Supplementary Material

High-efficiency adsorption of tetracycline by the prepared waste collagen fiber-derived porous biochar

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1. **Materials and reagents**

Waste collagen fiber (WCF) WCF was the precursor material obtained from tannery in China. TC (purity >98.0%, stored at -4 ℃) purchased from Aladdin Industrial Co. Potassium hydroxide (KOH), Sodium hydroxide (NaOH), hydrochloric acid (HCl), sodium chloride (NaCl), sodium nitrate ($NaNO_3$), sodium dihydrogen phosphate (NaH_2PO_4), sodium sulfate (Na_2SO_4), sodium carbonate (Na_2CO_3) and sodium bicarbonate ($NaHCO_3$) used in the experiment were came from Chengdu JinShan chemical reagent factory. Besides, all the chemicals and solvents came from JinShan chemical reagent factory were of analytical grade. All solution in the study were prepared with deionized water (Millipore Synergy, United States).

2. **Characterizations of material**

The carbon (C), hydrogen (H), oxygen (O), nitrogen (N) and sulfur (S) of WCF, 4BC and 8PBC were determined by the elemental analyzer (Elementar Vario EL cube). Metal minerals were roughly determined by energy dispersive X-ray fluorescence spectroscopy (XRF) (Shimadzu Corporation, Japan, XRF-1800) and mapping (Japanese electronics JSM-7500F). Brunauer–Emmett–Teller (BET) (Micromeritic ASAP2460), surface area (SA) and total pore volume were calculated by N_2 adsorption/desorption curve. Surface morphology of materials was obtained by high resolution field emission scanning electron microscope (SEM) (Japanese electronics JSM-7500F). X-ray diffraction (XRD) (Dutch PANaly, EMPYREAN) experiments were performed with PIXcel3D matrix detector. Raman spectra (LabRAM HR, French HORIBA) were recorded using model interferometer. The zeta potential of 8PBC was obtained by using Zeta potentiometer (Malvern Corporation, Zetasizer Nano ZS) at varying solution pH from 2.0 to 12.0. Surface functional groups of materials were analyzed by fourier transform infrared spectroscopy (FT-IR) (American Thermoelectric Corporation,

Nicolet 6700) and X-ray photoelectron spectroscopy (XPS) (Thermo Fisher Escalab 250Xi). Thermo gravimetric analysis of samples were measured by TG/DTA (Switzerland METTLER TOLEDO, DSC1) instrument under N_2 atmosphere at a heating rate of 10 °C/min until the target temperature.

Table.S1: Adsorption isotherm and kinetic models

	Names	*Equations*
Isotherm model	Langmuir	$q_e = \frac{q_m K_L C_e}{1 + K_L C_e}, R_L = \frac{1}{1 + K_L C_0}$
	Freundlich	$q_e = K_f C_e^{\frac{1}{n}}$
	Temkin	$q_e = \frac{RT}{B_T} ln(K_T C_e)$
	Sips	$q_e = q_m \frac{(K_s C_e)^r}{1 + (K_s C_e)^r}$
	Toth	$q_e = q_m \frac{b_T C_e}{1 + ((b_T C_e)^{N_T})^{\frac{1}{N_T}}}$
Kinetic model	Pseudo-first order	$q_t = q_e(1 - e^{-K_1 t})$
	Pseudo-second order	$q_t = \frac{K_2 q_e^2 t}{1 + K_2 q_e t}$
	Elovich	$q_t = \alpha ln\frac{\beta}{\alpha} + \alpha lnt$
	Intra-particle diffusion	$q_t = K_i\sqrt{t} + L$
	Two-compartment first order	$\frac{q_t}{q_{t=\infty}} = F_f\left(1 - e^{-tK_f}\right) + F_s(1 - e^{-t}$
	Boyd	$\frac{q_t}{q_e} = 1 - \frac{6}{\pi^2}\Sigma_{m=1}^{\infty}\frac{1}{m^2}e^{-m^2 B_t}$

q_e = adsorption capacity (mg/g) at equilibrium time, q_m = maximum adsorption capacity (mg/g), K_L = langmuir constant, Ce=liquid-phase concentration at equilibrium (mg/L), C_0 = initial concentration (mg/L), R_L = separation constant, K_f = Freundlich constant, n = exponent of adsorption intensity, R = universal gas constant (8.314J/mol), T = temperature in term of Kevin, K_T = equilibrium band constant related to the maximum energy of band, B_T = Temkin constant, K_S = Sips constant, γ = exponent of adsorption energy, b_T = Toth constant , N_T = exponent of heterogeneous adsorption, K_1 = rate constant of pseudo-first order, K_2 = rate constant of pseudo-second order, α = rate constant of chemisorption, β = constant of the surface coverage, K_i = intra-particle diffusion rate constant ($mg.min^{0.5}/g$), L = the thickness of boundary layer (mg/g), F_f =

mass fraction of fast, F_s = mass fraction of slow, K_f = two-compartment first-order rate constant for transfer into fast (h^{-1}), K_s = two-compartment first-order rate constant for transfer into slow (h^{-1})

Table.S2: Other metal and non-metallic elements present in 8PBC.

metal and non-metallic elements [b] (%)							
Cr	**Si**	**Mg**	**Na**	**Fe**	**Ca**	**Al**	**K**
47.76	4.48	4.10	2.64	2.16	2.18	0.799	0.631
Ti	**Px**	**Bi**	**Ni**	**Ag**	**Cl**	**Cu**	**La**
0.247	0.072	0.109	0.063	0.073	0.063	0.041	0.035

b: Semi-quantification by XRF.

Table.S3 Different kinetic model parameters for various initial concentrations (20ppm and 100ppm) TC sorption onto 8PBC.

Pseudo-first order	**Qe**	**K_1**	**R^2**
20mg/L	93.268	0.17256	0.8236
100mg/L	280.87156	0.25667	0.50305
Pseudo-second order	**Qe**	**K_2**	**R^2**
20mg/L	100.57331	0.00246	0.93971
100mg/L	304.94286	0.00109	0.72397
Elovich	**α**	**β**	**R^2**
20mg/L	112.56448	15	0.97937
100mg/L	588.70476	42.73431	0.95193
Intra-particle diffusion	**L**	**K_i**	**R^2**
20mg/L	42.42211	5.53764	0.8196
100mg/L	138.67607	17.11845	0.96337
Two-compartment first-order	**F_f and F_s**	**K_f and K_s**	**$Q_{t=\infty}$ and R^2**
20mg/L	0.45827 and 0.54173	0.8344 and 0.03891	101.33 and 0.97765
100mg/L	0.46431 and 0.53569	1.2494 and 0.01252	373.50 and 0.98816
Boyd	**k**	**b**	**R^2**
20mg/L	0.01404	0.32562	0.92997
100mg/L	0.01609	0.15679	0.98409

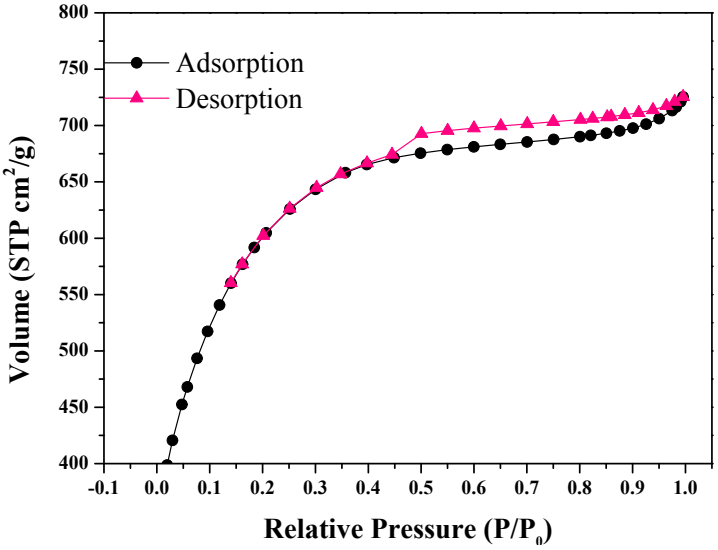

Fig.S1. Nitrogen adsorption and desorption isotherms of PBC-800.

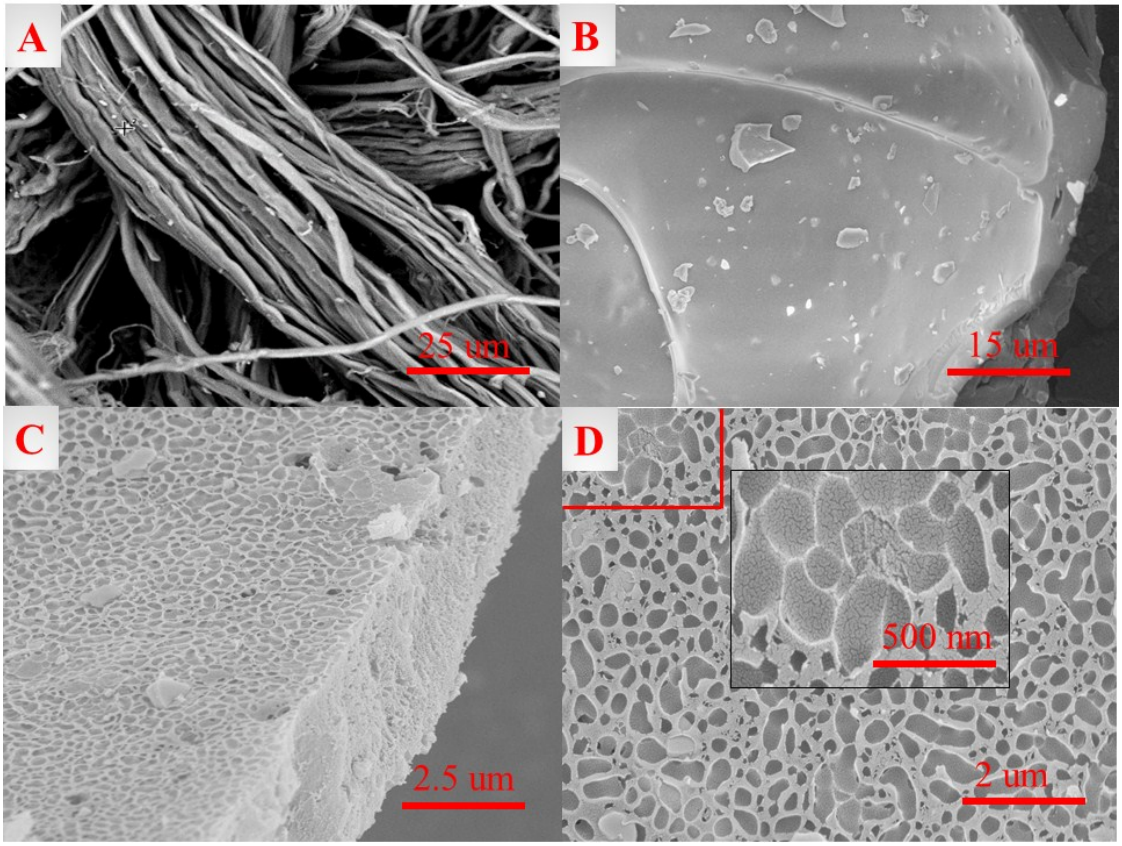

Fig.S2. SEM images of WCF (A, magnification 3,000X), BC-400 (B, magnification 6,000X), PBC-800 (C, magnification 30,000X) and PBC-800 (D, magnification 50,000X)

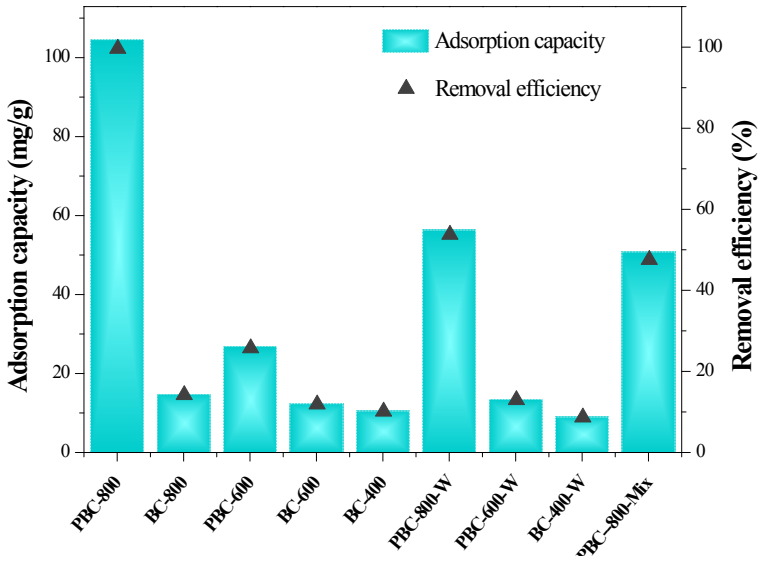

Fig.S3. Comparison of TC adsorption by various BC.

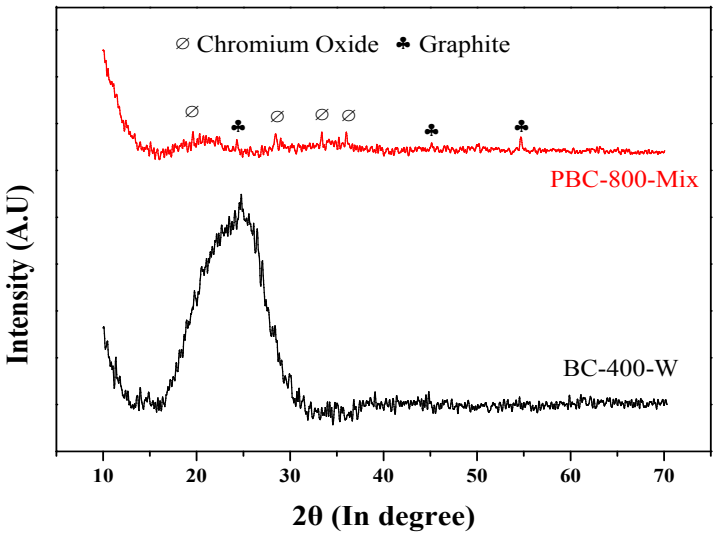

Fig.S4. The XRD of BC-400-W and PBC-800-Mix.

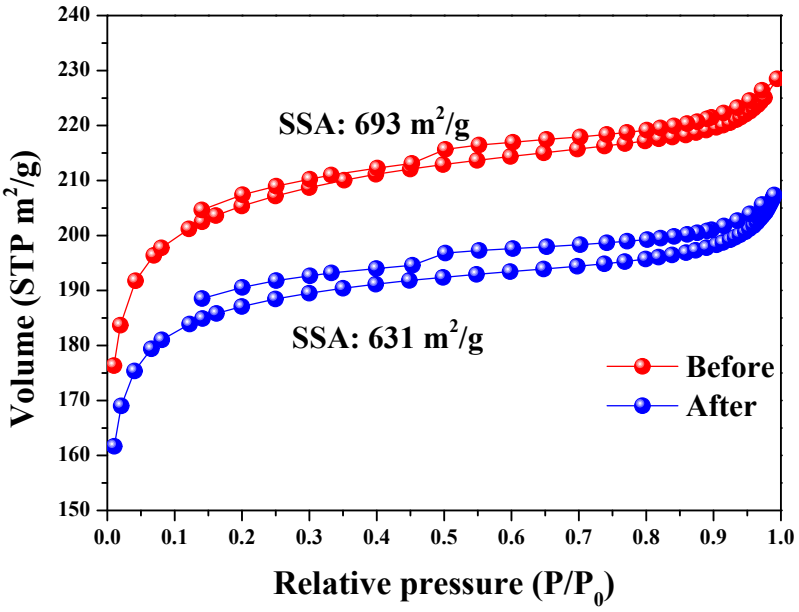

Fig. S5. Nitrogen adsorption and desorption isotherms adsorption of PBC-600 with or without TC.

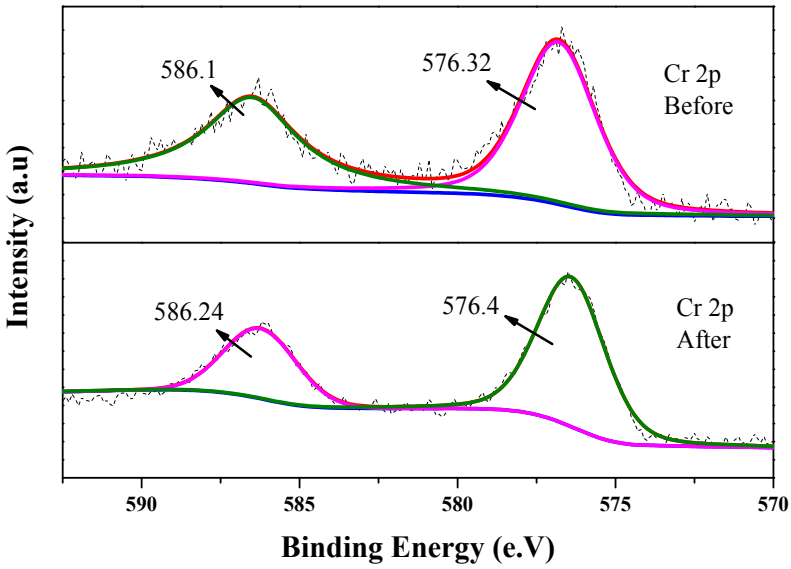

Fig. S6. XPS Spectra of Cr 2p core level before and after PBC-600 Adsorption of TC.

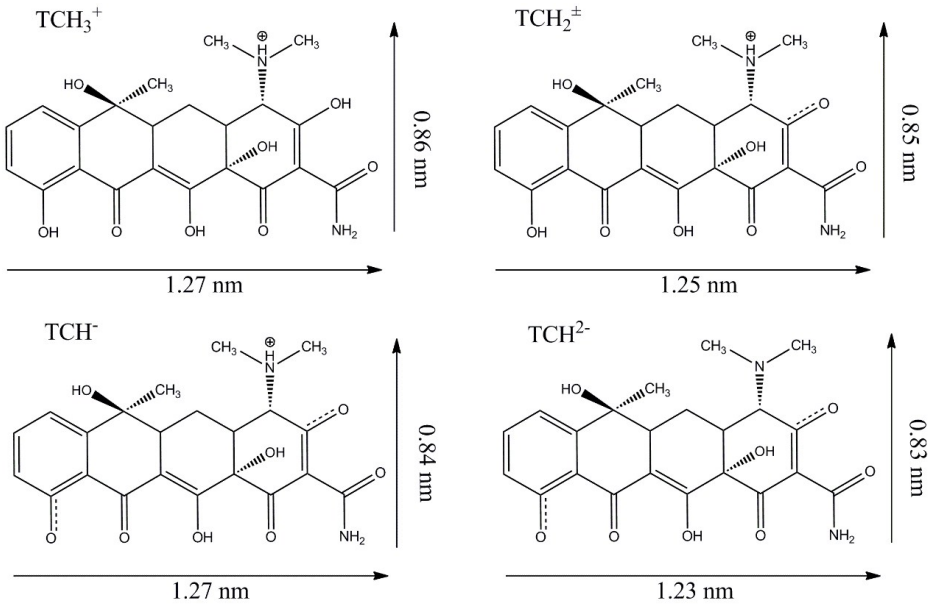

Fig.S7. Structure and size of TC.