

Electronic Supplementary Information (ESI)

Ferromagnetic hierarchical carbon nanofiber bundle derived from natural collagen fibers: a truly lightweight and high-performance microwave absorption material

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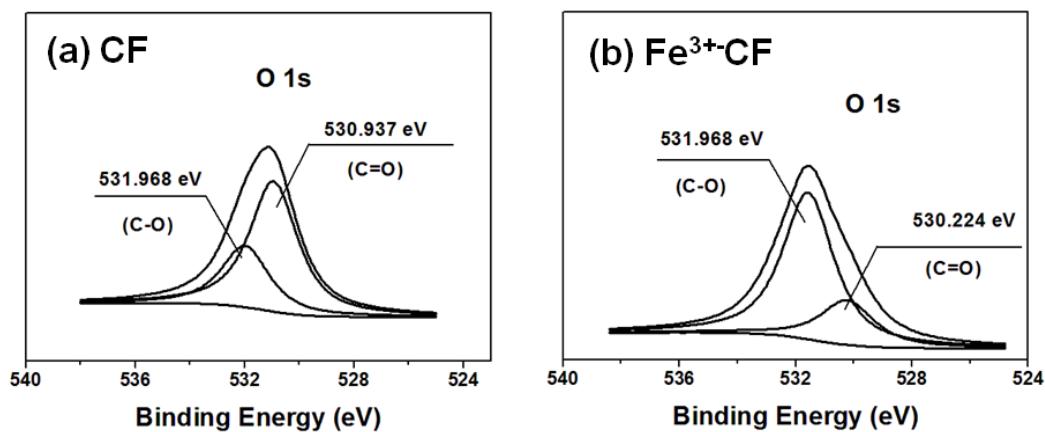


Fig.S1 O 1s X-ray photoelectron spectroscopy (XPS) spectra of CF (a) and Fe³⁺-CF (b).

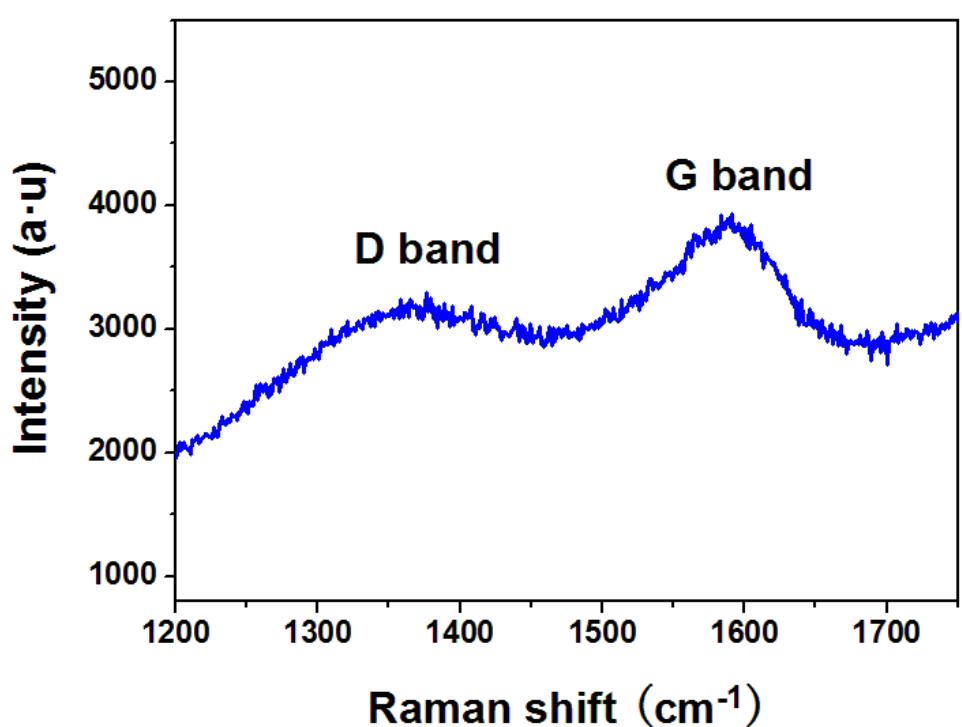
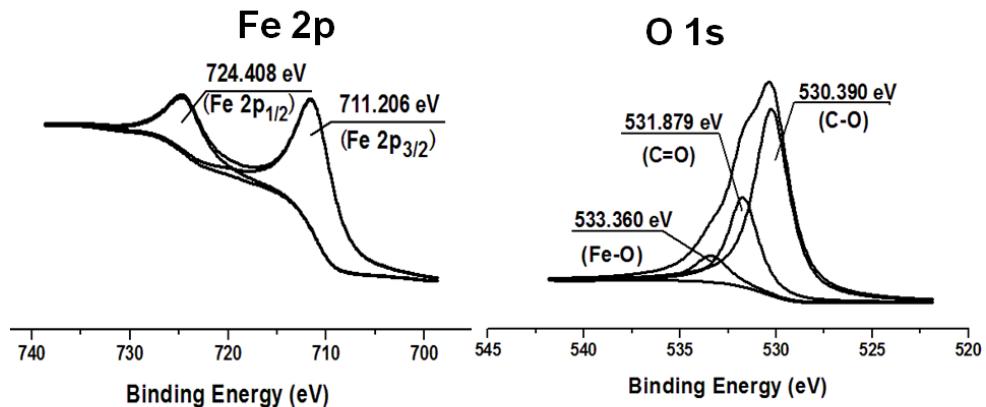


Fig. S2 The Raman spectra of Fe_3O_4 -HCNB.

(a) $\text{Fe}_3\text{N-HCNB}$



(b) $\alpha\text{-Fe-HCNB}$

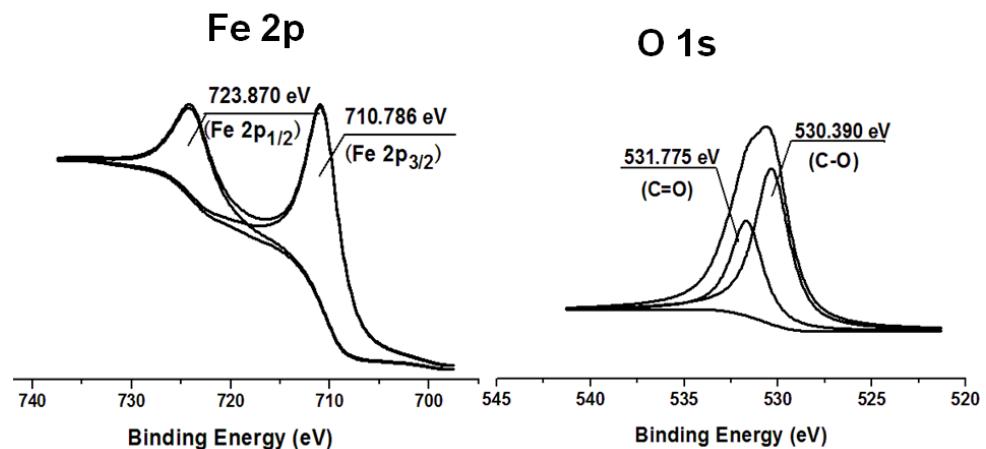


Fig. S3 The Fe 2p X-ray photoelectron spectroscopy (XPS) spectra and O 1s XPS spectra of $\text{Fe}_3\text{N-HCNB}$ (a) and $\alpha\text{-Fe-HCNB}$ (b).

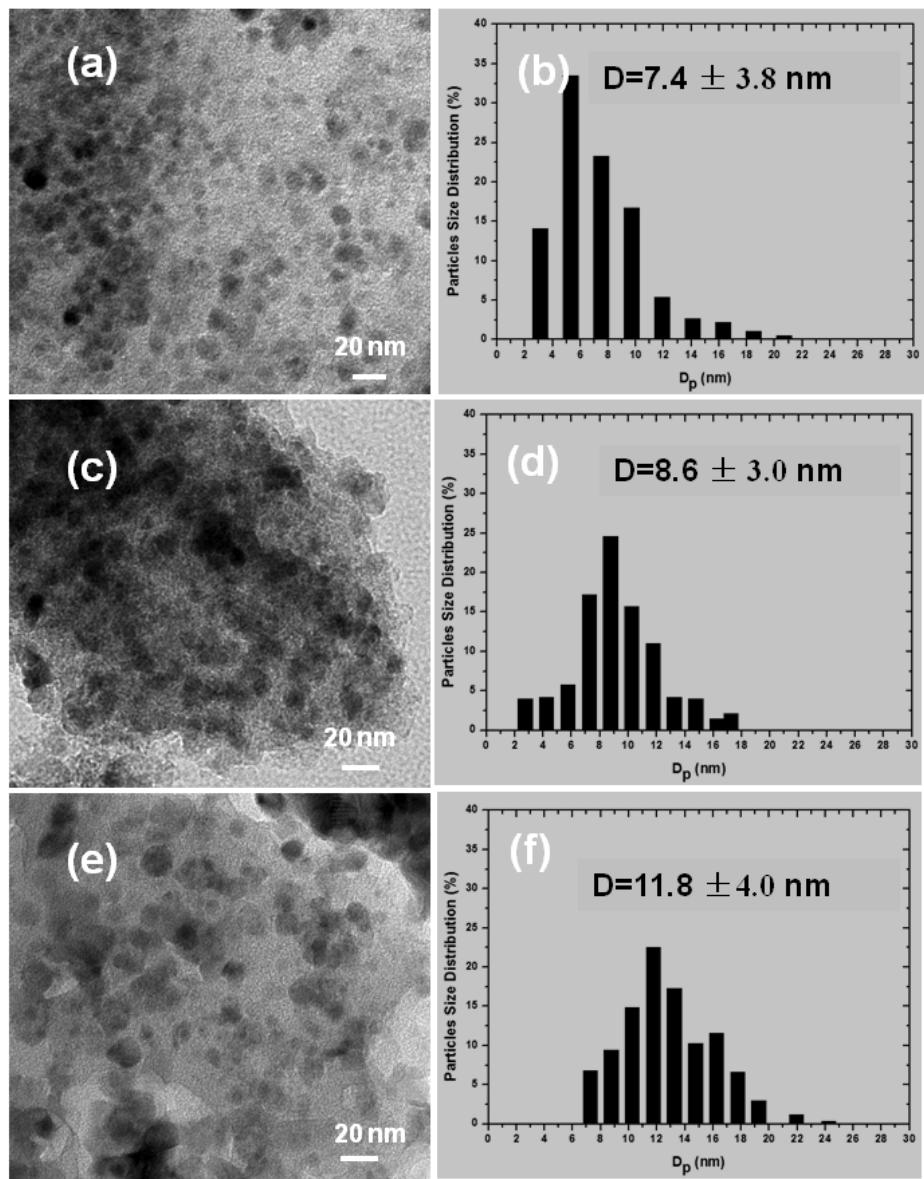


Fig. S4 Size distributions of Fe₃O₄-HCNB (a, b), Fe₃N-HCNB (c, d) and α-Fe-HCNB (e, f).

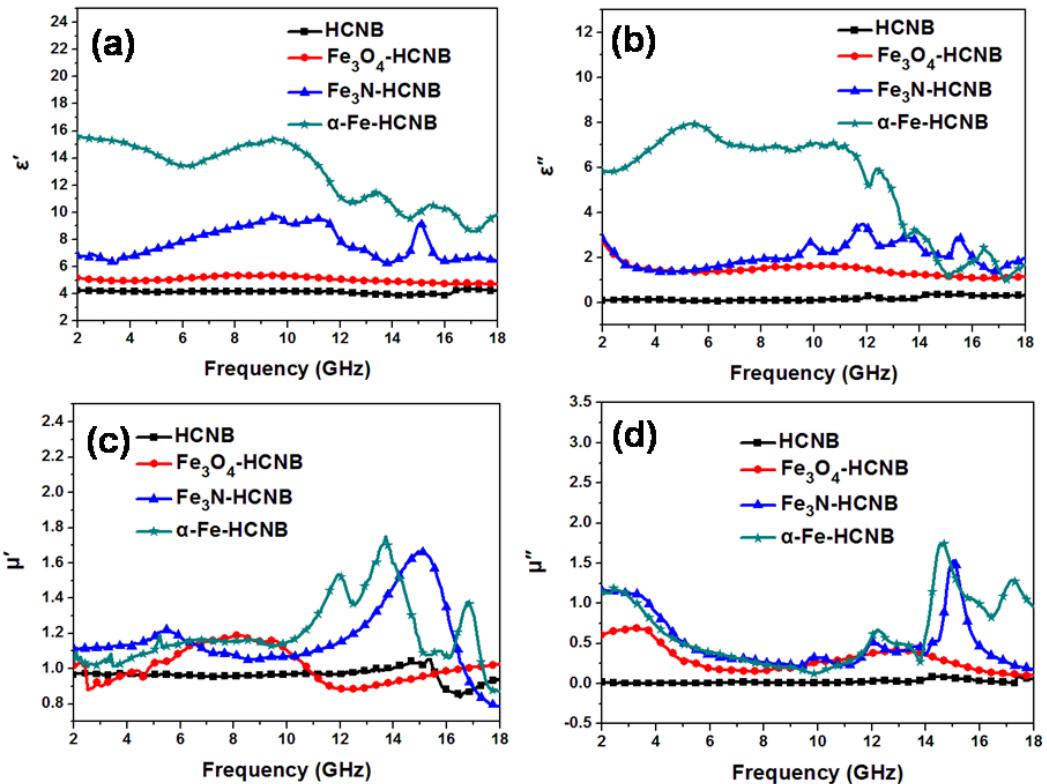


Fig. S5 Frequency dependence on the real part of complex permittivity ϵ' (a), imaginary part of complex permittivity ϵ'' (b), real part of complex permeability μ' (c), and imaginary part of complex permeability μ'' (d) for HCNB, Fe_3O_4 -HCNB, Fe_3N -HCNB and α -Fe-HCNB.

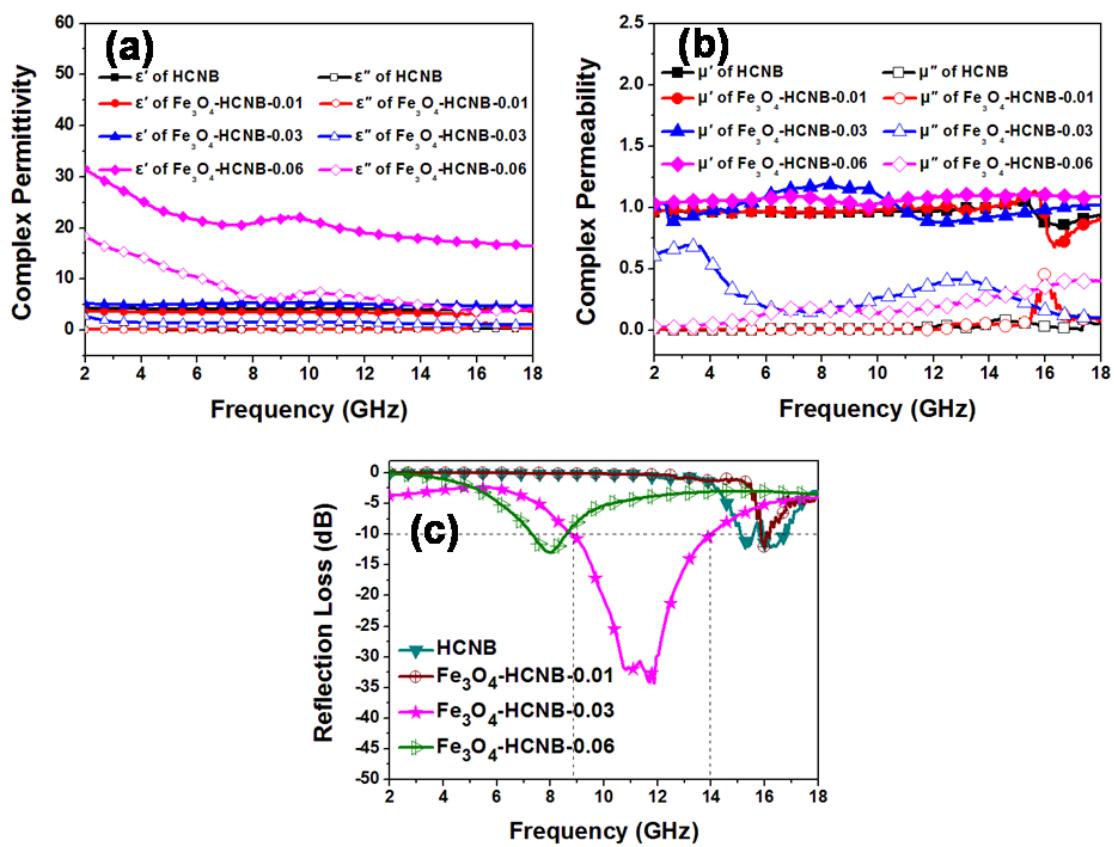


Fig. S6 The complex permittivity (a) and permeability (b) of HCNB, Fe₃O₄-HCNB-0.01, Fe₃O₄-HCNB-0.03 and Fe₃O₄-HCNB-0.06.

The content of ferromagnetic NPs (Fe_3O_4 and Fe_3N) of Fe_3O_4 -HCNBs and Fe_3N -HCNBs in Table 1 was calculated from the content of Fe_2O_3 in final products derived from thermogravimetric analysis (TGA) of Fe_3O_4 -HCNBs and Fe_3N -HCNBs in following Fig. S7, respectively.

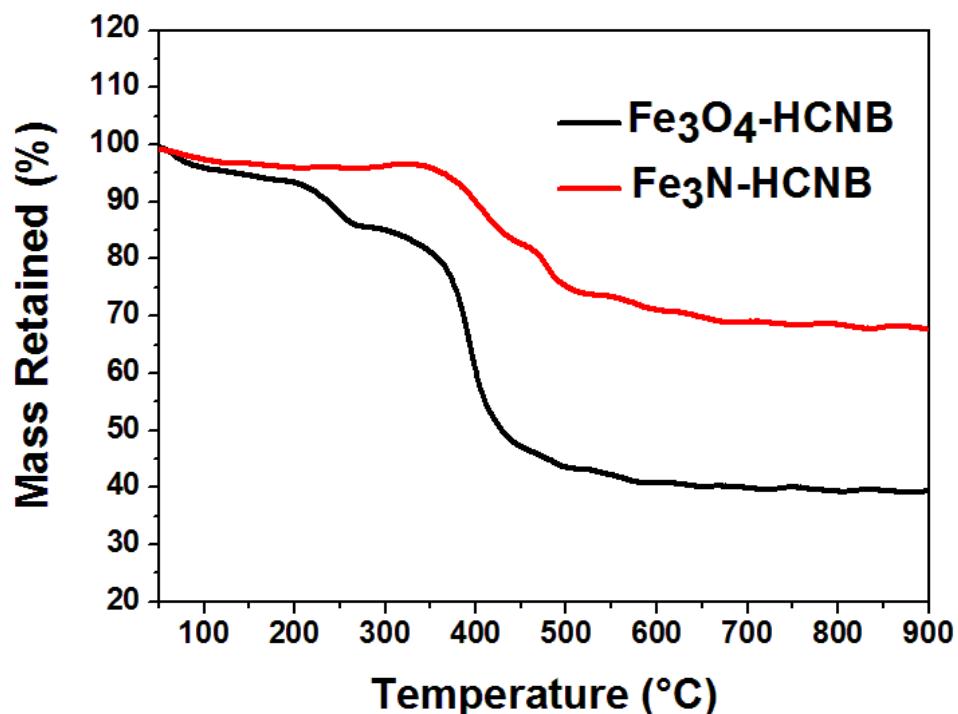


Fig. S7 Thermogravimetry curves of Fe_3O_4 -HCNB and Fe_3N -HCNB composites in air atmosphere.

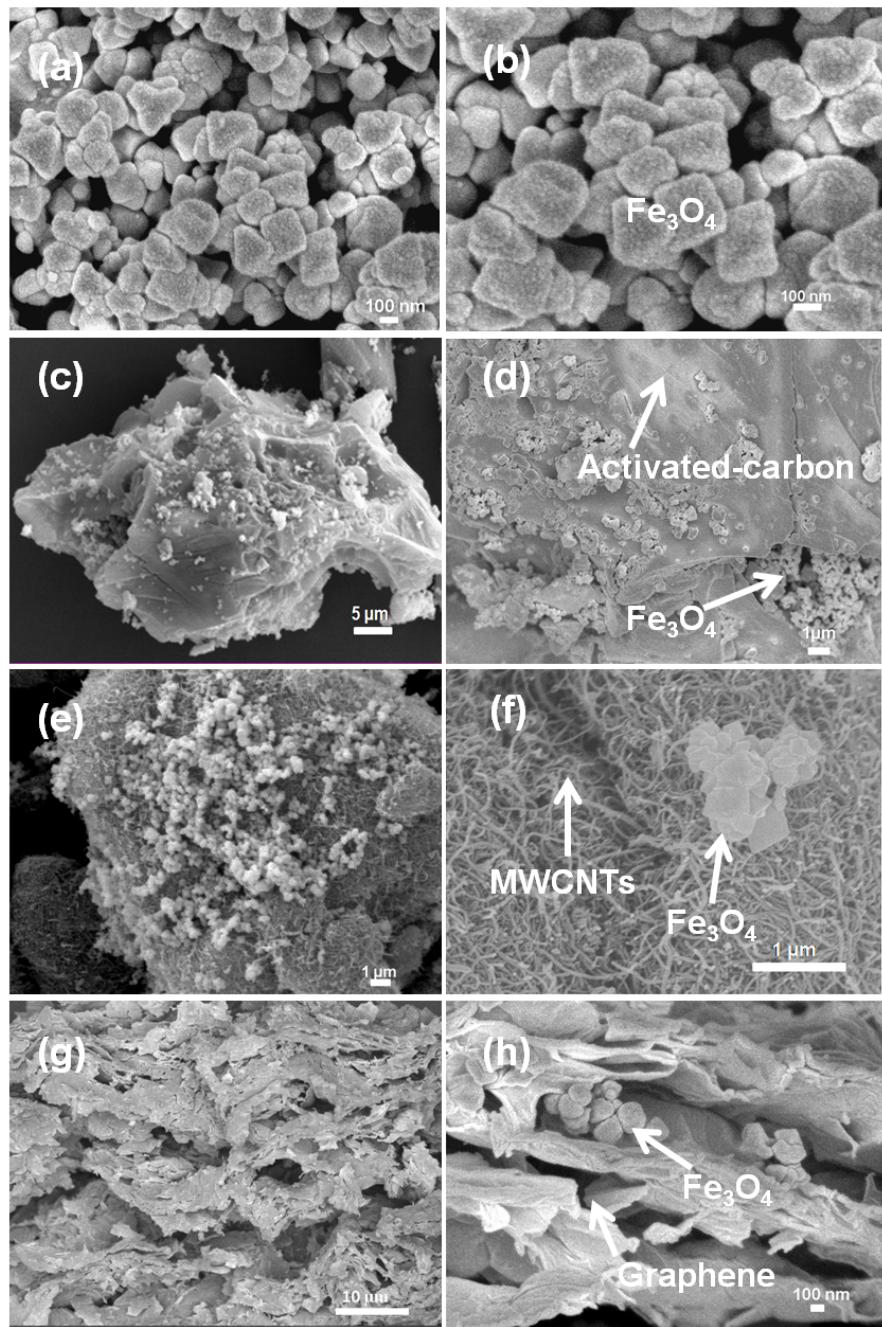


Fig. S8 Field emission microscopy (FESEM) images of commercial Fe_3O_4 NPs (a, b), Fe_3O_4 /activated-carbon (c, d), Fe_3O_4 /MWCNTs (e, f) and Fe_3O_4 /graphene (g, h).

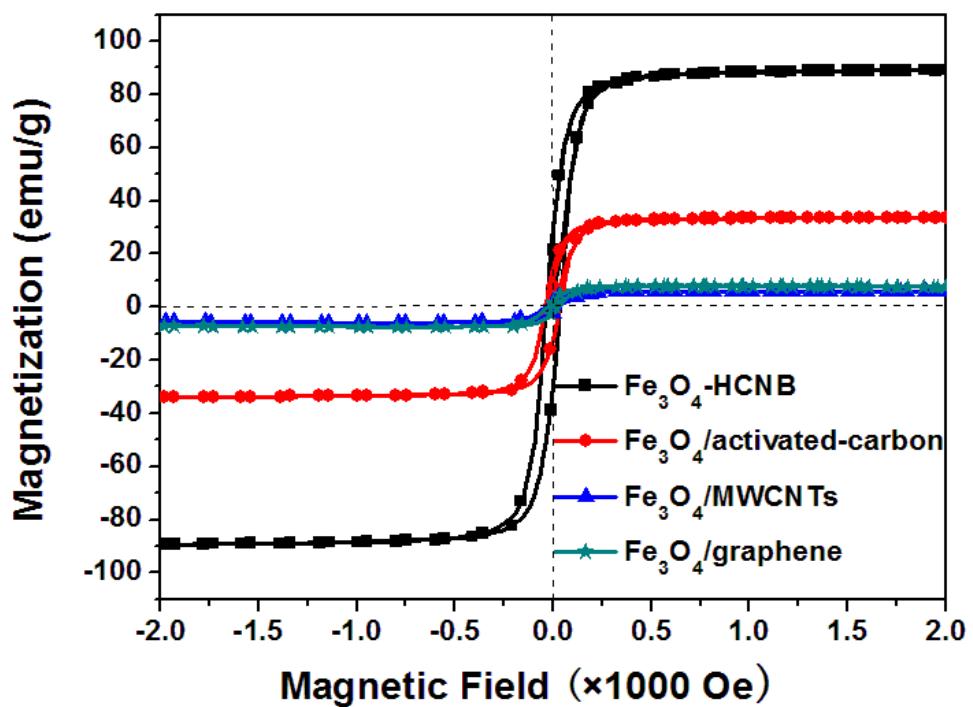


Fig. S9 Magnetization hysteresis loops of Fe_3O_4 -HCNB, Fe_3O_4 /activated-carbon, Fe_3O_4 /MWCNTs and Fe_3O_4 /graphene.

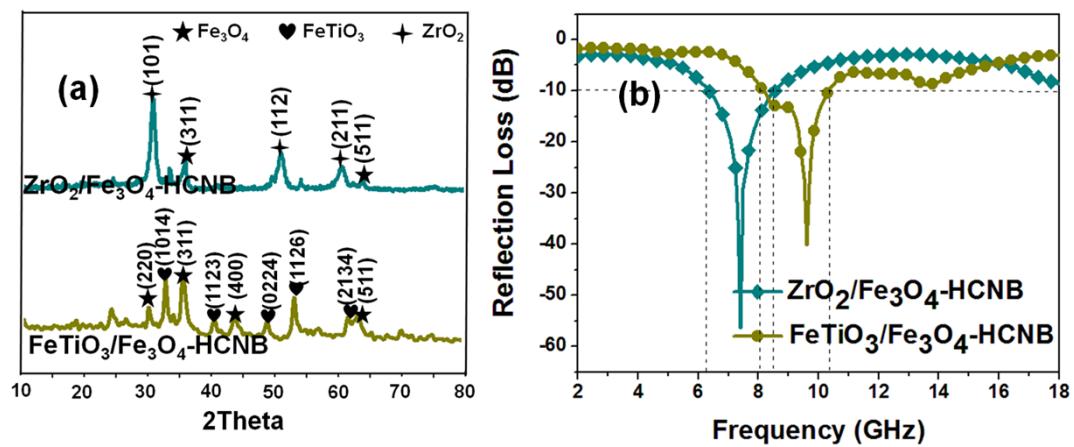


Fig. S10 X-ray diffraction (XRD) patterns (a) and microwave reflection loss (b) of $\text{FeTiO}_3/\text{Fe}_3\text{O}_4$ -HCNB and $\text{ZrO}_2/\text{Fe}_3\text{O}_4$ -HCNB with thickness of 2 mm in the frequency of 2~18 GHz.