Structure sensitivity in Fischer-Tropsch-Synthesis

The Fischer-Tropsch-Synthesis (FTS) is a polymerization reaction developed in the early 1920s in order to convert synthesis gas (CO/H₂), derived from coal, natural gas, or biomass, into long chain hydrocarbons. Due to the depletion of oil resources, FTS has become an important technology to convert the more abundant natural gas supplies into clean gasoline, diesel fuels, and other useful hydrocarbons such as waxes. It is easily catalyzed by group 8 transition metals such as cobalt, iron, and ruthenium, although due to cost and availability, only the former two are used for industrial purposes.

The structural properties like size and shape of catalyst particles may have a tremendous influence on the overall performance of the catalyst. Those so called structure-activity relationships are of great interest as an understanding of these relations enables an intelligent design of improved catalysts.

It was clearly shown for cobalt that the activity decreases with decreasing particle size which was related to a lower stability/number of the active sites on small particles [1]. The active sites can be probed by the scrambling reaction of a C¹²O¹⁶/C¹³O¹⁸ gas mixture. The extent of isotope exchange is directly related to the reactivity for CO dissociation which is assumed to be the initial step in FTS. This is supplemented by an extensive activity and selectivity study in a reactor setup under industrially relevant conditions.

The structure of an active catalyst may change during the reaction under industrially relevant conditions which in practice means often a loss of catalytic activity. This is also seen in the case of FTS showing a strong deactivation in the beginning of the reaction, leveling off after some time on stream, indicating massive surface reconstructions. In order to investigate this effect via scrambling, the existing setup has to be modified for higher pressures.

Possible projects may contain:

- Synthesis and characterization of cobalt and ruthenium catalysts on different supports (CNF, TiO₂)
- Evaluation of the catalytic activity under realistic process conditions
- Systematic study of promoter effects on activity, selectivity and deactivation behavior
- C¹²O¹⁶/C¹³O¹⁸ and H₂/D₂ scrambling
- Extension of existing scrambling setup

For further information

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