Simple preparation of 1D hierarchical magnetic CNTs/hollow porous macroscopic carbon fiber composites for efficient microwave absorption

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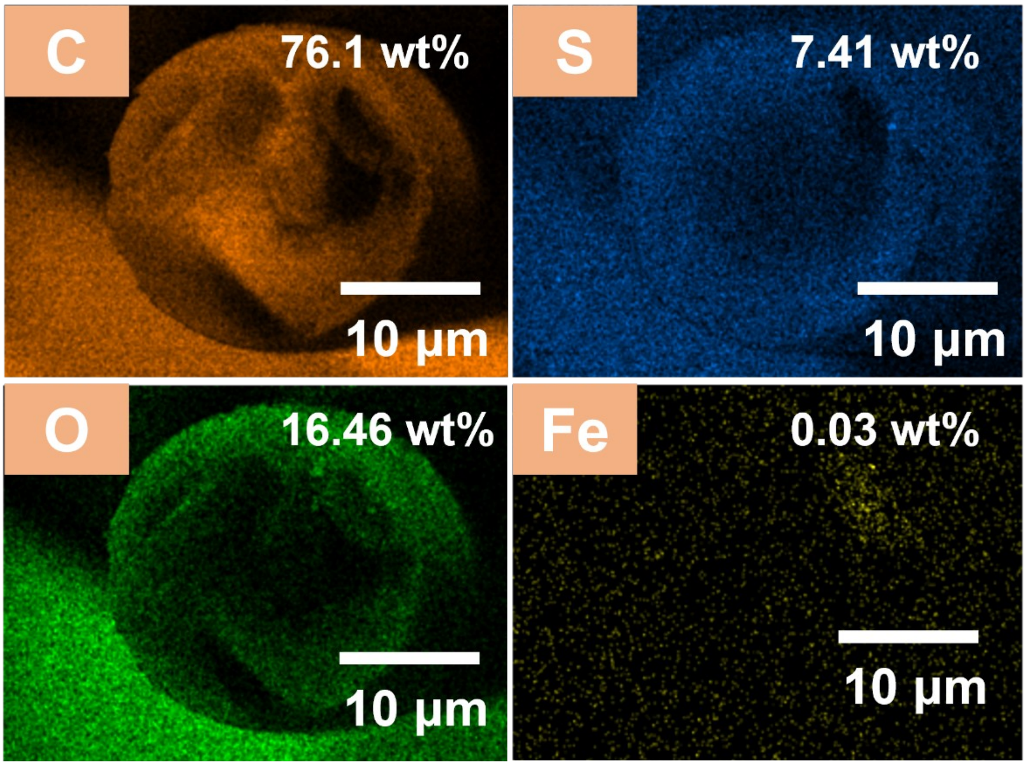

Fig S1.EDS images of Fe@SFs-1

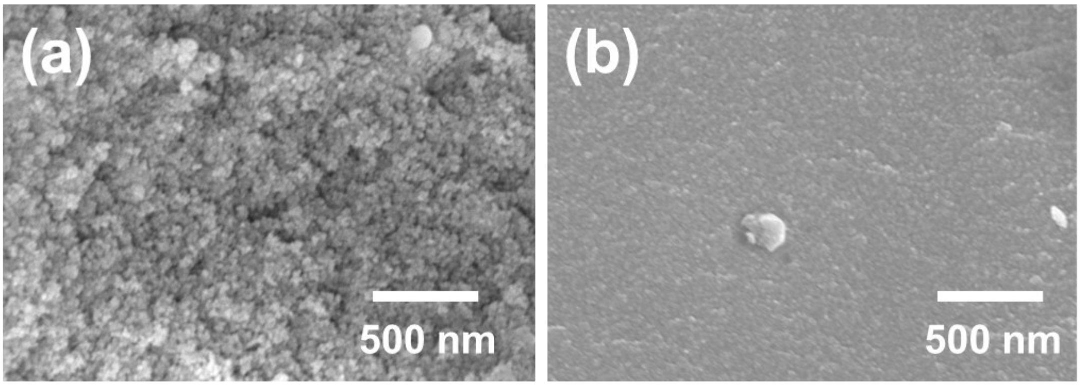

Fig S2. High magnification SEM images of (a) the porous layer in the cross section of HPCFs-1 and (b) the cross-section of HPCFs-3

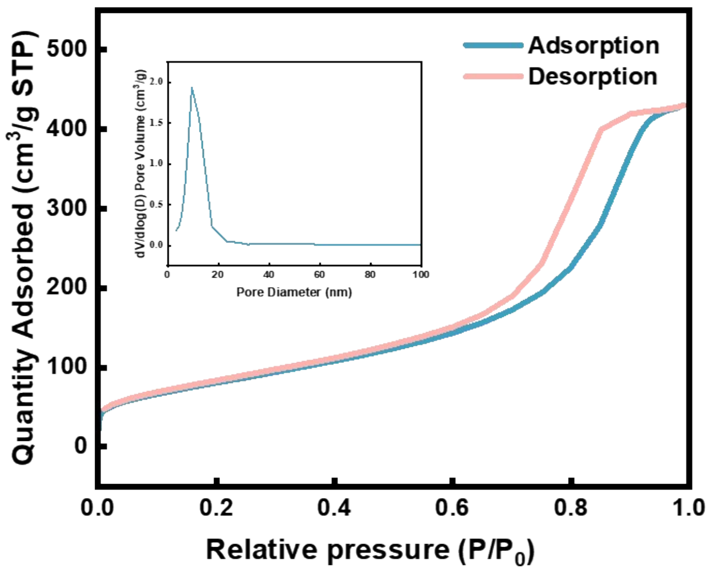

Fig S3. N_2 adsorption-desorption isotherms and pore size curves of HPCFs-1

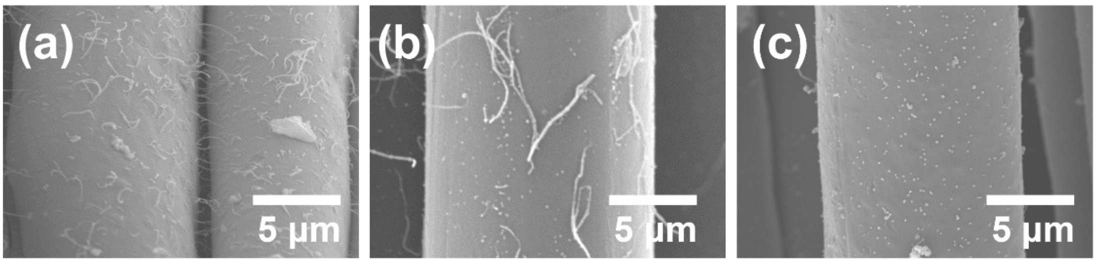

Fig S4. SEM images of surface of (a) CNTs@HPCFs-1, (b) CNTs@HPCFs-2, and (c) CNTs@HPCFs-3

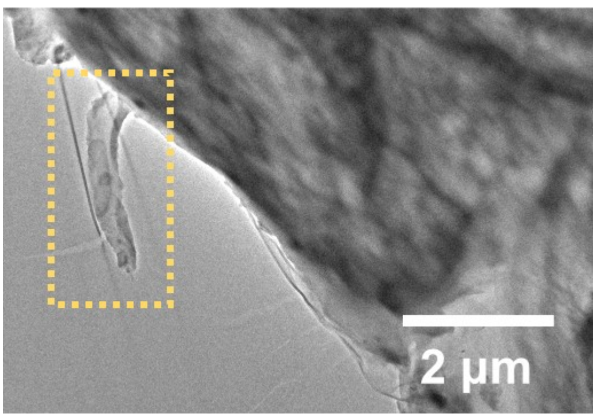

Fig S5. TEM images of surface of CNTs@HPCFs-1

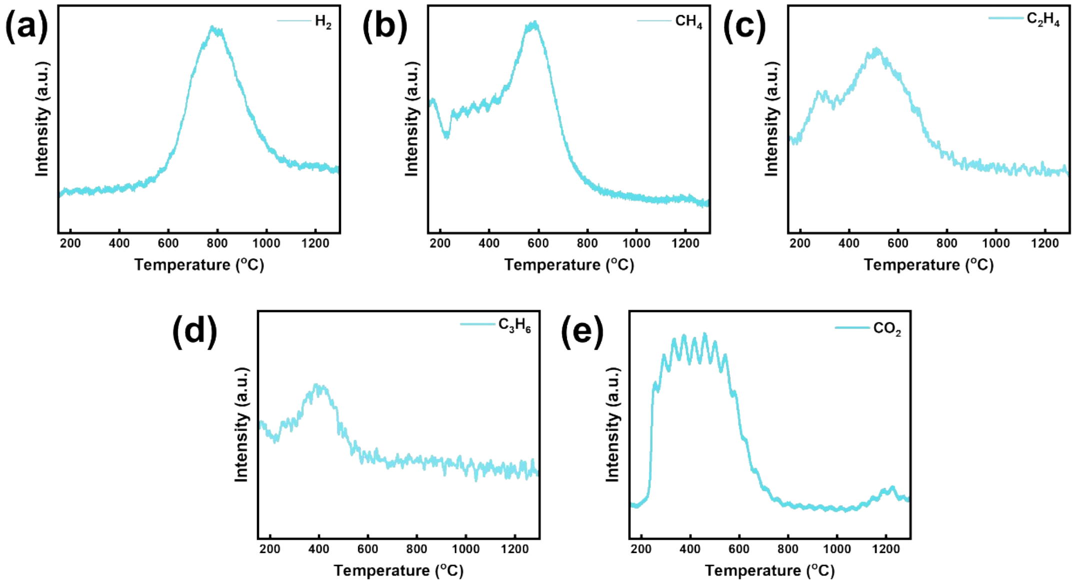

Fig S6.TGA-MS spectra of Fe@SFs-3

Table S1. Surface elemental content of fibers measured by XPS

Sample	C (Atomic %)	O (Atomic %)	S (Atomic %)	Fe (Atomic %)
HPCFs-1	95.88	3.87	0.26	-
CNTs@HPCFs-1	78.44	17.88	3.15	0.44

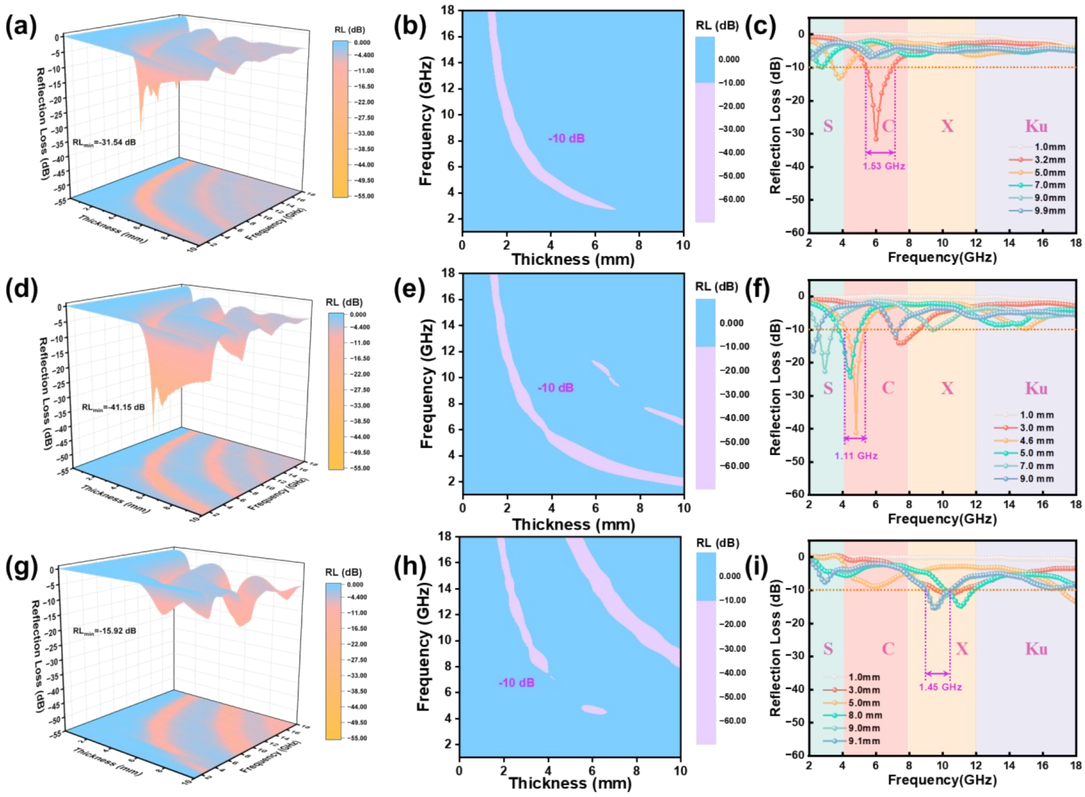

Fig S7. Calculated 3D/2D RL and contour maps of the RL of HPCFs-1 (a, b, c), HPCFs-2 (d, e, f), and HPCFs-3 (g, h, i)

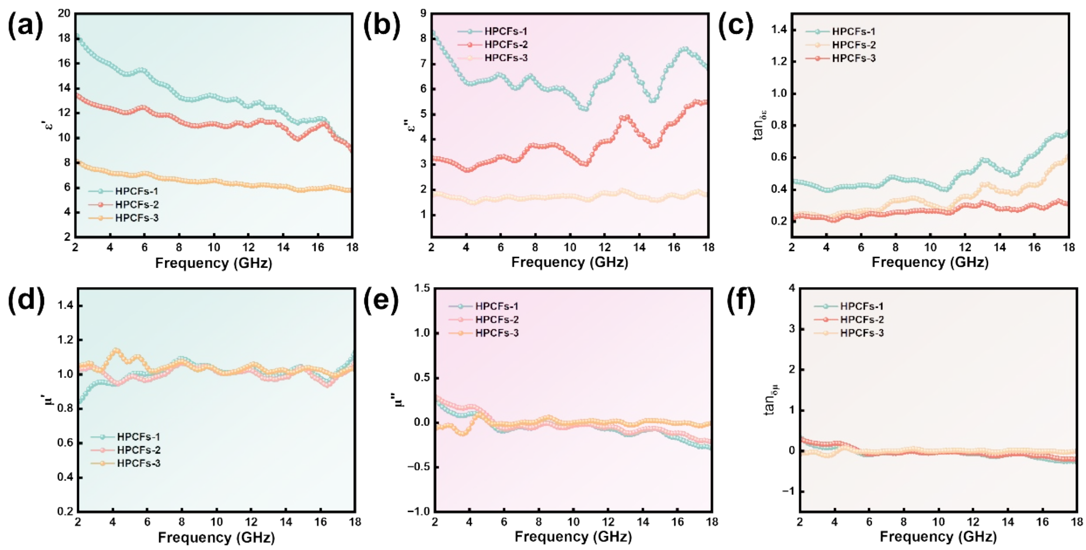

Fig S8. (a) Real permittivity (ε'), (b) imaginary permittivity (ε''), (c) dielectric loss tangent ($tan_{\delta\varepsilon}$), (d) Real permeability (μ'), (e) imaginary permeability (μ''), and (f) magnetic loss tangent ($tan_{\delta\mu}$) of HPCFs

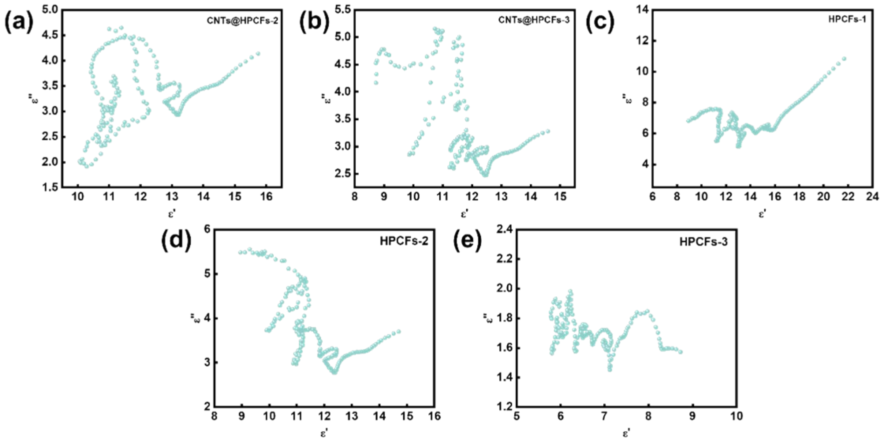

Fig S9. Cole-Cole curves of (a) CNTs@HPCFs-2, (b) CNTs@HPCFs-3, (c) HPCFs-1, (d) HPCFs-2, and (e) HPCFs-3

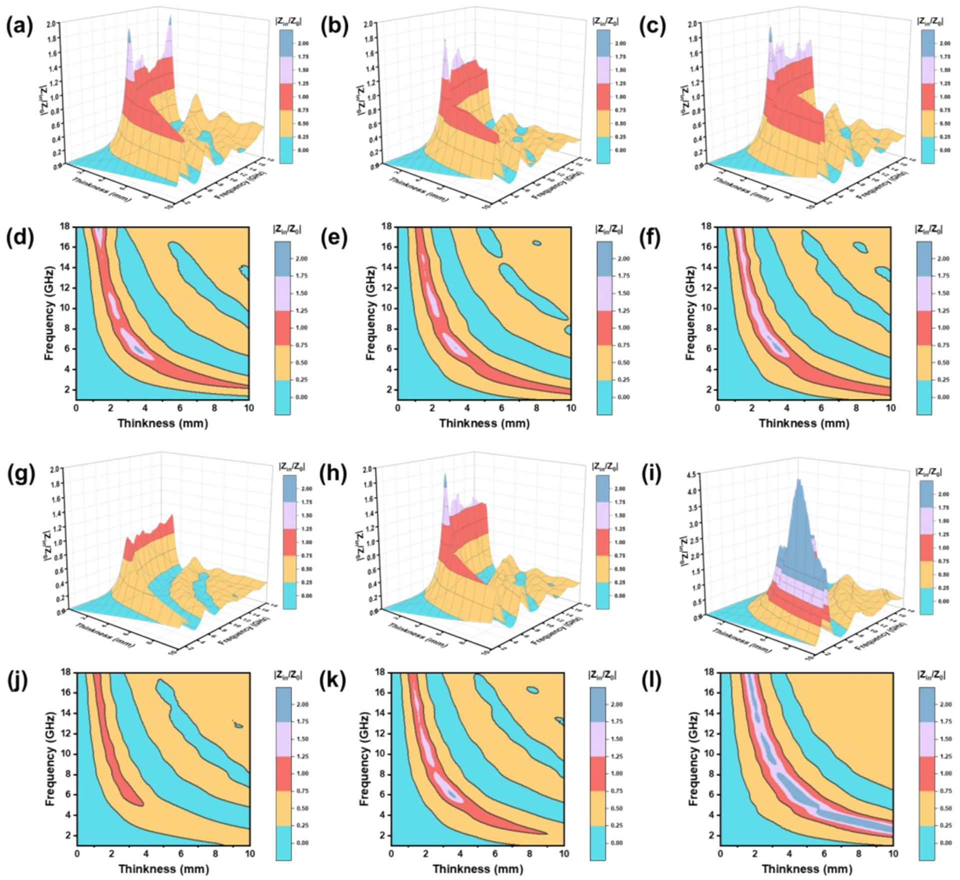

Fig S10. 3D and 2D contour maps of |Zin/Z0| for (a, d) CNTs@HPCFs-1, (b, e) CNTs@HPCFs-2, (c, f) CNTs@HPCFs-3, (g, j) HPCFs-1, (h, k) HPCFs-2, and (i, l) HPCFs-3

Table S2. Comparison with reported microwave properties of carbon materials

Microwave absorber	Thickness (mm)	RL_{min} (dB)	Effective bandwidth (GHz)	Reference
Carbon microtubes	2.06	-30.75	6.78	[1]
PAN-based carbon fiber	2.5	-39.90	1.30	[2]
CNTs/CF	1.18	-56.11	3.6	[3]
GO/CF	4.65	-57.3	4.88	[4]
Porous carbon	2.2	-30.46	5.44	[5]
Porous carbon nanosheets	1.70	-29.50	7.2	[6]
Porous carbon frameworks	1.75	-40.4	3.48	[7]
CNTs@HPCFs	1.90	-54.03	4.08	This work

Reference

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