PREPARATION OF TiFe FROM ILMENITE, $FeTiO_3$, FOR HYDROGEN STORAGE

Name (s) of author (s): Bruno G. F. Eggert[1], Bjørn C. Hauback, and Stefano Deledda
[1] Department for Hydrogen Technology, Institute for Energy Technology (IFE), Kjeller, Norway

Corresponding author's e-mail address: Bruno.eggert@ife.no

Keywords:Hydrogen and ammonia transport and storage

ABSTRACT

Storing hydrogen using metal hydrides offers a safer and more compact storage solution when compared to liquid hydrogen and compressed hydrogen gas. $TiFeH_x$ has during the last years emerged as a realistic candidate for solid state hydrogen storage applications [1, 2]. Partial substitution of Fe with other transition metals (e.g. Ni, Cu, Mn) allows a reversible hydrogen sorption at moderate conditions below 50 ºC and 50 and 2 bar for absorption and desorption, respectively. Significant progress has been achieved in the HyCARE EU-funded project (https://hycare-project.eu/), and GKN Hydrogen (Germany) and MAHYTEC (France) has commercial hydrogen storage units based on TiFe metal hydride.

Recently, titanium was included in the critical raw materials by the EU due to economic importance and an increased supply risk with China as the main global supplier. Thus, it becomes important to develop new and sustainable production routes for use of TiFe-based metal hydrides.

Ilmenite, $FeTiO_3$, is the most important source of titanium accounting for 89% of the global titanium mineral consumption. Norway has large resources of ilmenite ores, and it is mainly used to produce TiO_2. However, with Fe and Ti in correct stoichiometric ratio in ilmenite, it could be an ideal starting point for production of TiFe. No large-scale production of TiFe from ilmenite exists today, probably due to the limited market.

Two main approaches to produce TiFe from ilmenite are reported in the literature: Electrochemical reduction [3, 4] and self-sustaining high-temperature synthesis [5, 6].

We are exploring production of TiFe from Norwegian ilmenite both with a mechanochemical route and with solid-state reduction of ilmenite with different reducing agents. Here we will present the different methods for production of TiFe from ilmenite and with a focus on our strategy and recent results. Preliminary results on the hydrogen storage performance of the resulting TiFe alloys will be discussed.

This work has been produced with support from the HYDROGENi Research Centre (hydrogeni.no), performed under the Norwegian research program FMETEKN funded by the Research Council of Norway (333118).

References

[1] E.M. Dematteis, N. Berti, F. Cuevas, M. Latroche, M. Barrico, Mater. Adv. 2 (2021) 2524-2560.
[2] E.M. Dematteis,J. Barale, G. Capurso, S. Deledda, M.H. Sørby, F. Cuevas, M. Latroche, M. Baricco, J. Alloy Compd. 935 (2023) 168150.
[3] M. Panigrahi, E. Shibata, A. Iizuka, T. Nakamura, Electrochim. Acta 93 (2013) 143-151.
[4] Z. Zhou, Y.Hua, C. Xu, J. Li, Y. Li, Q Zhang, Y. Zhang, W. Kuang, Ionics 23 (2017) 213-221.
[5] Y. Wu, C. Yin, Z. Zou, H. Wei, X. Li, Rare Metals 25 (2006) 280-283.
[6] Z. Gao, G. Cheng, H. Yang, X. Xue, J. Ri, Metals 9 (2019) 962.