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EDDY CURRENT CHARACTERIZATION OF NANOMATERIALS

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Abstract

NDT Magnetic measurements as impedance in Eddy currents, corecitif and residual field in hysteresis loop are used to study the different stages of mechanical alloying in the Fe–Co system. In this paper, we changed the electromagnetic properties of Fe-Co, by developing their metallurgical parameters such as grain size. For this we are used a planetary ball mill, we are milled the FeCo alloy for different milling times until to obtain nanostructure, the lamellar structure with some small particles embedded in them was observed during the first stage of mechanical alloying. XRD patterns show after 10 h of milling the formation of a disordered solid solution having a body-centered cubic (bcc) structure. After 40h of milling, morphological studies indicated that the average crystallites size is around 15 nm.

Mots clés: *nanostructured materials, powder metallurgy, NDT, Eddy current, Magnetic measurement.*

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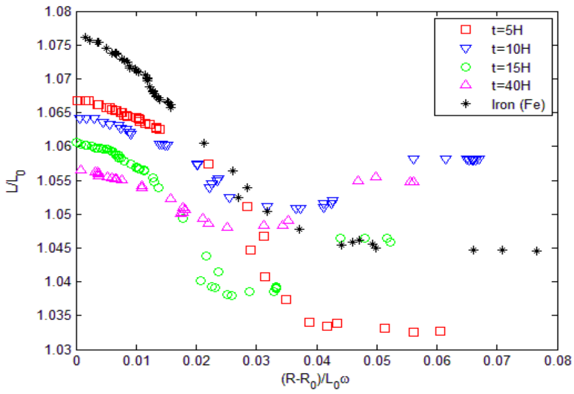
I. INTRODUCTION

In Recent years, we have witnessed a considerable development in nanomaterials science and technology. Nanomaterials were elaborated thanks to varied ways, and high-energy mechanical alloying is one technique that has many potentialities of application, the ability to control the nonstructural components is an important factor and gives important information's about in engineering developments. The characterization of microstructures, mechanical properties, deformation, damage initiation and growth by Non-Destructive Evaluation (NDE) techniques plays a vital role in various industries because of the growing awareness of the benefits that can be derived by using NDE techniques for assessing the performance of various components. In this study we apply NDT methods to characterize the nanostructure [1-8].

II. RESULTS

1. Eddy Current measurement

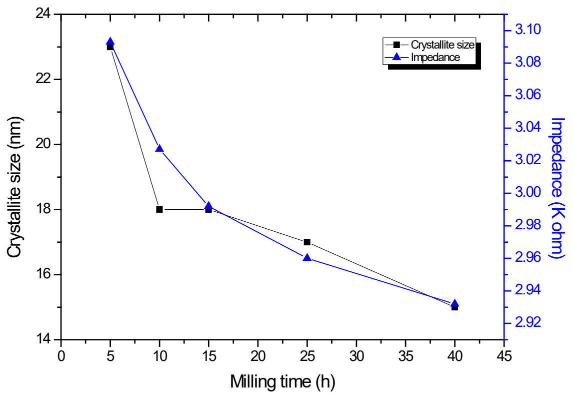
The analysis of Eddy Current shows that we can determine the status of nano structural by analyzing the impedance diagram [9-10].
The impedance diagram for each sample studied is different. This corresponds to a change of microstructure during milling, see Fig.1:

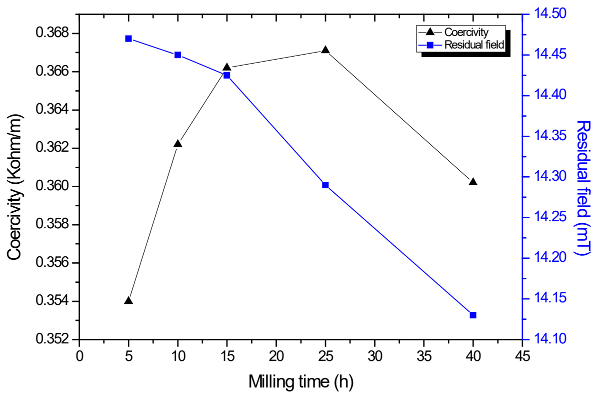


- Iron has a high impedance compared to Fe-Co
- For Fe-Co, the milling time influences the impedance diagrams; we note that when the frequency increases, a narrowing of the trajectories is obtained.

The curve is very important because we can see through the trajectories of the impedance diagram that the material obtained during milling loses its magnetic qualities stored according to the presence of Cobalt. For the nanostructure we have shown the relationship between impedance, crystallite size and lattice parameters.

Fig.2. illustrates the evolution of the impedance (Z) and crystallite size versus milling time in high frequency. The evolution of the impedance decreases in the same way of the curve representing the crystallite size.





The evolution of the impedance (Z) and crystallite size versus milling time at 4862Hz frequency follows the same evolution, Fig. 2.

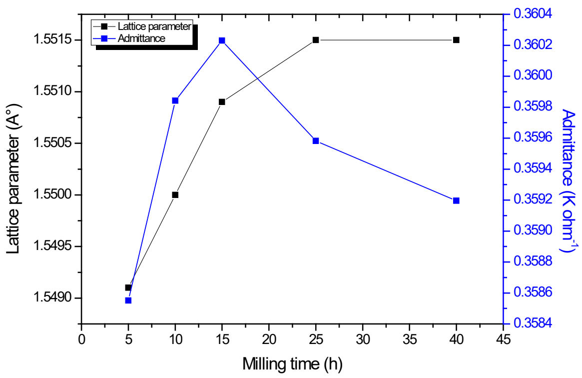


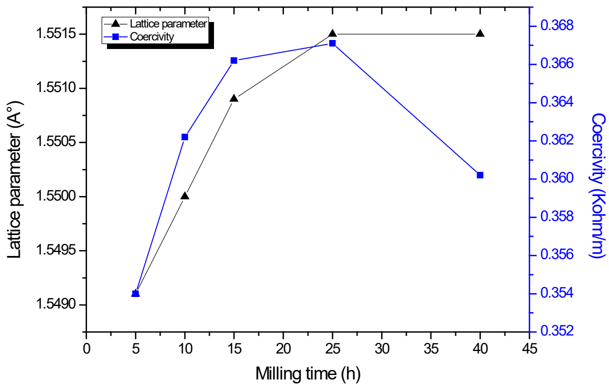
Fig.3. illustrates the evolution of the admittance and lattice parameters versus milling time in low frequency. The evolution of the admittance increases in the same way of the curve representing the Lattice parameter.
The evolution of the admittance and lattice parameter versus milling time at 1000Hz frequency has the same evolution, Fig. 3.

2. Magnetic Measurement

The coercivity is often seen as an important parameter if low losses are to be achieved. We were tried to find the relationship between the coercivity and microstructure of magnetic alloys [11, 14].

Fig.4. illustrates the evolution of the coercivity and the residual field versus milling time. As shown in Fig.5, the residual field shows a maximum value and the coercivity is a minimum value respectively at 5 hours of milling. The intersection of two curves at 15 h represented the appearance of FeCo alloy.

Fig.5. illustrates the evolution of the coercivity and lattice parameters versus millig time. The evolution of the coercivity increases in the same way of the curve representing the lattice parameter. As for soft magnetic systems in general, the coercivity of FeCo alloys depends strongly on the microstructure.



III. CONCLUSION

We can analyze the material nanostructured elaborated by mechanical alloying by NDT electromagnetic methods. The reduction of grain size enhanced the magnetic and mechanical property of FeCo alloys.
The coercivity of FeCo alloy depends strongly on the microstructure, the residual field and the coercivity shows a maximum and minimum value respectively at 5 hours of milling, the evolution of the coercivity increases in the same way as the curve representing the lattice parameters
It is possible to characterize the nanomaterials by the electromagnetic method (eddy currents).
The results are obtained:

- the evolution of the crystallite size have the same behavior of impedance
- the evolution of the lattice parameter have the same behavior of admittance

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