Supporting Information

(8 pages, including 7 Figures)

Strong and Heat-Resistant SiC Coated Carbonized Natural Loofah Sponge for Electromagnetic Interference Shielding

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CONTENT

It can be seen from Figure S1 that the natural loofah sponge lost weight quickly before 100 °C in an air atmosphere because the sample contained moisture inside. The natural loofah sponge was in a thermally stable phase from 100 to 278.1 °C. The sample underwent rapid thermal decomposition between 278.1 and 339.1°C. The sample stabilized after 436.6 °C, and was completely decomposed to leave only trace mineral elements. In 5% hydrogen-argon mixture (Ar/H_2) atmosphere, the thermal stability of natural loofah was the same as in air before 278.1 °C. However, the sample underwent rapid thermal decomposition between 278.1 and 393.4°C. And the sample tended to be stable after 497.9 °C and was completely carbonized.

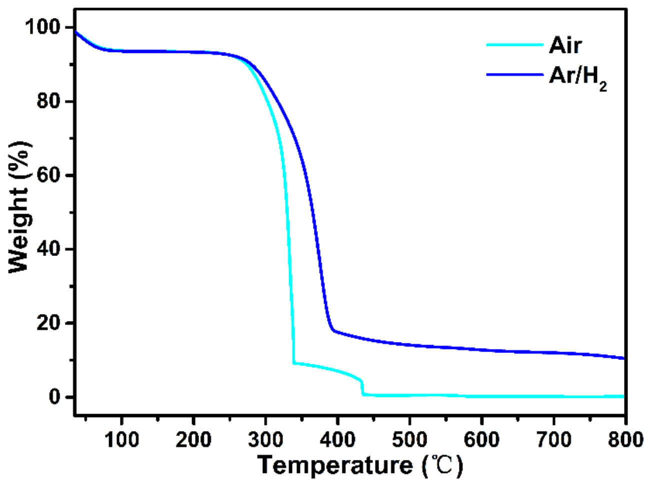

Figure S1. TGA curves of natural loofah sponge in 5% hydrogen-argon mixture (Ar/H_2) and air environment

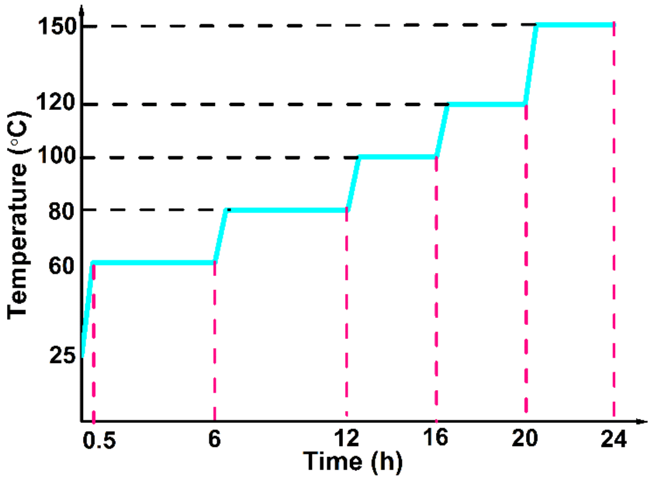

Figure S2. Hot-press curing parameters of PR coated loofah sponges

Theoretical explanation of shielding effectiveness.

The electromagnetic shielding effectiveness of the composite material is theoretically calculated based on the electromagnetic parameters (S). The S parameters correspond to the reflected (S_{11} or S_{22}) and transmitted (S_{21} or S_{12}) powers. Full two-port Thru-Reflect-Line (TRL) calibration was initially performed on the VNA. The shielding effectiveness is defined as the logarithm of the ratio of the incident power (P_i) to the transmitted power (P_0), and the total shielding effectiveness (SE_T) consists of reflection (SE_R), absorption (SE_A) and multiple reflections (SE_M) according to the transmission line model theory, the relationship is as follows

$$\mathrm{SE_T(dB)} = 10\log\left(\frac{P_i}{P_0}\right) = \mathrm{SE_R} + \mathrm{SE_A} + \mathrm{SE_M} \tag{S1}$$

With higher EMI SE values and absorption dominated, the SE_M may be ignored. Additionally, the SE_R and SE_A are related to the coefficients of reflection (R), absorption (A) and transmission (T) that can be calculated from S parameters, the formula is as follows[1]

$$\mathrm{SE_R(dB)} = 10\log\left(\frac{1}{1-\mathrm{R}}\right) \tag{S2}$$

$$\mathrm{SE_A(dB)} = 10\log\left(\frac{1-R}{\mathrm{T}}\right) \tag{S3}$$

$$1 = \mathrm{R} + \mathrm{A} + \mathrm{T} \tag{S4}$$

$$\mathrm{R} = |\,\mathrm{S_{11}}\,|^2 = |\,\mathrm{S_{22}}\,|^2, \mathrm{T} = |\,\mathrm{S_{21}}\,|^2 = |\,\mathrm{S_{12}}\,|^2 \tag{S5}$$

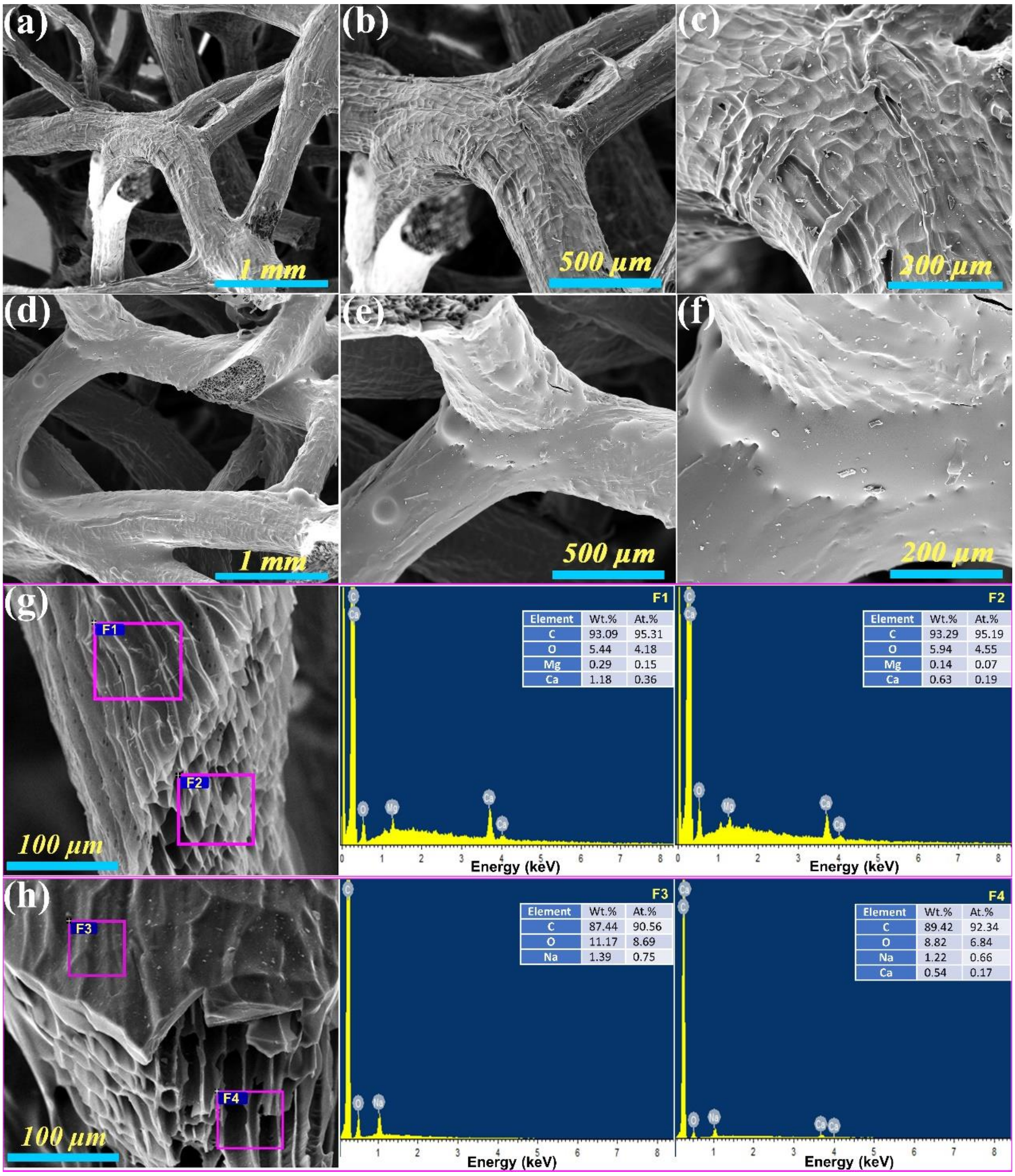

Figure S3. SEM images of carbonized pure loofah sponge (a-c) and carbonized PR coated loofah sponge (d-f); the EDS spectra of carbonized pure loofah sponge (g) and carbonized PR coated loofah sponge (h)

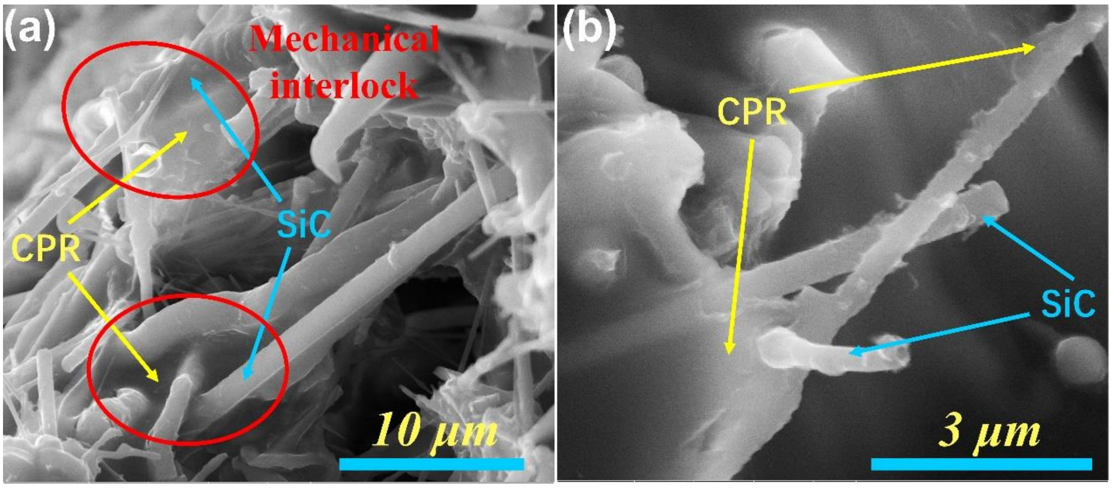

Figure S4. (a-b) SEM images of the mixture of SiC and carbonized PR (CPR) taken from SCLS1

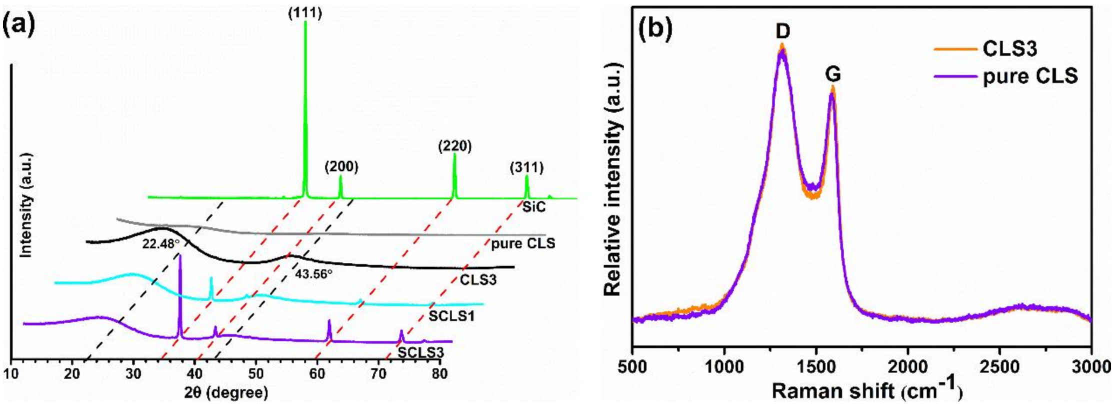

Figure S5. (a) XRD patterns of SiC, CLS3, SCLS1, and SCLS3; (b) Raman spectra of CLS3 and pure CLS

The electromagnetic radiation at high frequency levels can penetrate the near-surface regions of an electrically conducting materials, which is known as "skin effect".

The depth for the field to drop to 1/e of the incident value is called skin depth, which can be calculated based on the following equation [2]

$$\delta = \left(\frac{1}{f\pi\mu\sigma}\right)^{1/2} = 8.686\ (\frac{t}{\mathrm{SE_A}}) \quad \text{(S6)}$$

where δ is skin depth, f is frequency, σ is electrical conductivity, μ is permeability, and t is the sample thickness.

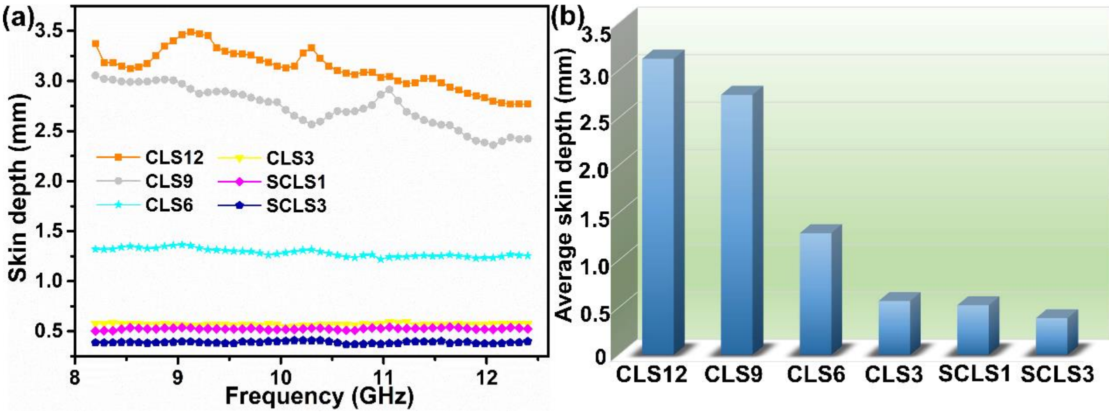

Figure S6. (a) Skin depth of CLS and SCLS as a function of frequency; (b) average skin depth of CLS and SCLS

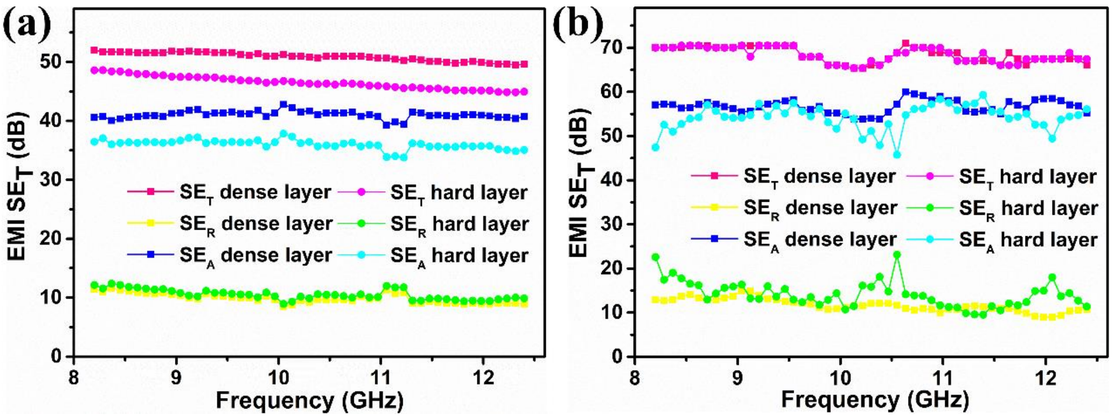

Figure S7. Description of electromagnetic shielding performance of CLS3 (a) and SCLS3 (b) under different test surfaces

REFERENCES

(1) Weng, G.-M.; Li, J.; Alhabeb, M.; Karpovich, C.; Wang, H.; Lipton, J.; Maleski, K.; Kong, J.; Shaulsky, E.; Elimelech, M.; Gogotsi, Y.; Taylor, A. D. Layer-by-Layer Assembly of Cross-Functional Semi-transparent MXene-Carbon Nanotubes Composite Films for Next-Generation Electromagnetic Interference Shielding. *Adv. Funct. Mater.* **2018,** *28* (44), 1803360, DOI: 10.1002/adfm.201803360.

(2) Xu, Y.; Li, Y.; Hua, W.; Zhang, A.; Bao, J. Light-Weight Silver Plating Foam and Carbon Nanotube Hybridized Epoxy Composite Foams with Exceptional Conductivity and Electromagnetic Shielding Property. *ACS Appl. Mater. Interfaces* **2016,** *8* (36), 24131-24142, DOI: 10.1021/acsami.6b08325.