SE05

Effects of Lattice Strain on Magnetic and Electromagnetic Absorption Properties for Crystalline Fe-Si-Al Alloy Powder-Polymer Composites

Sung Jae Lee[1,a], Yoon Bae Kim[2,b], Kyung Sub Lee[3,C], Dong Jin Byun[4,d], and Sang Woo Kim[1,e*]

[1]Nano-Materials Research Center, Korea Institute of Science and Technology, 39-1 Haweoulgog-dong, Sungbuk-gu, Seoul 136-791 Korea

*Corresponding author: swkim@kist.re.kr phone: +82-2-958-5512 fax: +82-2-958-5529

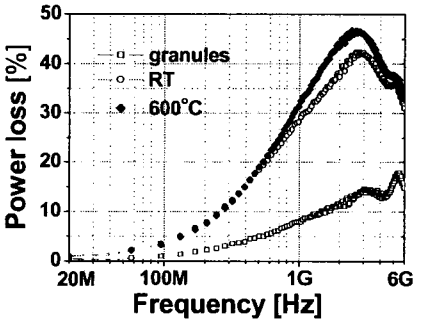
In order to improve electromagnetic absorption properties in the radio frequency for the electromagnetic absorber, we investigated effects of lattice strain on magnetic and electromagnetic absorption properties for crystalline FeSiAl alloy powder-polymer composites. The lattice of FeSiAl alloy powderswas highly strained during microforging process. The lattice strain of the microforgedFeSiAl powder gradually decreased with annealing temperature and greatly relieved by annealing at 600℃. The magnetic saturation and the magnetic permeability significantly increased by the microforging and subsequent annealing treatment due to the stress relaxation of the microforged powders. As a result, the electromagnetic absorption in the far field regime was considerably improved by the relief of lattice strain in the frequency range from 50 MHz to 6 GHz for the crystallineFeSiAl alloy powder-polymer composites.

Introduction

In order to obtain high performance electromagnetic absorption properties for the RF noise in the electronic devices, soft magnetic metal alloy powder-polymer composites have been studied because of their excellent soft magnetic properties such as relative permeability and saturation magnetization [1-3].

Experiments

The plate-like soft magnetic FeSiAl alloy powders were produced by microforging process in a high energy mill. The as-microforged powders were annealed in a furnace from 300℃ to 700℃ for 1 hour under argon gas atmosphere.



Results and discussion

Fig. 6 showed the power loss for the soft magnetic FeSiAl alloy-polymer composites at different powder condition. The maximum power loss of the 600℃ annealed powder-polymer composites was improved about 10% higher than that of the as-microforged powder-polymer composites.. Consequently, the improvement of the electromagnetic absorption by annealing treatment was attributed to the increase of the magnetic permeability due to the relief of internal strain of the as-microforged powders.

REFERENCES

[1] S. Ohnuma, H. J. Lee, N. Kobayashi, H. Fujimori, T. Masumoto, IEEE Trans. Magn. 37, 2251 (2001).
[2] S. Ge, X. Yang, K. Y. Kim, L. Xi, X. Kou, D. S. Yao, B. Li, X. Wang, IEEE Trans. Magn. 41, 3307 (2005).
[3] Ki Hyeon Kim, J. Magnetics. 11, 1235 (2006).

SE06

Ultrasoft Magnetic Properties of Co-Fe-Hf-O Nanocomposite Films

Nguyen Duy Ha[1], Le Anh Tuan[2], Cheol Gi Kim[2], Chong-Oh Kim[2], Seong-Cho Yu[3], The-Long Phan[4] and Manh-Huong Phan[5*]

[1]The Kamerlingh Onnes Laboratory, Leiden University, P.O. Box 9504, 2300 RA Leiden, The Netherlands
[2]Research Center for Advanced Magnetic Materials, Chungnam National University, Daejeon 305-765, Korea
[3]Department of Physics, Chungbuk National University, Cheongju 361-763, Korea
[4]Microstructures Group, Department of Physics, University of Bristol, Bristol BS8 1TR, England
[5]Advanced Composites Centre for Innovation and Science, University of Bristol, Queen's Building, Bristol BS8 1TR, England

*Corresponding author: M.H.Phan@bristol.ac.uk, Phone: +441173317917, Fax: +441179272771

Ferromagnetic Co-Fe-Hf-O thin films hold a big promise for high-frequency applications of micromagnetic devices such as thin-film inductors and transformers for microswitching converters and ultrahigh-density recording heads, owing to their high electrical resistivity, large saturation magnetization and hard-axis anisotropy field [1]. It has been shown that a Co-Fe-Hf-O film normally comprises two disordered phases, namely, a nanocrystalline Co(Fe)-rich phase and an amorphous HfO-rich phase, and the film properties vary considerably with the different phase structure [2,3]. Therefore, in order to produce a Co-Fe-Hf-O film with desired properties, it is necessary to tailor the phase structure through optimizing the phase volume fraction, and this represents an interesting topic in scientific research.

In this work, our efforts have been devoted to improve the high-frequency magnetic performance of Co-Fe-Hf-O films through fine-tuning the composition with varying oxygen concentration. The films were deposited onto Si(100) substrates using a oxygen reactive rf-sputtering method. It has been shown that the Co-Fe-Hf-O thin films possess not only high electrical resistivity but also large saturation magnetization and hard-axis anisotropy field. Among the compositions investigated, the $Co_{19.35}Fe_{53.28}Hf_{7.92}O_{19.35}$ film exhibits ultrasoft magnetic properties with high saturation magnetization of $4\pi M_s$~19.86 kG, and low coercivity of H_c~1.5 Oe. With increasing frequency, the magnetic permeability remains almost constant up to 3 GHz and reaches maximum at the ferromagnetic resonant frequency of 4.024 GHz. These magnetic properties together with an extremely high electrical resistivity of 3569 μΩcm make the film ideal for high-frequency applications. It is revealed that the formation of a particular structure, i.e. the $[CoFe/HfO_2/CoFe]_n$ tunnel multijunction, resulted in these superior properties.

REFERENCES

[1] T. Sato, Y. Miura, S. Matsumura, K. Yamasawa, S. Morita, Y. Sasaki, T. Hatanai, and A. Makino, J. Appl. Phys. 83, 6658 (1998).
[2] M. Esseling, Y. Luo, and K. Samwer, Europhy. Lett. 68, 100 (2004).
[3] Y. Luo, M. Esseling, K. Zhang, G. Guntherodt, and K. Samwer, Europhy. Lett. 73, 415 (2006).