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Influence of synthesis route on the structure and hydrogenation properties of TiNi

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Intermetallic compounds hold promise for solid hydrogen storage under ambient conditions and as negative electrodes in Ni-MH batteries, a technology commercially available since 1989 [1]. For both applications, the design of appropriate synthesis routes that maximize reaction yield and energy efficiency is of paramount importance. This study focuses on the TiNi compound, an AB-type intermetallic absorbing up to 1.4 hydrogen atoms per formula unit (H/f.u.), demonstrating an electrochemical capacity of 150 mAh/g [2].

Ti-rich $Ti_{1.01}Ni_{0.99}$ compound has been synthesised by three different routes: i) mechanical milling (MM) under Ar at 800 rpm for 1h, ii) induction melting (IM) for 5 times followed by 1 month annealing at 900°C and sample cutting, and iii) powder metallurgy (PM) by sintering of powders for 3 days at 900°C. Phase formation and microstructural properties were analysed by EPMA, XRD and DSC. Although MM is the least time-consuming method, it results in a significant material loss of 70% due to powder adhesion on the jar wall. In contrast, conventional IM synthesis takes long time for annealing and results in a material loss of 24% during cutting. PM synthesis is less time-consuming than IM and achieves a reaction yield as high as 95%. The solid-gas hydrogenation investigation shows that induction melting sample yields the highest capacity at 1.4 H/f.u., compared to 1.2 H/f.u. for powder metallurgy and 0.9 H/f.u. for mechanical milling one (Figure 1a). Similar capacity trends are observed in electrochemical measurements. The lower capacity observed for MM compared to IM synthesis is attributed to the low crystallinity of the material inherent to MM method (Figure 1b), while the case of PM is attributed to the presence of the formation of Ti_2Ni secondary phase (Figure 1b). Despite a slight decrease in hydrogenation capacity, PM metallurgy provides an interesting balance between the efficiency and yield. Reduction of secondary phases and substitutional effects are under research to increase hydrogenation uptake in TiNi compounds prepared by PM

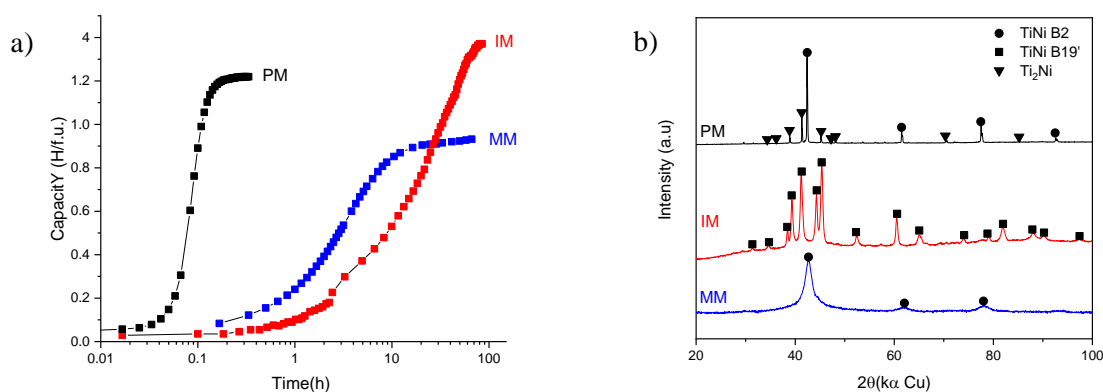


Figure 1: a) Influence of the synthesis route on the hydrogenation capacity and kinetics of $Ti_{1.01}Ni_{0.99}$. b) X-ray diffraction patterns of $Ti_{1.01}Ni_{0.99}$ for the three synthesis methods

References

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- [2] H. Emami, F. Cuevas, M. Latroche, Ti(Ni,Cu) pseudobinary compounds as efficient negative electrodes for Ni-MH batteries, J. Power Sources, 265 (2014) 182-191