

Promotor effect on Fe-based catalysts for CO₂-FTS: a XAS study

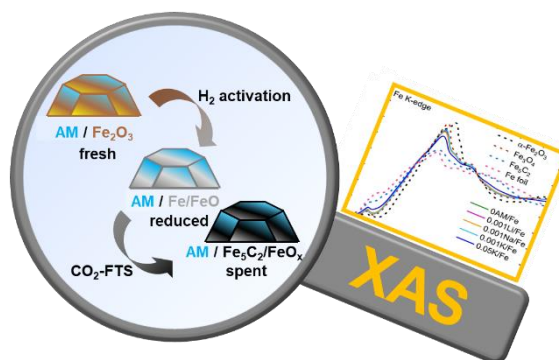
E. Saraçi¹, Q. Yang², E. Fedorova², D. Doronkin¹, E. Kondratenko²

¹Institute for Catalysis Research and Technology (IKFT), Karlsruhe Institute of Technology (KIT), Karlsruhe

²Leibniz Institute for Catalysis e.V. (LIKAT), Rostock

Abstract

Processes that store renewable H₂, from wind and solar power, in energy-dense molecules, like the Fischer-Tropsch synthesis (FTS) are in the core of a successful energy transition.¹ While the classical CO-FTS is more common², the CO₂-FTS that utilizes atmospheric CO₂ and green H₂ is highly desirable and also feasible.³ Fe-based catalysts have the ability to catalyze this reaction and are the most industrially relevant catalysts. Iron carbides, formed *in situ*, are considered the catalytically active species in the CO-FTS.⁴ These catalysts are often modified by alkali metal dopants, which act as electronic and/or structural promoters for improving product selectivity/activity. In addition, these promoters are assumed to enhance catalyst basicity required for CO/CO₂ adsorption and to stabilize iron carbides against oxidants (H₂O and CO₂). However, their function is still under debate and their role remains unclear. Therefore, it is of eminent importance to understand effect of these dopants on the formation of Fe-carbide species during activation and reaction. Therefore, in this collaborative study we used in-situ X-ray absorption spectroscopy (XAS) to identify the structure of alkali-promoted iron catalysts during reduction and under CO₂-FTS reaction conditions⁵. Insights on its reducibility and carbide formation aid the knowledge-based optimization of FTS catalysts as well as other catalytic processes where alkali promoters are used.



Scheme 1. XAS study of alkali metal (AM) promoted Fe-based catalyst in fresh, reduced and spent state.

References

1. G. Prieto, ChemSusChem, **2017**, 10, 1056.
2. M. Loewert, M. A. Serrer, T. Carambia, M. Stehle, A. Zimina, K. F. Kalz, H. Lichtenberg, E. Saraci, P. Pfeifer, J. D. Grunwaldt, React Chem Eng, **2020**, 5.
3. E. V. Kondratenko, G. Mul, J. Baltrusaitis, G. O. Larrazábal, J. Pérez-Ramírez, En. Env. Sci., **2013**, 6, 3112.
4. M. Albrecht, U. Rodemerck, M. Schneider, M. Bröring, D. Baabe, E. V. Kondratenko, Appl. Catal., **2017**, 204, 119.
5. Q. X. Yang, V. A. Kondratenko, S. A. Petrov, D. E. Doronkin, E. Saraci, H. Lund, A. Arinchtin, R. Kraehnert, A. S. Skrypnik, A. A. Matvienko, E. V. Kondratenko, Angew Chem Int Edit, **2022**, e202116517.