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Thesis Outline

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Zeolites, especially MWW zeolite, are increasingly recognized for their potential in catalytic applications due to their distinctive properties and adjustable characteristics. This summary presents key findings from two chapters of a comprehensive study on zeolite-based catalysts, showcasing their potential in chemical transformations.

Chapter 2 focused on synthesizing and characterizing titanosilicate zeolites with varying structures and pore sizes for the liquid-phase ammoximation of cyclohexanone. The Ti-MWW sample exhibited superior reaction performance in a semi-batch reactor compared to other zeolites tested. Surface modification was then introduced to enhance the catalytic lifetime of Ti-MWW, improving its performance by facilitating better adsorption of H_2O_2 onto active sites, resulting in faster formation of Ti-OOH species compared to the pristine sample. These findings highlight the benefits of surface modification in optimizing the performance of Ti-MWW for the ammoximation reaction, contributing to green and sustainable chemistry advancements.

Chapter 3 investigated the influence of charge balance cations (Na^+ and H^+) in Pd/MCM-22 (MWW) zeolite catalysts on CO_2 activation. Including Na^+ ions enhanced the physiochemical adsorption of CO_2 but negatively affected catalytic performance by forming stable attractions with carbonate and bicarbonate species, hindering the conversion of intermediates into formate, methanol, and water. *In-situ* DRIFT analysis showed that CO_2 activation primarily occurred around the Al sites of MCM-22 zeolite, along with the reduction sites provided by Pd particles, following the formate pathway. This research deepened the understanding of zeolite catalysts' role in CO_2 activation and their potential in CO_2 capture and reduction at low temperatures, supporting sustainable and eco-friendly processes.

In summary, both chapters underscore the significant potential of zeolite-based catalysts in diverse chemical reactions. Chapter 2 highlights the advantages of employing MWW-structured zeolites for the ammoximation of cyclohexanone and the effectiveness of surface modification in enhancing catalytic lifetime. Chapter 3 emphasizes the importance of charge balance cations in Pd/MCM-22 (MWW) zeolite catalysts for CO_2 activation, showcasing their potential in CO_2 capture and reduction. These studies provide valuable insights into designing and optimizing zeolite catalysts for specific reactions, demonstrating their potential in various applications as catalysts, adsorbents, and supports.

MWW zeolite offers several inherent advantages that make it promising for catalytic applications. Its large pore structure, exceptional thermal and chemical stability, size and shape selectivity, tunable acid sites, and versatility in liquid-phase and gas-phase environments make it a valuable catalyst. Additionally, its potential to promote green and sustainable chemistry and its ability to exhibit extended catalytic lifetimes with appropriate modifications further enhance its attractiveness for industrial and environmental applications.