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CANCELLED!!!!!! In-situ Neutron Imaging Study on Ammonia Sorbents for Novel Ammonia Synthesis Routes

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In 2021, the global production of ammonia was estimated at around 200 megatons, which makes ammonia the second-most produced chemical in the world. Among different ammonia synthesis routes, the most prevalent one is the Haber-Bosch process, occurring over the iron catalyst at high pressures (more than 150 bar) and high temperatures (more than 400°C). However, it has been recently demonstrated that with new types of catalysts, ammonia can be synthesized at lower pressures and temperatures, leading to significant reduction in capital and operational expenditures. To unlock the potential of this mild-condition ammonia synthesis, it is necessary to find an alternative to ammonia condensation, which, in the conventional Haber-Bosch process, is used for the cleaning of unreacted hydrogen and nitrogen (recycle gas). The promising solution can be ammonia absorption by metal halides, as these materials can efficiently and selectively remove ammonia down to ppm level, even at elevated temperatures. Within the framework of the ARENHA project (Horizon 2020, No 862482), we develop manganese chloride - silica gel sorbents to promote novel ammonia production paths.
In this work, the manganese chloride –silica gel sorbents were studied using in-situ neutron imaging at the NEUTRA beamline (SINQ, Paul Scherrer Institute, Villigen, Switzerland). Two-dimensional neutron radiography images of the sorbent bed were taken during breakthrough tests, during which a gaseous mixture of ammonia and nitrogen was passed through the bed at controlled flowrate. During the tests, we could observe ammonia uptake and release within the sorbents, thanks to the high neutron scattering cross section of hydrogen. The results of the image analysis are discussed with respect to the homogeneity of the ammonia sorption over the volume of the reactive bed and how it is affected by manganese chloride loading in the sorbents. Changes in the sorbent bed dimensions and sorbent morphology during cycling are also reported.

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