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Laboratory and industrial production of TiFe intermetallics for large-scale stationary hydrogen storage

Fermin Cuevas[1], Erika Michela Dematteis[1,2], Jussara Barale[2], Giovanni Capurso[3], Bettina Neumann[4], Stefano Deledda[5], Paola Rizzi[2], Michel Latroche[1,†] and Marcello Baricco[2]

[1]Univ. Paris Est Creteil, CNRS, ICMPE, Thiais, France

[2]University of Turin, Department of Chemistry, Italy

[3]Institute of Hydrogen Technology, Helmholtz-Zentrum Hereon, Geesthacht, Germany

[4]GKN Sinter Metals Engineering GmbH, Radevormwald, Germany

[5]Institute for Energy Technology, Kjeller, Norway

The intermittency of renewable sources requires the use of storage systems to equilibrate energy production and demand. The European project HyCARE (www.hycare-project.eu/), running from 2019 to 2022, aims to demonstrate the efficient use of metal hydrides, coupled with phase change materials, to store 50 kg of hydrogen, one of the highest quantity ever handled in Europe by solid-state hydrogen storage. Among the 10 partners of the HyCARE consortium, coordinated by the University of Turin, ICMPE (CNRS) leads the tailoring and optimization of the alloy composition. It includes alloy design, tuning to thermodynamic operational conditions, activation and kinetic issues, as well as cycling stability, resistance to impurities and limited use of raw critical materials. Low-cost TiFe-based intermetallics have been selected. Composition and microstructure are optimized, and their hydrogen properties deeply characterized by many-fold techniques in terms of thermodynamics, activation, kinetics, cycle-life as well as reversible hydrogen uptake by *in-situ* neutron diffraction.

A batch of 5 kg of alloy was synthesized at industrial level and fully characterized through similar methods. Comparing results for alloys with same nominal composition, but prepared either under industrial or laboratory conditions, it was found that the alloy synthesis promotes discrepancies in phase abundance and microstructure and promotes the formation of a passive layer that deeply affect the hydrogen sorption properties. A storage system based on this alloy can be integrated with an electrolyser upstream (25 bar) and a fuel cell downstream (1 bar) at 55 °C, storing 1.0 H_2 wt.%, displaying fast kinetic, resistance to oxygen, water and nitrogen gas impurities, and stability over more than 250 cycles

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