Supplementary Information

3D printing lamellar $Ti_3C_2T_x$ MXene/graphene hybrid aerogels for enhanced electromagnetic interference shielding performance

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Mathematical formulation of the shield efficiency calculate ：

S11 and S21 represent the reflection coefficient and transmission coefficient of the material to the electromagnetic (EM) wave, which are directly obtained by the vector network analyzer. The transmittance (T) and reflectance (R) of the samples are calculated by the following formulas[1-3]:

$$R = |S11|^2, \quad T = |S21|^2$$

And the absorbance coefficient (A) can be calculated from the follow relationship:

$$A=1-R-T \tag{1}$$

Absorption efficiency is related to the absorbed power of the incident EM wave after entering the material and the residual power of the incident EM wave after reflection. The calculation formula is as follows:

$$A_{eff} = \frac{A}{1-R} = \frac{1-R-T}{1-R} \tag{2}$$

The total EMI SE (SE_T) of a material consists of the contributions from reflection (SE_R), absorption (SE_A) and multiple reflections (SE_M), and their relationship is that:

$$SE_T = SE_R + SE_A + SE_M \tag{3}$$

and SE_M can be ignored in case SE_T> 15 dB, therefore,

$$SE_T(dB) = SE_R(dB) + SE_A(dB) \tag{4}$$

The reflection and absorption shielding effectiveness can be extracted from the following equation:

$$SE_R(dB) = -10\, log_{10}(1-R) \tag{5}$$

and

$$SE_A(dB) = -10\log\left(1-A_{eff}\right) = -10\log\left(1-\frac{1-R-T}{1-R}\right) = -10\log\left(\frac{T}{1-R}\right) \tag{6}$$

and, Z_{in} is the absorbent input impedance, calculated with the equation:

$$Z_{in} = Z_0\sqrt{\frac{\mu_r}{\varepsilon_r}}thah(j\frac{2\pi f d\sqrt{\mu_r\varepsilon_r}}{c}) \tag{7}$$

where Z_0 is the impedance of air, μ_r is the relative permeability, ε_r is the relative permittivity, j is the imaginary unit of complex number, c is the speed of light, d is the thickness of the sample, and f is the microwave frequency.

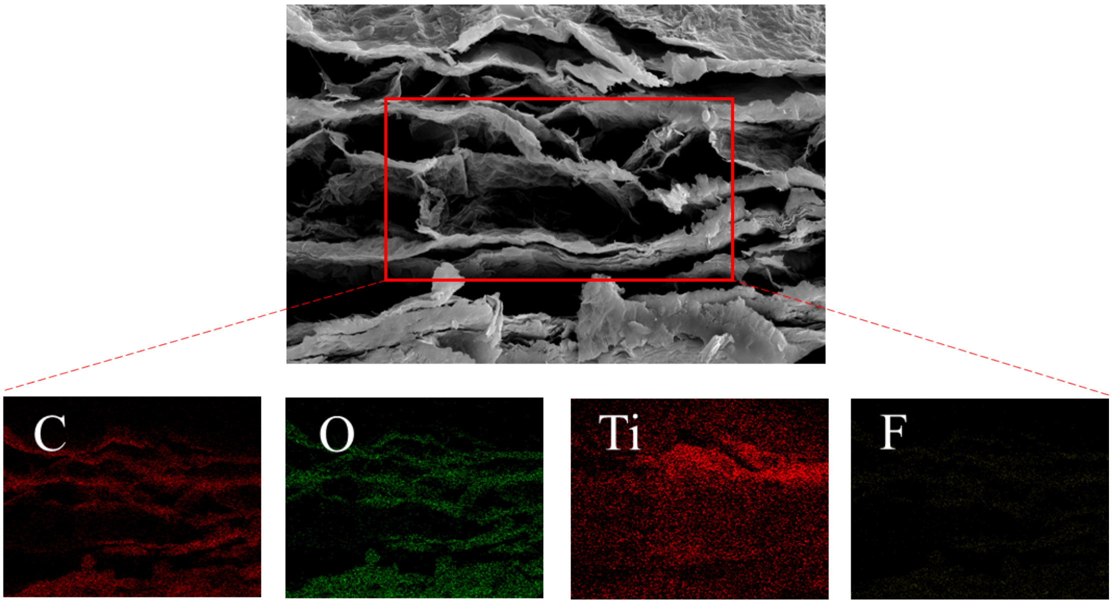

Figure S1. SEM image of MGA-3 and corresponding EDX elemental mappings of C, O, Ti and F in the same area, in which F is the original picture.

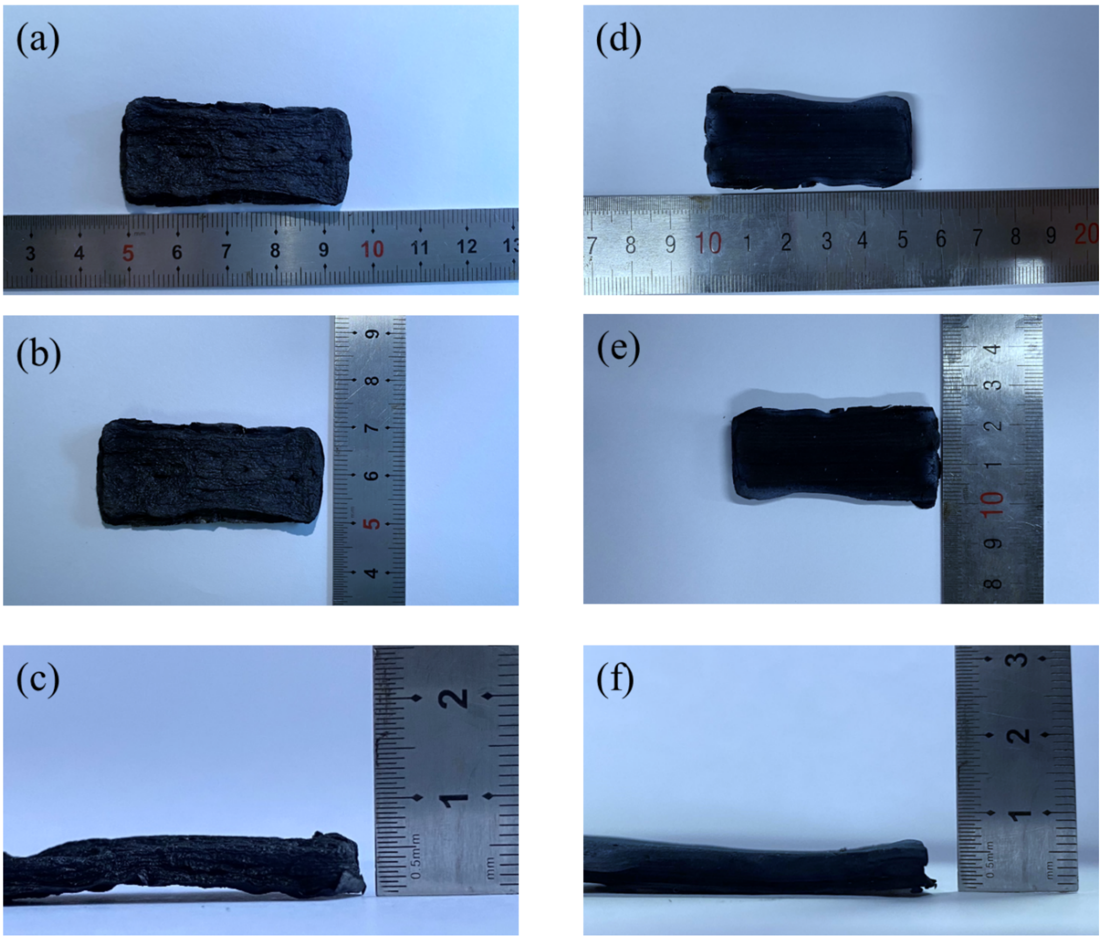

Figure S2. (a-c) Digital photos of MXene/rGO aerogel. (d-f) Digital photos of

MXene/GO aerogel.

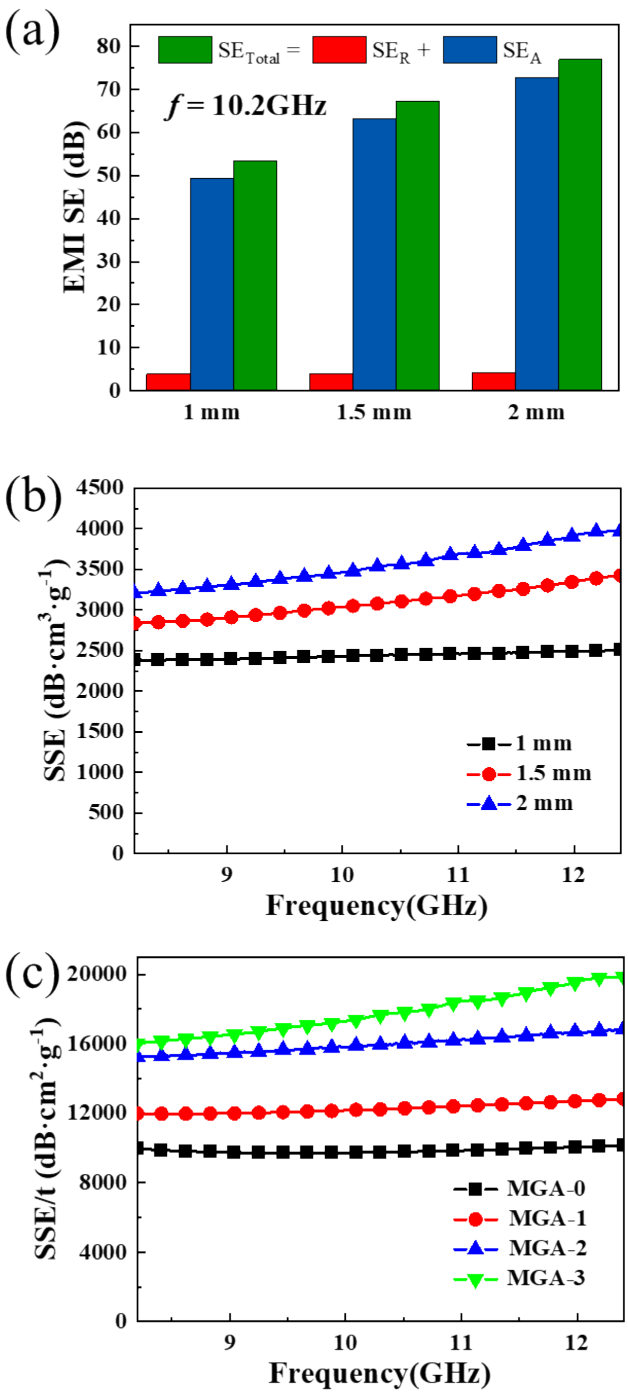

Figure S3. (a) Contrast of total shielding effectiveness (SE_{Total}), absorption shielding effectiveness (SE_A), and reflective shielding effectiveness (SE_R) at 10.2GHz of GMA-3 with the thickness from 1 mm to 2 mm. (b) SSE of MGA-3 with the thickness from 1 mm to 2 mm. (c) SSE/t of MGA-0, MGA-1, MGA-2 and MGA-3 with the thickness of 2 mm.

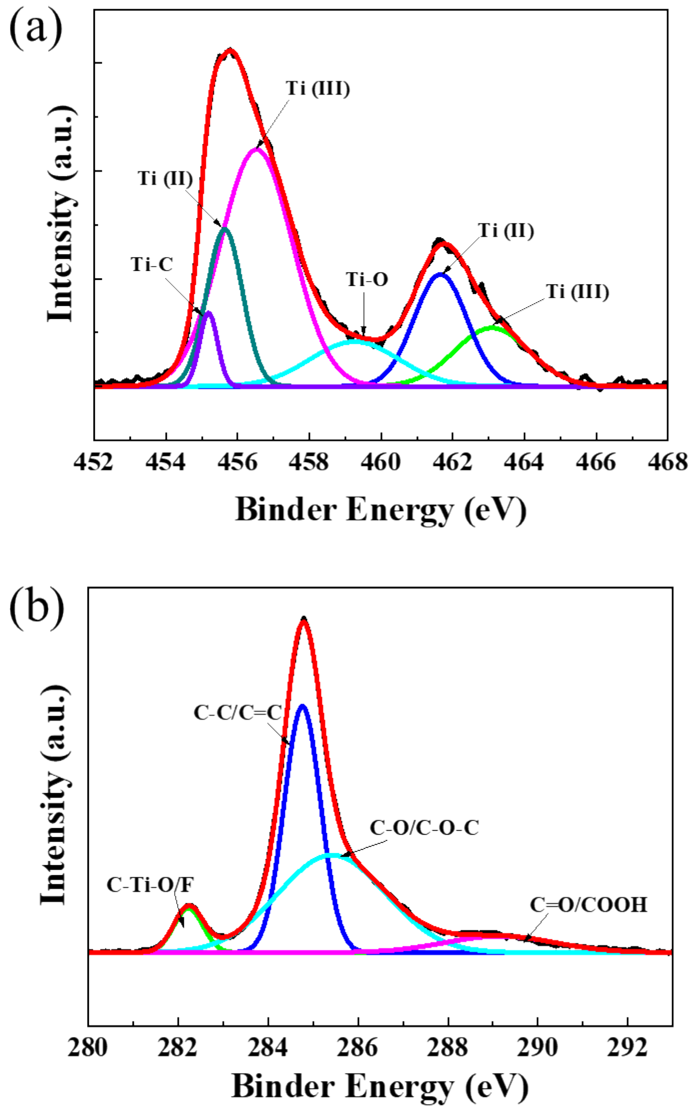

Figure S4. High-resolution XPS spectra of Ti 2p (a) and C 1s (b) of MXene/graphene aerogels.

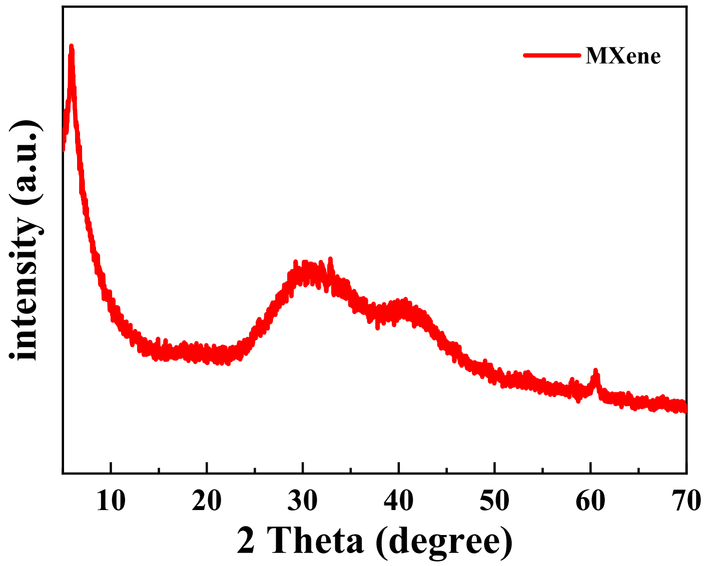

Figure S5. X-ray diffraction (XRD) patterns of Mxene aerogels.

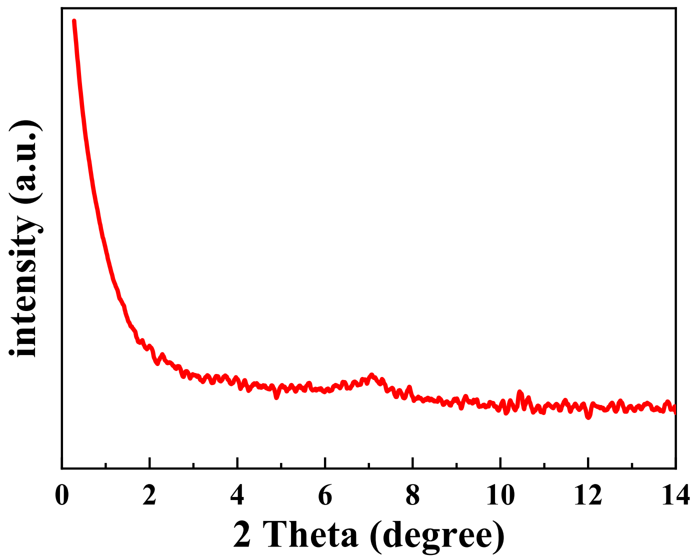

Figure S6. Small Angle X-ray Scattering (SAXS) patterns of Mxene/rGO aerogels.

References

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3. J. Liu, Z. Liu, H.-B. Zhang, W. Chen, Z. Zhao, Q.-W. Wang and Z.-Z. Yu, *Advanced Electronic Materials*, 2020, **6**, 1901094.