AF-3-P1

Microstructure and magnetic characteristics of Mn-doped Finemet nanocomposites

L.A. Tuan*, C.O. Kim*, N.Chau**, N.D. Tho**, and Heebok Lee***

* *Department of Materials Engineering, Chungnam National University, Daejeon, Korea*

E-mail: heebok@kongju.ac.kr

** *Center for Materials Science, National University of Hanoi, Hanoi, Vietnam*

*** *Department of Physics Education, Kongju National University, Kongju, Korea*

Microstructure and magnetic characteristics of Finemet nanocomposites doped with Mn have been systematically investigated in conjunction with thermal treatment. The $Fe_{73.5-x}Mn_xSi_{13.5}B_9Nb_3Cu_1$ (x=1, 3, 5) nanocomposites composed of ultra-fine Fe(Si) grains embedded in an amorphous matrix were obtained by annealing their precursor amorphous alloys, which were prepared by the melt-spinning technique, at temperature range between 500°C and 600°C for 1 hour in vacuum. It was found that the addition of Mn decreased the mean size of the Fe(Si) grains. The Curie temperatures of the initial amorphous phase and the remaining amorphous phase in the nanocrystallized samples decreased with Mn content. The presence of Mn altered the soft magnetic properties of the nanocomposites and resulted in a decrease in coercivity and saturation magnetization, while initial permeability and maximal permeability increased. Accordingly, an increase of giant magneto-impedance (GMI) and a decrease of anisotropy field were observed. This is likely ascribed to the increase of the magnetic permeability and the decrease of the coercivity. The increased magnetic permeability is resulted from a reduction in the magnetic anisotropy evaluated from the incremental permeability and GMI curves. The study of GMI effect provides further understanding of the magnetic exchange between these crystallized grains through the amorphous boundaries in Fe-based nanocomposites materials. The correlations between the microstructure, magnetic softness and GMI behaviors are discussed in detail.

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