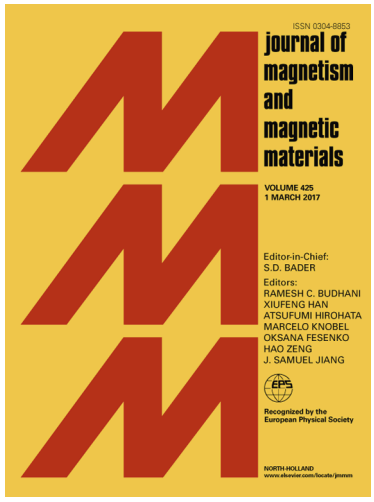

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Effects of Co_2O_3 on electromagnetic properties of NiCuZn ferrites

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The effects of Co_2O_3 addition on the electromagnetic properties of NiCuZn ferrite were investigated, by considering the variation of complex permeability, complex permittivity and quasi-microwave absorption property in the 1~1000 MHz frequency range. Results show that the introduction of Co^{3+} ions in NiCuZn ferrite leads to the marked shifting of magnetic resonance towards high-frequency and a slight increase of the permittivity. These Co-related effects enhance the maximum reflection loss in NiCuZn ferrite to reach -55.1 dB with its absorption bandwidth being tunable in the frequency range 480 to 1000 MHz, which provides a potential absorber for the anti-electromagnetic interference applications in electronic industry.

NiCuZn ferrite; Co_2O_3 addition; Permittivity; Permeability; Absorption property

1 Introdution

With rapid development and wide application of modernized instruments and electronic devices, the surroundings are jammed with electromagnetic (EM) radiations and their interferences, giving rise to the unwanted EM noises and pollution [1-4]. The reduction or elimination of electromagnetic interference (EMI) between EM wave radiating systems and electronic devices plays a significant role in practical applications [5-8]. Motivated by this, EM wave absorbing materials have attracted ever-increasing attention. Spinel ferrite, as an attractive magnetic materials, have been most widely used in quasi-microwave bands for suppressing EMI, which is superior to the conventional dielectric counterparts owing to the excellent magnetic properties [8-11]. Among them, NiCuZn ferrite has attracted many attentions in recent years due to their high electrical resistivity, outstanding chemical stability and appreciable permeability at intermediate to high frequencies [10-13]. Considerable efforts have attempted to further improve the sintering, dielectric and magnetic properties of NiCuZn ferrites by introducing oxide substitutions or additives into NiCuZn ferrites [10-15]. Specially, the introduction of Co_2O_3 into NiCuZn ferrites had been demonstrated to be an efficacious way to modulate the electromagnetic behavior by tuning complex permeability and the complex permittivity [14-16]. Early on, Dimri *et al*. studied the effect of Co substitution with small concentration on the dielectric behavior in NiCuZn ferrites at microwave frequency. The Co-substituted NiCuZn ferrite presented an increase in the value of ε'←with increasing Co addition in the range of 0.01 to 0.03wt% [14]. Subsequently, Su *et al*. investigated the influences of Co_2O_3 concentration on the magnetic properties of nanocrystalline NiCuZn ferrite [15]. They found that the permeability of the ferrite decreased monotonically with increasing Co_2O_3 and the observed Q-factor of ferrite reached a peak value with 0.2 wt% Co_2O_3 added. Recently, Yang *et al*. reported the improved Q-factor in substituted NiCuZn ferrites and confirmed its excellent electromagnetic shielding function at 13.56 MHz [16]. However, the absorption property of Co_2O_3-doped NiCuZn ferrites in the quasi-microwave region had seldom been studied. Proverbially, the reflection and attenuation characteristics of absorber largely depended on the complex permeability, the complex permittivity, electromagnetic impedance matching and layer thickness [17, 18]. As described above, the dynamic electromagnetic response of NiCuZn ferrite doped by Co_2O_3 may provide a feasible pathway to improve the absorption property. In view of this, the influence of Co_2O_3 concentration (0, 0.5, 1.0 and 1.5 wt%) on microstructural, permeability and permittivity, as well as absorption property were investigated. It is found that EM-wave absorption property is improved by the additive Co_2O_3 in the developed NiCuZn ferrites.

2 Experimental details

The NiCuZn ferrite with the composition of $Ni_{0.78}Cu_{0.20}Zn_{0.02}Fe_{1.96}O_{3.94}$ was prepared by the conventional solid-state reaction method. Analytical grade Fe_2O_3, NiO, CuO and ZnO were weighed according to the target formula and mixed for 2 hours in a planetary ball mill. After drying, the powder was calcined at 800 ℃ for 2 hours. The calcined powder was mixed with Bi_2O_3 sintering aid (0.2 wt%) and different contents of Co_2O_3 (0, 0.5, 1.0 and 1.5 wt%), and then wet-milled for 3 hours in planetary mill. The dried powders were granulated with polyvinyl alcohol (PVA), pressed into toroidal and disk-shaped samples, and finally sintered at 900 ℃ for 2 hours.

The crystalline phases of sintered samples were identified by X-ray diffraction (XRD, Philips X-pert PRO). Microstructure of the samples was studied by scanning electron microscope (SEM, TESCAN VEGA 3). The elemental spectra of the sintering samples