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 PhD public defence

18. 3. 2021, 14:00 - 15:00, EPFL Valais/Wallis via Zoom

Zoom link: https://epfl.zoom.us/j/89560176324?pwd=enBOTGE5MEs4cm1Gb3I4QWNLNWtmZz09

Decreasing the Stability of Borohydride with Ionic Liquids for Hydrogen Storage and Carbon Dioxide Conversion

Loris LOMBARDO

LMER, EPFL Valais,
Rue de l'Industrie 17, Sion, Switzerland

The world needs to move from a fossil fuel-based to a renewable energy-based society. With the increasing electricity production from wind and PV, short and long-term energy storage is becoming one of the main challenges of the 21st century. While batteries are the preferred method for short term storage, a different technology is required for seasonal storage. Hydrogen is a valuable energy carrier, owning its high energy density (122 kJ/g). However, compact and safe storage of H_2 is challenging. Complex hydrides are especially attractive for solid-state H_2 storage due to their high gravimetric and volumetric hydrogen density. Sodium borohydride ($NaBH_4$) contains more than 10 mass% of H_2, but high temperatures are needed to release the H_2 (505°C). The work presented in this thesis focused on the combination of borohydride and ionic liquid (IL) cations, in order to modify the stability of borohydride. The materials developed in this thesis are able to release H_2 at moderate temperature (< 100°C), thanks to the charge transfer between the IL cation and borohydride, making them interesting candidates for solid-state H_2 storage.
In addition, I will present the unique reactivity of these IL borohydrides with CO_2. Due to the destabilization of the B-H bond, direct CO_2 capture and reduction can be achieved under ambient conditions. Up to three CO_2 molecules are fixed per borohydride anion, even at low CO_2 concentrations. The obtained reaction product can be easily transform to formic acid (HCOOH), or used as formylation agent in organic synthesis. These results represent a promising path for CO_2 capture and valorisation.

References:

[1] L. Lombardo, H. Yang, A. Züttel, *Materials Today Energy* **2018**, *9*, 391–396.
[2] L. Lombardo, H. Yang, A. Züttel, *Journal of Energy Chemistry* **2019**, *33*, 17–21.
[3] L. Lombardo, H. Yang, K. Zhao, P. J. Dyson, A. Züttel, *ChemSusChem* **2020**, *13*, 2025–2031.
[4] L. Lombardo, Y. Ko, K. Zhao, H. Yang, A. Züttel, *Angewandte Chemie International Edition* **n.d.**, *n/a*, DOI https://doi.org/10.1002/anie.202100447.

Born in 1992, Sion, Switzerland. Loris Lombardo graduated M.S degree in Molecular and Biological Chemistry from Ecole Polytechnique Fédérale de Lausanne (EPFL), in 2017. During this time, he worked in the fields of catalysis for CO_2 reduction, water splitting, and biomass conversion. His research during the PhD is focusedg on complex hydride for hydrogen storage and CO_2 reduction at EPFL, Switzerland in the group of Prof. Andreas Züttel. He defended his PhD thesis on 25. Jan. 2021.