Contribution ID: **91** Type: **Invited/plenary talk**

PLENARY (online): Spectroscopy of a Co(0001) model catalyst during Fischer-Tropsch synthesis (Chair Hendrik Bluhm)

Wednesday, 7 December 2022 08:30 (50 minutes)

To produce clean transportation fuels without emission of CO2, a possible route is the synthesis of hydrocarbons from CO and H2 via the Fischer-Tropsch process [1]. In the industrial process, cobalt is the catalyst of choice [2-5]. Although this process has been investigated intensively, open questions still remain. Examples are the oxidation state of cobalt during the actual chemical reaction, and the coverages of reactants, products, and possible impurities on the surface of the catalyst. Near-ambient-pressure X-ray photoelectron spectroscopy (NAP-XPS) is an excellent method to try to answer these two questions.
In this talk, I will present the results we obtained using NAP-XPS during the Fischer-Tropsch synthesis reaction on the Co(0001) model catalyst surface. I will show that the oxidation behavior of cobalt depends on the structure of the sample, the water partial pressure, and the H2-to-CO ratio. We found that CO is more effective than H2 to reduce cobalt. This behavior can be explained by the different adsorption and dissociation sites of H2, CO, and H2O on Co(0001).
Furthermore, I will discuss the role of adsorbates on the surface. We found that at least 70% of carbon present on Co(0001) during Fischer-Tropsch synthesis is in carbidic form. We can also distinguish two different hydrocarbon peaks, one resulting from hydrocarbon impurities in the CO gas feed, and one being the product of the chemical reaction.

[1] F. Fischer and H. Tropsch. The Synthesis of Petroleum at Atmospheric Pressures from Gasification Products of Coal. Brennstoff-Chemie 7 (1926), 97-104.
[2] J. van de Loosdrecht, B Balzhinimaev, J. A. Dalmon, J W Niemantsverdriet, S. V. Tsybulya, A. M. Saib, P. J. van Berge, and J. L. Visagie. Cobalt Fischer-Tropsch synthesis: Deactivation by oxidation? Catalysis Today 123 (2007), 293-302.
[3] A. M. Saib, D. J. Moodley, I. M. Ciobîca, M. M. Hauman, B. H. Sigwebela, C. J. Weststrate, J. W. Niemantsverdriet, and J. Van De Loosdrecht. Fundamental understanding of deactivation and regeneration of cobalt Fischer-Tropsch synthesis catalysts. Catalysis Today 154 (2010), 271-282.
[4] Korneel H. Cats, Ines D. Gonzalez-Jimenez, Yijin Liu, Johanna Nelson, Douglas van Campen, Florian Meirer, Ad M.J. Van der Eerden, Frank M.F. de Groot, Joy C. Andrews, and Bert M. Weckhuysen. X-ray nanoscopy of cobalt Fischer-Tropsch catalysts at work. Chemical Communications 49 (2013), 4622-4624.
[5] P. J. Van Berge, J. Van De Loosdrecht, S. Barradas, and A. M. Van Der Kraan. Oxidation of cobalt-based Fischer-Tropsch catalysts as a deactivation mechanism. Catalysis Today 58 (2000), 321-334.

if "Other", please specify:

I apply for a travel grant

No

Primary author: GROOT, Irene (Leiden Institute of Chemistry)

Presenter: GROOT, Irene (Leiden Institute of Chemistry)

Track Classification: Surface science/chemistry