Abstract

This thesis presents an innovative approach to address these challenges by developing a range of chiral scaffold structures anchored onto silica-based supports. These chiral scaffolds, including *L*-Proline, *S*-BINOL, Salen, and Thiourea, were synthesized and characterized extensively, utilizing various physicochemical techniques. These techniques provided invaluable insights into the structural and chemical properties of the catalysts. The primary objective of this research was to assess the catalytic performance of the synthesized catalysts in industrially significant organic transformations, including asymmetric aldol, asymmetric hydrogenation, Biginelli coupling, chiral β-aminoketones synthesis and Strecker reactions. Parameters such as catalyst loading, reaction time, and temperature were optimized to enhance catalytic efficiency, resulting in improved yields and selectivity. Importantly, the organic products generated in these reactions have a crucial role in pharmaceutical intermediate synthesis, contributing significantly to the production of valuable drugs and advancements in the field of medicine and healthcare. This research covers the way for more sustainable and environmentally friendly practices in the field of heterogeneous catalysis.

In concluding remarks, the thesis comprises seven chapters, which are outlined as follows:

1) Provides a foundational introduction to the field of asymmetric catalysts in Chapter 1. It outlines the historical context, fundamental aspects, and the current state of these catalysts, emphasizing their types, advantages, disadvantages, and their applications in industrial contexts. It also delves into the heterogenization of homogeneous catalysts using solid supports, with a specific focus on silica-based supports.

2) In Chapter 2 presents a pioneering approach for synthesizing L-proline chiral scaffolds tethered onto silica, *L*-proline-(3°amine)-*f*-SiO_2, without the use of protecting/deprotecting groups. The chapter includes the characterization of the catalyst through various physicochemical techniques and highlights its exceptional performance in promoting an asymmetric aldol reaction under ambient conditions, along with remarkable recyclability.

3) In Chapter 3 shown the development of a greener protocol for a Cu(II)-salen complex encapsulated in an MWW-framework for asymmetric synthesis of 3,4-dihydropyrimidin-2-(1*H*)-

one (DHPMs) derivatives. The structural properties are confirmed through various techniques, and the chapter explores the catalyst's efficiency, reusability, and examination of derivatives.

4) In Chapter 4 introduces a novel approach for immobilizing the (*S*)-1,1-Bi-2-naphthol ligand (BINOL) on amine-functionalized mesoporous silica nanoparticles (MSNs), forming Ru-BINOL-AP@MSNs. The chapter includes extensive characterization of the catalyst and demonstrates its effectiveness in asymmetric transformations of chiral alcohols, specifically in asymmetric hydrogenation, with high enantioselectivity and recyclability.

5) In Chapter 5 discusses the synthesis of a Zn(II)-Salen ligand encapsulated in an MWW host, Zn(II)-Salen@MWW, as a heterogeneous chiral catalyst. The chapter examines the catalyst's character through various techniques and highlights its ability to generate chiral β-amino carbonyl compounds under green, solvent-free conditions, with several runs of reusability.

6) In Chapter 6 present the fabrication of a composite material, MMT-silica-GO, encapsulated with a chiral thiourea-based moiety (CTU). Characterization techniques are used to verify the composite material, and its catalytic performance is evaluated for the Strecker reaction, including the recyclability of the catalyst.

7) In Chapter 7 provides a comprehensive summary of the research, highlighting key findings and outcomes from the systematic investigation of chiral catalysts. It concludes by discussing potential future research directions in related areas, offering insights into the possibilities for further exploration.