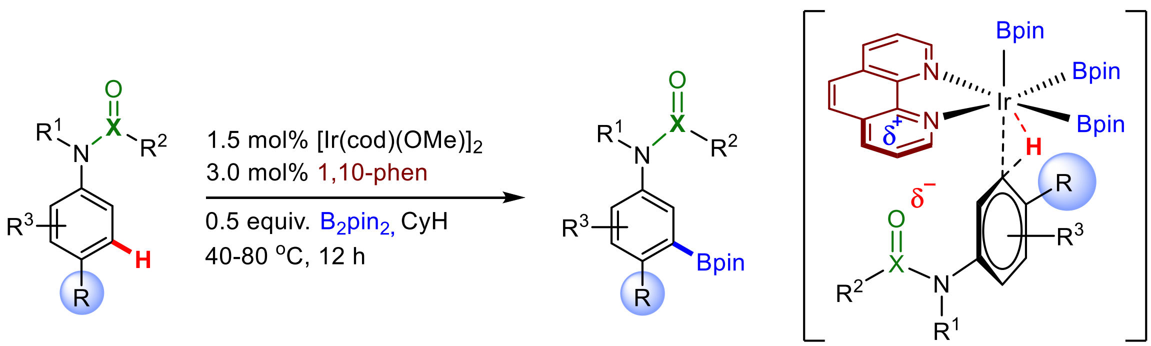
Chapter 1 highlights seminal advances in iridium-catalyzed *ortho*, *meta* and *para*-C-H borylation as well as C(sp^3)-H borylation reaction. Numerous elegant C-H borylation strategies are deliberated including pioneering examples of catalytic C-H borylation, reaction scopes, limitations and its mechanism, directed and noncovalent interaction assisted proximal and distal C-H bond borylation reactions. Beside these, some important application of boron containing molecules towards the synthesis of natural products, therapeutics, and applications in materials chemistry also discussed in this chapter.

Chapter 2 demonstrates a double-fold *ortho* C−H borylation of BINOL derivatives. The proposed mechanisms for *ortho* C−H activation and borylation processes involved an electrostatic interaction. The borylating agent B_2eg_2 (eg = ethylene glycolate) directs the C-H activation at *ortho* positions. The borylation protocol was combined with Suzuki

arylation as a one-pot method for the rapid synthesis of 3,3' diarylbinol derivatives with retention of chirality.

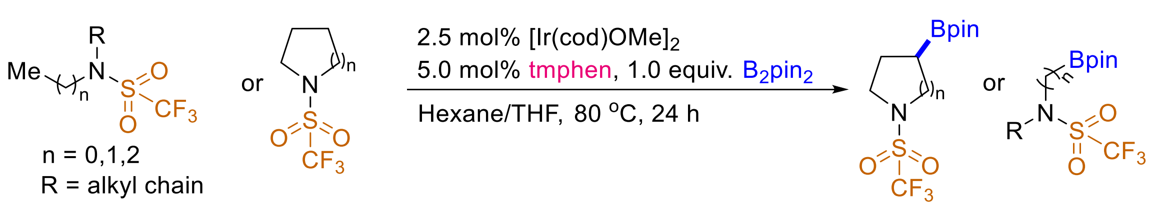


Chapter 3 describes an electrostatically directed *meta* borylation of sterically biased and unbiased substrates. An electrostatic interaction between the partially positive and negative charges between the ligand and substrate controls the *meta*-selectivity of this borylation process. With this protocol, it has been demonstrated that a broad number of challenging substrates, especially 4-substituted arenes can selectively be borylated at the *meta* position.



A variety of unsubstituted substrates displayed excellent *meta* selectivity, especially four substituted substrates, can selectively borylated at the *meta* position. The employment of bench-stable ligand, milder temperature, makes this borylation method more useful in organic synthesis.

Chapter 4 explains C(sp^3)-H borylation of the *N*-protected alkylamines. In this method, a bench stable 3,4,7,8-tetramethylphenanthroline ligand is used for borylation at moderate



reaction temperature. Long chain as well as cyclic substrates are well compatible under these borylation reaction. This C(sp^3)-H borylation strategy will be useful for the synthesis of various alkylboron reagents and would be widely used in pharmaceutical industries, natural product synthesis and drug discovery.

In the last, fifth chapter explains the summary of all the work.