Mg-Ni ALLOYS FOR HYDROGEN STORAGE OBTAINED BY BALL MILLING

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Abstract—The effect of the atmosphere and milling time on the structural, morphological and hydrogen reactivity properties of the mechanically alloyed Mg-Ni system is studied. Nanocrystalline Mg$_2$Ni formed by ball milling in argon exhibits a higher thermal stability than the metals amorphized by milling during shorter times. It is shown that the initially fast hydrogen absorption kinetics of Mg$_2$Ni at 250°C strongly depends on the crystallinity degree. When the Mg-Ni mixture is mechanically alloyed under hydrogen atmosphere, MgH$_2$ is formed at first and Mg$_2$NiH$_4$ is obtained later. Samples prepared in argon show a higher hydrogen absorption capacity than those obtained in hydrogen.

Keywords—Mg-Ni, metallic hydrides, mechanical alloying, hydrogen absorption.

I. INTRODUCTION

In the last years, several studies related with mechanically alloyed materials useful for hydrogen storage have been reported. This technique allows obtaining intermetallic compounds that react with hydrogen in a reversible process. In this way, the properties of the materials related with their surface, their particle size and the density of defects are important factors to be considered to improve the rate of the reaction with hydrogen (Abdellaoui et al., 1999; Huot et al., 1995; Liang et al., 1998; Orimo et al., 1997). In particular, there are several works on the Mg-Ni system that analyze the product of the mechanical alloying from pure metals (Huot et al., 1995; Liang et al., 1998), the effect of milling parameters on the formation of the Mg$_2$Ni intermetallic compound (Orimo et al., 1997; Tessier et al., 1998) and also the characterization of the reaction with hydrogen.

In this paper we study the effect of milling time on the thermodynamics and the structural properties of Mg-Ni mixtures (2:1 atomic proportion) prepared under argon or hydrogen atmospheres. The hydrogen reaction kinetics is also analyzed.

II. EXPERIMENTAL

Mechanical alloying of Mg-Ni mixtures was performed in a Uni-Ball-Mill-II (Australian Scientific Instruments) apparatus, using ferromagnetic steel balls as milling media and an external magnetic field controlling the movement of balls.

Mg granules (purity higher than 99.9%) and Ni powder (purity higher than 99.9%) in the atomic proportion 2:1 were placed in the milling chamber under argon or hydrogen atmospheres. The ball to powder weight ratio used was 18:1. The milling was performed under argon atmosphere. MgH$_2$ was formed at first and Mg$_2$NiH$_4$ was obtained later. Samples prepared in argon show a higher hydrogen absorption capacity than those obtained in hydrogen.