

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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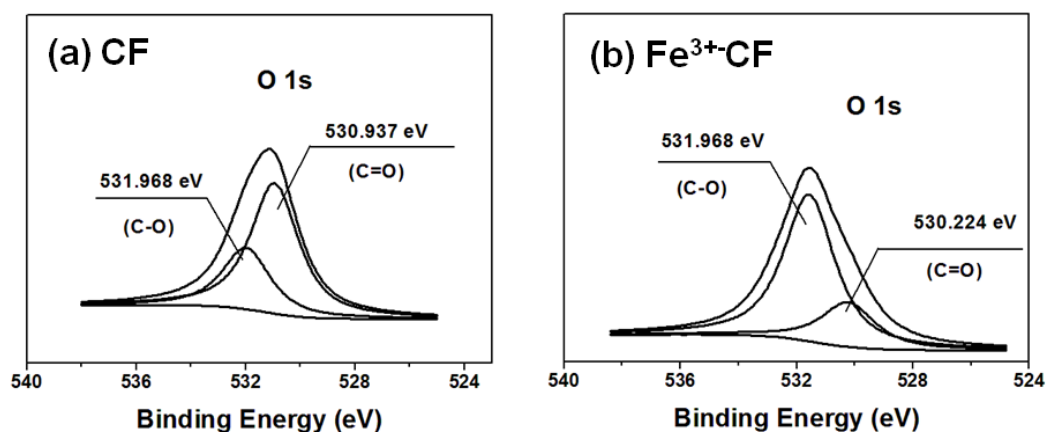


Fig.S1 O 1s X-ray photoelectron spectroscopy (XPS) spectra of CF (a) and Fe³⁺-CF (b).

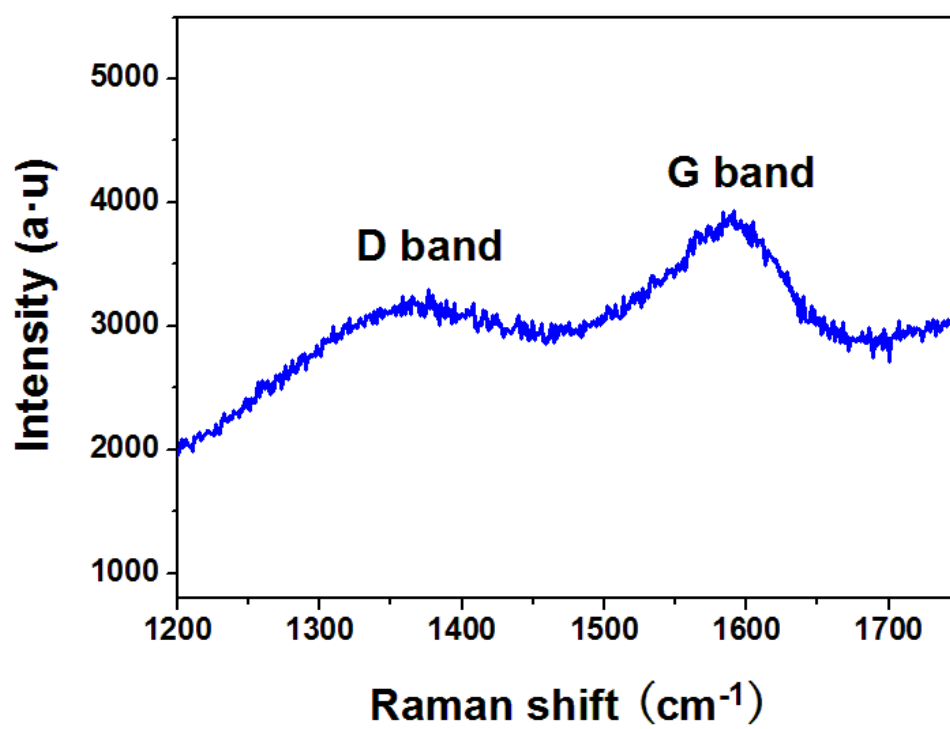
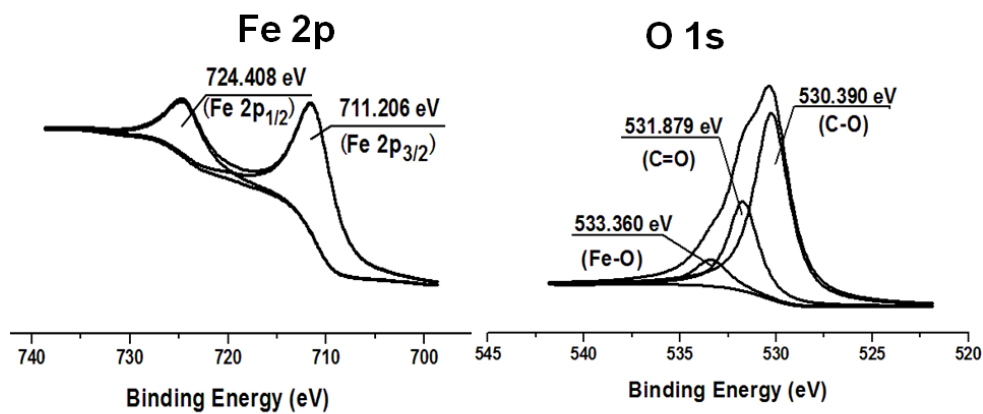


Fig. S2 The Raman spectra of Fe₃O₄-HCNB.

(a) Fe₃N-HCNB



(b) α -Fe-HCNB

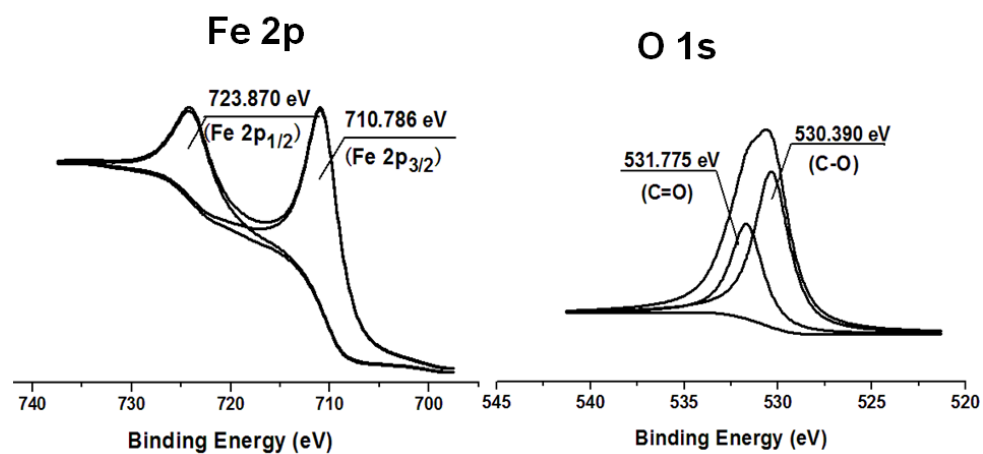


Fig. S3 The Fe 2p X-ray photoelectron spectroscopy (XPS) spectra and O 1s XPS spectra of Fe₃N-HCNB (a) and α -Fe-HCNB (b).

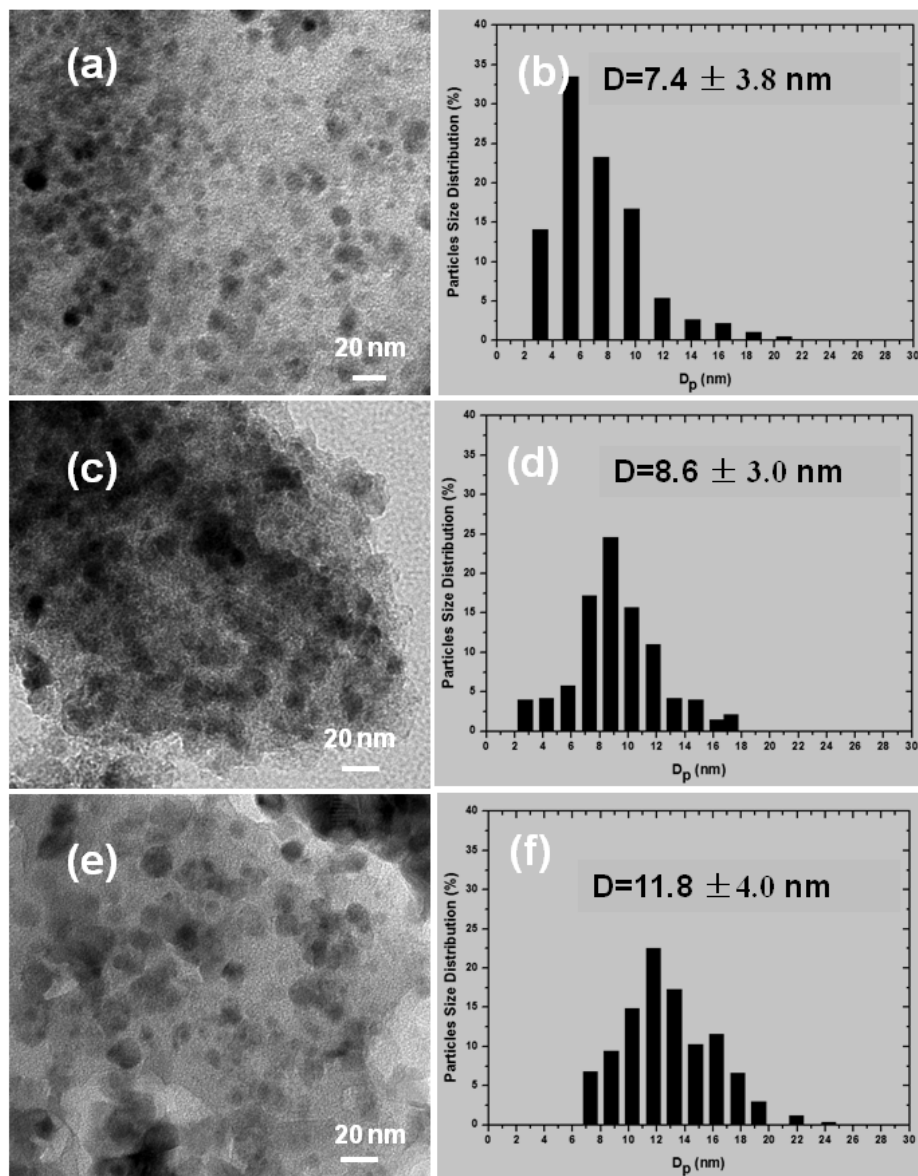


Fig. S4 Size distributions of Fe₃O₄-HCNB (a, b), Fe₃N-HCNB (c, d) and α-Fe-HCNB (e, f).

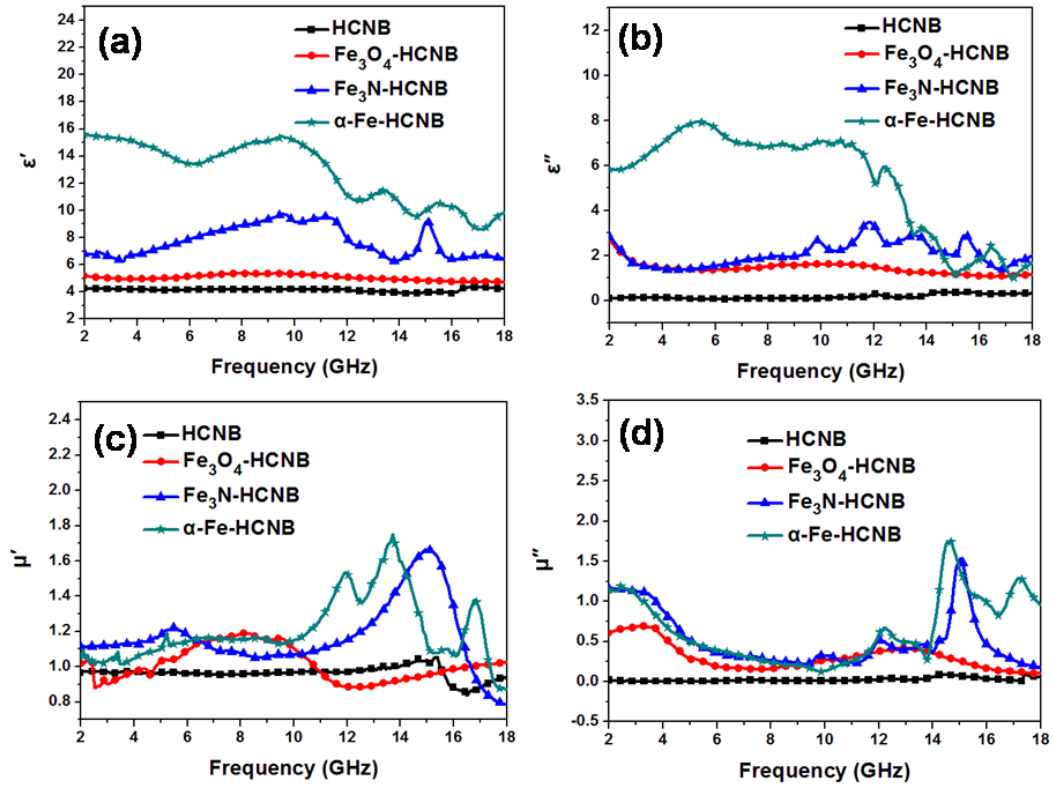


Fig. S5 Frequency dependence on the real part of complex permittivity ϵ' (a), imaginary part of complex permittivity ϵ'' (b), real part of complex permeability μ' (c), and imaginary part of complex permeability μ'' (d) for HCNB, Fe₃O₄-HCNB, Fe₃N-HCNB and α-Fe-HCNB.

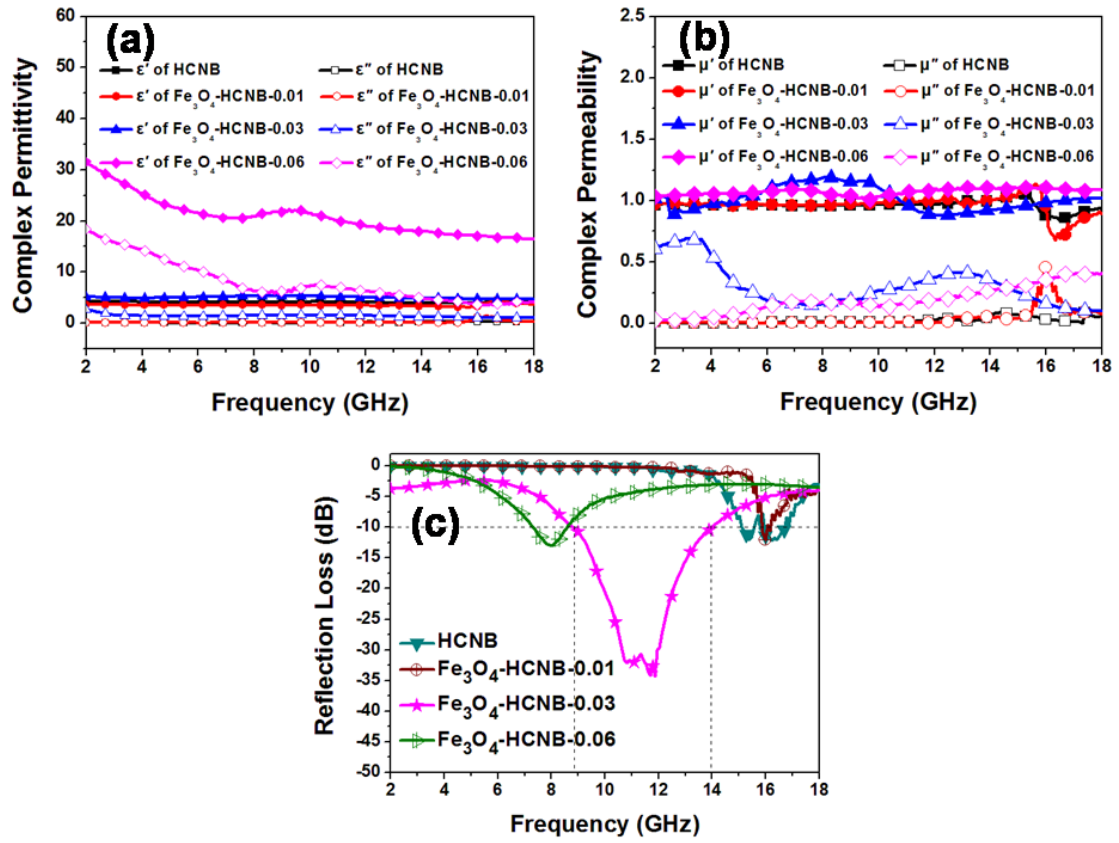


Fig. S6 The complex permittivity (a) and permeability (b) of HCNB, Fe₃O₄-HCNB-0.01, Fe₃O₄-HCNB-0.03 and Fe₃O₄-HCNB-0.06.

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.

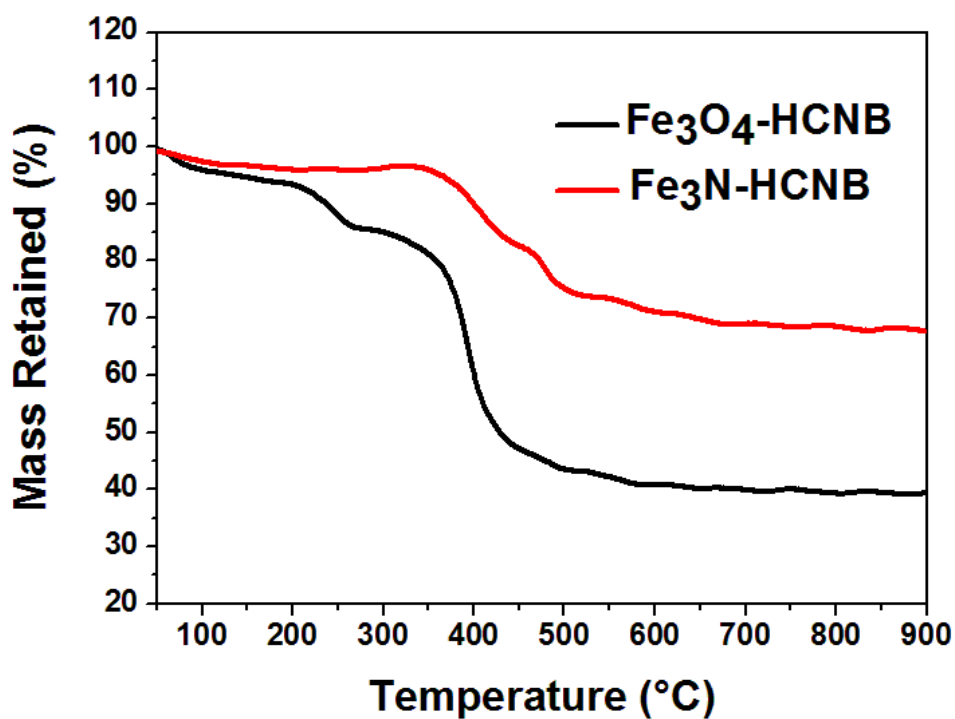


Fig. S7 Thermogravimetry curves of Fe_3O_4 -HCNB and Fe_3N -HCNB composites in air atmosphere.

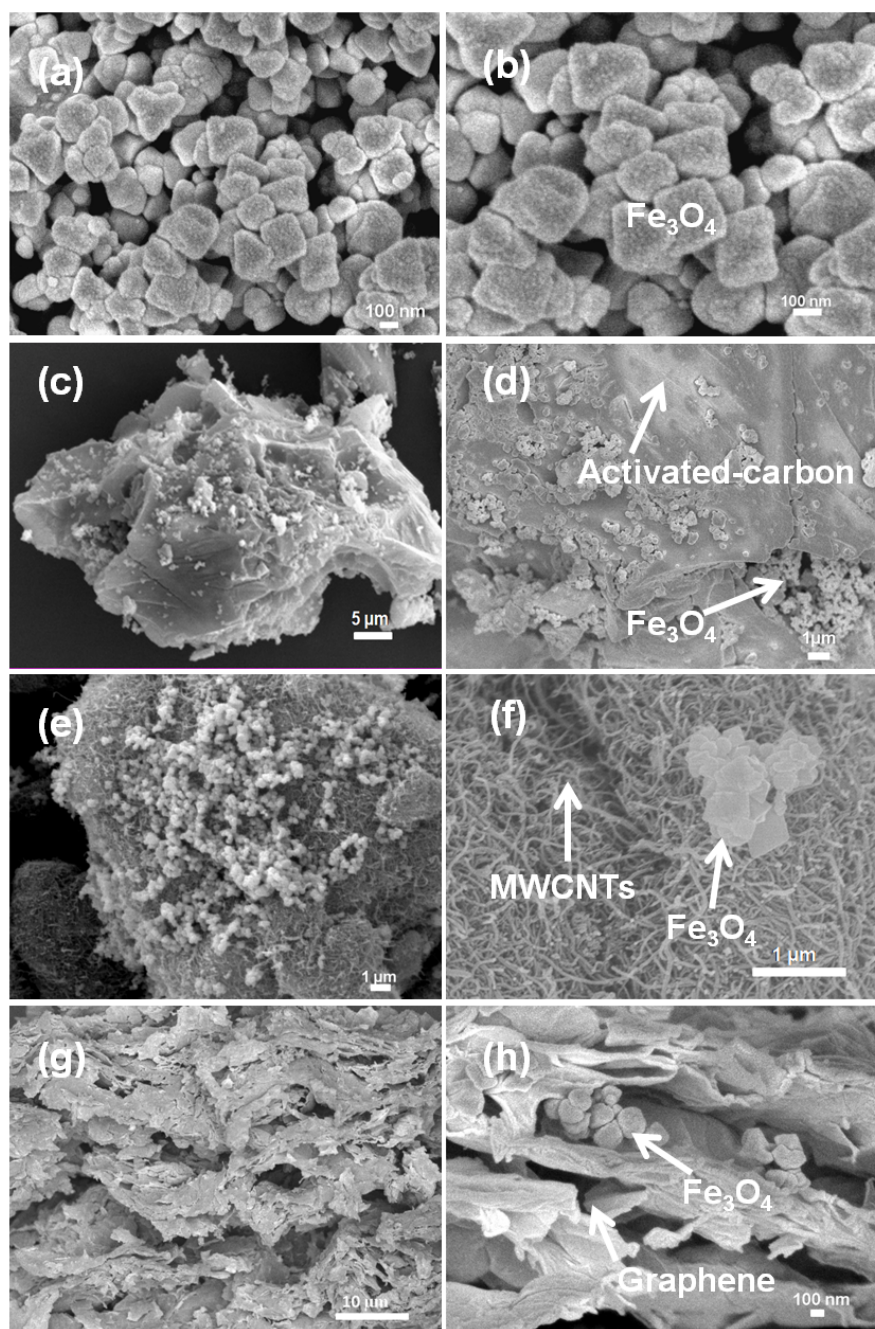


Fig. S8 Field emission electron microscopy (FESEM) images of commercial Fe_3O_4 NPs (a, b), Fe_3O_4 /activated-carbon (c, d), Fe_3O_4 /MWCNTs (e, f) and Fe_3O_4 /graphene (g, h).

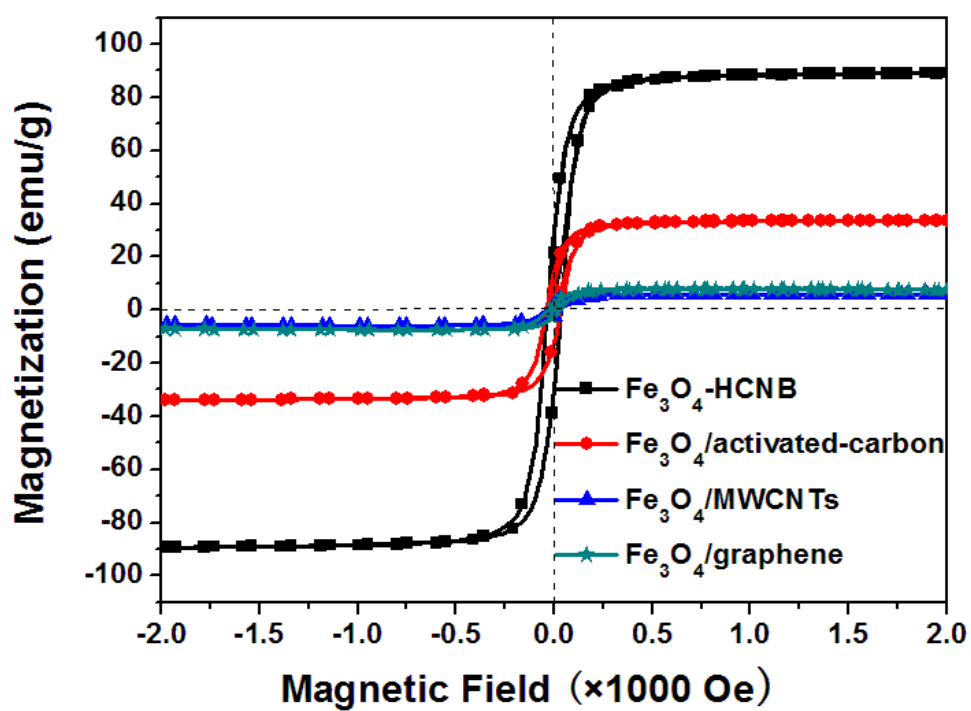


Fig. S9 Magnetization hysteresis loops of $\text{Fe}_3\text{O}_4\text{-HCNB}$, $\text{Fe}_3\text{O}_4/\text{activated-carbon}$, $\text{Fe}_3\text{O}_4/\text{MWCNTs}$ and $\text{Fe}_3\text{O}_4/\text{graphene}$.

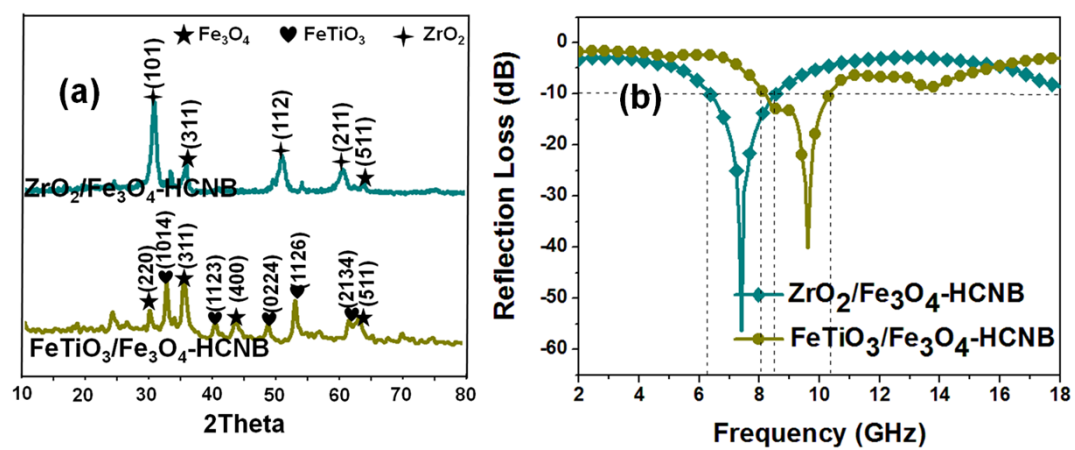


Fig. S10 X-ray diffraction (XRD) patterns (a) and microwave reflection loss (b) of $\text{FeTiO}_3/\text{Fe}_3\text{O}_4\text{-HCNB}$ and $\text{ZrO}_2/\text{Fe}_3\text{O}_4\text{-HCNB}$ with thickness of 2 mm in the frequency of 2~18 GHz.