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# AFM studies and soft magnetic properties of nanocrystalline $Fe_{73.5-x}Cr_xSi_{13.5}B_9Nb_3Au_1$(x=1~5) alloys

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The effect of surface roughness and morphological developments on the magnetic properties including the giant magneto-impedance (GMI) effect of the $Fe_{73.5-x}Cr_xSi_{13.5}B_9Nb_3Au_1$ (x= 1, 2, 3, 4, 5) alloys, which were prepared by the melt-spinning technique, has been thoroughly investigated. It was found that the as-quenched samples were amorphous. The nanocrystalline samples were obtained by annealing their amorphous alloys at 540°C for 1hour in vacuum. The GMI profiles were measured as a function of the dc external magnetic field at various frequencies. AFM studies indicated that the surface roughness and the morphology features varied with increasing Cr content. This altered both the magnetic softness and the anisotropy, and therefore to the GMI behaviors of crystallized samples. An increase of the permeability, a decrease of the coercivity, and maximum GMI value up to 160% were observed in the sample containing 3%atCr (x=3) among the samples investigated. This is can be explained in terms of ultrasoft magnetic properties as well as a low surface roughness were found in the sample. With further increasing Cr content, the surface roughness increased leads to deteriorate the soft magnetic properties. The correlations between the surface roughness, the surface morphological developments, and the magnetic properties were discussed. These results indicate that the nanocrystalline sample containing 3%atCr (x=3) can be used for quick-response magnetic sensor applications.

1. A.K. Panda, M. Manimaran, A. Mitra, and S. Basu, Appl. Surf. Sci. **235**, 475 (2004)