

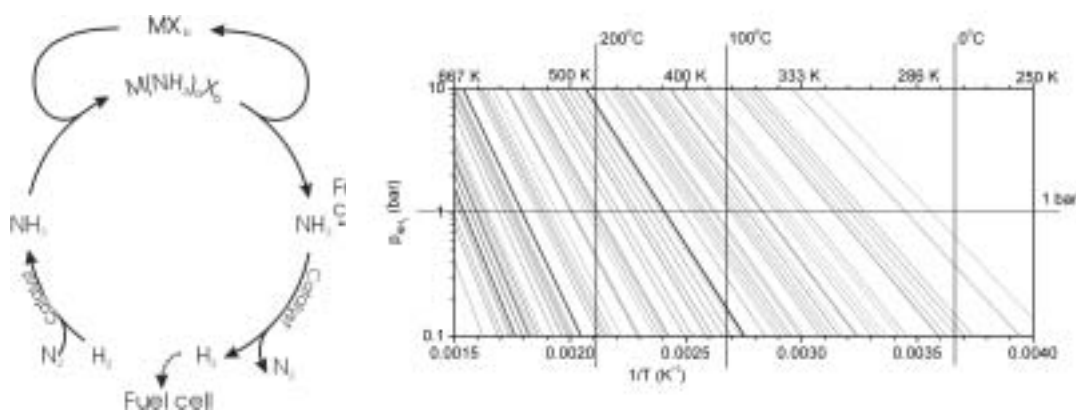
Indirect, Reversible Hydrogen Storage in Metal Ammine Salts: Recent Progress and Prospects

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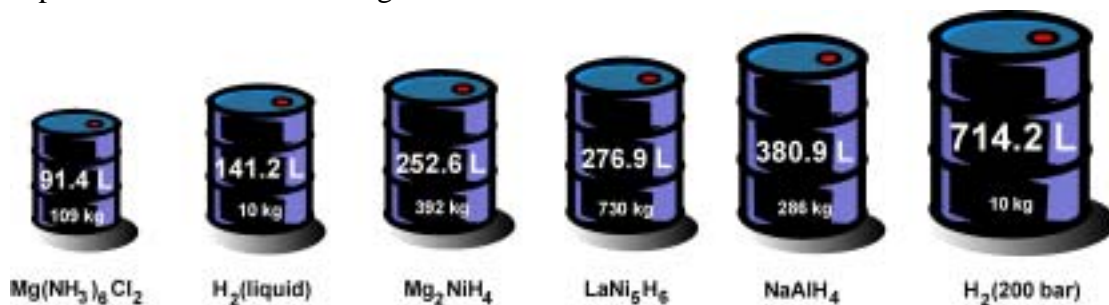
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Many consider the hydrogen economy a possible solution to significant global challenges. The possibilities of improving the efficiency of energy conversion processes and reducing the reliance on fossil fuels are main drivers for the currently increasing research and development efforts but environmental concerns are also gaining importance. Despite the on-going efforts, significant technological breakthroughs are still necessary for making a hydrogen economy viable. The three most important challenges relate to: hydrogen production, hydrogen storage, and hydrogen consumption. In particular, it seems that development of appropriate hydrogen storage and transportation technologies will be a major hurdle. Recently, the use of metal ammine salts as *safe, reversible, high-density* and *low-cost* hydrogen carriers was proposed according to the Figure below. In the presentation, it is shown how this development could provide a platform for using ammonia as a fuel for the hydrogen economy. It appears that in several scenarios, this offers significant new opportunities that should be explored in more detail. To fully elucidate the potential of this new method, we have studied the use of a wide range of ammine salts as potential hydrogen storage materials by a combination of experimental and theoretical methods.



To give an impression of the scope of the chemistry of metal ammines, the Figure above shows van't Hoff plots of over 90 metal ammine halides of the general formula $M(NH_3)_nX_2$. With these materials there are obviously many opportunities for selecting metal ammine salts with the desired ammonia bond strength, i.e. with an appropriate desorption temperature. Moreover, we have found that it is generally

possible to compress the metal ammine salts into very dense tablets that have densities that are more than 95% of the crystal density. Thus, these tablets are essentially compact and that results in very high volumetric hydrogen storage capacities as shown in the Figure below.



Currently, such tablets are produced on the kg-scale and even in these systems the desorption of ammonia is facile. We also show that with micro-fabricated catalytic reactors, it is possible to decompose ammonia to hydrogen at temperature of about 500 K. Interestingly, the metal ammine salts will this year be tested in diesel cars as sources of ammonia for pollution abatement in the SCR of NO and NO₂. This will demonstrate if the system can be easily used in automotive applications.