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Structural and Magnetic Properties of $Fe_{50}Mn_{50}$ Nanocrystalline Alloys

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Introduction

Mechanical Alloying (MA) process is an effective way to fabricate nanocrystalline alloys and their physical properties are related to structural variations.

Some regularity in atomic arrangement in solids can be classified by the short-range order (SRO) and long-range order (LRO). Among these, LRO is frequently examined by X-ray diffraction studies while SRO could be examined by extended X ray absorption fine structure (EXAFS).

Fe-Mn alloys have been studied extensively for many applications in electromagnetic devices, such as magnetic sensors and spin-valve reading/recording heads

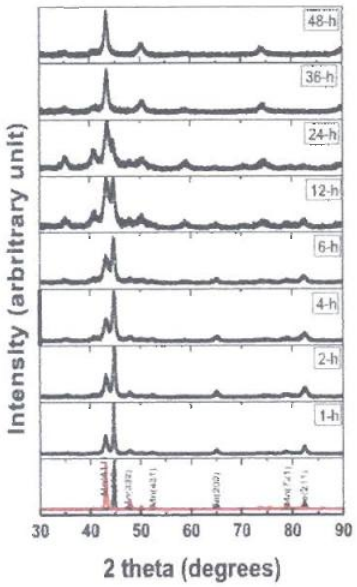
In this work, we present preparation and characterization of the structure and magnetic behavior of $Fe_{50}Mn_{50}$ alloys as changing the milling time.

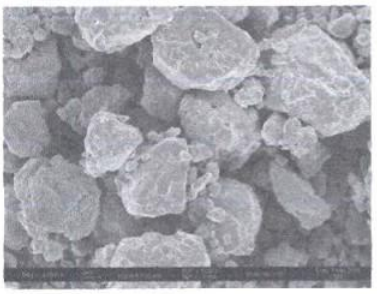
Experiment

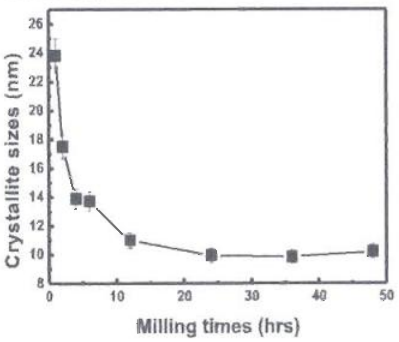
$Fe_{50}Mn_{50}$ metastable alloys were prepared by MA .The starting material was a mixture of pure Fe and Mn powders (used commercial Fe and Mn powders as the precursors). The weight ratio of balls-to-powder mixture was 5:1. $Fe_{50}Mn_{50}$ alloys were mixed and ground for different times of 1, 2, 4, 6, 12, and 24 hrs in Ar ambient to prevent oxidation during the alloying process.

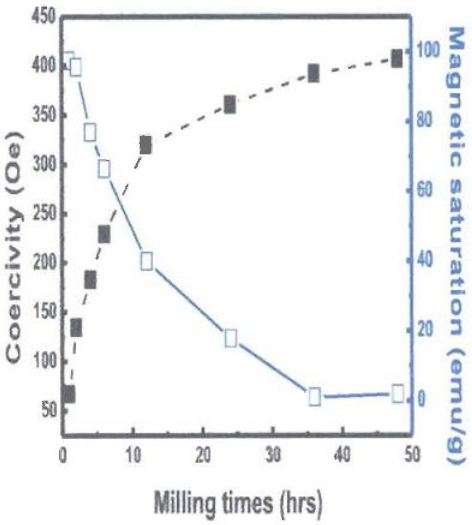
Magnetic measurements were carried out on SQUID. XRD using the Cu-K_α radiation. Based on these data, crystallite size estimated with Scherrer formula. EXAFS data were operated with an energy of 2.5 GeV, and a maximum current of 200 mA. EXAFS spectra were obtained at Fe K-edge (7112 eV) in the transmission mode at room temperature. The sample chamber was filled with pure nitrogen gas. The EXAFS data were analyzed by FEFF software. Finally, the nanoparticle size and their shape were checked by SEM.

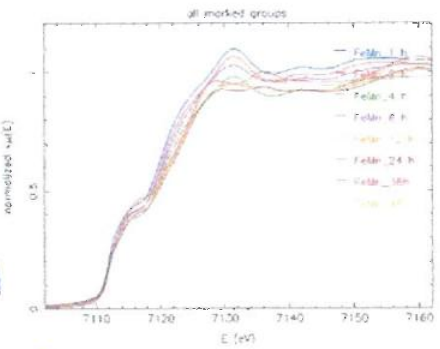
Results and discussions

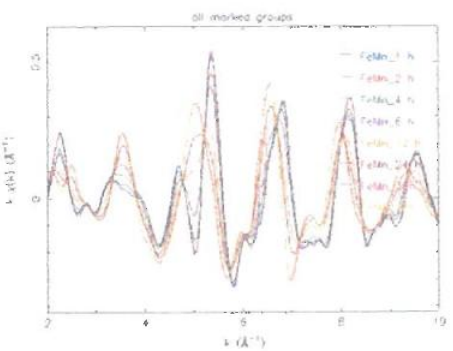


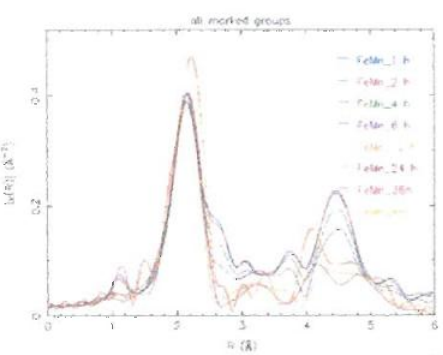












Conclusions

The formation of $Fe_{50}Mn_{50}$ metastable alloys is explicitly shown in the EXAFS spectra by the variation of amplitude and phase between 12 hrs and 24 hrs milling times. The significant change of the structural phase revealed that new atom neighbors between the central Fe and Mn atoms increased during the MA process. The Fe and Mn atoms are diffused each other to form the FeMn alloy phase.

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