Facile, Large-scale and Expeditious Synthesis of Hollow Co and Co@Fe Nanostructures: Application for Electromagnetic Wave Absorption

Peipei Yang,[†] *Xiuchen Zhao,**[†] *Ying Liu,*[†] *Yue Gu*[b‡]

[†]School of Materials Science and Engineering, Beijing Institute of Technology,

Beijing, 100081, China

[‡]Materials Science and Engineering Program, nanoEngineering Department, 9500

Gilman Drive La Jolla, CA 92093, United States

Figure S1 shows the HRTEM images of Fe nanospheres and Fe nanochains. Fe nanospheres (Figure S1a) corresponds to amorphous structure without an obvious lattice fringe. Figure S1b displays the HRTEM image of Fe nanochains, in which the lattice fringe is assigned to 2.026 Å of (110) plane.

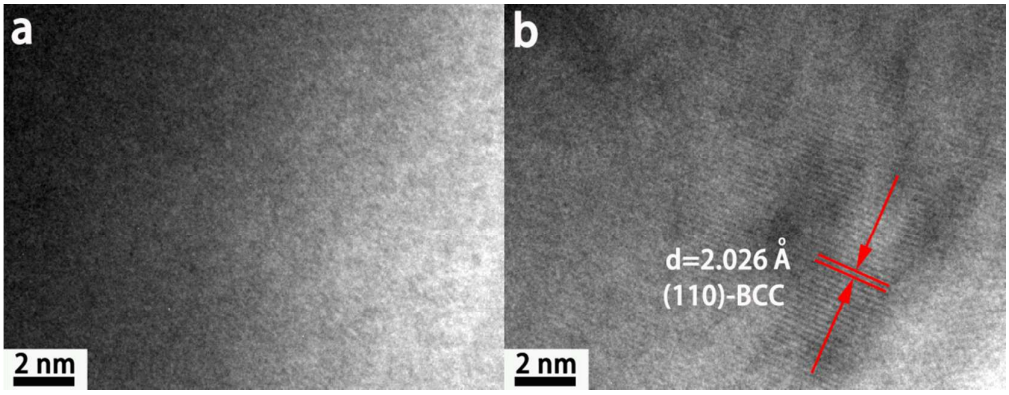

Figure S1 HRTEM images of (a) Fe nanospheres and (b) Fe nanochains.

Figure S2 shows the TEM images of Fe@Co nanospheres and nanochains. The average diameter of the Fe@Co nanospheres is about 280 nm. The Fe@Co nanochains have an average diameter of about 120 nm.

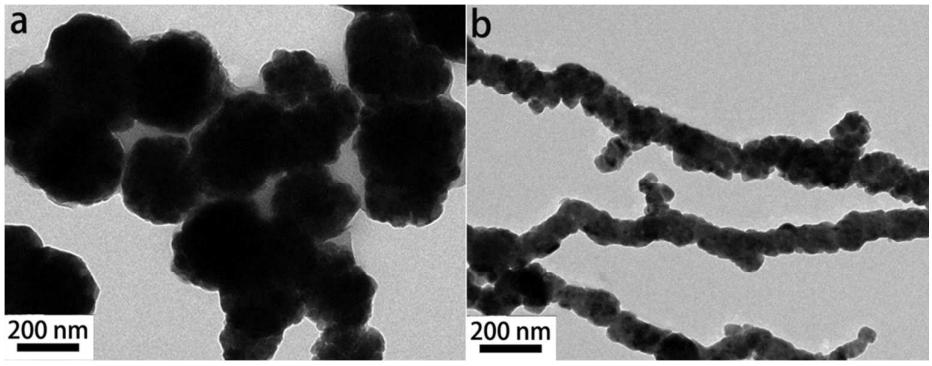

Figure S2. TEM images of (a) Fe@Co nanospheres and (b) Fe@Co nanochains.

Figure S3 shows the XRD patterns of Fe@Co nanospheres and nanochains. Fe@Co nanospheres have an obviously amorphous peak which is ascribed to the Fe core, and

the Co shell is a mixed structure of FCC and HCP. However, Fe@Co nanochains has a crystal structure: Fe core has a BCC structure, while Co shell also has a mixed structure of FCC and HCP.

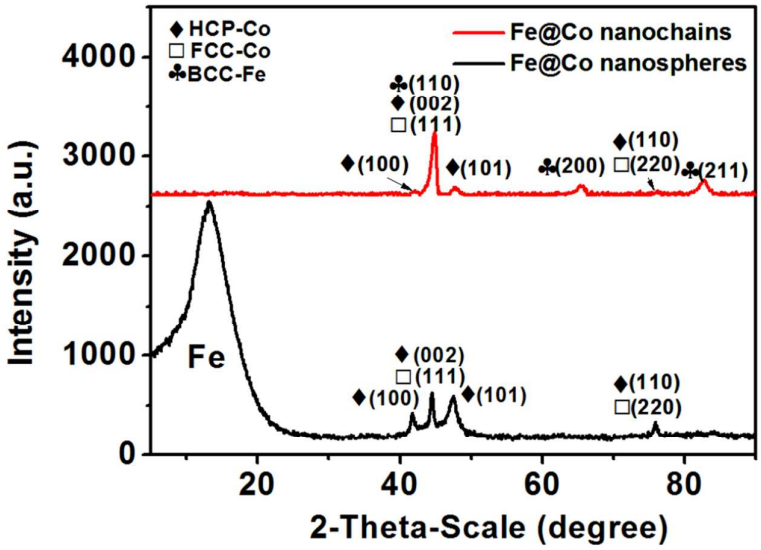

Figure S3. XRD patterns of Fe@Co nanospheres and Fe@Co nanochains.

Figure S4 shows the TEM image of hollow Co@Fe nanospheres. The average diameter of hollow Co@Fe nanospheres is about 330 nm and the shell thickness is about 60 nm.

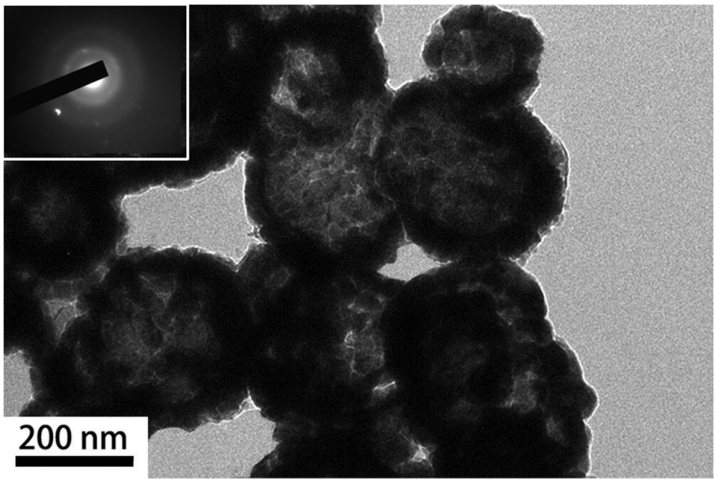

Figure S4 TEM image of hollow Co@Fe nanospheres.

The EM parameters of hollow Co@Fe nanospheres and Fe@Co nanospheres are shown in Figure S5. Notably, the dielectric loss and magnetic loss of hollow Co@Fe nanospheres are both larger than that of Fe@Co nanospheres.

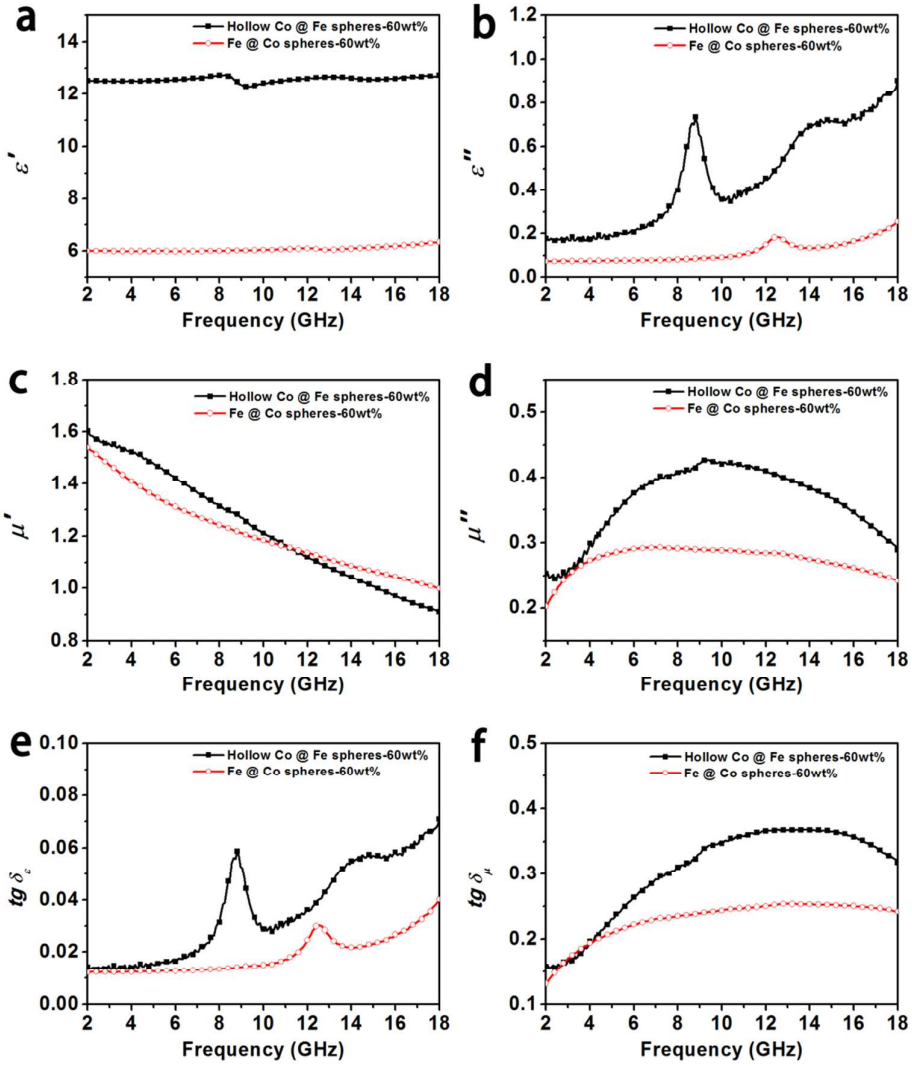

Figure S5 EM parameters of hollow Co@Fe nanospheres and Fe@Co nanospheres: (a) ε', (b) ε'', (c) μ', (d) μ'', (e) $tan\delta_e$, (f) $tan\delta_\mu$.

The reflection loss of two samples are calculated, as shown in Figure S6 and Table S1. It is indicated that EM wave absorption properties of hollow Co@Fe nanospheres is superior to that of Fe@Co nanospheres. On one hand, the density of hollow Co@Fe nanospheres is larger than that of Fe@Co nanospheres. Therefore, volume fraction of

hollow Co@Fe nanospheres dispersed in paraffin wax increases, and the contacted area of particles and paraffin also increases, leading to the enhanced RL_{min}. On the other hand, the interfaces amount of hollow Co@Fe nanospheres is more than that of Fe@Co nanospheres, leading to the multiple reflection in the materials to consume electromagnetic wave.

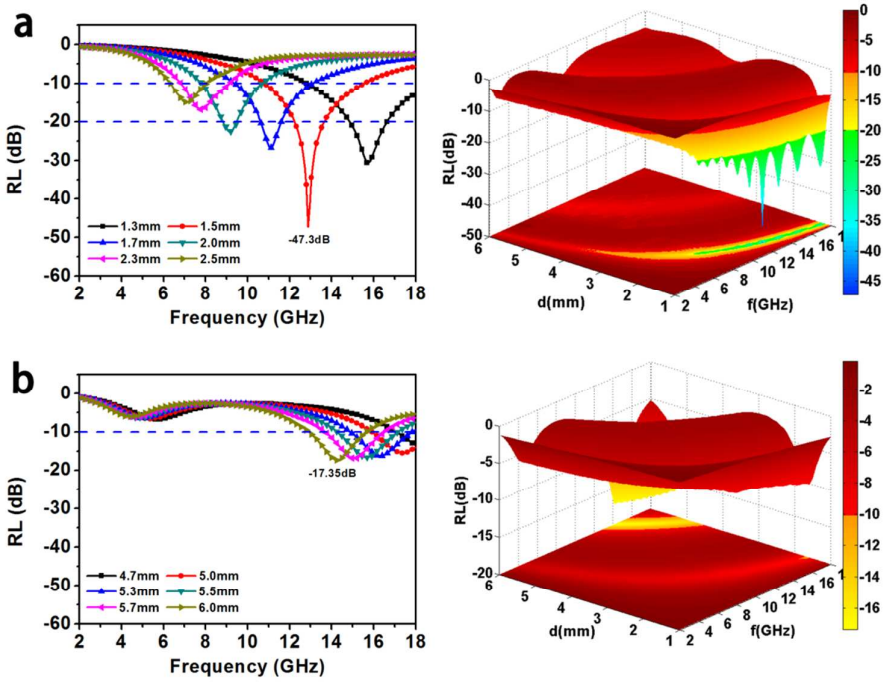

Figure S6 EM wave absorption properties of (a) hollow Co@Fe nanospheres and (b) Fe@Co nanospheres.

Table 1. The comparison of EM wave absorption of two samples

Sample	RL_{min}(dB)	f(GHz)	d(mm)	Bandwidth(GHz)
hollow Co@Fe nanospheres-60 wt.%	-47.3	12.8	1.5	4.8(10.7-15.5)
Fe@Co nanospheres-60 wt.%	-17.35	14.2	6.0	2.9(12.8-15.7)