



Hydrazine borane and derivatives for solid state hydrogen storage

Romain Moury^{1, 2*}, Umit B. Demirci¹, Yaroslav Filinchuk³ and Philippe Miele¹

¹*Institut Européen des Membranes, Université de Montpellier 2, Montpellier, 34095, France*

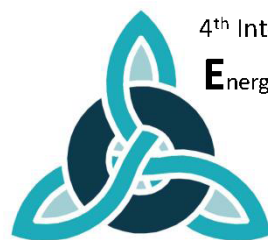
²*Department of Heterogeneous Catalysis, Max-Planck-Institut für Kohlenforschung, Mülheim an der Ruhr, 45470, Germany*

³*Institute of Condensed Matter and Nanosciences, Université Catholique de Louvain, Louvain-la-Neuve, 1348, Belgium*

Accepted for publication on 27th May 2015

Solid state hydrogen storage is one of the main roadblocks to the development of a suitable hydrogen economy. Among the numerous solutions to overcome this problem, boron- nitrogen-based materials have emerged owing to their high gravimetric and volumetric hydrogen contents. A typical example is ammonia-borane (NH_3BH_3 , 19.6wt%H) intensively studied since the early 2000s. A more recent material (2009) envisaged is hydrazine-borane ($\text{N}_2\text{H}_4\text{BH}_3$, 15.3wt%H). Both materials are attractive for hydrogen storage purpose; nevertheless two main drawbacks have been encountered, namely, high temperatures of dehydrogenation (100-200°C) and emission of impurities (borazine, hydrazine, ammonia ...). Consequently, to overcome these issues, several strategies have been proposed. Chemical destabilization of these materials belongs to the solutions. Herein, we present our solutions to chemically destabilize hydrazine-borane leading to the synthesis of two novel materials so-called metal hydrazinidoboranes. In a first part, the description of the synthetic methods, to obtain first hydrazine-borane, with a straightforward and relatively low price synthesis optimization (purity $\geq 99\%$ and yield $\approx 80\%$), followed by the mechano-chemical synthesis of lithium and sodium hydrazinidoboranes ($\text{MN}_2\text{H}_3\text{BH}_3$, $\text{M}=\text{Li}$ 11.6wt%H and $\text{M}=\text{Na}$ 8.8 wt%H), are given. Here also, novel in-situ methods, using PXRD and pressure measurements, to follow the reaction between sodium hydride (NaH) and hydrazine-borane are exposed. Then, the physicochemical characterization of these novel materials are drawn, with crystal structure resolution and refinement of sodium and lithium hydrazinidoboranes, ^{11}B MAS NMR results are exposed and compared as well as FTIR spectrum. We have put forward the metastability of lithium hydrazinidoborane leading to two polymorphs and this aspect is described in details. In a final part, we will discuss about thermal characterization, TGA, DSC, isothermal decomposition as well as in- and ex-situ results. Based on the aforementioned results the dehydrogenation mechanisms and optimization of the performances are discussed.

Keywords: hydrogen storage; hydrazine-borane; crystal structure; in-situ XRD; dehydrogenation



4th International Symposium on
Energy **C**hallenges & **M**echanics
 - working on small scales

11-13 August 2015
 Aberdeen, Scotland, UK

