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High Frequency Magnetic Properties of Fe-Based Nanocrystalline Alloy Powder Cores

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Introduction

The Fe-based nanocrystalline alloy has been reported to exhibit excellent soft magnetic properties including high saturation magnetization[1]. Therefore, the fabrication of soft magnetic powder cores using Fe-based nanocrystalline alloy is of interest. In the fabrication of soft magnetic powder cores, appropriate insulation between magnetic powders is important for obtaining optimum properties. In this study, Fe-based nanocrystalline powder cores were produced by cold pressing using silicon and phenol resin as an insulating material, and the high-frequency magnetic properties of compacted cores were reported.

Experimental details

Nanocrystalline FeSiBNbCu alloy powder was produced by pulverizing the melt-spun Febal.Si15.5B7Nb3Cu1 amorphous ribbon by rotor mill after annealing at 550 °C for 1 h in a vacuum. The mixture of the particle size under 45 m and 45-75 m intermixed by weight ratio of 1:1was used for fabrication of the cores. Toroidal shape powder cores were prepared by cold pressing under a pressure of 1.8 GPa using silicon and phenol resin as an insulating material, respectively. The high frequency magnetic properties of the compacted cores were measured by impedance analyzer and B-H analyzer.

Results and Discussion

Fig. 1 shows the frequency dependence of the effective permeability(e) and quality factor(Q) of the nanocrystalline FeSiBNbCu powder cores using phenol resin as an insulating material. The core without phenol resin shows a stable permeability of about 100 up to 50 kHz, indicating a high permeability in that range of frequency, whereas the permeability of the core with 5 wt.% phenol resin is 63 and persists up to 500 kHz. Although the addition of phenol resin reduces the level of permeability, the frequency dependence of the permeability could be improved. The core prepared from the powder with 9 wt.% phenol exhibits more improved frequency dependence of the permeability over 1 MHz. The nanocrystalline FeSiBNbCu powder core without phenol resin shows a core loss of 1400 mW/cm3. The core loss has a tendency to decrease as the amount of phenol resin increases. The core with an addition of 9 wt.% phenol resin exhibits a core loss of 630 mW/cm^3 at 50 kHz for Bm=0.1 T, indicating a remarkable decrease of the core loss. The well-distributed phenol resin between nanocrystalline FeSiBNbCu powders can separate powders electrically from each other, resulting in the reduction of eddy current loss in high frequency range. As a result, the high frequency characteristics of the nanocrystalline FeSiBNbCu powder cores could be improved by using phenol resin as an insulating material.

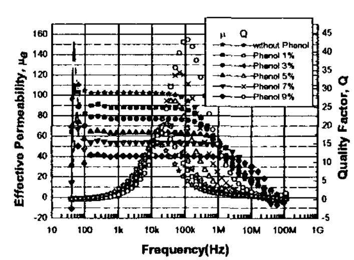

Fig. 1. frequency dependence of the effective permeability and quality factor

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RD03

Ferromagnetic Resonance of Soft Magnetic CoFeAlO Thin Films

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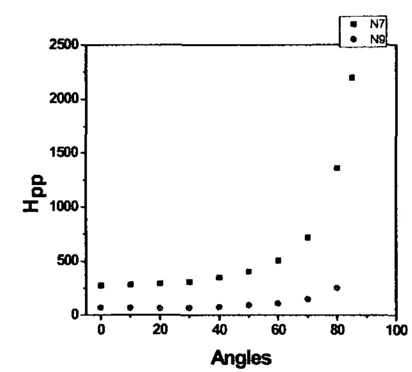
Soft magnetic materials have attached much interest in the scientific community, because of the capability of using them for high-density magnetic recording applications. CoFe-based alloys are considered to be the most suitable candidates for those applications because of high magnetization saturation, high effective permeability··· In order to investigate the temperature and annealing condition, angle dependence of magnetic properties in $Co_{70}Fe_{30}Al_{12}O_{4.5}$ soft magnetic thin films prepared by RF magnetron reactive sputtering technique, such as effective magnetization M_{eff}, the spectroscopic splitting factor g, and the exchange stiffness constant A, we carried out ferromagnetic resonance (FMR) experiments. Co-Fe-Al-O thin films were deposited in argon and oxygen mixed atmosphere using rf magnetron sputtering. Sputtering power was 300W and pressure was 2mTorr. The FMR linewidth depended on the applied field orientation as a function from 0 to 90° angles. The g factor is almost constant in the temperature range from 298 to 238K, but increase with decrease of temperature in the range below 238K, stiffness constant was analyzed by using the resonance condition of the spin wave modes.



The FMR linewidth depended on the applied field orientation as a function from 0 to 900 angles

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