Supporting information

Synthesis and microwave absorbing properties of highly ordered mesoporous crystalline $NiFe_2O_4$

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◆ Experiment Part:

Synthesis of mesoporous nickel/iron spinel: The chosen synthesis procedure was the "incipient wetness" method. The molar ratio of nickel to iron was fixed to 1:2. Typically, calculated amounts of $Fe(NO_3)_3 \cdot 9H_2O$ and $Ni(NO_3)_2 \cdot 6H_2O$ were dissolved in de-ionized water. The concentration of the mixture was about 1.7 $mol \cdot L^{-1}$. According to the pore volume of the silicate template, 1.1 mL of solution was gradually added to 0.3 g KIT-6 and dried at 50 °C for 3 hours, and calcined at 200''°C for 2 h and at 750°C for 5h. The impregnation and calcination was repeated twice. 2M NaOH solution was used to dissolve the silica template at 80 °C overnight. The obtained powder was washed with de-ionized water unless the effluent was neutral and then it was dried at 90 °C overnight.

Characterization: Powder X-ray diffraction (XRD) patterns were recorded on a Stoe STADI P diffractometer operating in reflection mode with Cu Kα radiation using a secondary graphite monochromator. Scanning electron microscope (SEM) and energy dispersive X-ray (EDX) analyses were performed on a Hitachi S-3500 N instrument equipped with an Oxford EDX unit (INCA Surveyor Imaging System). Transmission electron microscopy (TEM) was carried out with Hitachi HF 750 instrument. All samples were prepared on lacey carbon films supported by a copper grid. N_2 sorption measurements were performed with a Micrometrics ASAP 2010 instrument. Magnetic properties of the sample were measured by using a superconducting quantum interference device (SQUID) magnetometer. The mesoporous $NiFe_2O_4$/paraffin (weight ratio: 1:3) composites were pressed into a toroidal shape with outer diameter of 7 mm and inner diameter of 3 mm for microwave measurements. Complex permittivity and complex permeability were measured with an Agilent Vector Network Analyzer 8720 in the frequency range of 0.5-18 GHz.

◆ Calculation Part :

For a single-layer absorbing material backed by a perfect conductor, the input impedance (Z_{in}) at the air-material interface is given by

$$Z_{in} = Z_0\sqrt{\frac{\mu_r}{\varepsilon_r}}\tan(j\frac{2\pi fd}{c}\sqrt{\mu_r\varepsilon_r}) \qquad (1)$$

Where d is the thickness of the absorber, f is the frequency, c is the velocity of light, μ_r is the complex permeability, and ε_r is the complex permittivity. The reflection loss of a normal incident electromagnetic wave at the absorber surface is given by

$$R = 20\log\left|\frac{Z_{in} - Z_0}{Z_{in} + Z_0}\right| \qquad (2)$$

where Z_0 is the impedance of air.

Figures

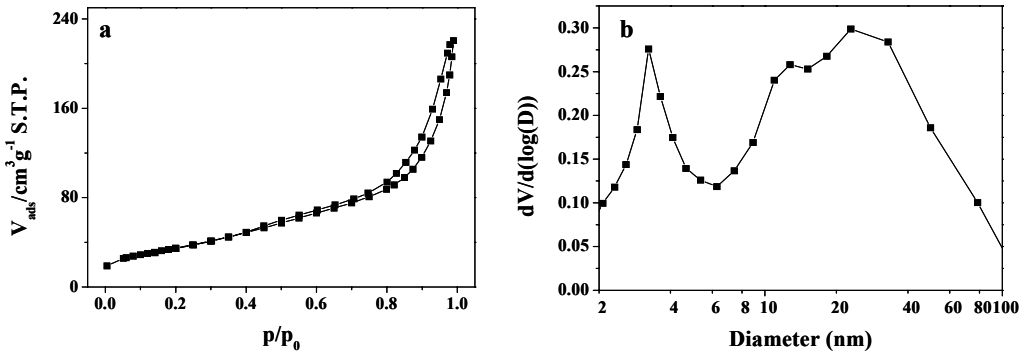

Figure S1. (a) Nitrogen sorption isotherm and (b) BJH pore size distribution of meso-$NiFe_2O_4$ (BJH calculated from the desorption branch).

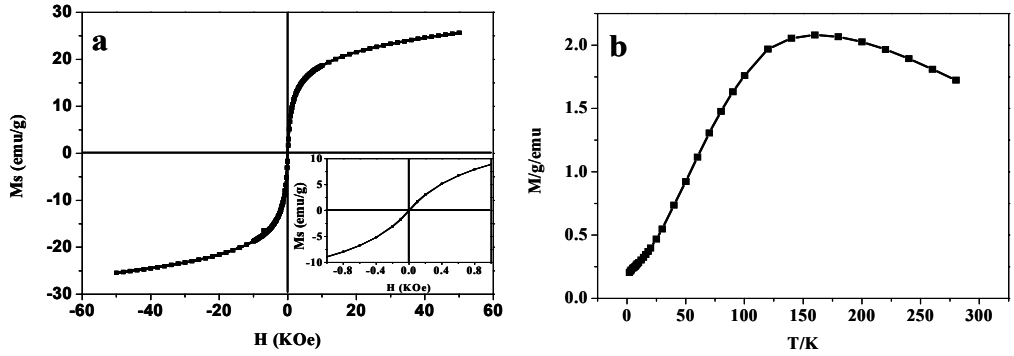

Figure S2. (a) Magnetization curve and zoomed detail (inset) in the low field range and (b) ZFC magnetization curve of meso-$NiFe_2O_4$.

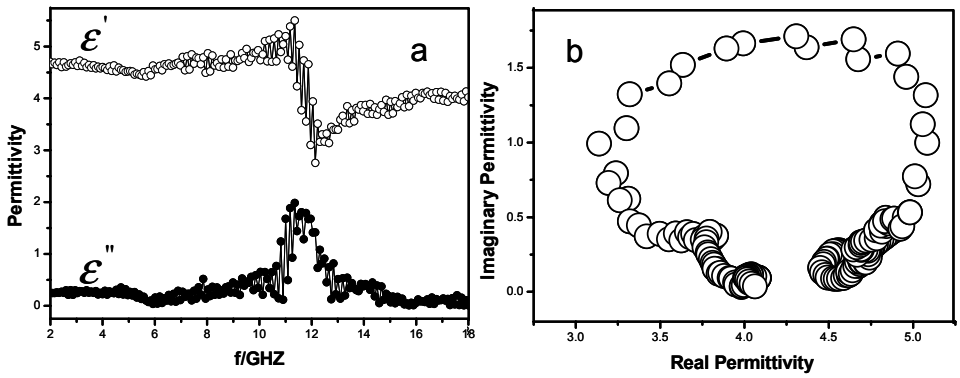

Figure S3. (a) Relative permittivity of mesoporous $NiFe_2O_4$/paraffin composites as a function of frequency and (b) the relation between real part and imaginary part of the complex permittivity *(Cole-Cole plot)*.

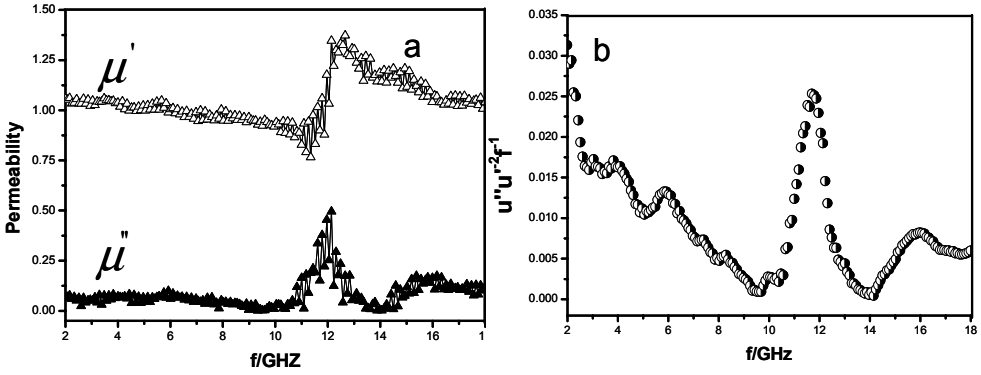

Figure S4. (a) Relative permeability of mesoporous $NiFe_2O_4$/paraffin composites as a function of frequency. (b) The value of $\mu''(\mu')^{-2}f^{-1}$ as a function of frequency.