

Supplementary data to:

A hierarchical porous cellulose sponge modified with chlorogenic acid as a antibacterial material for water disinfection

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Molecular weight of microcrystalline cellulose and absorbent cotton

0.3 g microcrystalline cellulose and 0.05 g absorbent cotton were dissolved in 50 mL cupri-ethylenediamine (CED), and then stirred at 20 °C for 30 min, respectively. The relative viscosity of cellulose solution with different concentrations was measured using an Ubbelohde viscometer in a 25 °C water bath. If the solution flows through the capillary with the acting of gravity, it follows the Poiseuille law:

$$\frac{\eta}{\rho} = \frac{\pi h g r^4 t}{8 V L} - m \frac{V}{8 \pi L t}$$

The equation can be expressed as:

$$\frac{\eta}{\rho} = A t - \frac{B}{t}$$

When $B < 1$ and $t > 100$ s, the equation is simplified:

$$\eta = A \rho t$$

The drop time of CED and cellulose solution were recorded as t_0 and t_1 . The density of CED and cellulose solution were recorded as ρ_0 and ρ_1 . The values of ρ_0 and ρ_1 . The relative viscosity η_r can be rewritten as shown below because the values of ρ_0 and ρ_1 are usually similar:

$$\eta_r = \frac{\eta}{\eta_0} = \frac{A \rho_1 t_1}{A \rho_0 t_0} = \frac{t_1}{t_0}$$

The intrinsic viscosity $[\eta]$ can be obtained by plotting $\ln \eta_r / c$ vs c according the following equation:

$$\frac{\ln \eta_r}{c} = [\eta] + \beta [\eta]^2 c$$

Where c is mass concentration (g/cm^3) and β is Kramer constant.

The viscosity averaged molecular weight of cellulose was calculated by Mark-Houwink-Sakurada equation:

$$[\eta] = k M^a$$

Where k is proportional constant and a is empirical constant. According to the study of Łojewski et al. [1], k was $1.87 \text{ cm}^3/\text{g}$ and α was 0.771. The plot of $\ln \eta_r / c$ vs c ($y = -2566.56x + 151.77$, $R^2 = 0.99922$ for microcrystalline cellulose and $y = -220706.84x + 777.61$, $R^2 = 0.99619$ for absorbent cotton) was shown in Fig. S1, the intrinsic viscosity

$[\eta]$ of cellulose was obtained. Then viscosity averaged molecular weight of microcrystalline cellulose and absorbent cotton can be calculated.

[1] Tomasz Łojewski *, Katarzyna Zieba, Joanna Łojewska, Size exclusion chromatography and viscometry in paper degradation studies. New Mark-Houwink coefficients for cellulose in cupri-ethylenediamine, Journal of Chromatography A, 1217 (2010) 6462–6468

Physical properties determination

Bulk density (mg/cm^3) is measured by dividing mass by volume after freeze-drying the sponges.

The porosity (%) was calculated according to the following equation:

$$\text{Porosity (\%)} = \left(1 - \frac{\rho}{\rho_n}\right) \times 100\%$$

Where ρ is the bulk density, ρ_n is the cellulose density ($1.6 \text{ g}/\text{cm}^3$).

The moisture content (%) was determined after mechanical property test and calculated according to the following equation:

$$\text{Moisture content (\%)} = \frac{m_1 - m_2}{m_1} \times 100\%$$

Where m_1 and m_2 are the weight of cellulose sponge before and after drying completely.

The water absorption (g/g) was calculated according to the following equation:

$$\text{Water absorption} = \frac{m_3 - m_2}{m_2} \times 100\%$$

Where m_2 is the weight of cellulose sponge after drying completely, m_3 is the weight of weight of dry sponge after absorbing water for three days.

HPLC analysis method of chlorogenic acid

The chlorogenic acid was determined by Waters e2695 Separations Module HPLC apparatus coupled with Waters 2475 Multi λ Fluorescence Detector. A 10 μ L aliquot of aqueous ethanol solution was fractionated by separated on SunFire C18 column (150 mm \times 4.6 mm i.d., 5 μ m, Waters, America). The mobile phase consisted of formic acid with deionized water (0.1:100, v/v) (A) and methanol (B). Gradient elution was performed as follows: 0-5 min, 12-18% B; 5-15 min, 18-27% B; 15-20 min, 27% B; 20-32 min, 27-38% B; 32-40 min, 38-41% B; 40-55 min, 41% B; 55-60 min, 41-45% B; 60-65 min, 45-55% B; 65-70 min, 55% B; 70-75 min, 55-65% B; 75-80 min, 65-75% B; 80-85 min, 75% B. The detected compounds were quantified at wavelength of 254 and 280 nm and identified by comparing their relative retention times, UV spectra with standard compounds and were detected using an external standard method. The sample injection volume was 2 μ L, the flow rate was set to 1 mL/min, and the column temperature was set at 30 $^{\circ}$ C.



Figure S1. The digital image of the device used in water bacteria disinfection test and cyclic bactericidal tests.

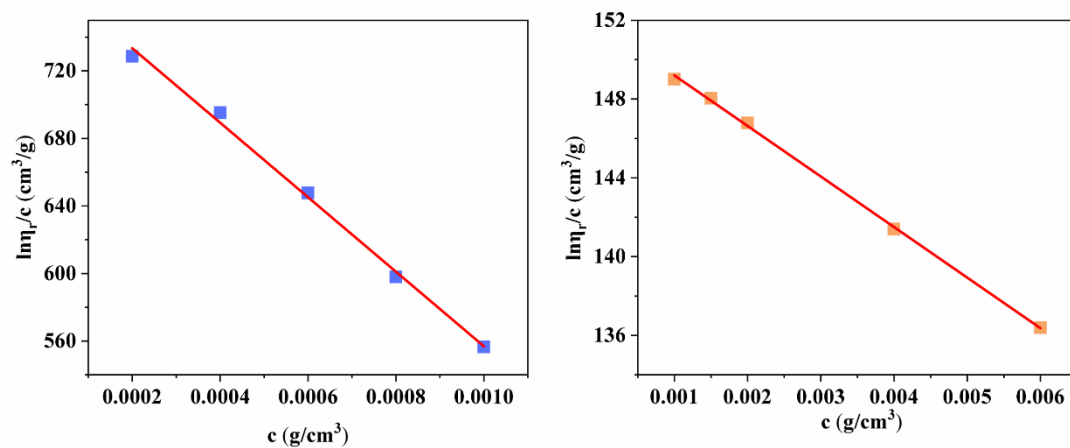


Figure S2. $\ln \eta_r/c$ vs c of (a) absorbent cotton and (b) microcrystalline cellulose in CED at 25 °C ($[\eta]_{AC} = 777.61$ cm³/g, $[\eta]_{MCC} = 151.77$ cm³/g).

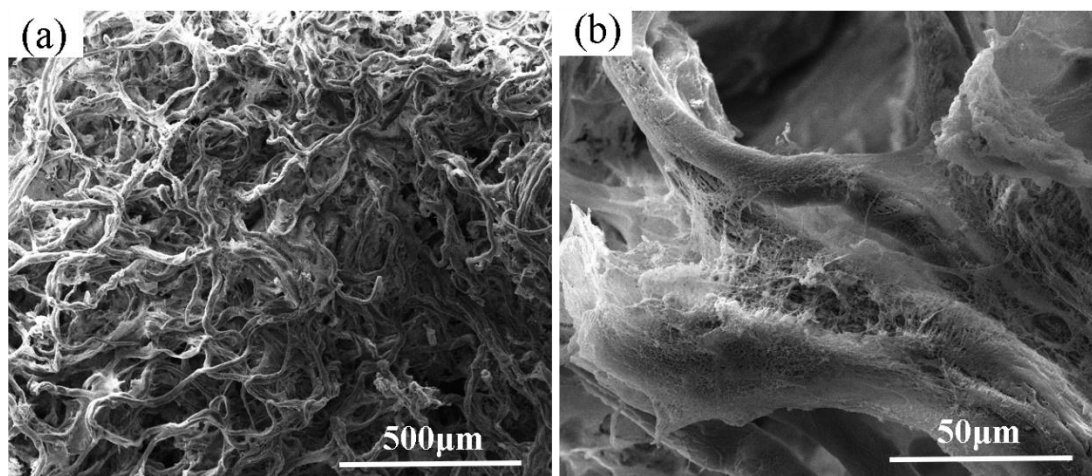


Figure S3. SEM images of the C-CGAS at (a) low magnification and (b) high magnification.

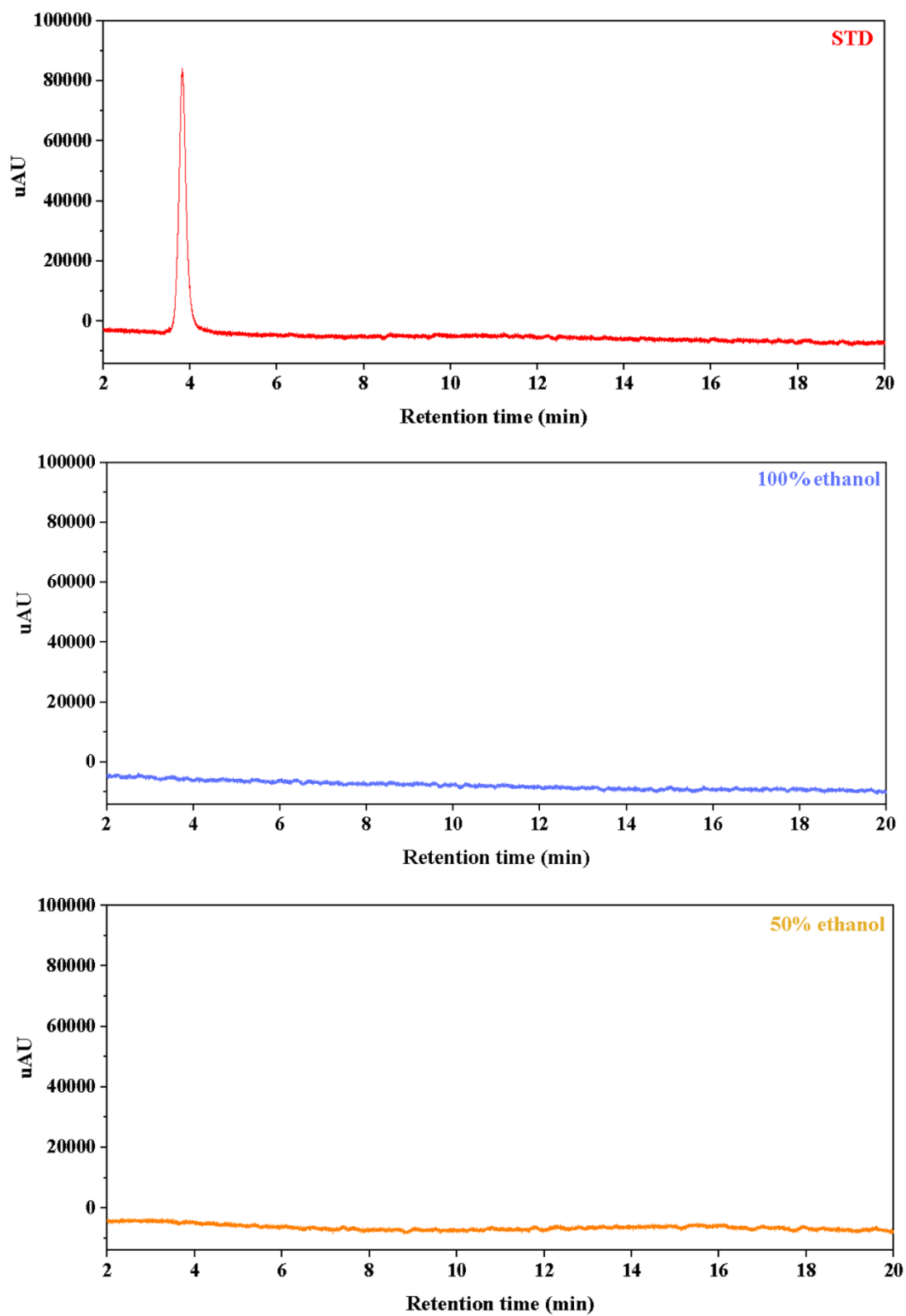


Figure S4. HPLC chromatograms of the extractants after immersing C-CGAS for 3 days and ethanol standard solution (STD).

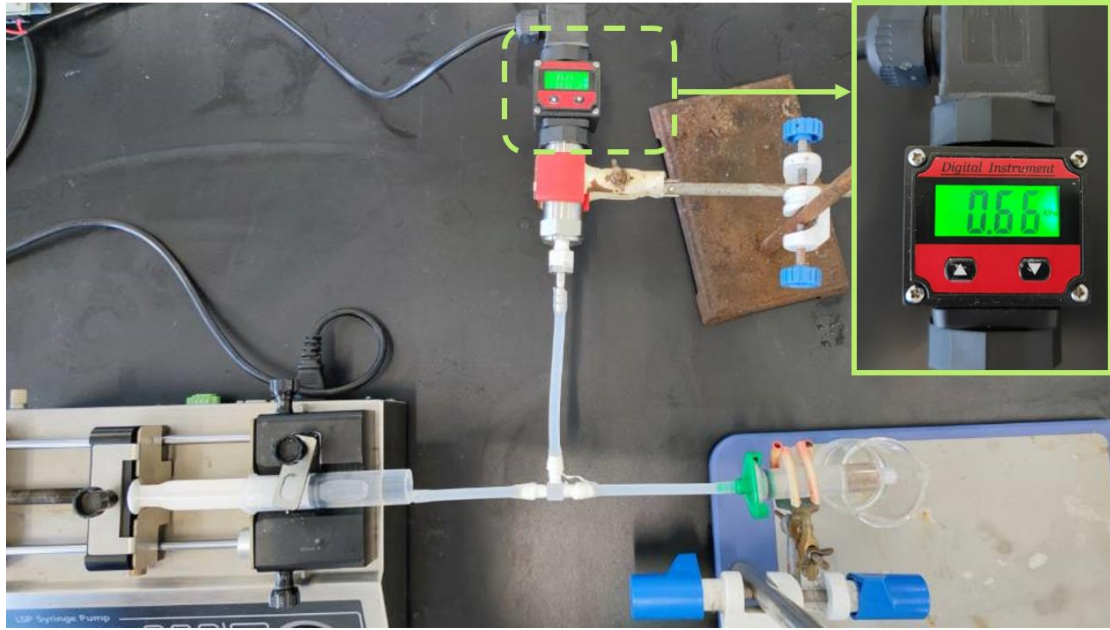


Figure S5. Digital image of C-CGAS water flux stress testing device.

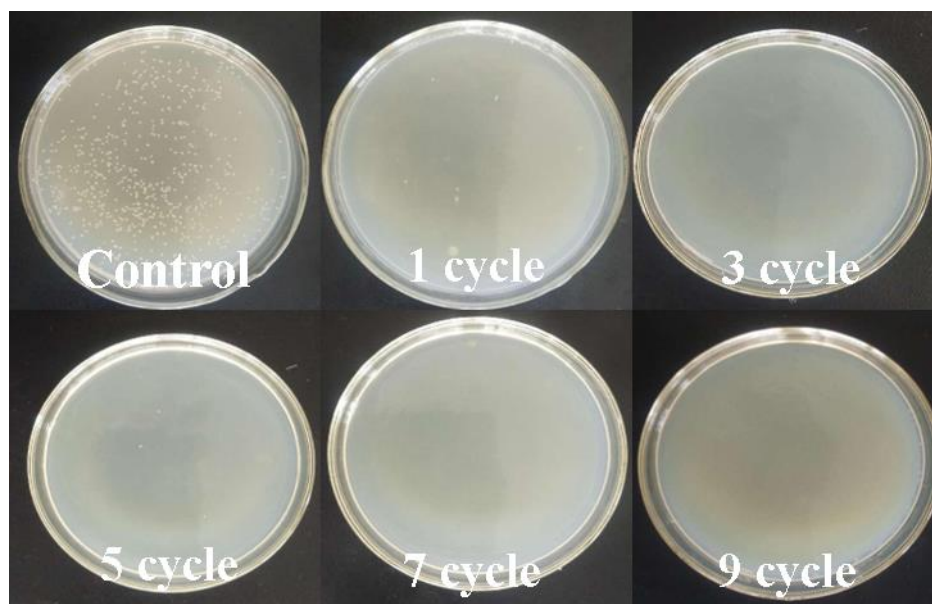


Figure S6. Digital images of agar plates of bacterial suspensions in cyclic antibacterial ability test.

Table S1 Summary of XPS spectral parameters of CS and C-CGAS.

Sample	Spectra	Component (%)	
CS	C1s	C-O	70.00
		C-C/C-H	18.62
		O-C-O/C=O	11.38
	O1s	C-O-H/C-O-C	97.30
		C=O	2.70
C-CGAS	C1s	C-O	38.28
		C-C/C-H	43.51
		O-C-O/C=O	18.21
	O1s	C-O-H/C-O-C	88.64
		C=O	11.36

Table S2 The density, porosity, moisture content, water absorption of the cellulose sponges.

Samples	Bulk density (mg/cm ³)	Porosity (%)	Moisture content (%)	Water absorption (g/g)
AC	50.16 ± 3.02 ^a	97.66 ± 8.09 ^a	70.87 ± 3.25 ^a	18.13 ± 9.50 ^a
MCC	44.78 ± 8.21 ^a	96.62 ± 7.74 ^a	84.47 ± 3.62 ^b	18.51 ± 0.87 ^a
CS	46.54 ± 2.78 ^a	96.95 ± 0.98 ^a	76.97 ± 2.68 ^c	20.51 ± 4.45 ^a
C-CGAS	47.88 ± 4.22 ^a	96.22 ± 0.20 ^a	77.57 ± 0.26 ^c	21.28 ± 2.46 ^a