**Towards large-scale hydrogen storage in TiFe intermetallic compounds: state of art and outlook**

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The increase of air pollution and global temperatures demonstrates how essential it is to look for alternatives to fossil fuels. The efficient storage of renewable energy would enable the transition towards CO2-free energy. Hydrogen can be produced from renewable sources and, as an efficient energy carrier, it can be stored for a long period. Metal hydrides are safe materials for solid-state hydrogen storage under mild conditions and with high volumetric densities. TiFe is a low-cost and efficient intermetallic compound for hydrogen storage. It crystallizes in the CsCl-type cubic structure. Upon hydrogen absorption, the consecutive formation of monohydride, β-TiFeH, and dihydride, γ-TiFeH2, occurs, with a total volume expansion of 18 % and a maximum gravimetric capacity of 1.86 wt.% H2.1 However, TiFe exhibits drawbacks and particular features as hydrogen storage material. Firstly, it is difficult to activate towards hydrogen absorption. Secondly, Pressure-Composition-Isotherms are characterized by two subsequent plateau pressures. All these properties are at the origin of controversial results concerning the crystal structure of TiFe hydrides/deuterides.1

Elemental substitutions in TiFe intermetallic compound can change significantly activation processes and hydrogen storage properties. In this work, characteristics of TiFe alloys will be discussed, featuring their homogeneity domain, structures and hydrogen storage properties, *i.e.* both thermodynamics and kinetics, activation issues and cycling properties.

Interestingly, it has been shown that the compound TiFe0.90 requires almost no activation process for the first hydrogenation.2 Partial substitution of Fe by Mn is also reported to reduce the need of alloy activation and, moreover, promotes lower equilibrium pressures at room temperature.3 Thus, substituted Ti(Fe1-*x*Mn*x*)0.9 alloys combine easy activation and low plateau pressures, being good candidates for hydrogen storage applications. The influence of stoichiometry and Mn-to-Fe substitution in TiFe-type alloys on structural properties during reversible hydrogen loading have been investigated. Alloys have been synthetized by induction melting and annealed at 1000 °C. Their activation conditions, kinetic and thermodynamic properties, in relation to phase formation and stabilities will be discussed.

This study enables remarkable understanding on hydrogen storage, basic structural knowledge and support to the industrial application of TiFe-type alloys for the development of an integrated hydrogen tank. Application of TiFe-based intermetallics for hydrogen storage will be shortly presented together with future prospective for these materials.

**References**

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