CR01

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

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The fabrication of soft magnetic powder cores using Fe-based amorphous and nanocrystalline alloy powder is of great interest due to their excellent soft magnetic properties[1]. In the fabrication of soft magnetic powder cores, insulation between soft magnetic powder is essential for obtaining superior high frequency magnetic properties[2]. Various insulating materials such as the glass frit, phenol resin or polyamide were generally used to insulate the magnetic powders electrically. In the present work, oxide layer as an insulator was synthesized on the surface of Fe-based amorphous and nanocrystalline powder by dipping the powder into acid solution and electroless plating followed by thermal oxidation, respectively. Then, the toroidal shape powder cores were prepared by vacuum hot pressing and compaction at room temperature, respectively. The characteristics of the oxide layer and its effect on the high frequency magnetic properties of the compacted cores were investigated. The cores fabricated from the Fe-based amorphous and nanocrystalline alloy powder without oxide layer on the surface showed a stable permeability of about 100 up to 50 kHz and a core loss of over 1000 mW/cm^3 at 50 kHz for B_m=0.1 T, indicating a high permeability in that range of frequency but low high frequency characteristics due to the absence of insulating material between powders. Whereas, the Fe-based amorphous and nanocrystalline alloy powder cores prepared from the powder having oxide layer on the surface exhibited a stable permeability up to high frequency range over 10 MHz. The frequency dependence of the permeability could be effectively improved by the formation oxide layer on the Fe-based amorphous and nanocrystalline alloy powder. The cores fabricated from the Fe-based amorphous and nanocrystalline alloy powder with oxide layer showed a core loss of below 500 mW/cm^3 at 50 kHz for B_m=0.1 T, indicating a remarkable decrease of the core loss in comparison with that of the core without oxide layer. It is considered that oxide layer synthesized on the Fe-based amorphous and nanocrystalline alloy powder could reduce the eddy current loss by separating the powders electrically from each other, resulting in improvement of the high frequency characteristics of the powder cores. In addition, the effects of oxide layer thickness and mixed ratio of the powders with different oxide layer thicknesses on the high frequency characteristics of the powder cores are further discussed in this study. The Fe-based amorphous and nanocrystalline alloy powder cores prepared by this route can provide a potential alternative for high-frequency applications

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CR02

Preparation of Nano-crystalline Magnetite by SHS Method

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Nano-crystalline magnetite powder has been prepared successfully by self-propagating high-temperature synthesis (SHS) reaction using Fe and Fe_2O_3 as starting materials. The driving force for the reaction was the oxidation of iron powder. Reaction was carried out with the addition of sodium perchlorate as an internal oxidizing agent [1]. Starting materials were mixed with various molar ratios of Fe/Fe_2O_3, pressed into a cylindrical compact and then ignited by electrical heating in air. The synthesized powder has been subjected to intense milling using a planetary ball mill up to 10 h. The effects of Fe/Fe_2O_3 molar ratio as well as the milling time on the powder particle characteristics were investigated using XRD, SEM, TEM and VSM techniques. XRD results showed that the non-stoichiometric Fe/Fe_2O_3 molar ratio of Fe/Fe_2O_3=5 is more favourable to synthesize magnetite phase. The phase composition was not affected significantly by milling process while the mean particle size and crystallite size were decreased. The mean crystallite size of magnetite was measured as 90 nm in a sample processed with a Fe/Fe_2O_3 molar ratio of 5 and then milled for 10 h (see Fig. 1). The results was also showed that the post synthesis milling resulted in increasing the saturation magnetization probably due to the formation some Fe phase which could not be detected by XRD due to its low amount.

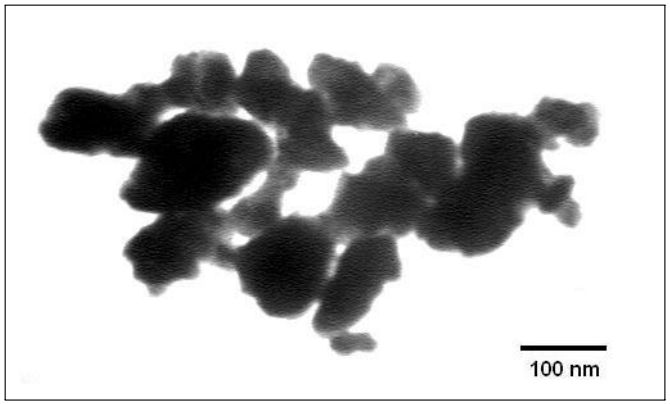

Fig. 1. TEM image of 10 h milled sample.

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