TE02

Permeability and Electric Resistivity of Spin-Sprayed Zn Ferrite Thin Films for High Frequency Device Applications

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By spin spray ferrite plating (an aqueous process) we have successfully prepared Ni-Zn ferrite films that have $\mu_s f_r$ (μ_s: static permeability, f_r: natural resonance frequency) product far exceeding the Snoek's limit. Utilizing the spin-sprayed Ni-Zn ferrite films we have fabricated GHz conducted noise suppressors, and we are developing their mass production system at present[1]. By varying concentration of Zn in the films, we can change f_r and thus tailor the operating frequencies of the noise suppressors[2]. In this study we measured complex permeability ($\mu = \mu' - j\mu''$) and electrical resistivity ρ in spin-sprayed pure Zn ferrite films in order to explore the feasibility of applying the films to MHz devices of current demand in IT field.

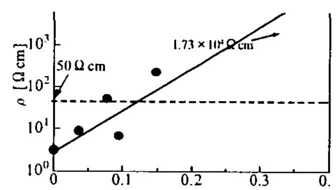

Fig. 1. Resistivities for $Zn_xFe_{3-x}O_4$ thin films.

We plated $Zn_xFe_{3-x}O_4$ ($0 \le x \le 0.97$) films for 30 minutes to the thickness of ca. 1.5 μm onto polyimide sheet and glass substrates. X-ray diffraction measurements revealed that they are of single phase with spinel structure, having (100) texture when $x < \sim 0.1$ and (111) texture when $x > \sim 0.15$. The films exhibited a linear increase of ρ in logarithmic scale on x as shown in Fig. 1. We obtained $\rho > 50$ Ωcm (a rough lower limit for high frequency device applications) when $x \ge 0.15$. Fig. 2 shows permeability spectra for the films having $\rho > 50$ Ωcm. The $x = 0.15$ film ($\rho = 2.28 \times 102$ Ωcm) had $\mu_s = 38.9$ and $\mu'' = 0$ at f < 200 MHz. For the $x = 0.36$ film ($\rho = 1.73 \times 104$ Ωcm) we obtained $\mu_s = 58.1$ and $\mu'' = 0$ at f < 100 MHz. When $x = 0.70$, ρ exceeded our experimental limit, and the film had $\mu_s = 93.5$ and $\mu'' = 0$ at f < 20 MHz. These data promise feasibility of applying the $x = 0.70$ film to such commercial power transformer or power line communication operated at several or tens MHz frequencies.

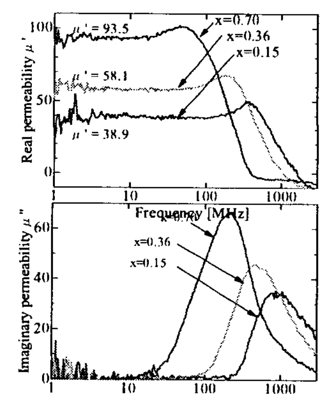

Fig. 2. Complex permeability spectra for $Zn_xFe_{3-x}O_4$

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TE03

Synthesis and magnetic properties of ferrite films prepared by coprecipition technique

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Magnetic nanoparticle films prepared by sol - gel reactions are widely investigated because of their excellent electromagnetic and chemical properties [1,2]. In this study, nanoparticle films of ferrite have been synthesized by a chemical coprecipitation technique. It is shown that densely packed ferrite films with a thickness of 5μm can be deposited from fine particles with a size of 10-30nm onto the Si substrate. The particle size, composition and magnetic properties are affected by the pH value of the reactive solutions. In general, for samples with lower pH value, the particles are small and agglomerate together, however, for samples with higher pH value, the particles are larger and distributed uniformly. Samples fabricated with higher pH value show larger values of magnetization and lower coercive force as shown in Fig. 1. This can be understood by the scan electron microscope and X-ray diffraction pattern studies (shown in Fig. 2). The result of larger magnetization relates to larger particle size and more uniform distribution for samples with higher pH values.

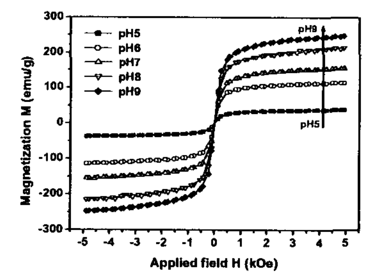

Fig. 1. X-ray diffractogram for all samples with different pH value of the reactive solutions.

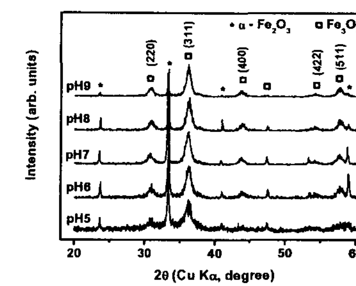

Fig. 2. Field dependence of magnetization curves for all samples with different pH value of the reactive solutions.

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