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2Mg-Fe alloys processed by hot-extrusion: Processing temperature influence in the hydrogenation properties

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Abstract – Two 2Mg-Fe alloy samples were processed by extrusion at 200 and 300°C producing bulk samples. Both were hydrogenated for 24 h, under 24 and 15 bar of H_2, respectively. The results shown that the sample extruded at 200°C showed higher desorption temperature (~68°C) when compared with the sample extruded at 300°C. The desorption kinetics is still slow for both samples. The phase Mg_2FeH_6 was identified in both samples; MgH_2 and superficial MgO were only observed in the sample extruded at 200°C. The absence of MgO in the sample extruded at 300°C probably led to its better initial desorption temperature that was about 200°C lower than for commercial MgH_2.

The magnesium and Mg based alloys are promising for solid-state hydrogen storage. Mg has high hydrogen capacity (7.6 wt.%), it is efficient and safe. In suitable conditions, bulks of Mg-Fe alloys may form Mg_2FeH_6 with 5.5 wt.% of H and the best well-know volumetric storage (150 g/l of H). In addition, Fe can act as a catalyst element. However, improvements should be done to reach lower temperatures and faster kinetics of sorption properties. Furthermore, temperature and kinetics are direct correlated with microstructural characteristics [1-3]. Bulk samples, like that produced by SPD processes, should present better air resistance and easier activation. Possible defects introduced by deformation may destabilize the microstructure [4]. So, all of these characteristics may lead to better sorption properties.

Two samples of 2Mg-Fe (at.%) powder alloys produced by high energy ball milling were cold-pressed producing pre-forms. The pre-forms were then hot-extruded (extrusion ratio of 3/1 aiming to ensure porosity and ram speed of 1mm/min.) at 200 and 300°C. The products were bulk samples, which were both hydrogenated for 24h in a reactor, under 24 and 15 bar of H, respectively.

XRD patterns showed the formation of Mg_2FeH_6 in both samples, and MgH_2 and superficial oxide MgO only in the sample extruded at 200°C. DSC analysis showed that the sample extruded at 300°C has the better starting desorption temperature (~68°C lower than the sample extruded at 200°C and ~200°C lower than the commercial MgH_2) despite its minor porosity when compared with the sample extruded at 200°C. This was correlated with the absence of superficial oxides. However, DSC data showed that the sorption kinetics for both samples is still slow. The hydrogenation did not produce bulk decrepitating. The results show that improvements must be done in the extrusion process to increase the porosity without compromising the mechanical properties of the bulk.

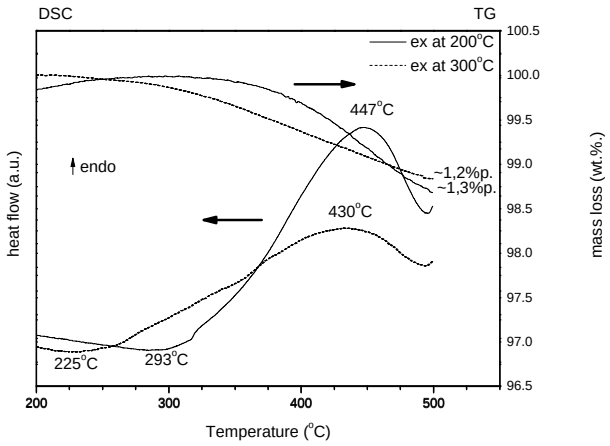

Figure 1: DSC/TG curves showing hydrogen desorption of bulk hydrides produced after hydrogenation of 2Mg-Fe alloy extruded at 200 and 300 °C, respectively. (Legend: ex = extruded)

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