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


# Photocured $Ti_3C_2T_x$ MXene/ SiOC ceramic composites for electromagnetic interference shielding in terahertz band

## Calculating of EMI shielding performance

The time-domain spectra obtained from the terahertz time-domain spectroscopy system (THz-TDS) were transformed to frequency-domain spectra by fast Fourier transform (FFT). The transmissivity (T), absorptivity (A), and reflectivity (R) were then calculated according to the following formula based on the frequency-domain spectra:[1-5]

$$R = \left[\frac{E_{Rs}(\omega)}{E_{Rr}(\omega)}\right]^2 \tag{S1}$$

$$T = \left[\frac{E_{Ts}(\omega)}{E_{Tr}(\omega)}\right]^2 \tag{S2}$$

$$A = 1 - T - R \tag{S3}$$

where $E_{Ts}(\omega)$ and $E_{Tr}(\omega)$ is the amplitude of the sample and reference in the frequency domain spectra of transmission mode, and $E_{Rs}(\omega)$ and $E_{Rr}(\omega)$ is the amplitude of the sample and reference in the frequency domain spectra of reflection mode, respectively.

The total EMI SE ($SE_T$), EMI wave reflection ($SE_R$), and EMI wave absorption were calculated according to the following formula:

$$SE_T = 10 \times \log\left(\frac{1}{T}\right) = SE_A + SE_R \tag{S4}$$

$$SE_A = -10 \times log\left(\frac{T}{1-R}\right) \tag{S5}$$

$$SE_R = -10 \times log(1-R) \tag{S6}$$

The reflection loss (RL) was calculated by the following equation:

$$RL = -20 \times \log\left[\frac{E_{Rs}(\omega)}{E_{Rr}(\omega)}\right]^2 \tag{S7}$$

The real part (ε′) and imaginary parts (ε″) of dielectric constant were calculated by:

$$\varepsilon^{'} = n^2(\omega) - k^2(\omega) \tag{S8}$$

$$\varepsilon^{''} = 2 \times n(\omega) - k(\omega) \tag{S9}$$

where $n(\omega)$ and $k(\omega)$ refers to the refraction index and extinction coefficient of the sample, and they were calculated by the following formula:

$$n(\omega) = \frac{\emptyset(\omega)c}{\omega d} + 1 \tag{S10}$$

$$k(\omega) = \ln\left\{\frac{4n(\omega)}{T(\omega)\left[n(\omega)+1\right]^2}\right\}\frac{c}{\omega d} \tag{S11}$$

$$T(\omega) = \frac{E_s(\omega)}{E_r(\omega)} \tag{S12}$$

Where $\emptyset(\omega)$ refers to the phase difference of the sample and reference signal, $\omega$ refers to the angular frequency, $d$ refers to the thickness of the sample, and *c* refers to the spread velocity of THz waves.

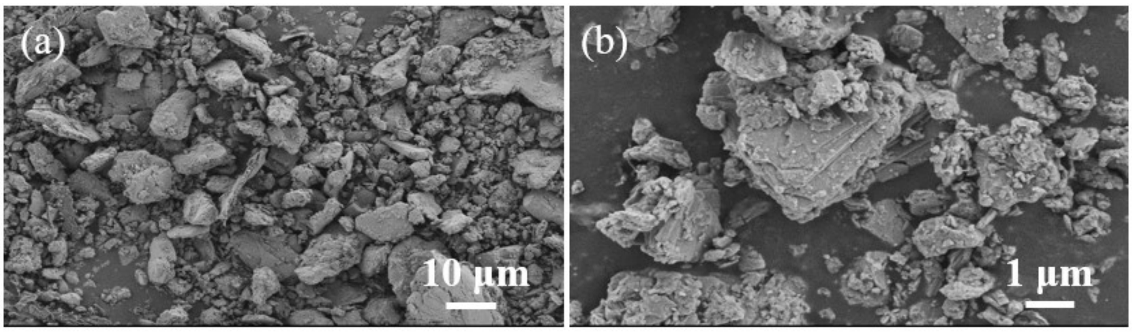


Fig. S1 (a, b) SEM images of $Ti_3AlC_2$.

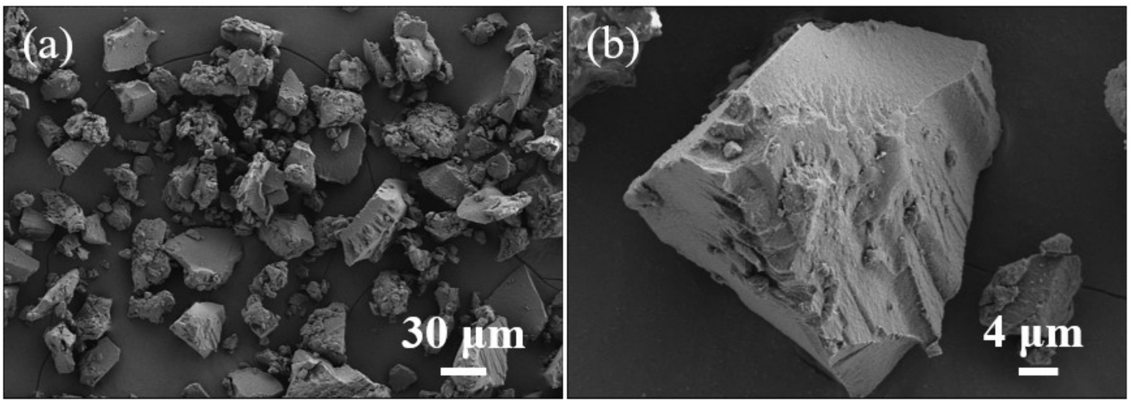

Fig. S2 (a, b) SEM images of the photocured $Ti_3C_2T_x$ MXene/resin-0.3 composite.

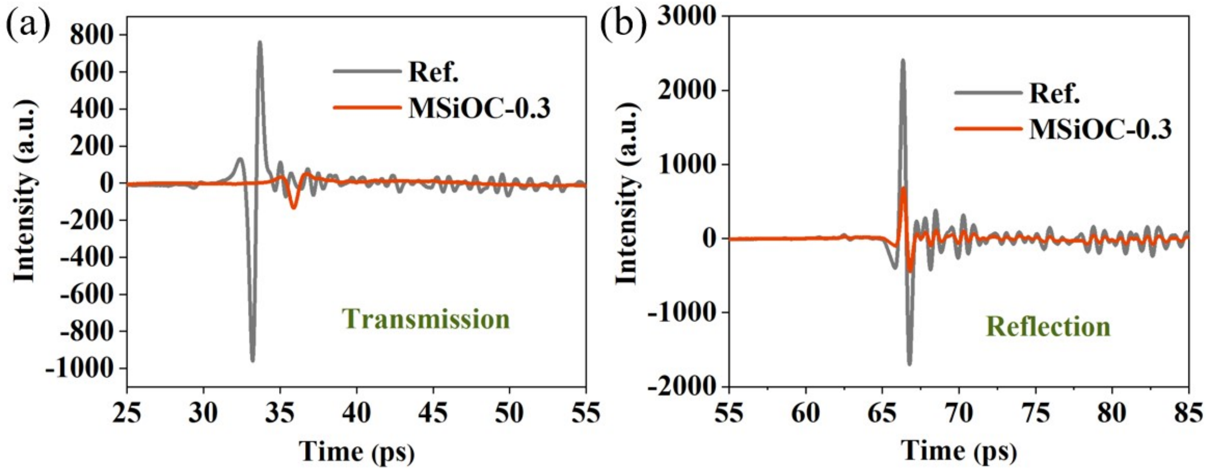


Fig. S3 Time-domain spectra of $Ti_3C_2T_x$ MXene/SiOC-0.3 composite in (a) transmission and (b) reflection mode.

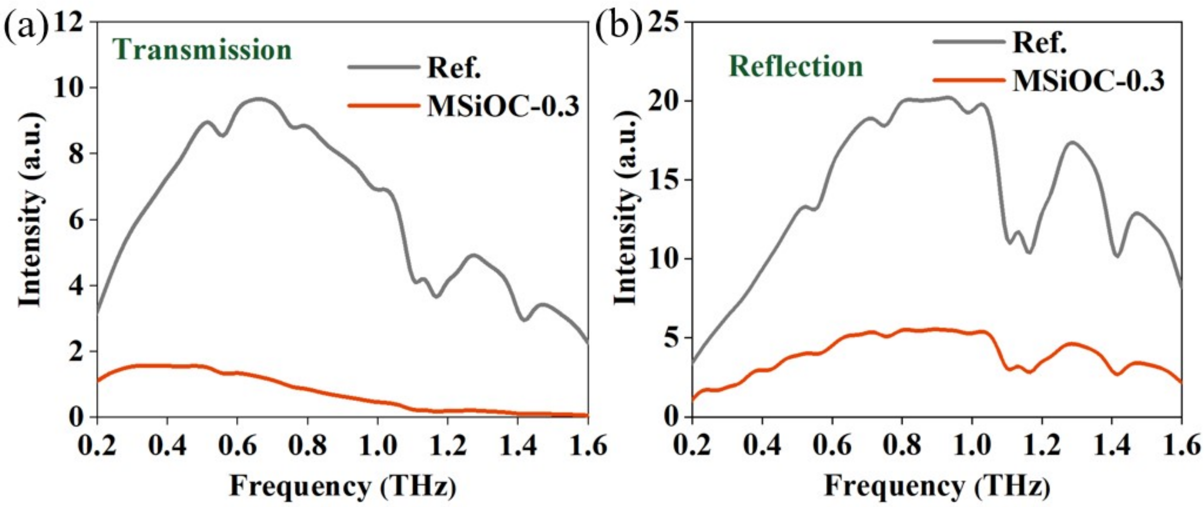


Fig. S4 Frequency-domain spectra of $Ti_3C_2T_x$ MXene/SiOC-0.3 composite in (a) transmission and (b) reflection mode.

Table S1 Comparison of EMI properties of the reported MXene composites to this work

| Material | Frequency /GHz | Content of MXene/wt.% | Average $SE_T$/dB | Ref. |
|---|---|---|---|---|
| $Ti_3C_2T_x$/AgNWs | 8.2-12.4 | 91 | 21 | [6] |
| $Ti_3C_2T_x$/AgNWs-PVB | 8.2-12.4 | 91 | 30 | [6] |
| $Ti_3C_2T_X$/cellulose nanofiber | 8.2-12.4 | 50-90 | 23-25 | [7] |
| $Ti_3C_2T_X$/wax matrix | 2-18 | 45-85 | 3-33 | [8] |
| $Ti_3C_2T_x$/polyimide | 8.2-12.4 | 0-30 | 2.6-34.7 | [9] |
| ZrO/1-(3-aminopropyl) imidazole grafted carboxylated nitrile rubber/$Ti_3C_2T_X$ | 8.2-12.4 | 0-15 | 6.9-27.2 | [10] |
| $Ti_3C_2T_x$ MXene/PDMS foam | 8.2-12.4 | 1-4 | 6-22.8 | [11] |
| MXene/SWCNT | 8.2-12.4 | - | 0.5-4 | [12] |
| $Ti_3C_2T_X$/SiOC (This work) | 200-1600 | 0.3 | 25 | |

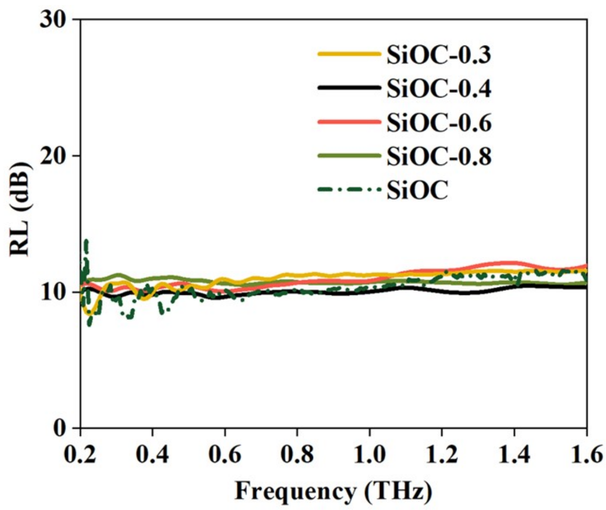


Fig. S5 The reflection loss (RL) of SiOC and $Ti_3C_2T_x$ MXene/SiOC ceramic composite

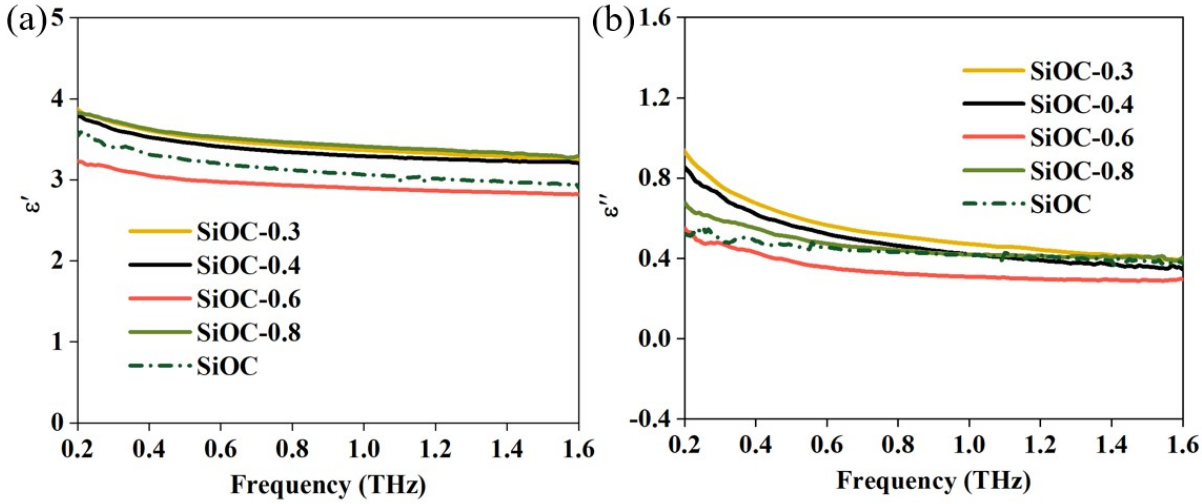


Fig. S6 (a) The real part (ε′) and (b) imaginary parts (ε″) of dielectric constant of SiOC and $Ti_3C_2T_x$ MXene/SiOC ceramic composite.

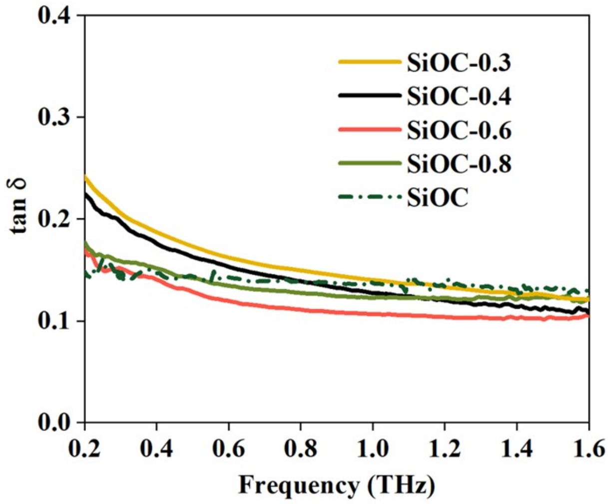


Fig. S7 The loss tangent value of the dielectric constant (tanδ) of SiOC and $Ti_3C_2T_x$ MXene/SiOC ceramic composite.

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