Mn-Zn FERRITE FABRICATED BY SPARK PLASMA SINTERING

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Introduction

Soft magnetic ferrite is used as magnetic core material for devices used in high frequency (MHz – GHz) because the eddy current loss can be suppressed because of its high electric resistively compared with metallic soft-magnetic materials. Nowadays, the soft magnetic ferrite is widely used in many kinds of devices such as in isolator, transformer, inductor, etc. to which requirements of miniaturization and reduction of height becomes very severe. Therefore, it is desired to develop ferrite with superior soft magnetic properties and small loss.

Spark Plasma Sintering (SPS) is a new sintering method performing pressurizing in uniaxial direction and heating up utilizing the effects of spark plasma generated in the gap between powder starting material. In this work, SPS method was applied to fabrication of Mn-Zn ferrite.

Experimental

SPS apparatus used in this experiment was SPS-1050 made by IZUMI TECH. CO., LTD.. Mn-Zn ferrite powder (Fe_2O_3:MnO:ZnO=53.5:32.2:14.3 (mol%)) made by TODA KOGYO CORP. was prepared as starting material. Ferrite powder was put in a graphite die, and was pressed from upside and downside by graphite punches. Carbon films were inserted between ferrite powder and graphite die and punches as a separator. Off and on DC voltage was applied to the punches to heat up ferrite powder and generate spark plasma. Sintering was performed in vacuum atmosphere applying uniaxial pressure of 15.9MPa at 1000℃ for 30minutes. Size of sintered cylindrical ferrite was 20mm in diameter and 15mm in height.

Sintered ferrite was sliced in parallel to the bottom surface. Thickness of each sliced specimen was about 0.6mm except for the most outer part whose thickness was 1.35mm. Magnetic properties of sliced specimen were measured by Vibrating Sample Magnetometer (VSM) and Hc meter. Crystal structure was measured by X-ray diffraction method.

Results and Discussion

The sliced ferrite specimens are marked as #1, #2, ···, #5 from the most outside toward the center of sintered ferrite.

Fig.1 shows X-ray diffraction diagrams of sliced ferrite specimen. Diffraction peaks marked with O was originated from Mn-Zn spinel ferrite. While the diffraction peak of carbon that was used separator was seen for specimen #1, it wasn't seen for the specimens #2 - #5. Diffraction peak intensity for #2 was smaller than that for #3 and #5. From this result, it was found that sintered ferrite with good crystallinity was formed at the position at least about 2mm apart from the edge without influence of carbon separator sheet.

Table 1 shows distance from the edge of sintered ferrite, Hc and Ms of sliced ferrite. Hc and Ms for specimen #1 are apparently different from others. It is supposed the carbon separator sheet influenced to increase Hc and decrease Ms. For specimens #2 - #5, good soft magnetic properties was achieved.

Summary

Cylindrical Mn-Zn ferrite material with height of 15mm was prepared by SPS method. Center part of the sintered ferrite showed good soft magnetic properties, large Ms and good crystallinity. However, the edge part within 2mm from the surface of sintered ferrite was deoxidized by the carbon film used as a separator.

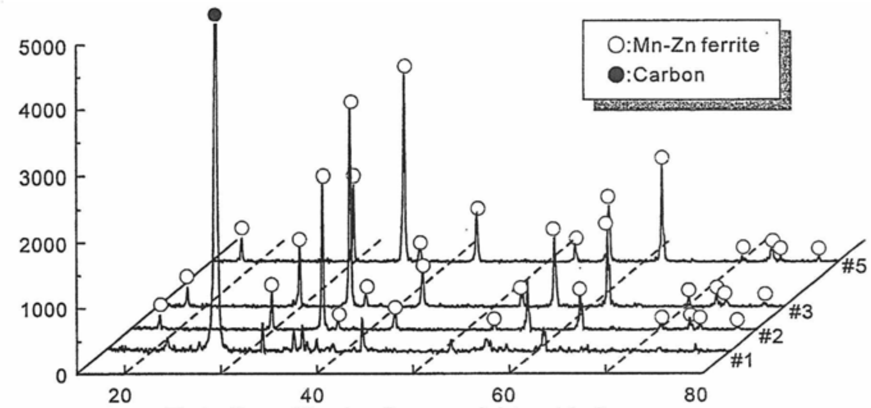

Fig.1 X-ray diffraction diagrams of sintered ferrite

Table 1 Distance, H_C and M_S of sintered sample from #1 to #5

Sample	Distance (mm)	H_C (Oe)	M_S (emu/g)
#1	0.68	2.15	30.6
#2	1.14	1.45	82.8
#3	2.28	1.12	84.0
#4	3.11	1.17	76.7
#5	3.93	1.18	77.9