Supplementary Information (SI) for Journal of Materials Chemistry A.

Supporting Information

Rational Design of Interwoven SiO_2@Gr/N-CNTs Heterostructures from Fe-C-Si Alloys for Achieving Superior Electromagnetic Wave Absorption

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Electromagnetic absorbing performance calculation

The relative complex permittivity (εr) can be calculated as follows:

$$\varepsilon_r = \varepsilon_\infty + \frac{\varepsilon_s - \varepsilon_\infty}{1 + j2f\pi\tau} = \varepsilon^{'} - j\varepsilon^{''} \tag{S1}$$

Where ε_r denotes the static permittivity, ε_∞ represents the optical permittivity (relative dielectric permittivity in the high-frequency limit), and τ corresponds to the relaxation time. The complex permittivity ε_r comprises both real and imaginary components, where ε' and ε'' signify the real part and imaginary part of permittivity, respectively. Through separation of the complex permittivity into its real and imaginary components, the following expressions can be derived:

$$\varepsilon^{'} = \varepsilon_\infty + \frac{\varepsilon_s - \varepsilon_\infty}{1 + (2f\pi)^2\tau^2} \tag{S2}$$

$$\varepsilon^{''} = \varepsilon_\infty + \frac{2\pi f\tau(\varepsilon_s - \varepsilon_\infty)}{1 + (2f\pi)^2\tau^2} \tag{S3}$$

Based on Equations (S3) and (S4), the expression for ε' - ε'' can be derived as:

$$(\varepsilon^{'} - \varepsilon^{''})^2 + (\varepsilon^{''})^2 = (\varepsilon_r - \varepsilon_\infty)^2 \tag{S4}$$

The attenuation constant (α) can be calculated using Equations (S5):

$$\alpha = \frac{\sqrt{2f\pi}}{c} \times \sqrt{(\varepsilon^{''}\mu^{''} - \varepsilon^{'}\mu^{'})^2 + \sqrt{(\varepsilon^{''}\mu^{''} - \varepsilon^{'}\mu^{'})^2 + (\varepsilon^{'}\mu^{''} + \varepsilon^{'}\mu^{''})^2}} \tag{S5}$$

The impedance matching (Z_{in}/Z_0) can be calculated using Equations (S6):

$$Z_{in} = \left|Z_{in}/Z_0\right| = \left|(\mu_r/\varepsilon_r)^{1/2}\tanh\left[j(2\pi fd/c)(\mu_r\varepsilon_r)^{1/2}\right]\right| \tag{S6}$$

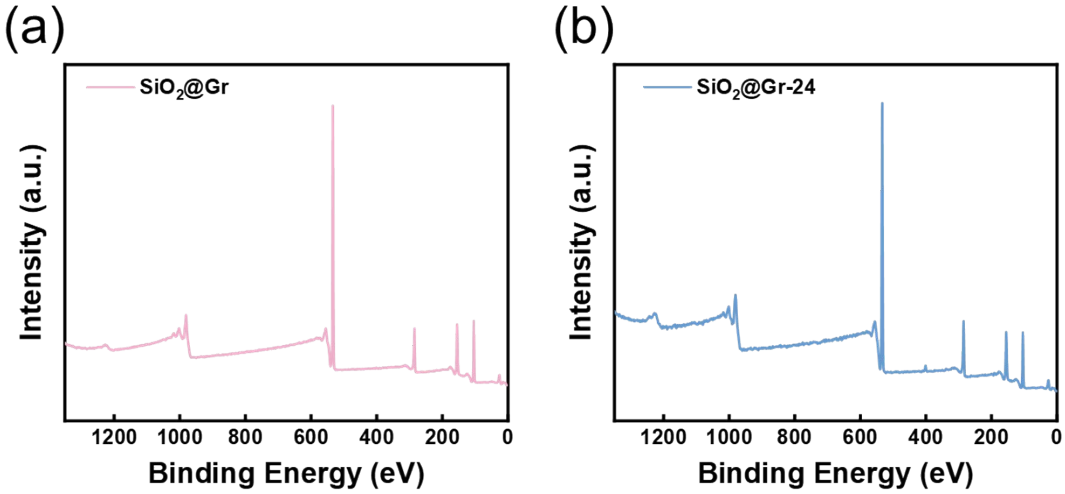

Fig. S1 (a) The XPS full spectrum of SiO_2@Gr; and (b) the XPS full spectrum of SiO_2@Gr-24.

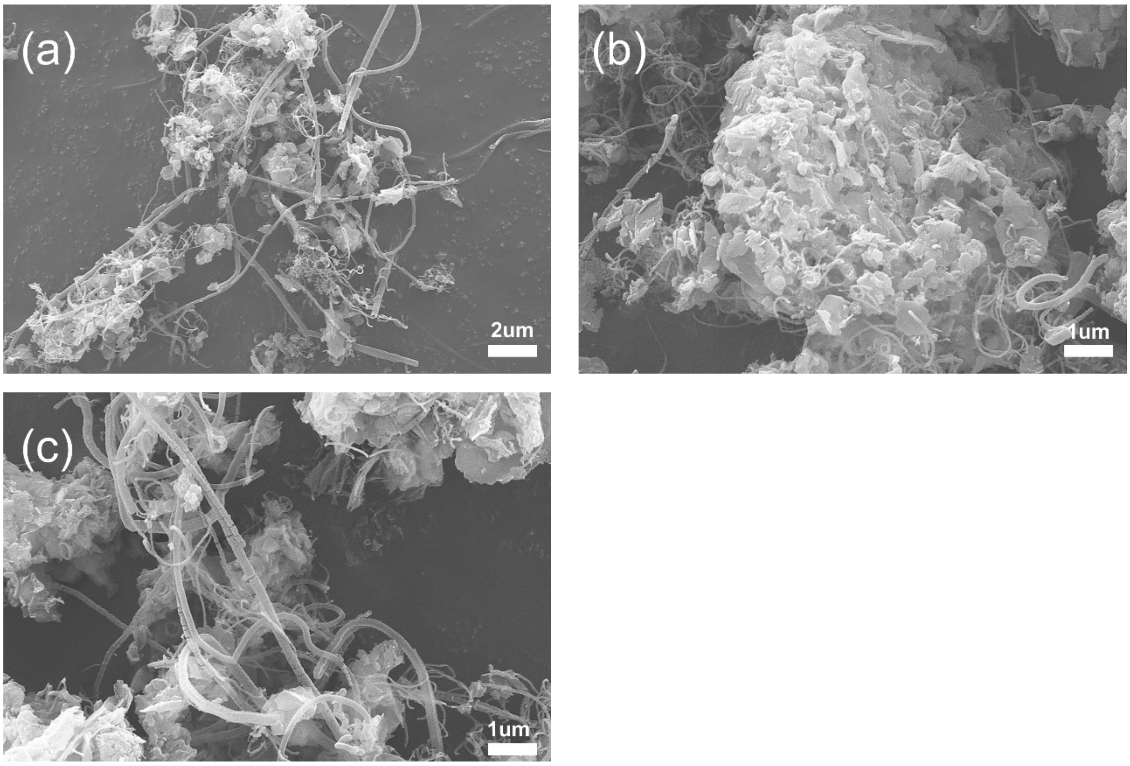

Fig.S2 (a)-(c) SEM images of SiO_2@Gr/N-CNTs at different multiples.

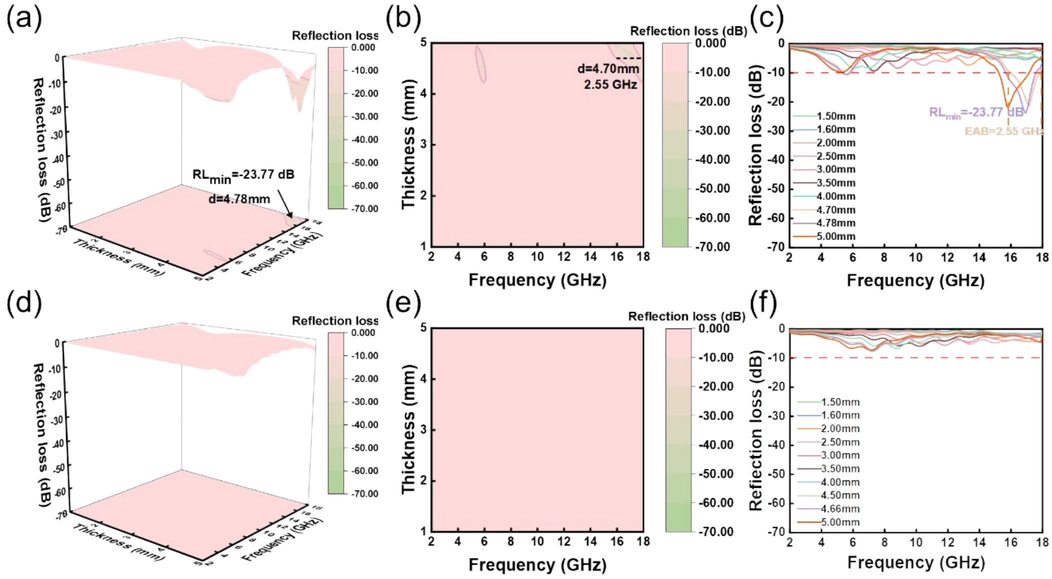

Fig.S3 (a)-(c) The 3D and 2D diagrams and RL loss values of SiO_2@Gr material. (d)-(f) The 3D and 2D diagrams and RL loss values of SiO_2@Gr-24 material.

Table S1 Analysis of Fe content in SiO_2@Gr, SiO_2@Gr-24, and SiO_2@Gr/N-CNTs composite materials by ICP-OES

Samples	Fe (wt%)
SiO2@Gr	0.27
SiO2@Gr-24	0.31
SiO_2@Gr/N-CNTs	0.91