Monomolecular Catalytic Cracking of n-Butane on HZSM-5 and HY Nanozeolites

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ABSTRACT

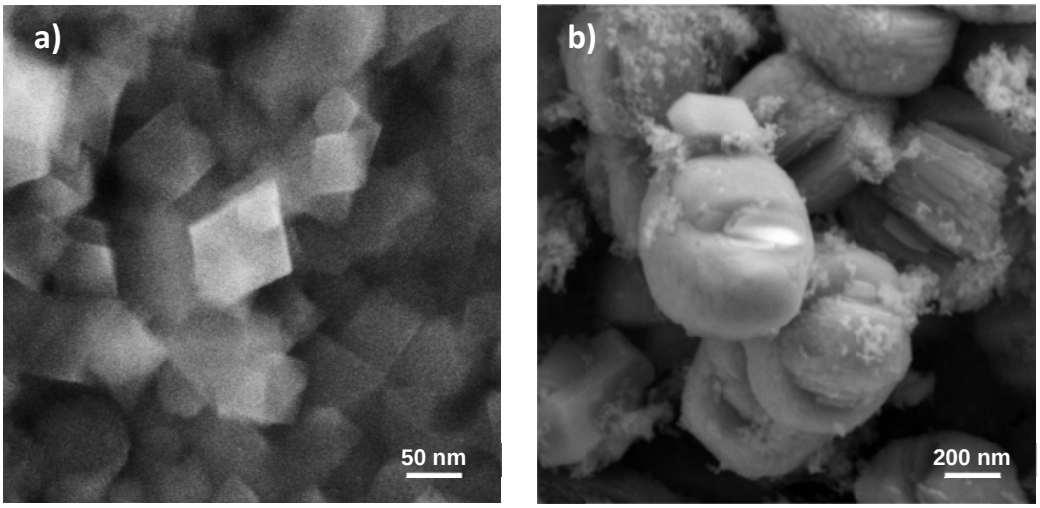

Figure 1: SEM images of Nanozeolite HY (a) and HZSM-5 (b).

Catalytic cracking of hydrocarbons is one of the most important and profitable processes in the petroleum refining industry with a major impact on production of petrochemicals. Increased demand of light and middle distillates has led to the development of nanosized zeolites, or *nanozeolites*. Compared to conventional micro-sized zeolites, nanozeolites offer a higher ratio of outer to internal surface, a higher amount of exposed active sites and lower diffusional resistance that can effectively prevent deeper cracking. Nanozeolites appear highly promising for modern refining processes, yet several matters require investigation, including selectivity, reaction kinetics and thermal stability.

The aim of this study is to evaluate and compare the catalytic behavior between micro- and nano-sized zeolite catalysts on cracking of n-butane. Two types of traditionally used zeolites were selected, specifically HZSM-5 and HY. Commercially available zeolites were used for the microsized specimens, while nanozeolites were developed in-house, shown in Figure 1. Between the two main catalytic routes known for cracking (shown in Figure 2), focus has been given on monomolecular cracking. Beside the fact that it allows for absolute control over the products, (methane, ethane, ethylene and propylene – which are of high importance for the oil and petrochemicals industry), monomolecular cracking allows for the accurate observation of secondary phenomena related to diffusion resistance, thermal stability and other. As butane is not considered to be a hydride donor, it inhibits the bimolecular mechanism and deactivation process, further supporting the monomolecular route that allows for complete mapping of catalyst behavior.

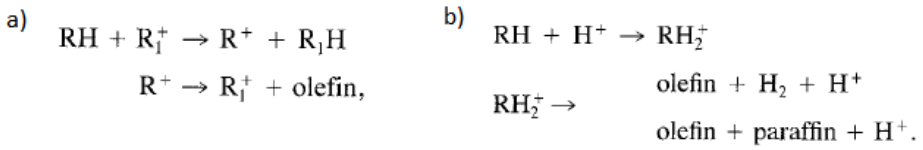

Figure 2: The classic (a) and the monomolecular (b) cracking mechanism.

Following extensive testing, reaction data have been collected on the monomolecular cracking of n-butane on nano- and micro- zeolites HZSM-5 and HY, including reaction rates and constants, intrinsic activation energies and deactivation. Nanozeolite specimens exhibit highly encouraging catalytic behavior for both zeolite types, attributed mostly to low diffusion resistance.