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Automatic equipment for hydrogen charge-discharge cycling and study of degradation and lifetime of hydrides

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The study and characterization of new materials for use in hydrogen storage includes knowing their performance, stability, aging and/or degradation resulting from charge-discharge cycles. With this objective in mind, our group has developed an automated device whose purpose is to repeatedly undergo hydrogen charging and discharging in order to assess the longevity of the hydride. The equipment was tested with the $LaNi_5$-H system, where a significant degradation is observed over 1500 cycles.

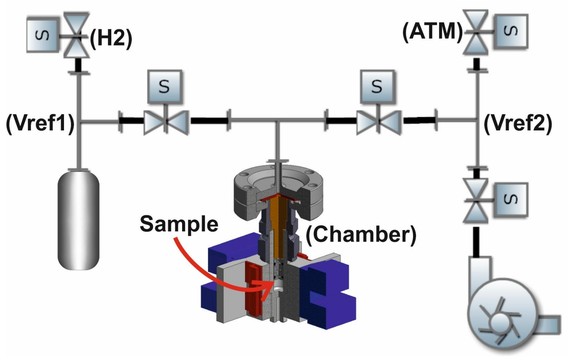
Introduction

The characterization of the hydrogen absorption of new materials for hydrogen storage is typically performed with high accuracy Sieverts-type volumetric devices.

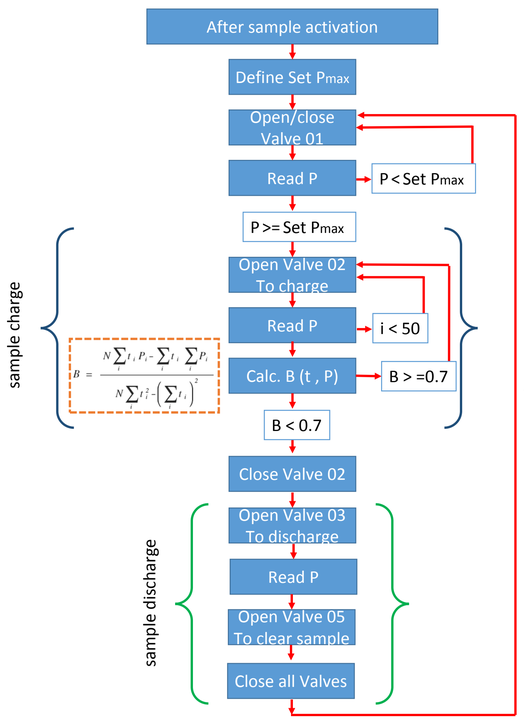
Studying the aging of hydrides requires taking a sample through many hydriding cycles [1], making conventional equipment inefficient for this task [2]. Here we present a dedicated device for the cycling over a significant number of cycles.

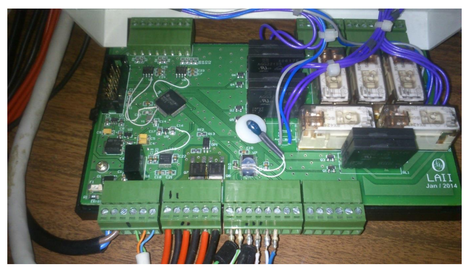
Pressure cycling system

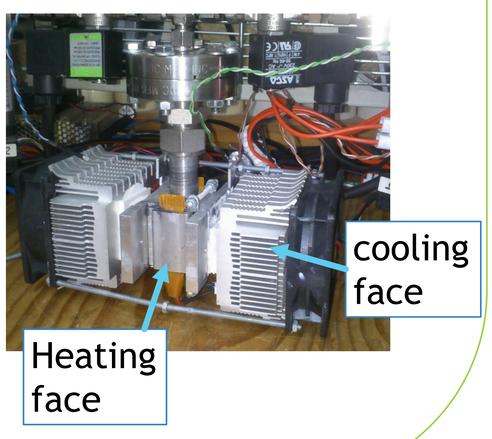
The developed equipment is a volumetric system mounted with purchased elements from Swagelok Ltd, Keller Ltd. pressure transducer, and electrovalves from ASCO Numatics Ltd. The sample chamber is equipped with heating and cooling devices with temperature control in the range from 10ºC to 230ºC. The test material ($LaNi_5$, 99.9%) was purchased from Alfa Aesar.



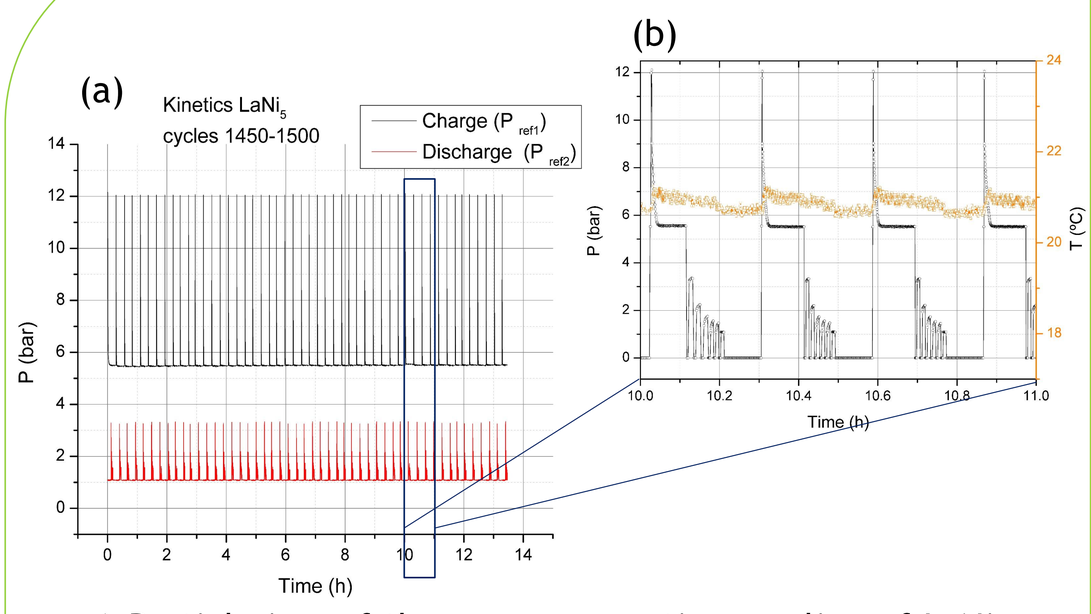
A dedicated control and communication board was developed for the automation of this equipment. The experiment is controlled through a code developed in LabView with a graphical interface, including a PID code for thermal control allowing the study at different temperatures.





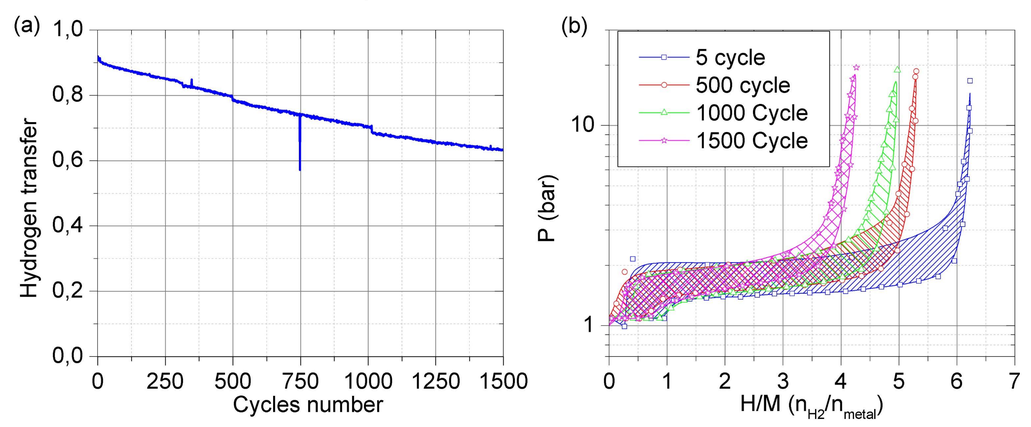


Results

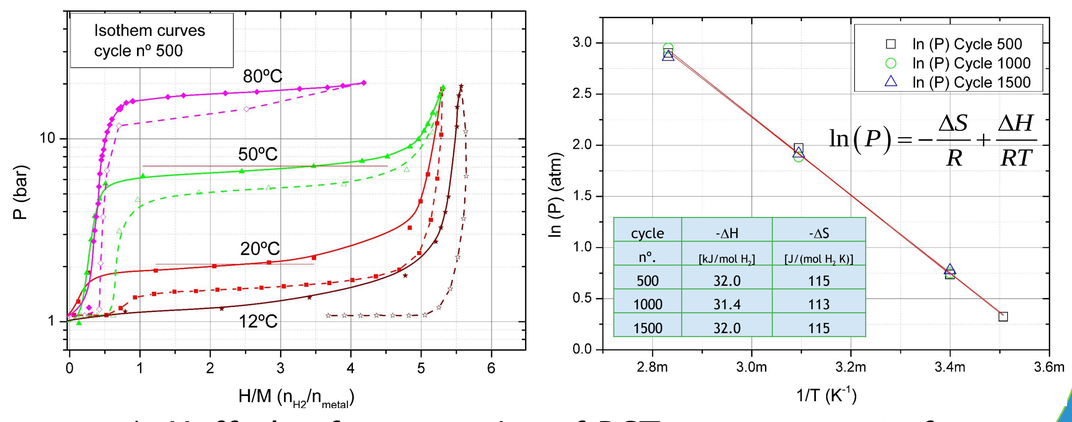


a) Partial view of the pressure vs. time cycling of $LaNi_5$;
b) One hour hydriding/dehydriding cycle.

The shape of the absorption/desorption isotherm curves is also relevant to the degradation of hydriding properties of an intermetallic compound.



The hydrogen capacity loss as function of the number of pressure cycles for $LaNi_5$.



van't Hoff plot from a series of PCT measurements for $LaNi_5$.

Conclusion

The testing equipment was successfully implemented, where we observe a loss of approximately 20% of the absolute capacity for $LaNi_5$-H system with 1500 cycles. For the study of new materials, we can use this equipment to simulate real situations of hydrogen storage tanks.

References

[1] Lambert, S.W., et al. *J. Alloys Compd*, 187, 113 (1992).
[2] G. Meyer, et. al. *Rev. Sci. Instrum*. 78, 023903 (2007).

Acknowledgements

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