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Effect of annealing on the permeability and magneto-impedance behaviors of $Fe_{68.5}Mn_5Si_{13.5}B_9Nb_3Cu_1$ alloy

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The influences of annealing on the permeability and giant magneto-impedance (GMI) behaviors of Fe-based amorphous alloy have been systematically investigated. The $Fe_{68.5}Mn_5Si_{13.5}B_9Nb_3Cu_1$ nanocrystalline materials consisting of ultrafine grains embedded in an amorphous matrix were obtained by annealing their precursor amorphous alloys. The incremental permeability (PR) and GMI profiles were measured for samples annealed at a temperature range from 500°C to 600°C for 1 hour in vacuum. It was found that an increase of the permeability and GMI with increasing annealing temperature up to 535°C was observed. This is likely ascribed to the ultrasoft magnetic properties in the sample, i.e., the decrease of the coercivity, whereas the opposite tendency was found for the sample annealed at 600°C which is due to the microstructural change caused by high-temperature annealing. This result indicates that variation in the magnetic characteristic of the amorphous phase upon annealing changed the intergrains exchange coupling, thus altering both the permeability and the GMI features. Investigation on the frequency dependence of the maximum GMI and PR values indicate that the GMI profile first increased with increasing frequency up to 2 MHz and then decreased at higher frequencies, while the PR values decreased with increasing frequency. These finding are interpreted by adapting the model of skin effect for thin alloys. The study of temperature dependence the permeability and GMI effect showed some insights into the nature of the magnetic exchange coupling between nanocrystallized grains through the amorphous boundaries in Fe-based nanocrystalline materials.

1. G. Buttino, and M. Poppi, J. Magn. Magn. Mater. **170**, 211(1997)