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High-frequency Ferromagnetic Properties of FeCoZr Nanocrystalline Films

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Future communication devices requirehigh frequency, high quality factor and small size. Integration of ferromagnetic materials with electronic component is a solution of chip integrating circuits. For this purpose, FeCoZr magnetic thin films with high uni-axial anisotropy were fabricated byRF co-sputter and post magnetic annealing. The crystal size of FeCo alloys can be decreased by adding Zr element due to its less solubility in FeCo alloy. The crystal size of FeCoZr thin film calculated by Scherrer equation is less from X-ray diffraction pattern than 23nm. The film exhibits a uni-axial anisotropy after magnetic field annealing at 400℃ for 1 hr.Optimal high frequency ferromagnetic properties are achieved at the composition of 19 at.% Zr, in which strong uni-axial anisotropy field of 250 Oe and high ferromagnetic resonance frequency in excess of 4 GHz were obtained. These facts suggest that FeCoZr nano-crystalline film is a potential candidate in high frequency electromagnetic devices operating in GHz bands.

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High-frequency Ferromagnetic Properties of $(Fe_5Co_5)_xHf_y$ Thin Film

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The magnetic materials operating at GHz require high saturation magnetization (Ms), appropriately high anisotropy field (Hk), and low coercivity (Hc). In this study, $(Fe_5Co_5)_xHf_y$ films with Hf compositional gradient from 7.7 to 15.8 at% were prepared by magnetron co-sputtering method. It was found that the magnetic properties of the samples significantly depend on the Hf composition. A strong uniaxial anisotropy with a maximum anisotropic field of 400 Oe was obtained for the samples annealed in presence of a magnetic field. With the increase of Hf composition, Ms firstly increases to 22 kG, then linearly decreases to 16 kG. Similarly, the anisotropic fields linearly increase from 18.2 (at Hf 7.7 at%) to 400 Oe (at Hf 13.5 at%), then rapidly decrease to 140 Oe (at Hf 15.8 at%). As a result, high-frequency ferromagnetic properties of the samples are altered with the variation of Hf composition. Samples with higher or lower Hf contents exhibit relatively low self-resonance frequency (SRF). However, in a wide Hf composition rangefrom 8 to 13.5 at%, samples have a higher SRF in excess of 2.5 GHz. The sample with optimal Hf content of 9.7 at% exhibits permeability over 100 and SRF in excess of 3 GHz. These facts indicate that FeCoHffilm is a potential magnetic material for the miniaturization of the electronic devices in GHz applications.

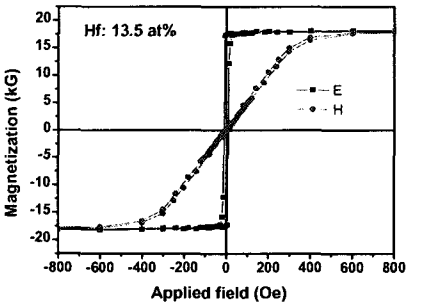

Fig. 1. Typical hysteresis loops of the magnetic field annealed FeCoHf film, showing a strong uniaxial anisotropy.

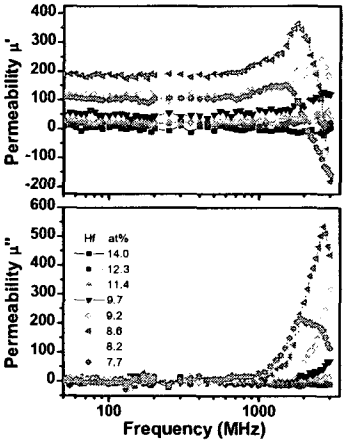

Fig. 2. Hf composition dependence of high-frequency ferromagnetic properties for the magnetic field annealed samples.