NANOHy

Novel Nano Composites for Hydrogen Storage Applications

Project acronym: NANOHy

EC contract #210092

Theme 5

Energy

Collaborative project

Deliverable 5.3

Report on upscaling of materials

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D 5.3 (M 39)
Report on upscaling of materials

The content of D 5.3. is similar to D 5.2.

Summary

The wet incipient impregnation and melt infiltration techniques have been established and developed for the preparation of the nanocomposites for the NANOHy project. The melting infiltration has been examined to be a technically possible method to meet the requirement of upscaling the composites. The reversible hydride $NaAlH_4$ with a melting point at 181 °C is a suitable complex hydride for the melting procedures. Experimental details are similar to those reported in D 3.4 and D 3.5. The essential difference is that more material has been prepared in a bigger autoclave per batch and that several 100 g of the material could be produced successfully in a few batches only.

The characterization of $NaAlH_4$ nanocomposite has been thoroughly carried out by means of neutron experiments, Raman spectroscopy etc. as reported in D4.2. The investigation of hydrogen storage properties of the nanoconfined $NaAlH_4$ shows significantly changed thermodynamic and improved kinetic properties as reported in D4.1. Therefore, $NaAlH_4$ has been chosen as the complex hydride for the optimised nanocomposite for a laboratory test tank of NANOHy. Activated carbon IRH33 prepared by the Institut de recherche sur l'hydrogène (IRH) at the Université du Québec à Trois-Rivières, Canada, has been selected as the support for the preparation of the optimised nanocomposite because of its extraordinarily large micropore volume.

Experimental details

$NaAlH_4$/carbon nanocomposite

The preparation of the composite has been has been carried out by melting infiltration procedures as described in D3.4.

The as prepared $NaAlH_4$/AC2 nanocomposite has been characterized by X-ray diffraction measurements. The $NaAlH_4$ decomposes according to the following reaction:

$$3\ NaAlH_4 \rightarrow Na_3AlH_6 + 2\ Al + 3\ H_2 \rightarrow 3\ NaH + 3\ Al + 4.5\ H_2$$

The XRD data of the resulting composites $NaAlH_4$/AC2 is shown in Figure. 1. As a general observation, the diffraction data reveals a partly decomposition of the alanate during the melting procedure.

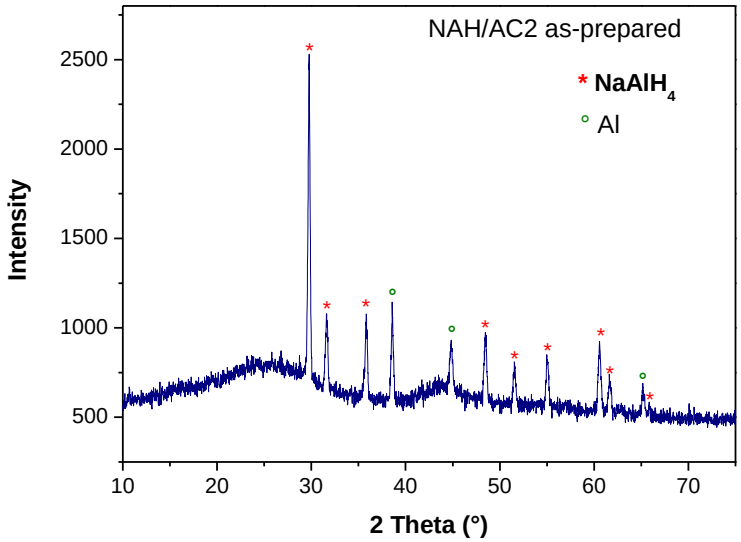

Figure 1. The X-ray diffraction patterns of the $NaAlH_4$/AC2 composite.

The desorption properties of the $NaAlH_4$/AC2 composite has been examined by the thermal volumetric measurement with the Sieverts apparatus. Both $NaAlH_4$/AC2 and $NaAlH_4$/IRH33 nanocomposite were heated at 150 °C under initial H_2 pressure about 0.2 bar for desorption, then rehydrogenated at 125 °C by applying 115 bar of H_2. The amount of desorbed H_2 has been calculated to weight percent as presented in the Figure 2 and Figure 3. By taking the advantage of the large micropore volume of IRH33, the $NaAlH_4$/IRH33 nanocomposite shows the higher hydrogen storage capacity than that of $NaAlH_4$/AC2 composite.

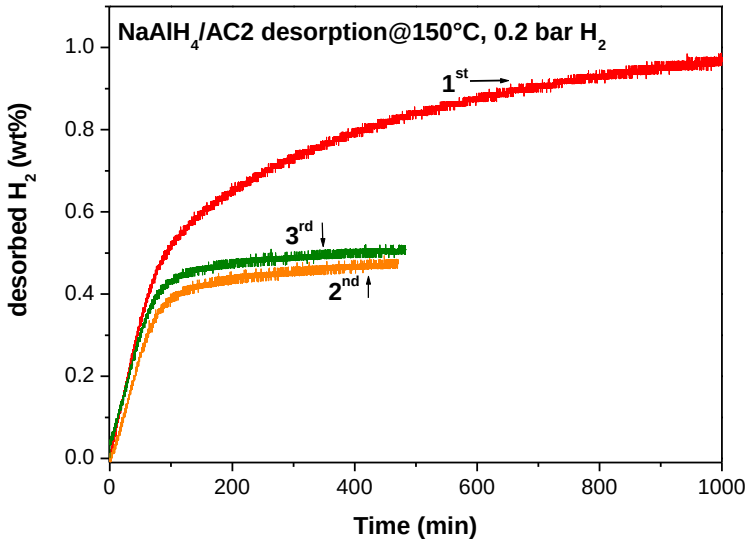

Figure 2. The desorption kinetics of the $NaAlH_4$/AC2 nanocomposite.

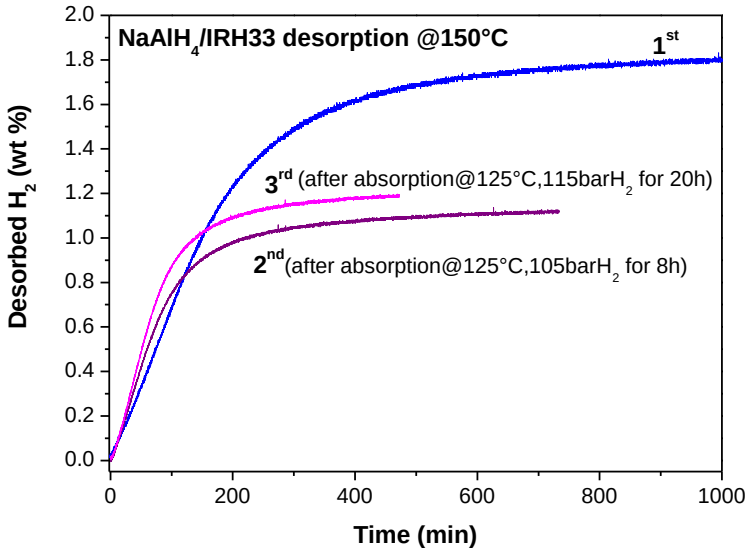

Figure 3. The desorption kinetics of the $NaAlH_4$/IRH33 nanocomposite.