FMRI RET 2016-Effects of Bi_2O_3 Doped Ni-Zn Ferrite

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Abstract

Many studies recently have been focused on Ni-Zn ferrite as microwave material. The goal is to produce Ni-Zn ferrite with structural characteristics that enhance magnetic properties that allow for application in NFC (Near Field Communication. The ferrite sheet enhances the ability for the antenna to function at longer distances between the frequency range of 1Mhz to 3Mhz as well as decrease any magnetic losses. Ni-Zn ferrites ($Ni_{0.33}$ $Cu_{0.2}Zn_{0.47}Fe_{1.96}O_{3.94}$) were successfully prepared using solid state method and doped with Bi_2O_3 0.5 wt%. Bi_2O_3 has been used before to improve densification of ferrites. The effects of Bi_2O_3 with differing ball milling times on sintering temperature as well as structural properties that enhanced magnetic properties were investigated. It was found that as the ball milling time increased, particle size decreased. After 12 hours, particle size was decreased to 2.276 micron. Previous studies have shown that smaller particles are correlated to increased permeability. Though further research is needed in this area, this material may be beneficial in ferrite sheets for applications in NFC.

Background

NFC (Near Field Communication) is technology that allows for two electronic devices to communicate with each other. Current technology allows for NFC to occur between 1-10 cm. Ni-Zn ferrites work to improve magnetic characteristics by enhancing the distance that the antenna is able to operate at with minimal power loss. Ni-Zn ferrites have high resistivity, low dielectric losses, high Curie temperature and chemical stability. [1]

Doping is a process used to introduce impurities to the material that enhances its properties. Bismuth III oxide has been used commonly to improve densification of ferrites. It's low melting point allows Bi_2O_3 to form a liquid phase through the sintering process. [2] Ni-Zn ferrites were successfully synthesized and doped with Bi_2O_3 0.5 wt% at different ball milling times. The effects of Bi_2O_3 with differing ball milling times on sintering temperature as well as structural properties that enhanced magnetic properties were investigated.

Objectives

- To prepare Ni-Zn ferrite doped with Bi_2O_3 using the solid state technique.
- To measure effects of Bi_2O_3 on structural properties.

Approach

Ni-Zn ferrite was synthesized with the solid state method.

Preparation of Powder:

1.The powders were measured precisely according to molecular weight.
2.Powders were then mixed for 2 hours in steel ball-mill using distilled water as the mixing medium.
3.Powders were dried at 100 ◦C on hot plate.
4.They were then calcined at 800 ◦C for 2 hours

Fig. 1. Planetary ball mill station and furnace.

Doping of Ferrite Powder

1.Bi_2O_3 powder was measured precisely for 0.5 wt% to use as dopant.
2.Powders were then dry ball-milled for 1 hour, 4 hours, 7 hours and 12 hours.

Formation of Pellet

1. The powders were then mixed with a binding agent, polyvinyl alcohol, 10 wt%, with mortar and pestle.
2. Once pellet was formed, it was sintered for 2 hours at 890 ◦C

Fig. 2. Mixing powders with binding agent, pellet after sintering, Malvern particle size analyzer.

Characterization of Ferrite Powder:

1.Using the Malvern particle size analyzer, particle sizes were measured.
2.Repeat for each sample.

Conclusions

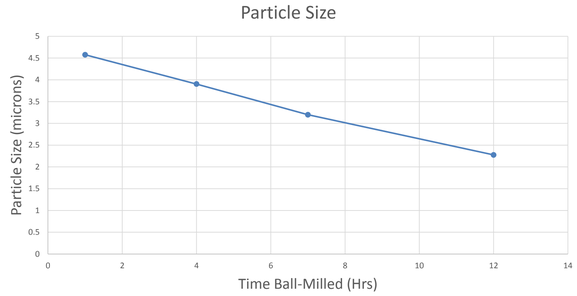

Fig. 3. The particle grain size of Bi_2O_3 0.5 wt% doped Ni-Zn ferrite as a function of time ball milled.

The Malvern particle size analyzer was used to determine the particle size of the powder. It was found that as ball milling time increased, particle size decreased. After 1 hour, particle size was at 4.576 micron and slowly decreased as ball milling time increased. After 12 hours, particle size was at 2.276 micron. Previous studies have shown with decreased particle size, magnetic properties increased. As magnetic losses are decreased, permeability of the material increases. These properties are important to the increase of functionality in the ferrite sheets.

Future work

Some areas of future work include:

1. Determination of permeability and permittivity of Bi_2O_3 doped Ni-Zn ferrites.
2. Determination of reflection coefficient with VNA (Vector Network Analyzer.

Referenced Resources

1. Liew, X. T., Chan, K. C., & Kong, L. B. (2009). Magnetodielectric Ni ferrite ceramics with Bi2O3 additive for potential antenna miniaturizations. *Journal Of Materials Research*, *24*(2), 6.
2. Bhalla, Deepak, et al. "Material Processing Technology for Soft Ferrites Manufacturing." *American Journal of Materials Science* 2.6 (2012): 165-170.

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