Graphene Film Based CPW-fed Antenna for Wearable Application

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***Abstract*—This paper presents a CPW-fed antenna based on graphene film for wearable applications The conductivity of graphene film is 1.1×10⁶ S/m. The new antenna with flexible substrate has the advantages of excellent flexibility, smaller size and lighter weight, which is suitable for human wear. The proposed antenna covers the frequency range from 4 GHz to 8 GHz for a $|S_{11}|$ greater than -10 dB.**

Keywords*—*graphene film; CPW-fed; wearable antenna;

I. INTRODUCTION

In recent years, with the rapid growth of wearable equipment market and the emergence of various flexible devices, wearable devices have been widely used in entertainment and leisure, positioning and trajectory tracking, health management, medical assistance and military fields [1]. At present, wearable electronic devices are smaller and lighter in size and weight. However, due to the limitation of metal patches, it is still impossible to achieve real flexibility and integration into clothing. Flexible graphene film material has become the most advantageous material in wearable antenna due to its excellent machinability, excellent flexibility, fast and low-cost processing, and light weight [2].

Generally, antenna have a variety of different types and application. For wearable, Broadband antenna may be the most suitable choice [3]. Broadband technology is one of the rapidly advancing and promising technologies because of its beneficial such as large bandwidth, short range, high speed, high data rate, low power consumption, small size and low-cost [4].

In order to realize broadband characteristics of CPW feed antenna, the appropriate frequency band can be generated by adjusting the position and shape of slots in radiation patch slots or on coplanar waveguide floor slots, so as to obtain the required multi-band characteristics or broadband characteristics of antenna.

In this paper, we propose a graphene film based CPW-fed broadband antenna for wearable applications. The antenna is fed by coplanar waveguide and its ground plate is slotted for broadband application. The grooved shape is H-shaped slot. The proposed antenna has the advantages of miniaturization, light weight and low profile compared with the traditional wearable antenna. The graphene film has the conductivity of 1.1×10^6 S/m. The bandwidth of the antenna is 6.14 GHz, which ensures that when the antenna is worn, the frequency offset it can still work properly.

II. THE ANTENNA CONFIGURATION AND DESIGN

Fig. 1 shows the geometry of the proposed antenna. The antenna is designed on flexible substrate with a thickness of 0.25 mm and dielectric constant of 2.5. The size of the antenna is 32 mm×48mm. Excitation is made through a 50 Ω CPW feed line. The center strip (W_0) and gap (g) of the CPW line are 6 mm and 0.13 mm to achieve the 50 Ω characteristic impedance. The spacing between the bottom edge of the tuning stub and the ground plane is 1 mm, which critically controls the impedance matching and the power coupling from feed line to the tuning stub. Other dimensions of the antenna are illustrated in Table1. Broadband is obtained mainly by the excitation of multiple resonant modes. Besides the original resonant mode of the slot (L_3, W_3, L_4, W_4, L_5, W_5, respectively.), the tuning stub can introduce another resonant mode. The length and width of the antenna patch and ground are W_1 and L_1, W_2 and L_2, respectively.

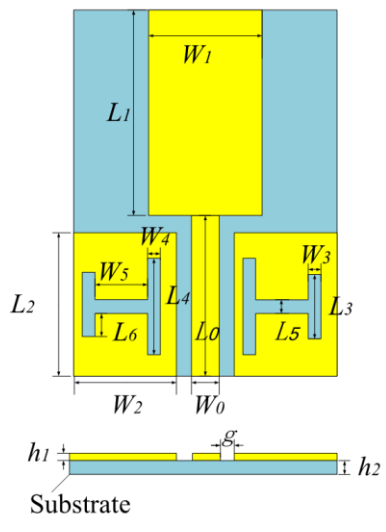

Figure 1. The schematic diagram of antenna

The parameters of H-shaped slots affect the performance of antenna. As shown in Fig. 2, the influence of L_3, L_4, L_5 and L_6 on the resonant frequency of the antenna is different. We can clearly see that the size of the H-slot will change with the change of the $|S_{11}|$ of the antenna. As shown in Fig. 3, the gap g

between microstrip line and ground affects the impedance matching of antenna.

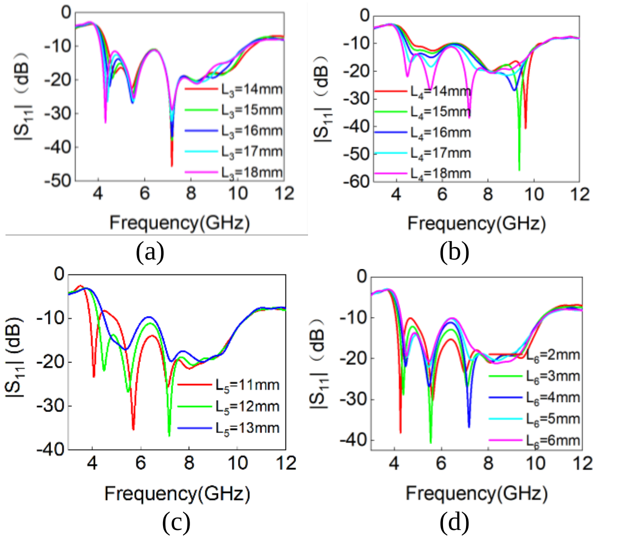

Figure 2. Effect on $|S_{11}|$ due to variation of H-shaped slots in mm. (a) L_3, (b) L_4, (c) L_5 and (d) L_6

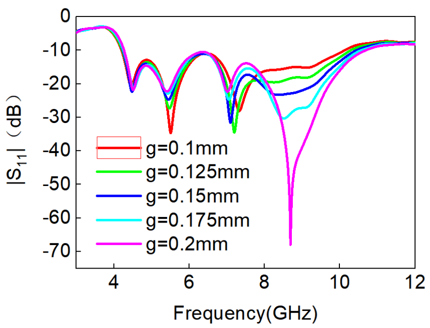

Figure 3. Effect on $|S_{11}|$ due to variation of g in mm

TABLE I

The optimized parameters of antenna

Parameter	value (mm)	Parameter	value (mm)
W_0	6	W_3	2
L_0	21	L_3	8
W_1	18	W_4	2
L_1	27	L_4	15
W_2	13	W_5	7
L_2	20	L_5	2
h_1	0.025	h_2	0.25

III. Simulation And Measurement Results

According to the optimized parameters, the antenna model is simulated. Fig. 4 shows the simulated $|S_{11}|$ of antenna. A significant resonance with a reflection coefficient around −37 dB is attained at 7.2 GHz. Additionally, the response is relatively well balanced with a reflection coefficient around −28 dB at 5.5 GHz. The simulated -10 dB bandwidth of the antenna is 4.22 GHz to 10.36 GHz.

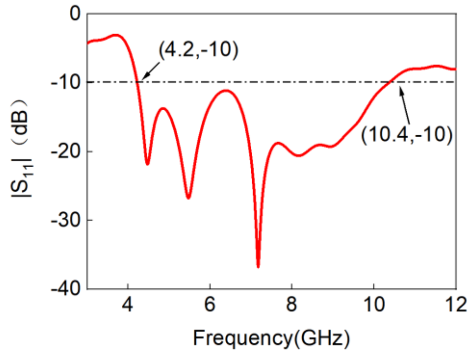

Figure 4. The simulated $|S_{11}|$ of antenna

As shown in the simulated results (Fig.5), good matching performance is achieved with a VSWR of below 2 in the frequency range of 4.22 GHz–10.36 GHz.

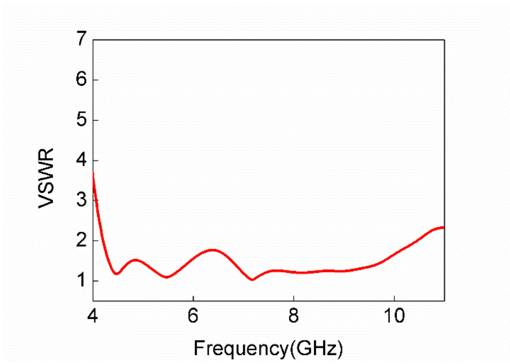

Figure 5. The VSWR of antenna

The digital photo of antenna is shown in Fig. 6. The antenna has good flexibility. The measured and simulated reflection coefficient ($|S_{11}|$,) curves in air space are given in Fig.7. The measured $|S_{11}|$ was obtained using an network analyzer with coaxial calibration The measured -10 dB, bandwidth achieved more than the 4.22 GHz -10.36 GHz needed for the broadband communication system with good agreement between the simulated results.

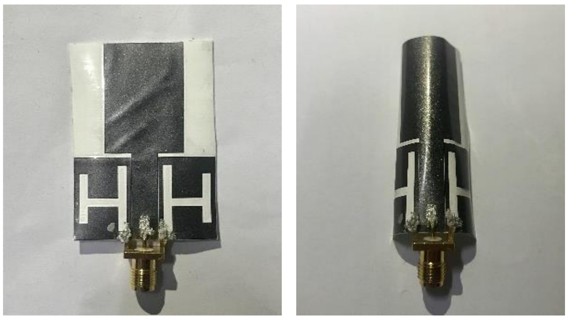

Figure 6. Digital photos of antenna.

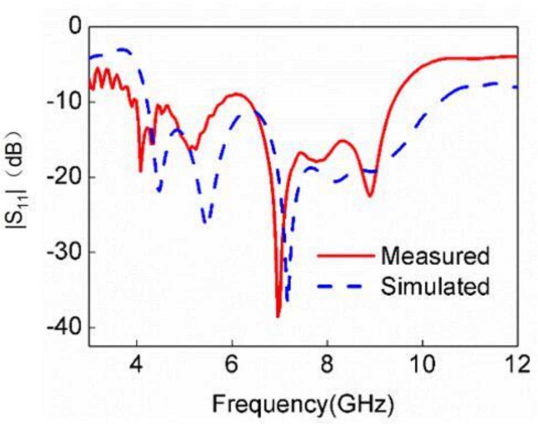

Figure 7. The $|S_{11}|$ of antenna

IV. CONCLUSIONS

In this paper, a novel compact CPW-fed broadband antenna for wearable applications has been presented. The antenna is made up of H-shaped slot ground plane and patch. All conductor of the antenna are graphene films with conductivity of 1.1×10^6 S/m. The antenna achieves sufficient -10 dB bandwidth matching to cover the 4.22 GHz to 10.36 GHz.

ACKNOWLEDGEMENT

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REFERENCES

[1] S. M. H. Varkiani and M. Afsahi, "Grounded CPW multi-band wearable antenna for MBAN and WLAN applications," Microwave and Optical Technology Letters, vol. 60, pp. 561-568, Mar 2018.

[2] R. Song, Q. Wang, B. Mao, Z. Wang, D. Tang, B. Zhang, et al., "Flexible graphite films with high conductivity for radio-frequency antennas," Carbon, vol. 130, pp. 164-169, Apr 2018.

[3] M. Klemm and G. Troester, "Textile UWB Antennas for Wireless Body Area Networks," IEEE Transactions on Antennas and Propagation, vol. 54, pp. 3192-3197, 2006.

[4] M. T. Islam, M. Samsuzzaman, M. Z. Mahmud, M. T. Islam, and Ieee, "A Compact Spectacles Shaped Patch Antenna for UWB Applications," presented at the 2016 9th International Conference on Electrical and Computer Engineering, Dhaka, 2016.