Compact Multi-Layer Handset Phone 13.56 MHz NFC Antenna Design by Novel Laser-Induced Thin-Film Antenna (LITA) Technologies

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***Abstract* – This article presents a compact multi-layer handset phone 13.56 MHz NFC antenna design by novel LITA (Laser-Induced Integrated Thin-Film Antenna) technologies, which is jointly developed by ITRI and ACON in Taiwan. Through the proposed LITA technology, metal layouts of antennas can be formed on the internal surface of a smartwatch casing successfully with conformal, thin-film type, multi-layer and highly integrating characteristics. It is demonstrated that by designing a NFC antenna to become a two-layer overlapped coil structure by LITA technology, the required antenna layout area can be reduced about 40% compared to the co-planar NFC coil designs and also keep good inductive distance. The constructed antenna prototype integrated with a NFC reader chip (NXP NPC300) is analyzed and the read distance between the proposed antenna and type1 to type4 NFC tags classified by the NFC Forum are tasted and discussed in this paper.**

***Index Terms* — Compact NFC antennas, Thin-film antennas, Handset phone antennas, Multi-layer antennas.**

1. Introduction

The HF band NFC (Near Field Communication) technologies have become one of very popular and important application functions to today's commercial mobile phone devices [1]. In practical applications, for achieving required thin type and highly integrating characteristics of mobile phones, the NFC antennas are usually adhered and integrated on internal surface of mobile phone backside casings due to the relatively larger layout of 13.56 MHz NFC antennas than other antennas in the mobile phones [2]. The common practices on the markets for integrating NFC antenna designs with plastic casing are using FPCB (Flexible Printed Circuit Board) [3] or LDS (Laser Direct Structuring) [4] processes.

In this paper, a novel multi-layer 13.56 MHz NFC antenna design by novel LITA (Laser-Induced Integrated Thin-Film Antenna) technologies is proposed for achieving more compact NFC antenna layout area. The LITA technology is jointly developed by ITRI and ACON in Taiwan. LITA sprays a special laser-activatable colloid on surface of supporter materials to replace prior metal-particle-mixed plastics of LDS [4, 5] for achieving more flexibility on substrate choosing. Through the LITA, the metal layouts of antennas can be formed on internal surface of a device casing successfully with a thin-film type, conformal and highly integrating characteristics. The LITA technologies evolved from the LIM (Laser Induced Metallization) technology of ITRI [5] and enhance the insulativity of LIM colloid to improve the layer-by-layer fabrication characteristics. With this advantage of LITA, it is demonstrated that by designing a NFC antenna to become a two-layer overlapped coil structure by LITA technology, the required antenna layout area can be reduced about 40% compared to the prior co-planar NFC coil designs [2] and also keep good performance by increasing turns of the NFC coil. The constructed NFC antenna prototype is analyzed and discussed in this paper.

2. Antenna Design

Fig. 1 shows the geometry of the proposed multi-layer thin-film NFC antenna prototype implemented by the LITA

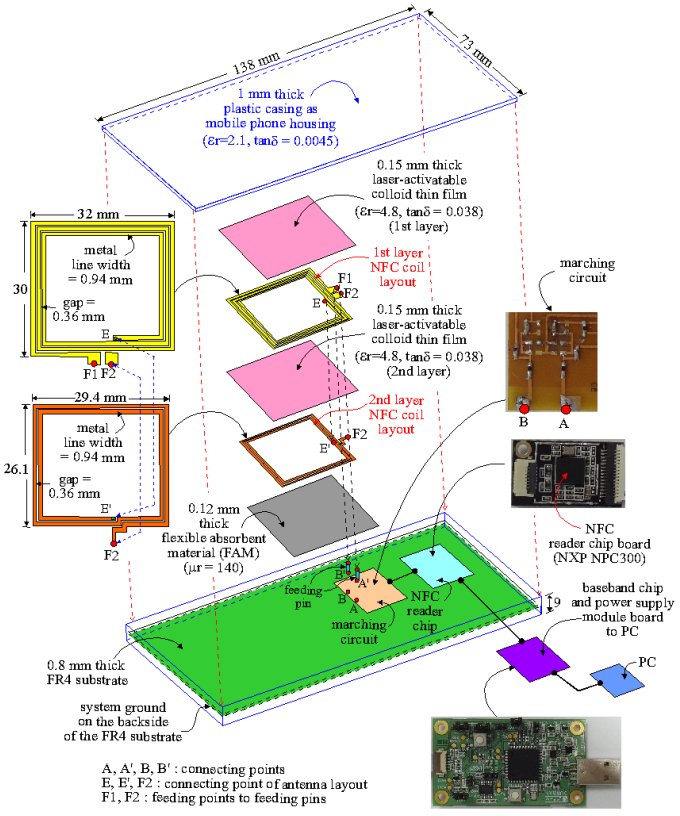

Fig. 1. Geometry of the proposed compact multi-layer 13.56 MHz NFC antenna by LITA technologies.

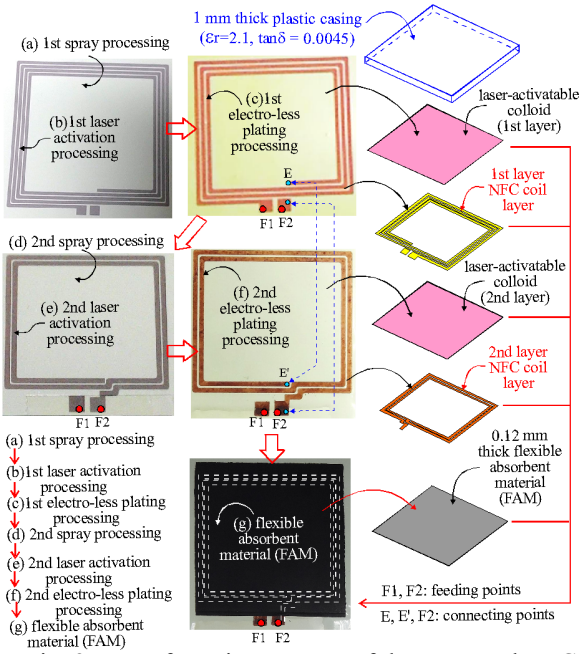

Fig. 2. Manufacturing process of the proposed NFC.

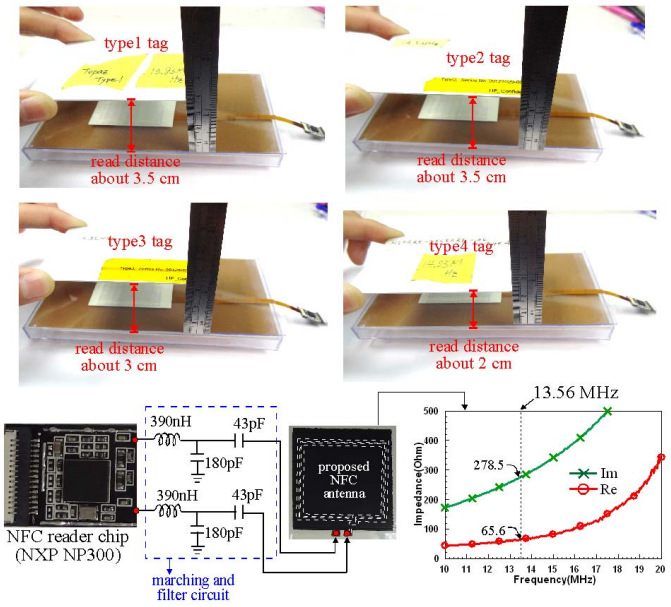

Fig. 3. Experimental photos and measured results for the proposed compact multi-layer NFC antenna by LITA process.

technologies. The proposed NFC antenna is designed for HF band 13.56 MHz operation [2]. It has two metal coil layers as shown in Fig.1: a 1st layer metal coil layout is adhered on a mobile phone backside plastic casing through a 1st laser-activatable colloid thin-film, a 2nd layer metal coil layout is formed on the 1nd layer coil through a 2nd laser-activatable colloid thin-film and finally the 2nd layer NFC coil is covered by a magnetic FAM (Flexible Absorbent Material) ferrite sheet [2] with high permeability (μr = 140). The FAM sheet can usefully prevent the NFC antenna to be blocked by nearby metal components in practical situations [2]. The 1st and 2nd layer metal coils are connected through points E and F2. The two feeding points (F1, F2) of the NFC antenna are connected to a NFC reader chip (NXP NPC300) [6] board through two feeding pins and a matching circuit. The NFC reader chip board is further connected to a baseband chip and power supply board (NXP Durban) [6] than it is connected to a PC for communication distance texting experiments. It can be seen that by designing the NFC antenna to become a two-layer thin-film overlapped coil structure through LITA technologies, a compact NFC antenna layout area of 960 mm^2 (32×30 mm^2) only can be achieved successfully, which is reduced about 40% area compared to the prior co-planar NFC antenna designs 1600 mm^2 (40×40 mm^2) [2].

Through the fundamental theory of magnetic field and flux [2], it can be understood that the magnetic field and flux are positive correlated with area and number of turns of the NFC antenna coil. Therefore, although coil area of the proposed NFC antenna is reduced, the strength of the magnetic flux can also be enhanced and compensated by increasing the turns of the NFC antenna coil layout easily through the proposed multi-layer NFC coil architecture to achieve similar inductive read distance and performance compared to the prior relatively large co-planar NFC antenna designs [2]. Fig.2 shows the step-by-step manufacturing process of the proposed NFC antenna by LITA technologies. More detail design considerations will be presented in the conference.

3. Result and Discussion

Fig.3 shows experimental photos and measured results for the proposed compact multi-layer NFC antenna by LITA process. It can be see that the inductive read distances between the proposed NFC reader antenna and type1 to type 4 NFC tags classified by the NFC Forum [1] are tasted. The inductive read distance for type1, type2, type3 and type4 tags can be successfully achieved about 3.5 cm, 3.5 cm, 3 cm and 2 cm respectively. More details about the antenna analysis, performance studies and manufacturing process will be presented and discussed in the conference.

4. Conclusion

A compact multi-layer thin-film handset phone 13.56 MHz NFC antenna design by novel LITA technologies jointly developed by ITRI and ACON in Taiwan has been presented. It is demonstrated that by designing a NFC antenna to become a two-layer overlapped coil structure by LITA technology, the required antenna layout area can be reduced about 40% compared to the co-planar NFC coil designs and can also keep good inductive read distance.

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