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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Zeolites, particularly MWW zeolite, have emerged as promising materials for various catalytic applications due to their unique properties and tunable characteristics. This summary highlights key findings from two chapters of a comprehensive study focused on zeolite-based catalysts and their potential in chemical transformations.

Chapter 2 delved into synthesizing and characterizing titanosilicate zeolites with different structures and pore sizes for the liquid-phase ammoximation of cyclohexanone. Among the zeolites tested, the Ti-MWW sample demonstrated superior reaction performance in the semi-batch reactor. To further enhance the catalytic lifetime of Ti-MWW, the silica nanosphere (SNS) was introduced, successfully extending the catalyst's lifespan and improving its performance. The SNS modification facilitated better adsorption of H_2O_2 onto active sites, resulting in faster formation of TiOOH species when compared to the pristine sample. These findings emphasized the potential benefits of SNS modification in optimizing the overall performance of Ti-MWW for the ammoximation reaction, thereby contributing to advancements in green and sustainable chemistry.

In Chapter 3, the focus shifted to investigating the impact of charge balance cations (Na^+ and H^+) in Pd/MCM-22 (MWW) zeolite catalysts on CO_2 activation. The inclusion of Na^+ ions significantly enhanced the physiochemical adsorption of CO_2 but had a negative effect on the catalytic performance. The Na^+ ions formed stable attractions with carbonate and bicarbonate species during gas-phase reactions, particularly at temperatures below 250°C, hindering the conversion of intermediates into formate, methanol, and water. In-situ DRIFT analysis provided valuable evidence that CO_2 activation primarily occurred around the Al sites of MCM-22 zeolite, alongside the reduction sites provided by Pd particles. The reaction followed the formate pathway, with CO_2 adsorbed as carbonate species and subsequently reduced to formate, methanol, and related products. This investigation deepened our understanding of zeolite catalysts' role in CO2 activation and their potential in CO_2 capture and reduction at low temperatures, contributing to the development of sustainable and eco-friendly processes.

In summary, both chapters underscore the immense potential of zeolite-based catalysts in diverse chemical reactions. Chapter 2 highlights the use of Ti-MWW zeolites for the ammoximation of cyclohexanone, emphasizing the advantages of employing MWWstructured zeolites for this reaction and the effectiveness of SNS modification in enhancing catalytic lifetime. Chapter 3 sheds light on the significance of charge balance cations in Pd/MCM-22 (MWW) zeolite catalysts for CO_2 activation, elucidating their potential in CO_2 capture and reduction. These studies provide invaluable insights into designing and optimizing zeolite catalysts for specific reactions and demonstrate their potential in various applications as catalysts, adsorbents, and supports.

MWW zeolite, in particular, boasts several inherent advantages that make it a promising material for catalytic applications. Firstly, its large pore structure, comprising a well-defined supercage and external 12 MR pocket, renders it ideal for catalyzing reactions involving large molecules or bulky substrates. MWW zeolite exhibits exceptional thermal and chemical stability, making it well-suited to withstand harsh reaction conditions, including high temperatures and corrosive environments. Additionally, the pore structure of MWW zeolite facilitates size and shape selectivity in catalytic reactions, allowing it to act as a molecular sieve that selectively accommodates specific reactants and products. Furthermore, MWW zeolite can be tailored to possess different types and densities of acid sites, thereby providing control over catalytic activity and selectivity in various chemical transformations. This tunability translates to MWW zeolite's versatility as a catalyst in diverse reactions in liquid-phase and gas-phase environments. Its potential as a support for active metals further enhances catalytic performance by providing a confined environment on the crystal exterior that allows for efficient metal dispersion and stabilization. One of the most compelling aspects of MWW zeolite is its potential to promote green and sustainable chemistry. The zeolite has demonstrated effectiveness in environmentally friendly processes, such as ammoximation and CO_2 activation, contributing to a reduction in environmental impact. Moreover, MWW zeolite can exhibit extended catalytic lifetimes with appropriate modifications and optimization, thereby minimizing catalyst deactivation and increasing process efficiency.

In conclusion, the unique properties of MWW zeolite offer plenty of benefits that make it an attractive and promising catalyst for a wide range of industrial and environmental applications. Its large pore structure, stability, selectivity, tunable acid sites, versatility, and support for active metals have all been thoroughly researched and proven to enhance catalytic processes and facilitate green chemistry initiatives. These advances in zeolite-based catalysts hold great promise for fostering sustainable and efficient chemical transformations.