Electronic Supplementary Material (ESI) for RSC Advances.

Support Information

1. Current distribution at 1.3 GHz and 3.4 GHz

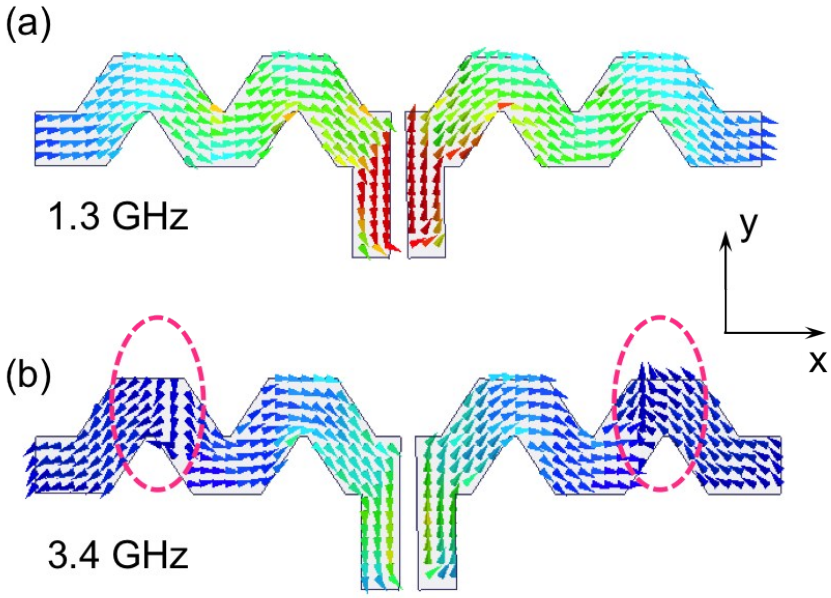

Figure S1. Simulated current distributions for the graphene-flakes antenna at 1.3 GHz and 3.4 GHz.

At 1.3 GHz, the current distribution is along the same direction (+x) as shown in Figure S1a, while the current distribution is opposite along y-axis, which means the radiation cancelled with each other along y-axis as a result. On the other hand, the current distribution of 3.4 GHz is totally different. The current distribution at the middle part of the antenna is opposite to the left and right arms, inducing the reduction of the electrical length.

2. The XPS spectra of GFs and Me-CNTs

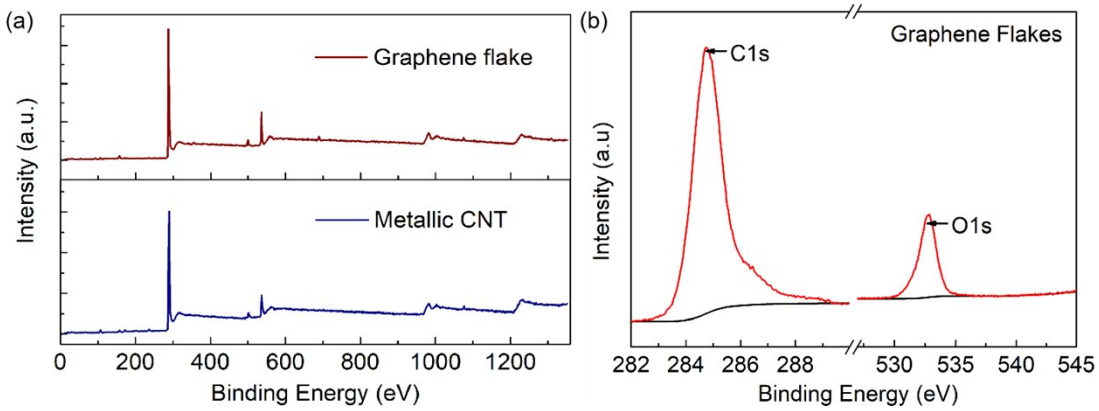

Figure S2. (a) The XPS survey spectra of GFs and Me-CNTs. (b) O1s XPS spectra.

The survey spectra of GFs and Me-CNTs are shown in Fig. S2 (a). It is obvious that the materials have high purity and are absence of other elements. Fig. S2 (b) presents the O1s spectra.

3. Parameters of the antennas

Table S1. Parameters of the proposed antenna

L_1 (mm)	6	L_2 (mm)	10.8
L_3 (mm)	16	L_4 (mm)	7.2
w_1 (mm)	6	w_2 (mm)	4
w_3 (mm)	2	θ	0.36π

4. Parameters for the calculation of atomic ratio

Table S2. Parameters for the calculation of atomic ratio

	Atomic%	*Area*(*P*) (*CPS·eV*)	*SF*	*TXFN*
GFs (C1s)	89	54546.36	1	1110
GFs (O1s)	11	20679.36	2.8	1216

5. Square Ohmic resistance

Table S3. Square Ohmic resistance

Nws-Ag	0.2 Ω/Squ	GFs	**4 Ω/Squ**
Me-CNTs	2 Ω/Squ	MR = 1:1	0.6 Ω/Squ
MR =1:5	8 Ω/Squ	MR =1:10	20 Ω/Squ
MR =1:20	40 Ω/Squ	Semi-CNT	59 Ω/Squ

6. Comparison with other dipole antennas

Table S4. Comparison with other dipole antennas

Characteristics	Substrate	Band/frequency	Bandwidth
This work	PDMS	Dual/1.3 GHz,	316 MHz
		3.4 GHz	773 MHz

[1]	Soda-lime glass	Single/1.5 GHz	500 MHz
[2]	PET	Single/1.8 GHz	190 MHz
[3]	PI aerogel	Single/2.4 GHz	62.1 MHz
[4]	Felt Fabric	Dual/2.2 GHz, 3 GHz	100 MHz

The comparison with other works is presented in Table S2. The proposed graphene antenna of this work has good dual band performance and bandwidths of 316 MHz/773 MHz at 1.3 GHz/3.4 GHz, which used in radio positioning and 5G communication. The antennas presented in Ref. [1], [2], [3] have smaller bandwidth and single band. Though the antennas proposed in Ref. [4], the bandwidth of 100 MHz is poor. The good performance might be due to three reasons. The geometry of the antenna was designed as a dual band antenna with wide band width, the fabrication process can achieve high accuracy, which is important for transferring design to a prototype and the materials have high purity.

Reference

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2. Hassan, A.; Ali, S.; Bae, J.; Lee, C. H. All printed antenna based on silver nanoparticles for 1.8 GHz applications, *Appl. Phys. A*, **2016**, 122:768
3. Meador, M. A. B.; Wright, S.; Sandberg, A.; Nguyen, B. N.; Van Keuls, F. W.; Mueller, C. H.; Solís, R. R.; Miranda, F. A. Low Dielectric Polyimide Aerogels As Substrates for Lightweight Patch Antennas, *ACS Appl. Mater. Interfaces,* **2012**, 4, 6346−6353
4. Sung, D.; Vornbrock, A. De La F.; Subramanian, V. Scaling and Optimization of Gravure-Printed Silver Nanoparticle Lines for Printed Electronics, *IEEE Trans. Compon. Packag. Technol*. **2010**, 33, 105.