Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supplementary information for：

Glass-iron oxide, glass-iron and glass-iron-carbon composite hollow particles with tunable electromagnetic properties

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China.

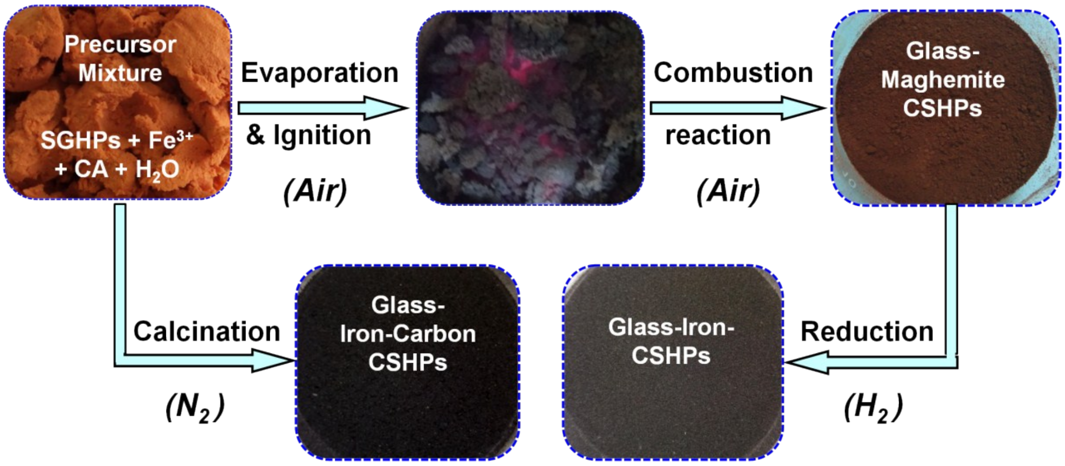

Fig. S1 Schematic illustration of the synthetic process of different CSHPs (the images are photographs of the reactant and products at different reaction stages).

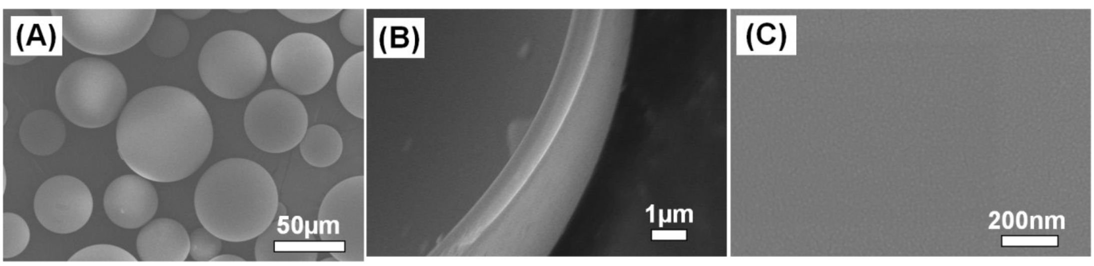

Fig. S2 SEM images of the glass SGHPs after washing and drying.

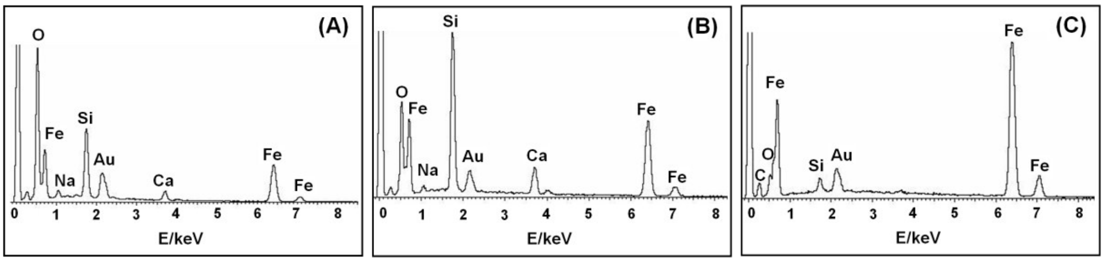

Fig. S3 EDX spectrums of (A) glass-iron oxide CSHPs (S-1), (B) glass-iron CSHPs (S-2), (C) glass-iron-carbon CSHPs (S-3).

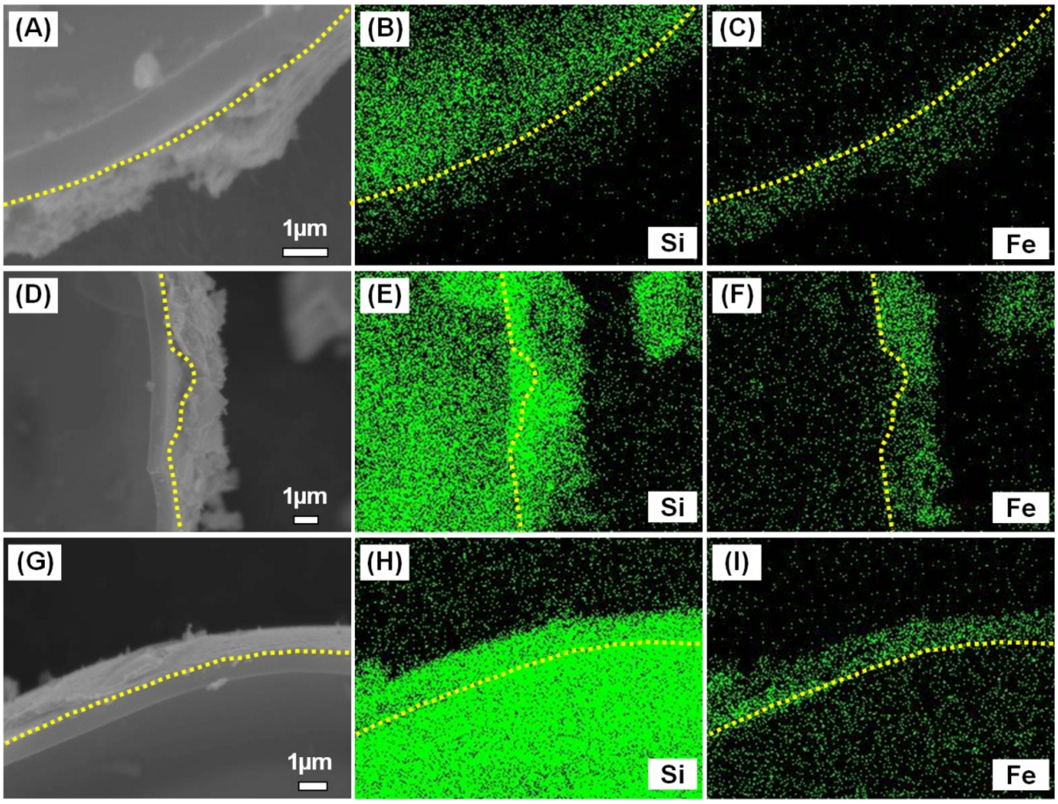

Fig. S4 SEM image and the corresponding EDX element mapping of Si and Fe taken on a fragment of the as-obtained CSHPs (glass-iron oxide CSHPs (S-1, (A)-(C)), glass-iron CSHPs (S-2, (D)-(F)) , and the glass-iron-carbon CSHPs (S-3, (G)-(I))).

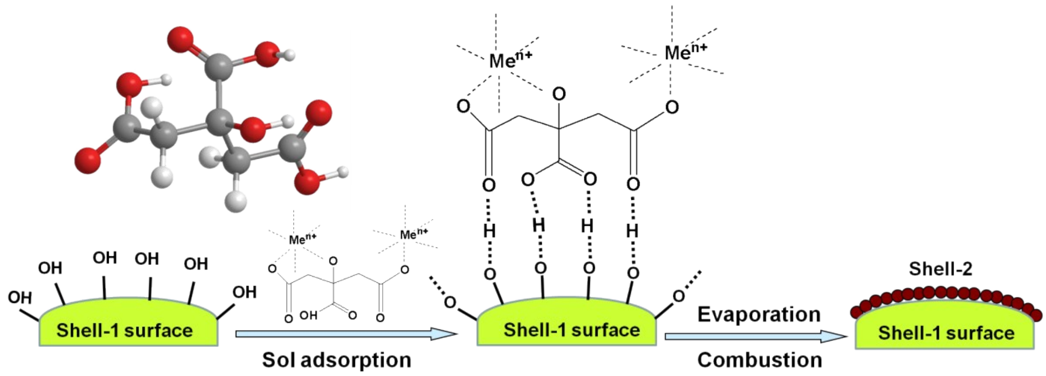

Fig. S5 Schematic illustration of the directed assembly process of shell-2 on shell-1.

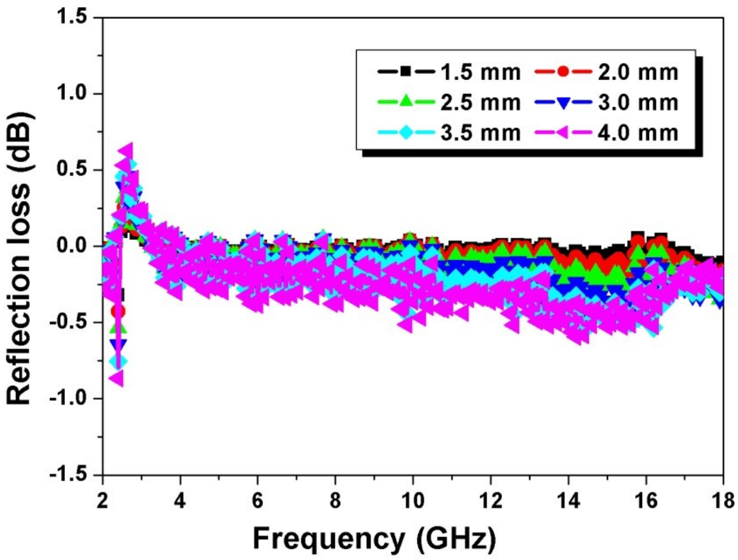

Fig. S6 Microwave reflection losses of the as-obtained SGHPs (S-0) at different absorber thicknesses.

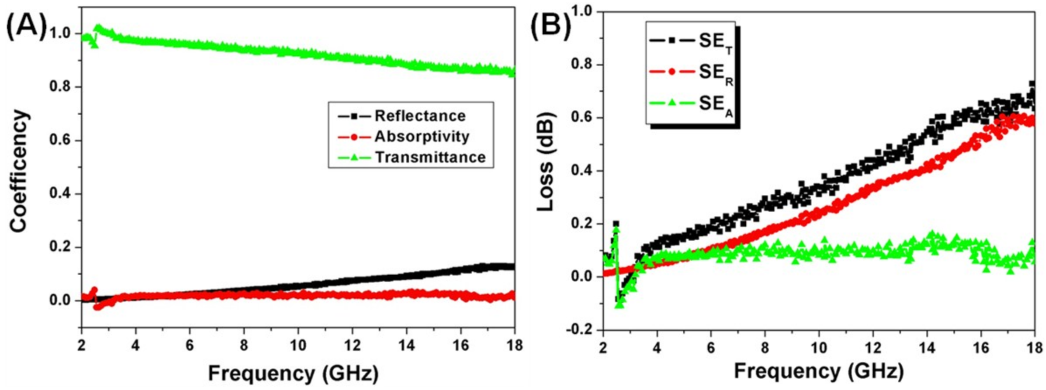

Fig. S7 Frequency dependence of (A) power balance and (B) absorbing mechanisms (SE_A Absorption loss, SE_R reflection loss and SE_T total loss) of the SGHPs.

The total shielding (SE_T), absorption loss (SE_A), reflection loss (SE_R), reflected power (R), transmitted power (T) and absorbed (A) power were calculated based on the S parameters by the following equations:

$$SE_T = SE_R + SE_A \quad (1)$$

$$SE_R = 10\log_{10}\left(\frac{1}{1-|S11|^2}\right) \quad (2)$$

$$SE_A = 10\log_{10}\left(\frac{1-|S11|^2}{|S12|^2}\right) \quad (3)$$

$$R = |S11|^2 = |S22|^2 \quad (4)$$

$$T = |S12|^2 = |S21|^2 \quad (5)$$

$$A = 1 - R - T \quad (6)$$

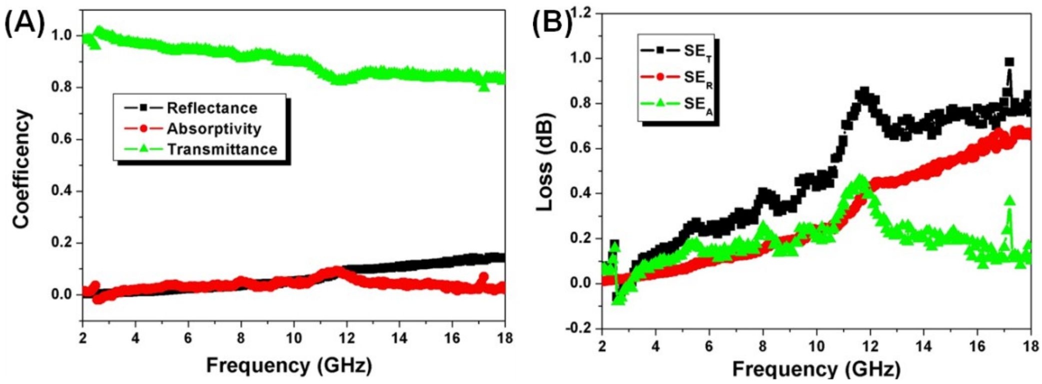

Fig. S8 Frequency dependence of (A) power balance and (B) absorbing mechanisms (SE_A Absorption loss, SE_R reflection loss and SE_T total loss) of the glass-maghemite CSHPs (S-1).

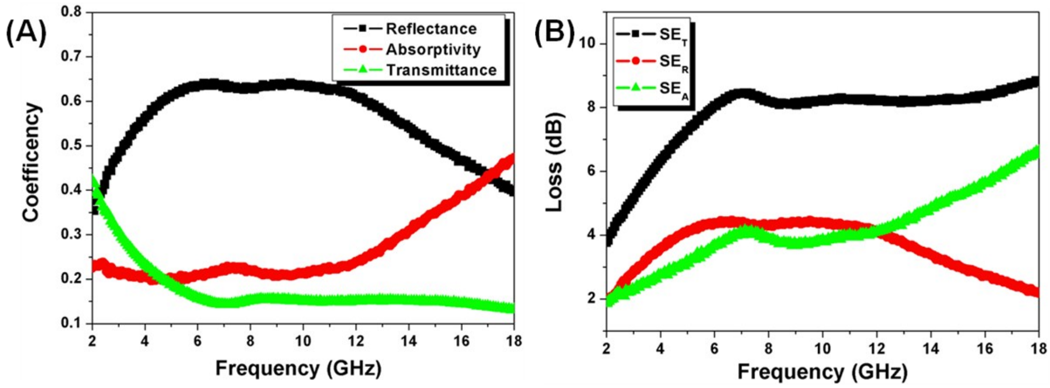

Fig. S9 Frequency dependence of (A) power balance and (B) absorbing mechanisms (SE_A absorption loss, SE_R reflection loss and SE_T total loss) of the glass-iron CSHPs (S-2).

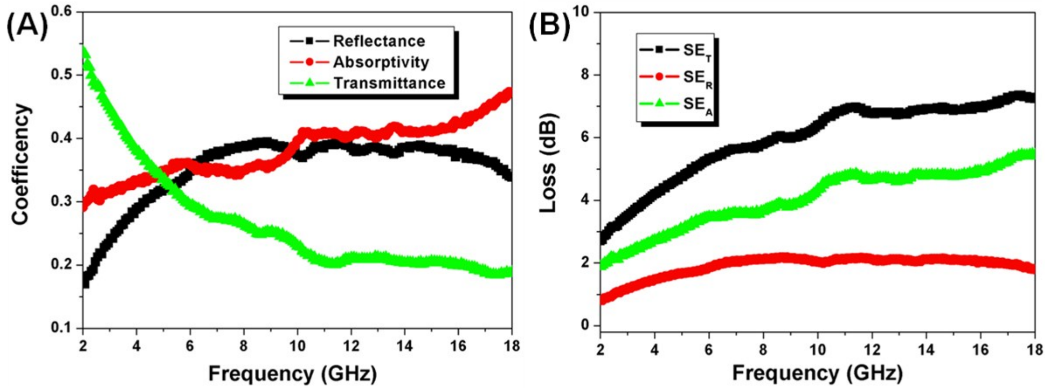

Fig. S10 Frequency dependence of (A) power balance and (B) absorbing mechanisms (SE_A Absorption loss, SE_R reflection loss and SE_T total loss) of the glass-iron-carbon CSHPs (S-3).

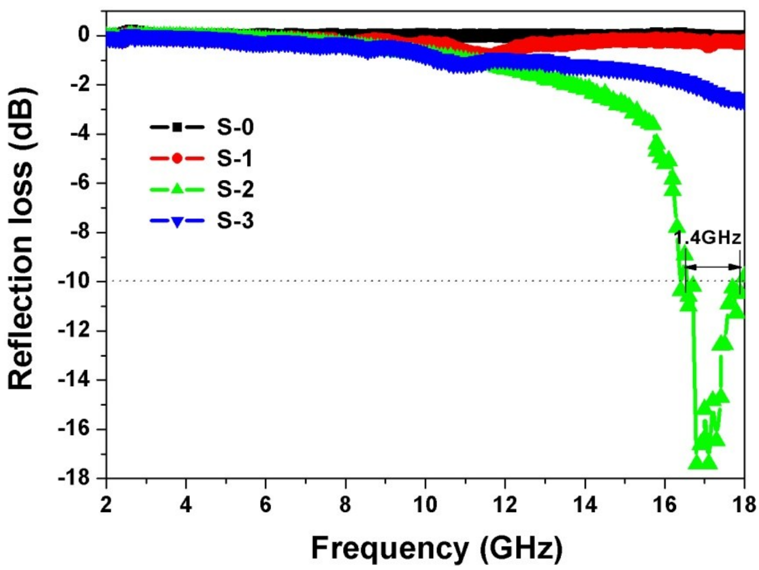

Fig. S11 RL at a microwave absorbing layer thickness of 1.0mm of different samples.

TABLE S1. Microwave absorption performances of some magnetic hollow structured materials.

Items / Samples	Measured Frequency range (GHz)	Thickness (mm)	EAB (TL⩽ -10dB) (GHz)	Ref.
Hollow $CoFe_2O_4$–Co_3Fe_7 microspheres	2-18	2	<1	1
$CoFe_2O_4$ hollow sphere/graphene	2-18	2	3.7	2
Hollow glass/nickel flowers microspheres	2-18	3.5	0.8	3
Hollow ceramic-barium ferrites composite single shell microspheres	1-18	2.5	<1	4
Hollow glass / $CoFe_2O_4$ microspheres	2-18	1.5	0	5
Hollow glass microspheres/ Fe_3O_4	2-18	2.4	1.4	6
Hollow glass microspheres/Co-Fe	1-18	2	1.6	7
Hollow ceramic/barium ferrite double shell microspheres	5-18	3	2.2	8
Glass-iron CSHPs	2-18	2	2.2	Present work
Glass-iron-carbon CSHPs	2-18	2	>6	Present work

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