Magnetic Properties of NiZnCu Ferrite Powders and Thin Films Prepared by a Sol-Gel Method

Woo Chul Kim, Sam Jin Kim, Young Rang Uhm, and Chul Sung Kim

Abstract—**Ultrafine $Ni_{0.63}Zn_{0.17}Cu_{0.2}Fe_2O_4$ powders and thin films were fabricated by a sol-gel method and their magnetic and structural properties were investigated with thermogravitric and differential thermal analysis (TG-DTA), x-ray diffractometer (XRD), transmission electron microscope (TEM), Mössbauer spectrometer, atomic force microscope (AFM), and vibrating sample magnetometer (VSM). TG-DTA measurements showed exothermic reaction peak at 306 °C with weight loss of 49%. NiZnCu ferrite powders which were fired at and above 450 °C had only a single phase spinel structure and behaved ferrimagnetically. Powders annealed at 250 and 350 °C had a typical spinel structure and were simultaneously paramagnetic and ferrimagnetic in nature. The magnetic behavior of NiZnCu ferrite powders fired at and above 550 °C showed that an increase of the annealing temperature yielded a decrease in the coercivity and an increase in the saturation magnetization. The maximum coercivity and the saturation magnetization of NiZnCu ferrite powders were $H_c = 160$ Oe and $M_s = 64$ emu/g, respectively. NiZnCu ferrite thin films annealed at 650 °C had a single phase spinel structure and there was no significance difference of their magnetic properties for external fields applied parallel and perpendicular to their planes. The microstructure of thin films annealed at 650 °C consisted of spherical grains with the average size of 120 nm and 5 nm in surface roughness (rms).**

Index Terms—**Ferrites, Mössbauer spectroscopy, sol-gel method, thin film, vibrating sample magnetometer.**