Effect of Preparation Conditions on the Structural and Magnetic Properties of NiZn Ferrite Nanoparticles

유춘리*, 유필선, 채윤기, 권윤미, 이보화
한국외국어대학교 전자물리학과

1. Introduction

Ferrites are advantages over other soft magnetic materials for applications in high frequencies because they exhibit high electrical resistivities combined with useful ferrimagnetic properties. Recently, there has been enhanced interest in developing ferrite materials at nanoscales. When the size of the magnetic particle is smaller than the critical size for multidomain formation, the particle exists in a single domain state and domain wall resonance is avoided; therefore the material can work at higher frequencies.[1,2] In this respect, more investigations of ferrite particles at nanoscales need to be carried out in order to understand the physical properties and to meet the technological requirement for high frequency applications.

Regarding the synthesis methods of nanoparticles, chemical methods often provide better homogenieity and greater uniformity in particle size and size distribution.[3] Among various chemical synthesis routes, sol gel in 2-methoxyethanol is simple and excellent in composition control. In this work, we discuss the effects of precursor solution concentration and annealing temperature on the structural and magnetic properties of NiZn ferrite nanoparticles synthesized by sol gel in 2-methoxyethanol.

2. Experimental Method

Iron(III) nitrate nonahydrate($Fe(NO_3)_3 \cdot 9H_2O$), nickel nitrate hexahydrate ($Ni(NO_3)_2 \cdot {}_6H_2O$) and zinc nitrate hexahydrate ($Zn(NO_3)_2 \cdot 6H_2O$) were used as precursors for the preparation of the starting sol. The precursors were dissolved in 2-methoxyethanol with molar ratio of Ni:Zn:Fe=1:1:4. The precursor concentration was adjusted by the volume of the solvent 2-methoxyethanol. The precursor solution was stirred for 3 h at room temperature to form a stable solution. Then the solution was evaporated at ~60℃ to remove most of the liquid. The solution was finally dried at 95℃ in an oven to form powder, which was annealed at 300~800℃ to crystallization and form nanoparticles.

3. Results

The annealing temperature showed critical effect on the crystallization of the NiZn ferrite nanoparticles. It is clearly shown in Fig 1. that NiZn ferrite crystallized at annealing temperature higher than 600℃. The better crystallinity also induced an improved magnetic property, which was confirmed by the M-H curve measurement using Vibrating Sample Magnetometer (VSM). as illustrated in Fig. 2.

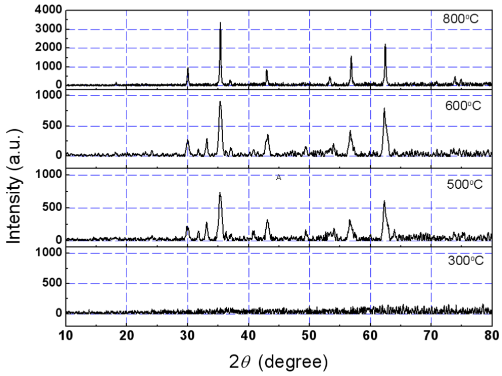

Fig. 1 XRD of NiZn ferrite nanoparticles annealed at different temperatures.

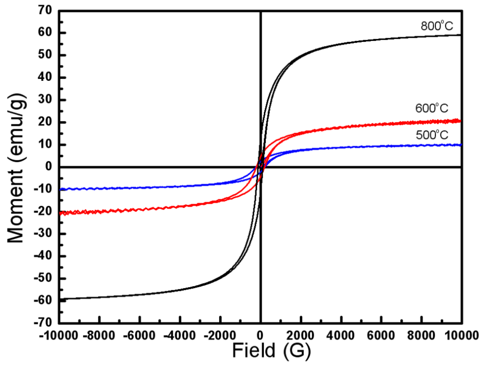

Fig. 2 M-H curves of NiZn ferrite nanoparticles annealed at different temperatures.

The effect of the concentration of the precursor solution was also investigated. The concentration of the precursor solution was adjusted to 0.1, 0.3, 0.5, and 0.75M by 2-methoxyethanol. The VSM measurements revealed that the saturation magnetization of the NiZn ferrite nanoparticles increased increased with the precursor solution concentration. Through the XRD, and TEM measurement, we will discuss the change of structural and magnetic properties of NiZn ferrite with the concentration of the solution.

4. Conclusion

The effects of preparation conditions (annealing temperature and solution concentration) of NiZn ferrite nanoparticles using sol gel in 2-methoxyethanl were investigated. According to these results, it is possible to adjust the properties of NiZn ferrite nanoparitcles according to applications by varying the preparation conditions.

5. References

[1] A. C. Razzitte and S. E. Jacobo, J. Appl. Phys. **87**, 6232 (2000).

[2] Z. X. Tang, C. M. Sorensen, K. J. Klabunde, and G. C. Hadjipanayis, Phys. Rev. Lett. **67**, 3602 (1991).

[3] B. P. Rao, G.S.N.Rao, A. M. Kumar, K. H. Rao, Y. L. N. Murthy, S. M. Hong, C.-O. Kim, and C.G. Kim, J. Appl. Phys. **101**, 123902 (2007).