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Development of Wireless Power transfer system Using Multilayer Ceramic Technology

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Abstract: This paper suggests a wireless power transfer system fabricated by a multilayer ceramic technology. The wireless power transfer system has been focused as power supply method. However, conventional coil for the wireless power transfer was used a winding wire, and it is difficult to miniaturize because it forms a spiral coil. The multilayer ceramic technology has a characteristic of that it can form a helical coil structures. Developed coil is fabricated by low temperature co-fired (LTTC) ceramic using multilayer ceramic technology. An electromagnetic induction method is adopted for transfer system. Fabricated ceramic transfer coil and a winding wire coil are compared, and the miniaturization of the transfer coil was realized.

1. Introduction

Wireless power transfer has been focused as power supply method. The wireless power transfer has some method. For example, there is a resonance system with the electromagnetic induction method and magnetic method. Most of power transfer method is used the electromagnet induction method because transmission efficiency is high. Recently, it is expect to apply in electric vehicle and medical equipment such as the implantable artificial heart and the endoscope micro-robot [1][2].

Conventionally, the wireless power transfer system has been constructed by the winding wire coil. In addition, the winding wire is usually designed spiral pattern. However, the spiral pattern coil is difficult to miniaturize. Because, the large area and the long coil are required for catch the divergence flux. In addition, the package of the coil is required. Moreover, the magnetic material is used for catch the magnetic flux. As a result, two different techniques such as the winding wire and the magnetic material is required.

Therefore, we focus on the multilayer ceramic technology. Multilayer ceramic technology is patterning the multilayered circuit in the structure. Therefore, miniaturize and three dimensional helical structures are achieved and it is possible to integrate. In addition, ferrite shows excellent magnetic characteristics. It is possible to fabricating the coil structure by the magnetic core and the deflection yoke by the ceramic technology. Moreover, miniaturization is possible by formed a helical structure.

In this study, the purpose is that the coil structure for wireless power transfer is fabricated only ceramic material. In addition, winding wire structure and the multilayer ceramic coil structure is compared.

2. Design and Experimental Procedure

We fabricated two coils to experiment. It is a helical coil and spiral coil. Figure 1 shows a schematic illustration of spiral coil. Top layer is ceramic layer, and second layer and third layer are coil pattern layers. Moreover, 10 ceramic layers are laminated to reduce deformation of the structure. This structure is hollow architecture to combine the magnetic ceramic. Spiral coil pattern is 18turns, Line and space are 250 μm.

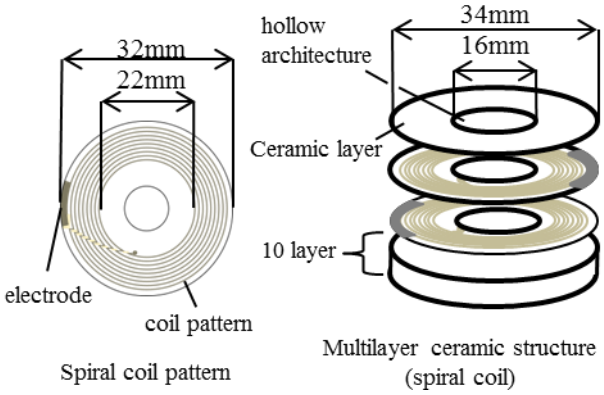

Fig.1. Design of spiral pattern coil

Figure 2 shows a schematic illustration of helical coil. Top layer is ceramic layer, and 19 layers are coil pattern layer. This is the same architecture as the spiral coil. Helical coil is 18turns, Line width is 250 μm.

Figure 3 shows a schematic illustration of ceramic transmission system. Ceramic coil is attached to the fabricated magnetic core and the deflection yoke. Diameter of the core is 10mm, and the each height cores are fabricated for the each coil. Diameter of the deflection yoke is 35mm, and height is 1mm. Moreover, the magnetic material was low temperature sintering nickel cupper zinc ferrite with the permeability of 900. Ferrite powder was made of each oxide

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of Ni, Cu, Zn, Fe, composition ratio was 8.8, 10, 32 and 49.2 respectively. In addition, Fig. 4 is multilayer ceramic technology method.

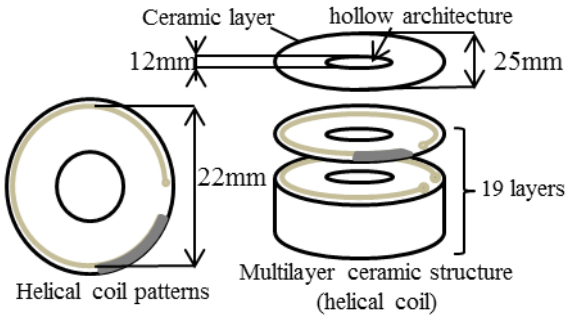

Fig2. Design of helical pattern coil

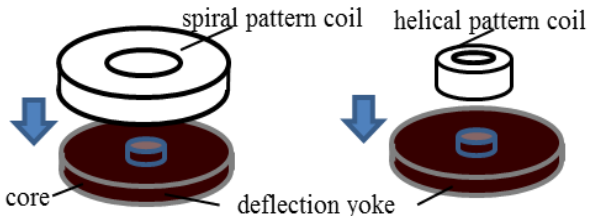

Fig3. Design of helical pattern coil

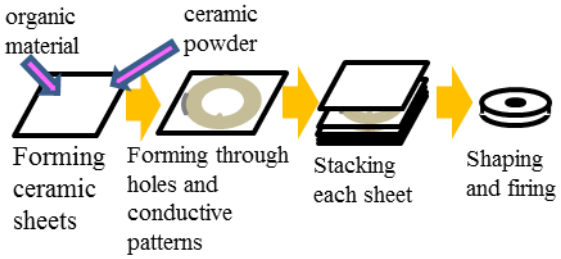

Fig4. Fabrication process of multilayer ceramic coil

Figure 5 shows a schematic illusturation of experimental system. In Fig. 5, plastic board is lying between two coils. Moreover, a resistance of 50Ω is connected to the receiver coil. The output waveform is measured by an oscilloscope. Transmitter coil is fabricated by winding wire. Turn number is 15.

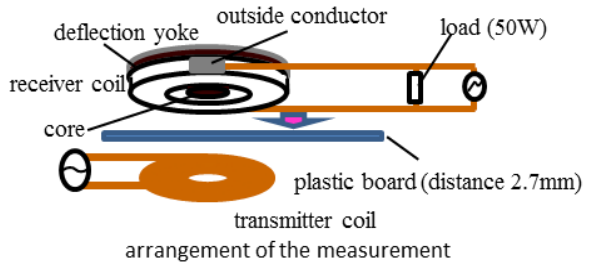

Fig5. Experimental system of generation

3. Result and discussion

The diameter of the spiral coil was 33.5 mm and helical coil was 25.0 mm the diameter of the ferrite deflection yoke was 34.6 mm and ferrite core 10.0 mm. Inductance of the spairal coil was 14.72 μH and helical coil was 14.00 μH. DC resistance is spiral coil was 8.23Ω and helical coil was 6.54 Ω. Fabricated coils were not patterned surface of the structure.

In addition, Table 1 shows the comparison of winding wire structure and multilayer ceramic coils. Winding wire structure was formed the spiral pattern. Moreover, the same core and deflection yoke were used. In table 1, helical coil could be less than 8.5mm spiral coil. The output voltage of ceramic coils were smaller than winding wire coil at 50Ω connected. The reason is the cross-sectional area of the coil pattern. Extending cross-section of internal electrode will improve the output efficiency. In addition, Helical coil were achieved each level transfer voltage of spiral coil.

Table1. Comparison coils table

	winding wire	spiral coil	helical coil
diameter [mm]	32	33.5	25.0
height [mm]	0.8	1.12	1.59
pattern width [mm]	0.4	0.26	0.26
DC resistance [Ω]	0.2	8.23	6.54
output voltage (open) [V]	14.7	14.6	13.0
output voltage (50Ω) [V]	13.7	11.8	10.6
output power [W]	4.0	2.8	2.2

4. Conclusion

Wireless transfer system using multilayer ceramic coil was fabricated. Helical coil was achieved the output voltage of the same level as the spiral coil. Helical coil could be downsized from spiral coil. Future work, co-fired with three materials as coil and yoke and core.

5. Reference

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Acknowledgments

The fabrication of the Ceramic coils was supported by Research Center for Micro Devices, Nihon University