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Development of High Capacity TiFe-$MmNi_5$ & Ti-Zr-Mn based and the Improvement their Activation Performance

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TiFe alloy has the characterization of low-cost, high capacity, and room reversible. However, the activation conditions for the alloy is very harsh. In order to solve this problem, Mn element was usually used to replace Fe, and the $TiFe_xMn_{1-x}$ ternary alloys show optimized activation performance and reduced absorption and desorption platform. However, this only works in small scale sample preparation by Arc-Melting or Magnetic-Levitation-Melting in the lab. In order to further optimize the activation properties of the alloy prepared by pilot-scale induction metiling method, $TiFe_{0.8}Mn_{0.2}$+y$MmNi_5$ (Mm=La, Ce, Y, Pr, Nd) alloy with a molar ratio of 1:y was prepared. Results show that when the molar ratio (y) is greater than or equal to 0.015, the alloys can be fully activated at 303K, and the hydrogen storage capacity reaches 1.2wt.%. It is assumed that the hydrogen is firstly physically adsorbed on the surface of the alloy, and then La accumulated on the surface of the alloy will be activated and formed some kind of La-H compound. After that, the H diffuse and transfer into the junction area of La-Ti, and finally enter the Ti-alloy to form metal hydride. The activation process of the alloy is thus enhanced.

Ti-Zr-Mn hydrogen storage alloy is also interested for its high hydrogen storage capacity. However, it also suffers from poor activation performance when prepared by induction metling. Therefore, we developed easy-activated Ti-Zr-Mn base AB_2 alloy by replacing its B-side elements content with V, Fe, Mn and Al. The capacity of the developed alloy $Ti_xZr_{1-x}Mn_{1.40}(V\text{-}Fe)_{0.52}$ reaches 1.81 wt%, with a ab-/desorption plateau pressure at c.a. 10.19/5.23 bar, respectively. It is interesting to find that the hydrogen storage capacity of the alloys prepared with V and Fe is higher than that of the alloys prepared with V-Fe alloy due to the impurity elements such as Si from the V-Fe alloys. However, the hydrogen storage capacity of the alloys decreased with the increasing of Fe, and the hydrogen ab-/desorption plateau slope increased as well. Although the increase of V content can enhance the hydrogen storage capacity and improve activation performance, the hydrogen ab-/desorption plateau pressure decrease significantly and the cost of the alloys rises and hinder its practical application. Addition of Al element could also reduce the plateau pressure and hysteresis, but the hydrogen storage capacity of the alloys decreased and the plateau slope increased.

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Mr. Li was born in 1995 in China, and get his Master's degree in Material Science & Engineering from South China University of Technology under the supervision of Prof. Liu Jiangwen in Prof Zhu Min's group. He is now working in the Institute of Rare Metals, Guangdong Academy of Sciences, and focus on the development of hydrogen storage alloy and the relative pilot scale production technologies.