École polytechnique fédérale de Lausanne (EPFL) Valais/Wallis
Institute of Chemical Sciences and Engineering (ISIC)
Basic Science Faculty (SB)
Energypolis, Rue de l'Industrie 17, CH-1950 Sion, Switzerland

EPFL Valais/Wallis SEMINAR

13. 3. 2020, 11:00 - 12:00, EPFL Valais/Wallis in Sion, 4th floor, Zeuzier Room

Hydride Surfaces for Catalysis

Emanuel BILLETER

Empa – Swiss Federal Laboratories for Material Science and Technology
Überlandstrasse 129, CH-8600 Dübendorf

Because of its relevance in catalysis, the interaction of hydrogen with metallic surfaces is generally well studied. However, knowledge on surface properties is limited when it comes to the class of metals, which form hydrides, such as titanium. Hydride surfaces have peculiar properties for their application as heterogeneous hydrogenation catalysts, e.g., they may have even less hydrogen on the surface than their metallic counterparts resulting in lower catalytic yields. I will discuss two archetypal hydrides: CO_2 methanation is catalyzed by various hydride-forming intermetallics because they supply highly reactive atomic hydrogen [1]. In contrast, on palladium surfaces the formation of the hydride PdH_x decreases the reaction rate for the Sabatier reaction [2].
Titanium dihydride TiH_2, though, has been recently shown to catalyze the ammonia synthesis under Haber-Bosch conditions while titanium metal shows no activity [3].
The key to understanding the catalytic properties of hydrides is their electronic structure. The standard electron spectroscopy methods are incompatible with hydrogen pressures needed to form hydrides, therefore these kind of experiments are usually restricted to post-mortem analysis. We have developed a method to hydrogenate thin films in-situ under UHV conditions compatible with electron spectroscopy measurements. The capabilities of this system are demonstrated on the example of Ti/TiH_2 and discussed in relation with the current understanding that hydrogen vacancies play a major role in the activity towards ammonia synthesis.

References:

[1] Kato et al., *Angew. Chem. Int. Ed.*, **55** (2016), 6028
[2] Billeter et al., *ChemPhysChem*, **20** (2019), 1398
[3] Kobayashi et al., *J. Am. Chem. Soc.*, **139** (2017), 18420

Born in Solothurn, Switzerland in 1992, Emanuel Billeter graduated from ETH Zürich with a MSc in Chemistry in 2018. For his master thesis under the supervision of Prof. N. Stadie, he went to Montana State Universtity to work on Phosphorus doped graphitic carbon. In 2018 he joined the Laboratory of Advanced Analytical Technologies at Empa for his PhD Project to work on high-pressure XPS of metal hydrides and their catalytic properties.