

Magnetic and Electronic Structure Studies of Nanocrystalline (Co₂Mn)₄₀Ni₆₀ Alloy

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Nanocrystalline (Co₂Mn)₄₀Ni₆₀ (wt%) alloy powder was prepared by high-energy ball milling under an argon atmosphere. Structure, microstructure, and magnetic properties were investigated by means of X-ray diffraction, scanning electron microscopy, and vibrating sample magnetometry. The X-ray diffraction analysis indicates that after 30 h of milling, a highly disordered (Co, Mn, Ni) solid solution emerges, having an average crystallite size of around 60 nm and a lattice parameter of about 3.5411 Å. Magnetization-field curves indicate the existence of ferromagnetic behavior irrespective of the milling time with a low hysteresis loop, a typical characteristic of a soft magnetic material. The magnetic properties, however, are found to be sensitive to the milling time: i.e. the ratio M_r/M_{sat} manifests the formation of multi-domains magnetic structure. Diverse magnetic parameters were acquired from the approach to magnetic saturation. The electronic structure of the ferromagnetic (Co₂Mn)₄₀Ni₆₀ alloy performed by self-consistent ab initio calculations based on the Korringa-Kohn-Rostocker method combined with the coherent potential approximation, reveals that the total DOS is mainly due to the 3d-like states of the constituent elements Mn, Co and Ni.

topics: ball milling, Ni-Co-Mn powder mixture, magnetic properties, electronic structure calculation

1. Introduction

Nanometals exhibit several physicochemical properties due to their hardness, small crystallite size, large surface area, varying morphology, mechanical strength, and interesting magnetic properties. Owing to the above characteristics, magnetic nanostructured materials were used in numerous fields such as magnetic recording [1], ferrofluids [2], magnetic resonance imaging [3], and magnetocaloric effect [4]. The magnetic behavior in nanostructured alloys based on transition metals is mainly governed by the magnetic anisotropy that depends on the chemical composition and the shape of samples. Furthermore,

structural, magnetic and electronic properties of the magnetic multi-constituent alloys exhibit interesting properties, usually associated with the local ordering and interactions among the different components.

Many previous researches have been performed to study Ni-Mn [5, 6], Co-Mn [7, 8], and Ni-Co [9, 10] binary systems. Recently, Zhou et al. [11] performed a comprehensive study on the phase transformation and the magnetic properties of twenty two (22) compositions of a Ni-Co-Mn system prepared by arc melting with subsequent homogenization by annealing at 1000°C for 24–72 h. The XRD results show that all samples have a face-centered-cubic (fcc) structure.