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MECHANICAL ALLOYING OF Mg-Ge BASED MIXTURES UNDER HYDROGEN AND ARGON ATMOSPHERES

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Abstract - **The effect of milling atmosphere and milling time on the nature and composition of milled products is investigated by X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray analysis (EDX) and differential scanning calorimetry (DSC). The milling of the 2Mg-Ge mixture under argon and hydrogen allows the formation of Mg_2Ge. The MgH_2 hydride is also formed after milling both 2Mg-Ge and 2Mg-0.5Ge-0.5Ni mixtures under hydrogen. The formation of Mg_2Ni during the milling of the 2Mg-0.5Ge-0.5Ni mixture under argon and the formation of MgH_2 under hydrogen make the formation kinetics of Mg_2Ge slower. The DSC measurements indicate that the decomposition temperature of MgH_2 is 250 °C. The presence of Ge and Ge-Ni reduces in more than 200 °C the MgH_2 decomposition temperature respect to pure MgH_2. The Mg hydriding process during the mechanical alloying is improved by the presence of Ni in the starting mixture.**

Keywords - **Mechanical alloying, Mg-Ge mixture, Mg-Ni mixture, magnesium hydride, mechanosynthesis.**

I. INTRODUCTION

Mechanical alloying (MA) is a solid-state powder processing method by which different alloys, ceramics, amorphous materials, intermetallics, etc., are synthesized at room temperature (Koch, 1992; Froes *et al*., 1995; Lü and Lai, 1998). MA involves two processes, *cold welding* between particles which are continuously impacted by the balls, and *fracturing* of the cold welded particles under the collision (Koch, 1992; Lü and Lai, 1998). These processes enable powder particles to be always in contact with each other creating new atomically clean surfaces and minimizing the diffusion distance. Without cold welding, the particles will not be bonded together by interdiffusion, while too much cold welding will lead to an increase in particle size and no formation of clean surfaces for diffusion. Therefore the balance between cold welding and fracturing is essential for a successful MA. The possible predominance of a process is in part due to the nature of particles. Ductile materials can be easily deformed plastically under compressive loading, whereas hard particles tend to resist the attrition and compressive forces.

MA has been successfully employed for fabrication of several metallic alloys that can not be prepared by traditional melting and casting techniques. The technique provides a way to overcome the usual difficulty of formation of new alloys using a starting mixture of low and high melting temperature elements, as example Mg-Si (Riffel and Schilz, 1998) and Mg-Ni (Singh *et al*., 1995). In the present work, we study the production of Mg based alloys, of stoichiometry 2Mg-Ge and 2Mg-0.5Ge-0.5Ni, by MA. We examine the effect of milling atmosphere and milling time on the MA process of the ductile (Mg) - brittle (Ge and Ni) mixture. The structural and microstructural characteristics as well as the thermal stability of milled materials were analyzed by X-ray powder diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray analysis (EDX) and differential scanning calorimetry (DSC).

II. EXPERIMENTAL

Elemental powders of magnesium, germanium and nickel (purity greater than 99.9%) were used. The powders were mechanically milled under argon (99.995 %, AGA, Argentina) and hydrogen (99.995 %, Air Liquid, Argentina) using a Uni-Ball-Mill II apparatus (Australian Scientific Instruments). The 2Mg-Ge and 2Mg-0.5Ge-0.5Ni mixtures together with ferromagnetic steel balls were put into a stainless steel container and closed in an argon glove box. In all experiments, about 6 g of starting materials were used, giving a ball to powder weight ratio of 44:1. The pressure inside