SYNTHESIS, THERMAL STABILITY, AND HYDROGEN STORAGE PROPERTIES OF TiVNbCuFe MULTI-PRINCIPAL ELEMENT ALLOY

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Multi-Principal Element Alloys (MPEAs), along with High-Entropy Alloys (HEAs), are emerging as a new group of hydrogen storage materials.[1] MPEAs are metal alloys in which the alloy (not necessarily crystalline or single-phase) consists of a mixture of several main elements.[2] To date, most published research has focused on crystalline alloys, and still little is known about amorphous MPEAs, especially for hydrogen storage applications.[1]

In this study, we synthesized an equimolar TiVNbCuFe MPEA in a mechanical alloying reaction under an Ar atmosphere. The XRD measurements showed the formation of an amorphous alloy after 28 h of milling. SEM imaging revealed the creation of alloy particles with a size of 5-30 microns. EDX analysis proved a uniform distribution of elements throughout the volume of the alloy. Moreover, the chemical composition of the alloy was found to be close to the targeted one.

TG and DSC studies with the following XRD measurements on as-synthesized alloy showed that the structure of the material is stable up to 460 °C. High-pressure DSC tests at 15 bar H_2 revealed that the alloy could be hydrogenated at a temperature of about 250 °C. DSC studies (under an Ar flow) of the hydrogenated TiVNbCuFe alloy showed that the material desorbs hydrogen between 200 and 450 °C. Simultaneously, TG measurement showed desorption of 0.3-0.5 wt.% H_2 in this temperature range. Moreover, mass spectroscopy studies on the desorbed gas revealed a multi-stage process of hydrogen desorption.

The obtained results prove that amorphous MPEAs may possess interesting hydrogen storage properties and it is desirable to continue and expand research on this group of materials.

References

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Mateusz Balcerzak received his Ph.D. degree from Poznan University of Technology (PUT), Poland in 2016. Later on, he worked as a Postdoctoral researcher at PUT and Catalan Institute of Nanoscience and Nanotechnology, Spain. In 2020 he joined Max-Planck-Institut für Kohlenforschung, Germany as a Postdoctoral researcher. His research focuses on amorphous and nanocrystalline materials synthesized by mechanochemical synthesis - mostly according to their utility as hydrogen storage systems and Ni-MH secondary batteries. Mateusz Balcerzak currently works on high-entropy alloys for hydrogen storage and metal hydrides for hydrogen separation from gas mixtures.