

## Sorption properties of the system $\text{NaBH}_4/\text{MgH}_2$ milled with different additives

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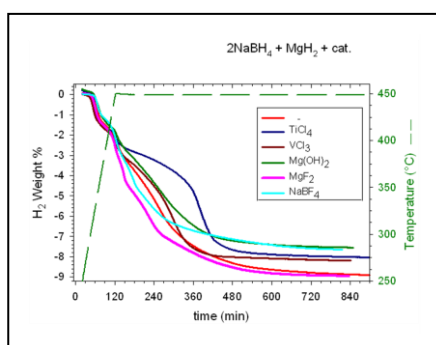
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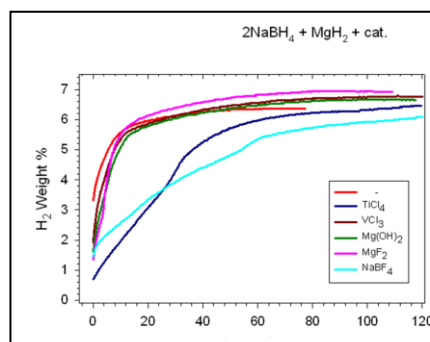
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**Abstract** –In the field of hydrogen storage, particular attention has been paid recently to Reactive Hydride Composites (RHC), where the combination of an alkaline borohydride with a reactive hydride induces a thermodynamic destabilization and a decrease of hydrogen desorption temperature with respect to the component phases. In this work, we focus on the sorption properties of the  $\text{NaBH}_4 - \text{MgH}_2$  system prepared by high energy ball-milling. Although numerous studies have been reported on these functional hydrogen compounds, fast kinetics performance has not been achieved. The effect of different additives on the sorption properties of the system  $\text{NaBH}_4 + \text{MgH}_2$  is presented here.

The aim of this work is to evaluate the influence of different additives on the storage properties of  $\text{NaBH}_4 - \text{MgH}_2$  composites, which up to now have not been extensively explored in literature [1-3]. Mixtures with molar ratio 2:1 with 0.05% mol of different additives were milled under pure Argon atmosphere with a ball to powder ratio of 1:10 and a rotation speed of 875 rpm by means of Spex mill device. The additives tested in this work were:  $\text{TiCl}_4$ ,  $\text{VCl}_3$ ,  $\text{Mg}(\text{OH})_2$ ,  $\text{NaBF}_4$  and  $\text{MgF}_2$ . X-ray powders diffraction analysis shows that milling does not lead to the formation of any new phase, but it reduces the average crystallite size of the powders down to nanometric scale. All the mixtures release an  $\text{H}_2$  amount close to the theoretical value expected for the full dissociation of both hydrides and much higher than the target fixed by the US Department of Energy for on-board application. The thermal programmed desorption profiles of the mixtures clearly show two steps. The first one corresponds to the dissociation of  $\text{MgH}_2$  at a high rate and the second to the gradual dehydrogenation of  $\text{NaBH}_4$  at temperatures close to  $450^\circ\text{C}$ . The best kinetic performance was obtained for the mixture prepared  $\text{MgF}_2$  (Fig.1). In order to check the reversibility of the sample, absorption tests were also performed. Complete absorption was not achieved regardless of the additive used, (Fig.2). X-ray powders diffraction analysis shows that during absorption the formation of the perovskite type-hydrides  $\text{NaMgH}_3$  phase took place. This unexpected product decreases the gravimetric capacity of the system. Moreover a small amount of free Mg was identified. This work clarifies some aspects of the sorption mechanism of the  $\text{NaBH}_4 - \text{MgH}_2$  system and shows the influence of different additives on the kinetic performance.  $\text{MgF}_2$  is the only substance effectively working as a catalyst in the experimental conditions of this study.



**Figure 1:** Desorption profile of the mixture  $2\text{NaBH}_4 + \text{MgH}_2$  milled with different additives.



**Figure 2:** Absorption profile of the mixture  $2\text{NaBH}_4 + \text{MgH}_2$  milled with different additives. All measures were performed at  $450^\circ\text{C}$ .

### References

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