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Fabrication and Magnetic Properties of $Fe_{65}Co_{35}$-B_2O_3 Granular Films for High Frequency Application

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Metal-insulator granular films (MIGF) are quite promising for high frequency application (from several MHz to GHz) because of the excellent soft magnetic properties caused by the exchange coupling between particles. So far, most of studies on MIGF focus on the (Fe, Co and alloys)—(SiO_2, [1] Al_2O_3 [2] or MgF_2 [3]) systems, no work concerning soft magnetic properties on the FeCo—B_2O_3 systems. In this paper, $(Fe_{65}Co_{35})_x(B_2O_3)_{1-x}$films with different metal volume fraction x were deposited on substrates in external magnetic field by magnetron sputtering. High resolution transmission electronic microscope and X-ray diffraction studies show that the sample consists of bcc $Fe_{65}Co_{35}$ particles embedded uniformly in amorphous insulating B_2O_3 matrix with particle size around a few nanometers.

It is seen in Figure 1 that good soft magnetic properties are obtained in a range $0.55<x<0.66$ with $H_{ce}<16$ Oe and $H_{ch}<5$ Oe, while resistivity ρ increases with decreasing x slowly first, then rapidly after $x<0.6$. Especially for the sample with x=0.61, coercivity in easy and hard axes is 13.4 Oe and 3 Oe, respectively, $4\pi M_S = 12.5$ kG and ρ reaches 2.38 mΩ·cm. The good soft magnetic properties of these samples can be understood by the exchange coupling between particles. Figure 2 shows the dependence of complex permeability $\mu = \mu' - j\mu''$ on frequency for the film of x=0.61. It is seen that real part μ' is more than 170 below 1.5 GHz and FMR frequency is 2.65 GHz, which implies that these films are promising for application in high frequency range such as transformers, inductors or noise suppressors.

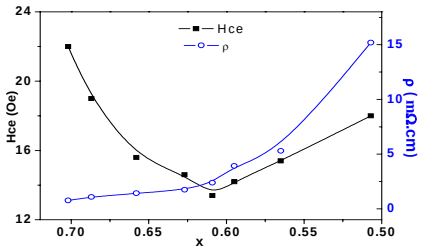

Fig. 1. x dependences of Hc and ρ.

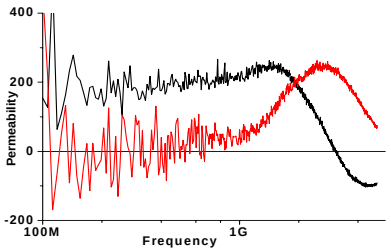

Fig. 2. Dependence of complex permeability on frequency for the film of x= 0.61.

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