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Electromagnetic Wave Absorption Property of $Fe_{73.5}Si_{13.5}B_9Nb_3Cu_1$ Powder/epoxy Composites in the 5 GHz Region

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In the last decade, with an increasing use of a high frequency, concern has arisen about the harmful effect of electromagnetic waves to humans and electric devices [1]. In particular, a 1~5 GHz frequency range is used in mobile devices or wireless network systems, and in the near future, it is expected that the frequency range will shift to a higher range in order to increase the transfer rates. There are three kinds of electromagnetic wave absorption mechanisms, i.e., dielectric loss, conductive loss and magnetic loss [2]. Among these mechanisms, there is a problem in absorbing an electromagnetic wave using a magnetic material in a high frequency region due to the eddy current loss.

In this study, we fabricated electromagnetic wave absorbers using $Fe_{73.5}Si_{13.5}B_9Nb_3Cu_1$ powder in an epoxy (diglycidyl ether of bisphenol A type) matrix in order to reduce the eddy current loss. Specially, an electron beam curing technique was used to cure the epoxy matrix. It is a non-thermal, non-autoclave curing process and it reduces the curing time and overall manufacturing costs [3]. The powder shape was a flake type with a 15 μm diameter and a 300 nm thickness observed using a scanning electron magnetic microscopy. And the complex permittivity and the complex permeability of the composites were measured using a network analyzer [4]. To establish the impedance matching condition, the reflection losses of the composites were calculated from the permittivity and permeability values with changes of the thickness of the absorber and the frequency [5]. It was shown that the reflection loss was below -20 dB from 4.23 GHz to 4.93 GHz with a 3.8 mm thickness. This result means that this electromagnetic absorber may cover a broad frequency range (about 700 MHz) with a 99 % absorption efficiency. Thus, it is believed that composites of $Fe_{73.5}Si_{13.5}B_9Nb_3Cu_1$ powders in an epoxy matrix may be promising materials for an electromagnetic wave absorber.

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AR01

The Investigation of the Magnetic Domain Structures in Exchange Biased thin Film Bilayers by Photoemission Electron Microscopy (PEEM)

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The shift of a magnetic hysteresis loop away from zero field in a system composed of a ferromagnet (FM) coupled to an antiferromagnet (AF) when the FM/AF bilayer is field-cooled below the Neel temperature (TN) of the AF is called exchange bias [1]. The magnetic circular dichoric (MCD) effect in XAS-based PEEM [2] was employed to acquire the magnetic domain structures in NiFe/Cr-oxide and NiCo/(Ni,Co)-oxide exchange biased thin film bilayers at temperatures below the TN of AFs. A dual ion-beam deposition technique [1] was used to prepare the NiFe/Cr-oxide and NiCo/(Ni,Co)-oxide bilayers. Direct evidence of exchange coupling between the AF and FM layers is provided by PEEM. The contrast reversal at room temperature in an ultra high vacuum system without the application of a magnetic field confirms that the magnetic domains consist of ferromagnetic NiCo. However, the NiCo/(Ni,Co)O (8%O2/Ar) bilayer clearly displays stripe domains which are characteristic of the exchange bias. This is due to the AF (Ni,Co)O layer being exchange coupled to the FM NiCo layer. Further, a sudden change in the PEEM images was observed in NiCo/(Ni,Co)O (30%O2/Ar) bilayer. This is likely due to the AF (Ni,Co)O spin reorientation from in-plane toward out-of-plane direction resulting from ion-beam bombardment [1]. For the NiFe/Cr-oxide bilayers, the magnetic domain seems to break into small domains with increasing %O2/Ar ratio. This is associated with the different magnetocrystalline anisotropy of Cr and Cr2O3 when either AFs are in contact with the top NiFe layer. However, unusual triangular-shape domains was observed when the bilayers were deposited on a single crystal Al2O3(0001) substrate. Further, the transition of the triangular-shape domains into stripe domains was observed in NiFe/annealed Cr2O3/ Al2O3(0001) bilayers. We attribute this domain wall behavior to an induced perpendicular exchange bias (as characterized by SQUID magnetometry) that results from microstructural modifications throughout the AF layer.

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