Novel LIM (Laser Induced Metallization) Technologies of ITRI Applied to 11 GHz High-Gain Microstrip Array Design on Mobile Phone Casing

Wei-Yu Li[1], Tune-Hune Kao[2], Wei Chung[1], Meng-Chi Huang[2] and Min-Chieh Chou[2]
[1]Information and Communication Research Laboratory
[2]Mechanical and Systems Research Laboratory
ITRI, Hsinchu 31040, Taiwan

Abstract **– This article presents an integrated 11 GHz microstrip array antenna implemented by novel LIM (Laser Induced Metallization) technologies of ITRI. Through the proposed LIM technologies, the metal layouts of radiating patches, feeding network and antenna ground can be formed on surfaces of handset casing successfully with conformal and highly integrating characteristics. Compared to the well-known LDS technologies, the LIM technologies spray a special laser-activatable colloid on surface of supporter materials to replace prior metal-particle-mixed plastics of LDS for achieving more flexibility on substrate choosing in practical applications. The constructed prototype is discussed and analyzed in the paper.**

Index Terms **— 11 GHz Band, Microstrip Array Antennas, LIM (Laser Induced Metallization), Smart Phone Devices.**

I. INTRODUCTION

Owing to the increasing demand of high data rate for mobile media applications, the explosion in data traffic has severely strained the available network capacity of the current 3G/4G systems [1]. There requirements have left standard bodies to explore new methods and spectrum to increase spectral efficiency [1~6]. In 2012, 3GPP began to hold symposiums for discussing possible technologies for B4G or 5G systems. Operators around the world have also been ready to propose their own 5G development schedules. For examples, the FP7/METIS plans from European Union [2], the IMT-2020 (5G) from China [3], and the proposals from Huawei [4], NTT DOCOMO [5] and Samsung [6]. And in order to improve the system capacities, much higher frequencies compared to the 3G/4G systems would probably be chosen for 5G systems, such as 11 GHz [5], 28 GHz [6], 38 GHz [3] or other mmWave bands [1~4].

Therefore, array antenna or beamforming technologies [7] would need to be applied on both base station and mobile phone applications for achieving high-gain radiation performance to compensate the increased propagation path loss for meeting link budget requirements [1-6]. However, it will be a challenge for implementing array antenna designs on the limited available area of mobile phone circuit board.

This paper presents a novel LIM technology [8] to be possible solutions for solving this problem. Through the LIM technologies, the metal patterns can be formed on surfaces of mobile phone casing successfully with conformal, highly integrating characteristics and more flexibility on substrate choosing compared to the LDS (Laser Direct Structuring) technologies [9]. A prototype of 11 GHz [5] 2x2 microstrip array antenna is constructed and studied in this paper.

II. ANTENNA DESIGN

Fig.1 shows manufacturing process of the proposed LIM technologies of ITRI [8]. The LIM technology sprays a special laser-activatable colloid on surface of supporter materials to replace prior metal-particle-mixed plastics of LDS for achieving more flexibility on substrate choosing in practical applications. The laser-activatable colloid contains epoxy, PU, and 1~3% of nano-ceramic particles [8]. After the colloid has been well-adhesion and solidified with the substrate. The laser energy is used to directly define the metal layouts on the colloid. After that, the electro-less plating process is applied to form the metal patterns [8].

Fig.2 shows geometry and experiment photos of the array antenna on the handset casing implemented by the LIM technology. It is a 2x2 microstrip array with 4 radiating

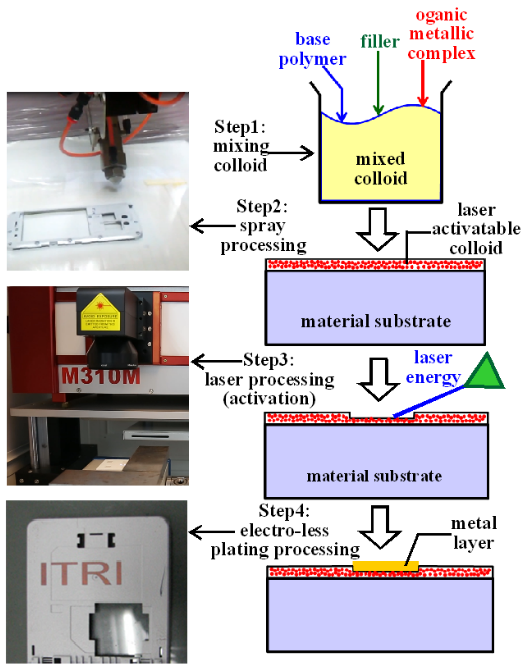

Fig. 1. The manufacturing process of proposed LIM technologies of ITRI.

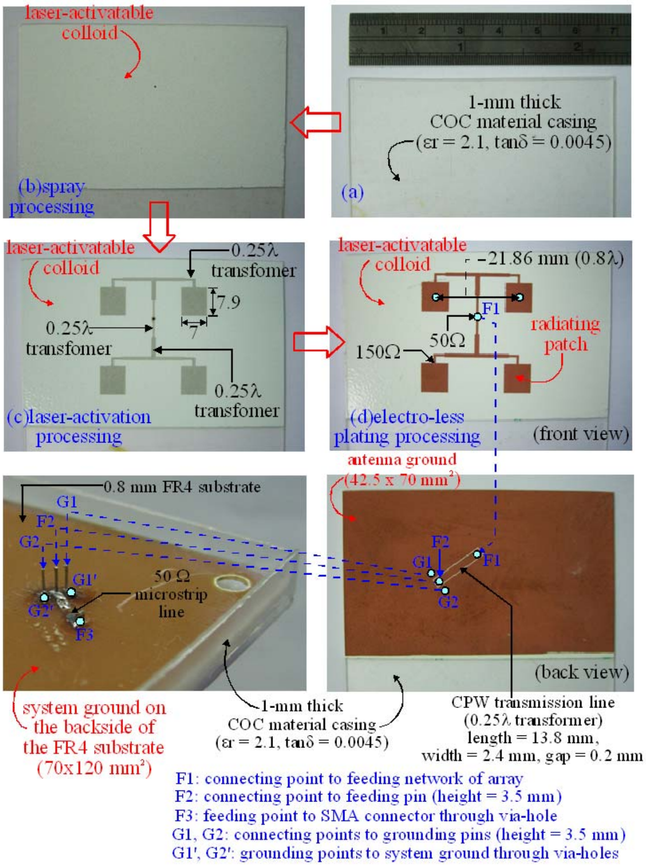

Fig. 2 Geometry and experiment photos of the constructed 11 GHz 2 x2 antenna array implemented by the LIM technologies of ITRI.

patches (150 Ω) connected to a feeding network for impedance matching, and it has an independent antenna ground. The patches and feeding network are formed on the colloid thin film adhered to the top surface of the casing, and the antenna ground is formed on the colloid film adhered to the bottom surface of it. The casing is formed by COC material. There is another system ground (70 x 130 mm^2) formed on the bottom side of a 0.8 mm FR4 substrate as a system circuit board. The feeding signal comes from a SAM (50 Ω) connector connected to the system ground and feeding point (F3) of a 50 Ω mircostrip line printed on top side of the FR4 substrate. By properly designing a 3-pins transmission structure (3.5 mm height), the feeding signal can be transferred from the system ground to the antenna ground successfully. The 3-pins structure comprises a center feeding pin with one end connected to the 50 Ω microstrip line, and 2 grounding pins at both sides connected to two grounding pads (G1' and G2') on the FR4 substrate. There is a CPW structure designed on the antenna ground with one end connected to the array feeding network (F1), and the other end fed by the 3- pins structure (F2, G1 and G2). The CPW functions as a 0.25λ transformer transferring the non-matched impedance of the 3-pins structure to around 50 Ω of the input impedance of the array feeding network.

III. Result And Discussion

Fig.3 (a) shows the simulated and measured return loss of the constructed array antenna on the casing, and Fig. 3(b)

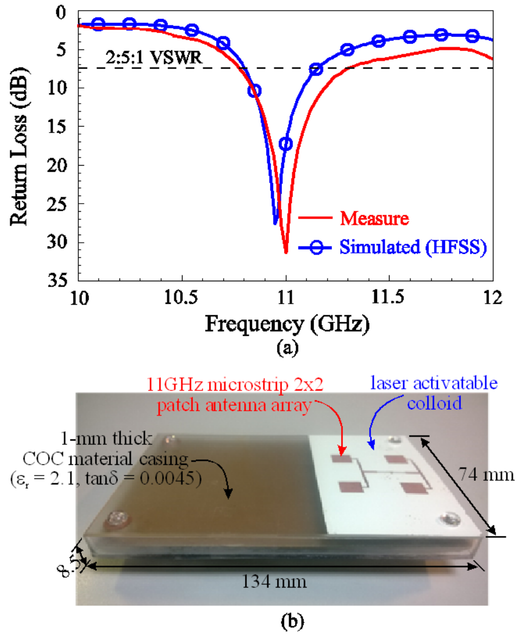

Fig. 3 (a) Simulated and measured return loss of the constructed 11 GHz high-gain antenna array on the casing, and (b) the experiment photos of it.

shows the experiment photos of it. From the results, the impedance matching is good around 11 GHz band, and agreement between the measurement and simulation results is seen. Around the 11 GHz band, the radiation efficiencies vary from 53~77%, and the maximum antenna gains vary from 9.3~10.9 dBi. Details about the analysis of far-field antenna characteristics would be presented in the conference.

IV. Conclusion

An integrated high-gain 11 GHz 2x2 microstrip array antenna on the handset casing implemented by proposed LIM technologies developed of ITRI has been presented. Through the LIM technologies, the metal layouts of radiating patches, feeding network and antenna ground can be formed on the outside and inside surfaces of handset phone casing successfully with conformal characteristics. And more flexibility on substrate choosing in practical applications can be achieved compared to the direct LDS technologies.

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