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High-Frequency Magnetic Properties of Fe-Based Amorphous Powder Cores by Cold Pressing

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1. Introduction

A great effort has been devoted to fabricate Fe-based soft magnetic amorphous cores by a powder metallurgical process using various consolidation techniques[1-2]. In a Fe-based amorphous alloy with a large supercooled liquid region($\Delta T=T_x-T_g$), amorphous powder can be easily transformed into bulk form by consolidation using the significant viscous flow of supercooled liquid. However, in a Fe-based amorphous alloy with a narrow or without a supercooled liquid region, it is difficult to obtain bulk amorphous alloy due to the large elastic limit and lack of plasticity. Therefore, the appropriate forming method and increase of packing density is an important issue for the fabrication of soft magnetic amorphous powder cores by cold pressing. In this study, the permalloy powder was used as a metallic binder for fabricating FeSiB amorphous powder cores by cold pressing. The effects of the permalloy powder on the compaction and high-frequency magnetic properties were reported.

2. Experimetal Procedure

FeSiB amorphous powder with a composition of $Fe_{bal.}Si_{14}B_{10}$ was fabricated by a gas atomization technique. The characteristics of the gas-atomized powder were verified by XRD using CuKα -radiation, VSM and DSC, respectively. Toroidal shape FeSiB amorphous powder cores with the addition of different amounts of permalloy powder were prepared by compaction under a pressure of 18 ton/cm^{2}at room temperature. Silicon resin of 1 wt.% and glass-frits of 1 wt.% was used as an insulator between FeSiB amorphous powders, respectively. The effective permeability(μ_e) and the dc-bias property were measured using an impedance analyzer. The core loss was measured by a B-H analyzer.

3. Results and Discussion

A fully amorphous FeSiB powder without any crystallinity could be successfully obtained in the particle size range below 75 m by gas atomization. The amorphous FeSiB powder smaller than 75 m shows and the saturation magnetization of 125 emu/g, a coercivity of 0.4 Oe and an onset temperature of crystallization(T_x) of 873.3 K.

Fig. 1 shows the frequency dependence of the effective permeability of the FeSiB morphous powder cores with an addition of permalloy powder. Here, silicon resin of 1 wt.% was used as an insulator between FeSiB amorphous powders. The FeSiB amorphous powder core without permalloy powder shows stable permeability of 25 up to 10 MHz, indicating a low permeability in

that range of frequency. The value of permeability increases with an increase of the permalloy powder content. The core with an addition of 50 wt.% permalloy powder shows stable permeability of about 45 up to 1 MHz. According to the SEM micrograph, the permalloy powders were plastically deformed by compaction. These plastically deformed permalloy powder filled empty space between FeSiB amorphous powders, which can be effective in improving the permeability of the FeSiB amorphous powder cores. However, the addition of permalloy powder deteriorates the frequency dependence of permeability at high content of permalloy powder. The core loss increased as the amount of permalloy powder increased. The increase of core loss is considered to be due to the increase of the eddy current loss caused by inter-particle contact. With an increase of permalloy powder content, electrical contact between non-insulated permalloy powder increases, which results in the increase of eddy current loss. The FeSiB amorphous powder core with an addition permalloy powder shows superior dc-bias properties of 85 % permeability at H=50 Oe.

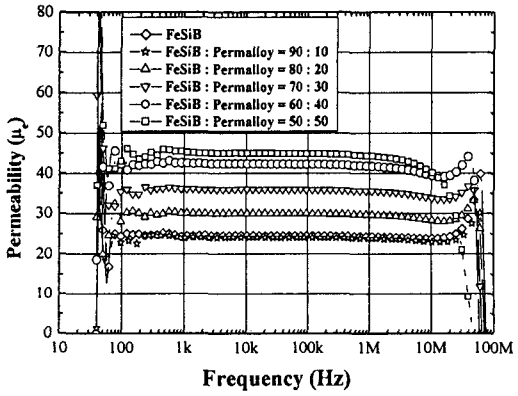

Fig. 1 The effective permeability for FeSiB amorphous powder cores with an addition of permalloy powder.

4. Conclusion

FeSiB amorphous powder with good soft magnetic properties was successfully obtained by high-pressure gas atomization in the particle size range below 75 μm. Permalloy powder as a metallic binder enables consolidation of the FeSiB amorphous powder cores by cold pressing. The addition of permalloy powder increases values of permeability of the cores, but it deteriorates the frequency dependence of permeability at higher content of permalloy powder.

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5. References

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