

Claims

1. A method for making a TiMn- or TiCrMn-based hydrogen storage alloy having a property profile, the method comprising modifying the composition of the alloy to achieve the property profile, wherein modifying the composition of the alloy comprises at least one of:
 - (a) including VFe and optionally one or more additional modifier elements (M) in the alloy;
 - (b) modifying the ratio of two or more elements in the alloy; and
 - (c) annealing the alloy at an annealing temperature of between 900 °C to 1200 °C.
2. The method according to claim 1, wherein the property profile comprises at least one property selected from increased H₂ storage capacity, increased H₂ uptake/release pressure, decreased H₂ uptake/release pressure, reduced plateau slope, reduced hysteresis, and substantially flat equilibrium plateau pressure.
3. The method according to claim 1 or 2, wherein the property profile comprises increased H₂ storage capacity, and modifying the composition comprises including VFe in the alloy.
4. The method according to any one of claims 1 to 3, wherein the property profile comprises increased H₂ uptake/release pressure, and modifying the composition comprises including at least one modifier element selected from Fe, Cu, Co and Ti.
5. The method according to any one of claims 1 to 4, wherein the property profile comprises decreased H₂ uptake/release pressure, and modifying the composition comprises including at least one modifier element selected from Zr, Al, Cr, La, Ni, Ce, Ho, V and Mo.
6. The method according to any one of claims 1 to 5, wherein the property profile comprises reduced plateau slope, and modifying the composition comprises including at least one modifier element selected from Zr and Co.
7. The method according to claim 6, wherein Zr is added as a partial substitution of Ti.
8. The method according to claim 6 or 7, wherein Co is added as a partial substitution of Mn.
9. The method according to any one of claims 1 to 8, wherein the property profile comprises reduced hysteresis, and modifying the composition comprises at least one of:
 - (i) modifying the ratio of Mn and Cr in the alloy,
 - (ii) including VFe in the alloy, and
 - (iii) including Zr as a partial substitution of Ti.
10. The method according to any one of claims 1 to 9, further comprising annealing at a temperature of from 900°C-1100°C.
11. The method according to any one of claims 1 to 10, wherein the property profile is suitable for the alloy to work in conjunction with an electrolyser and fuel cell.

12. The method according to claim 11, wherein the property profile of the alloy comprises a substantially flat equilibrium plateau pressure.
13. The method according to claim 12, wherein the substantially flat equilibrium plateau pressure enables the alloy to uptake hydrogen from a constant hydrogen supply delivered by the electrolyser and release hydrogen to the fuel cell at a constant pressure.
14. The method according to claim 11, wherein the alloy has a reversible hydrogen storage capacity of at least 1.5 wt% H₂, or at least 1.6 wt% H₂, or at least 1.7 wt% H₂, or at least 1.8 wt% H₂, or at least 1.9 wt% H₂, or at least 2 wt% H₂, or at least 2.1 wt% H₂, or at least 2.2 wt% H₂, or at least 2.3 wt% H₂, or at least 2.4 wt% H₂, or at least 2.5 wt% H₂, or at least 2.6 wt% H₂, or at least 2.7 wt% H₂, or at least 2.8 wt% H₂, or at least 2.9 wt% H₂, or at least 3 wt% H₂, or at least 3.25 wt% H₂, or at least 3.5 wt% H₂, or at least 3.75 wt% H₂, or at least 4 wt% H₂ at 30 bar.
15. The method according to any one of claims 11 to 14, wherein the alloy is capable of storing hydrogen at ambient temperature with an efficiency of at least 80%, at least 85%, at least 90% or at least 95%.
16. The method according to any one of claims 1 to 16, wherein the hydrogen storage alloy has the formula $Ti_xZr_yMn_zCr_u(VFe)_vM_w$, wherein
 - M is selected from one or more of V, Fe, Cu, Co, Mo, Al, La, Ni, Ce and Ho;
 - x is 0.6 – 1.1;
 - y is 0 – 0.4;
 - z is 0.9 – 1.6;
 - u is 0 – 1;
 - v is 0.01 – 0.6;
 - w is 0 – 0.4.
17. The method according to claim 16, wherein v is 0.02 – 0.6.
18. The method according to claim 16 or 17, wherein VFe is (V_{0.85}Fe_{0.15}).
19. The method according to any one of claims 16 to 18, wherein x is 0.9 – 1.1.
20. The method according to any one of claims 16 to 19, wherein y is 0.1 – 0.4.
21. The method according to any one of claims 16 to 20, wherein z is 1.0 – 1.6.
22. The method according to any one of claims 16 to 21, wherein u is 0.1 – 1.
23. The method according to any one of claims 16 to 22, wherein w is 0.02 – 0.4.
24. The method according to any one of claims 16 to 23, wherein the alloy is annealed at a temperature of from 900°C to 1100°C.
25. The method according to any one of claims 16 to 24, wherein the alloy has a C14 Laves phase structure.