11th International Conference
on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

Study of the local environments of iron sites in nanostructured $(FeCo)_{75}Si_{15}B_{10}$ powders obtained by Mechanical-Alloying

Ch. Rojas Ayala[(1)*], V.A. Peña Rodríguez[(1)], J. Quispe Marcatoma[(1)],
E.M. Baggio-Saitovitch [(2)], and E.C. Passamani[(3)]

(1) Universidad Nacional Mayor de San Marcos, Lima, Perú.
(2) Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro, Brazil.
(3) Universidade Federal de Espírito Santo, Vitória, Espírito Santo, Brazil
** Corresponding author, e-mail: crojasa@unmsm.edu.pe*

Abstract – During the milling process, Fe local environments in mechanically alloyed $(Fe_x Co_{1-x})_{75} Si_{15} B_{10}$ powders, x = 0.5 and 0.7, were systematically investigated using Extended X-ray Absorption Fine Structure (EXAFS) and ^{57}Fe Mössbauer Spectroscopy. Correlation of XRD, Mössbauer and EXAFS studies of the end-samples (19 h milling) revealed the presence of nano-crystalline bcc-FeCo (~ 7.5 nm) surrounded by a distribution of nano-structured (FeCo)-SiB clusters. It is suggested that the (FeCo)-SiB nanostructured clusters might result from the dispersion of Si and B atoms within the bcc-FeCo phase.

In recent years Mechanical Alloying has been attracting the attention of many research groups working on the development of new materials [1.2]. The preference to employ this technique is due to the possibility (i) to synthesize new materials in metastable phases, (ii) to reduce the sample grain-size, and (iii) to change the morphology of the particles.

In particular, amorphous and nanostructured alloys based on the combination of transition metals (i.e. Fe and Co combined with Si and B) are one of the best studied soft magnetic materials. These alloys are characterized by a high saturation magnetization, low coercive field, high magnetic permeability, and high Curie temperature . In general, some magnetic properties can be improved when the size of the grains is reduced to nanoscale, but this could also produce an increase of defects and internal stress. The structural disorder and short-range microstructure are determinant in their magnetic (anisotropy) and electronic transport (magneto-resistive effect) properties.

In this work we present a study of the microstructure, local structure and short-range order in nanostructured $(Fe_{0.5}Co_{0.5})_{75}Si_{15}B_{10}$ and $(Fe_{0.7}Co_{0.3})_{75}Si_{15}B_{10}$ alloys prepared by Mechanical Alloying, from a mixtures of high-purity chemical elemental powders of Si and B with precursor $Fe_{0.5}Co_{0.5}$ and $Fe_{0.7}Co_{0.3}$ alloys, respectively. X–ray diffraction (XRD) and electron microscopy were used to study the evolution of the microstructure. X-ray absorption (EXAFS) was used to obtain information on the local structure and short-range order around Fe and Co sites. Magnetic properties were investigated using Mössbauer spectroscopy and SQUID.

Fe-edge EXAFS data show no substantial changes on the Fe-short-range order as a function of milling time, in both $(Fe_{0.5}Co_{0.5})_{75}Si_{15}B_{10}$ and $(Fe_{0.7}Co_{0.3})_{75}Si_{15}B_{10}$ alloys. In contrast, the Co-edge EXAFS data show significant changes on the Co-short-range order for $(Fe_{0.7}Co_{0.3})_{75}Si_{15}B_{10}$ alloys milled longer than 10 hours, due to the affinity of Si with Co atoms[3]. Mössbauer results suggest that the milled end-samples (19 hours) consist of bcc-FeCo nanograins embedded in a distribution of nanostructured clusters based on (FeCo)-SiB, in both $(Fe_{0.5}Co_{0.5})_{75}Si_{15}B_{10}$ and $(Fe_{0.7}Co_{0.3})_{75}Si_{15}B_{10}$ alloys.

Work supported by the Brazilian Synchrotron Light Laboratory (LNLS) under proposal D04B - XAS1 – 1899. The authors would like to acknowledge the financial support provided by CSI-UNMSM under projects No. 021301021- 031301011, FAPERJ-Brazil (Cientista do Nosso Estado), FINEP, FAPES and Latin American Center of Physics (CLAF).

References

[1] M.D. Chermahini, M. Zandrahini, H. Shokrollahi, S. Sharafi, Journal of Alloys and Compounds 477 (2009) 45–50
[2] A.S. Khan, S.S. Yeong, X. Chen, L. Takacs, H. Zhang, International Journal of Plasticity 22 (2006) 195–209
[3] V.A. Peña Rodríguez, J. Quispe Marcatoma, Ch. Rojas Ayala, E.M. Baggio-Saitovitch, E.C. Passamani, Journal of Alloys and Compounds 475 (2009) 29–34