INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **“Designing Bifunctional Mn(I) and Mn(II)-Complexes to Control Selectivity in De(hydrogenative) Transformations”**

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SHORT ABSTRACT

This doctoral thesis, entitled **"Designing Bifunctional Mn(I) and Mn(II) Complexes for Selective De(hydrogenative) Transformations,"** is comprised of six chapters. The chapter’s present findings derived from both experimental and theoretical investigations undertaken throughout the Ph.D. program.

Chapter 1, provides a comprehensive overview of the development of control de(hydrogenative) transformations and de(hydrogenative) multicomponent reactions (MCRs) catalysed by transition metals, with lignocellulose biomass-derived alcohols serving as a key coupling partner.

Chapter 2 describes the alkenylation of fluorene and indene carbocycles using an NNS-Mn(I) complex catalyst. Notably, this catalyst can also be employed for the alkylation of fluorenes under controlled reaction conditions. A broad range of alcohols, including benzylic, heteroaryl, and aliphatic alcohols, are compatible with this method, leading to the efficient formation of both alkenylated and alkylated carbocycles. To elucidate the reaction mechanism, a series of control experiments and kinetic studies were undertaken. These investigations strongly suggest that the reaction proceeds through the dehydrogenation of the alcohol followed by a base-mediated condensation, leading to the alkenylated product. Subsequent transfer hydrogenation of the alkene furnishes the alkylated product.

Chapter 3 details a novel approach for the selective synthesis of both C-3 alkylated indoles and bisindolylmethanes from identical starting materials. This strategy achieves selectivity by controlling reaction parameters to switch between acceptorless dehydrogenation and borrowing hydrogen catalysis.

Notably, the process utilizes a phosphine-free manganese(I) complex, a readily available, earth-abundant, and nontoxic metal catalyst. The protocol demonstrates broad substrate compatibility, enabling the synthesis of various pharmaceutically relevant molecules in good to excellent yields. Furthermore, the reaction facilitates a one-pot synthesis and functionalization of indoles from readily available 2-aminoaryl ethanols and alcohols. However, the reaction's success hinges on the presence of a free NH group on the indole substrates.

Chapter 4 demonstrates the synthesis and functionalization of a novel Mn-complex derived from an NNN ligand. This complex is subsequently employed as a catalyst in the sequential dehydrogenative multicomponent synthesis of poly-substituted quinolines. The reaction sequence involves a borrowing hydrogen mediated C-alkylation of methyl aryl ketones with various alcohols, followed by dehydrogenative annulation with 2-amino benzyl alcohols. Notably, the protocol demonstrates broad alcohol compatibility, successfully utilizing not only activated alcohols but also a range of aliphatic alcohols to construct diverse quinoline derivatives. Interestingly, the synthesized quinolines bearing a methylene group at the C-3 position can be readily converted into structurally valuable azafluorenes via a two-step process. This transformation involves direct C-H hydroxylation followed by acid-catalyzed Friedel-Crafts annulation. To elucidate the reaction mechanism and the role of the catalyst in this reaction sequence, detailed organometallic and catalytic experiments were conducted.

Chapter 5 explores BH-mediated alkylation of sterically hindered α-branched carbonyl compounds with long-chain aliphatic alcohols. While the literature predominantly reports BH-mediated alkylation of such compounds with methanol, long-chain aliphatic alcohols are typically less suitable substrates. This is because steric hindrance from bulky electrophiles destabilizes the intermediate aldol adduct, promoting the retro-aldol pathway. Conversely, formaldehyde's small size and high reactivity favor aldol adduct formation. This chapter addresses this challenge by introducing four novel Mn(I) complexes featuring sterically less-hindered, bifunctional active sites. These catalysts exhibit efficient de(hydrogenative) properties while the less hindered environment facilitates the aldol step even for bulky substrates. The developed protocol enables chemoselective functionalization of α-branched ketones with various long-chain aliphatic alcohols, naturally occurring aliphatic alkenyl alcohols, and terpinols. This approach provides access to distally unsaturated branched ketones, which can be further diversified through various post-synthetic modifications.

Chapter 6 describes the synthesis of four novel Mn(II) complexes to investigate their catalytic activity in de(hydrogenative) transformations. The research explores the reactivity of these complexes towards the functionalization of methyl heteroarenes with a variety of alcohols. The established protocol enables the selective synthesis of a diverse range of functionalized *E*-heteroarenes and C-alkylated heteroarenes in good to exceptional yields. This method facilitates the successful synthesis of numerous medicinally and synthetically valuable compounds. Kinetic and control studies identified the cleavage of the *α*-C-H bond in the alcohol as the rate-limiting step in the reaction.