Inorganic Materials & catalysis

Research Project – Emiel Hensen / Nikolay Kosinov / Anna Liutkova

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Advanced catalytic testing of zeolite materials in hydrocarbon conversion reactions

Background

Sustainable production of fuels, light olefins and other hydrocarbons should be based on alternative carbon sources such as biomass or CO_2. Following this concept, methanol (that can be produced from CO_2) and biomass-derived furanic substrates are promising building blocks. Methanol-to-hydrocarbons (MTH) and furanics-to-aromatics (FTA) processes over zeolite catalysts are the key steps in these investigations. Several unsolved challenges, such as rapid catalyst deactivation by coking and suboptimal selectivity to high-value products (e.g. propylene and aromatics), are still present in the field. However, developing efficient catalysts for the MTH and FTA processes implies understanding the structure-activity relationships and the reaction mechanisms.[1]

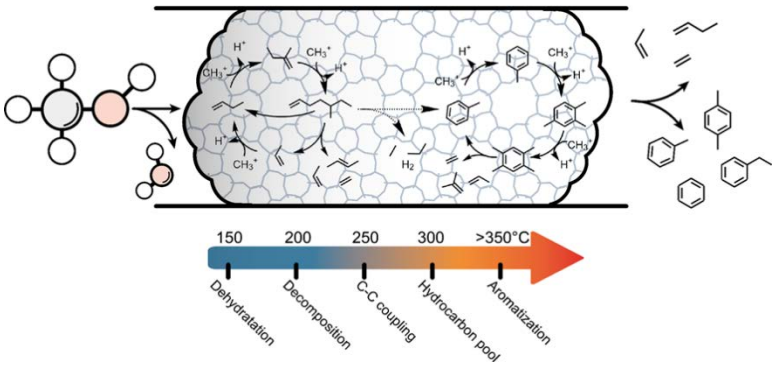

Figure 1. Schematic representation of dual cycle mechanism of MTH reaction.

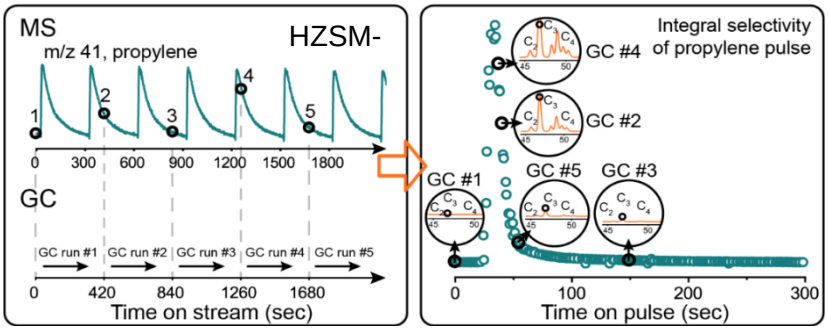

Figure 2. The process of obtaining and analyzing the SP-GC data exemplified by propylene formation from MTH reaction.

Based on idea of the pulse study [2] we have recently developed an advanced catalytic testing method for probing of the MTH reaction mechanism (Fig. 1) and thus understanding of the origin of reaction selectivity. The method comprises enhanced resolution of gas chromatography by supplying transient pulses of the reactant. With the aid of this method we continue unravelling mechanistic pathways for the conversion of furanic-based substrates over various zeolite-based catalysts. This novel approach allows us to extract the essential information such as retention time of products, kinetics and adjust selectivity toward high-valuable products reducing the time of experiment significantly. The overview of the Scanning Pulse Gas Chromatography (SP-GC) technique is represented by Fig. 2. The project will involve synthesis, advanced characterization (FTIR, NMR, XRD, XPS) and SP-GC testing of zeolite-based catalysts.

Techniques used:

Catalytic testing setup equipped with GC and MS; SS MAS NMR; FTIR; TGA; Ar physisorption; ICP; XPS; XRD

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[1] U. Olsbye *et al. Angew. Chemie Int. Ed.*, vol. 51, no. 24, pp. 5810–5831, 2012.
[2] N. Kosinov *et al. Angew. Chem. Int. Ed. Engl.*, vol. 55, no. 48, p. 15086—15090, 2016.