Engineering of Kaolin/SLS-Functionalized Biochar@β-cyclodextrin Composite for adsorbing o-Nitrophenol; Optimization, Mechanistic study, and Box–Behnken Design

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Figure S1. EDX spectra of (a) pristine BC and the as-fabricated SLS-BC (b) before and (c) after washing.

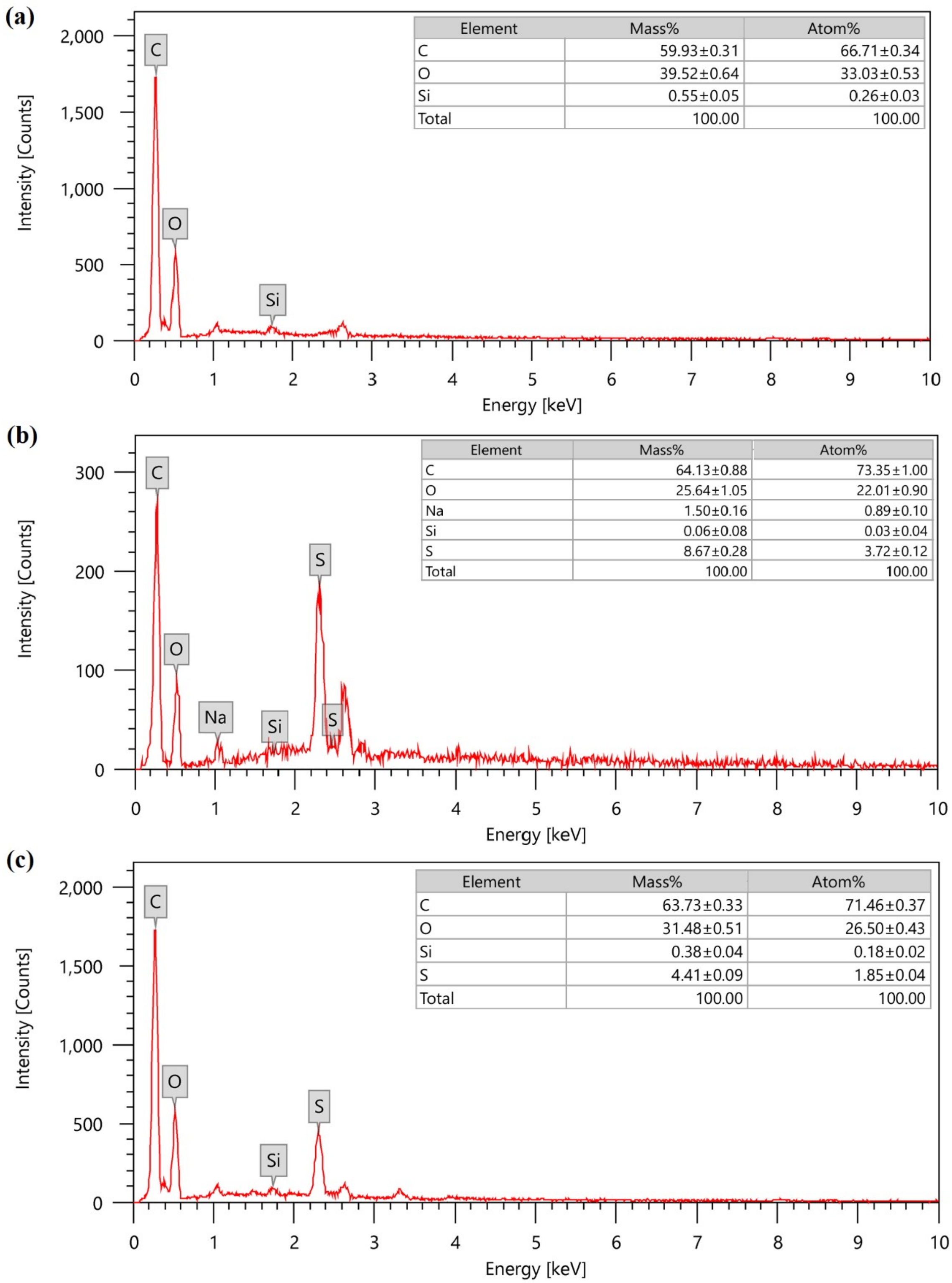

Figure S2. Removal% of different o-NP concentrations by Kaol/SLS-$BC_{0.5}$/β-$CD_{0.5}$ composite.

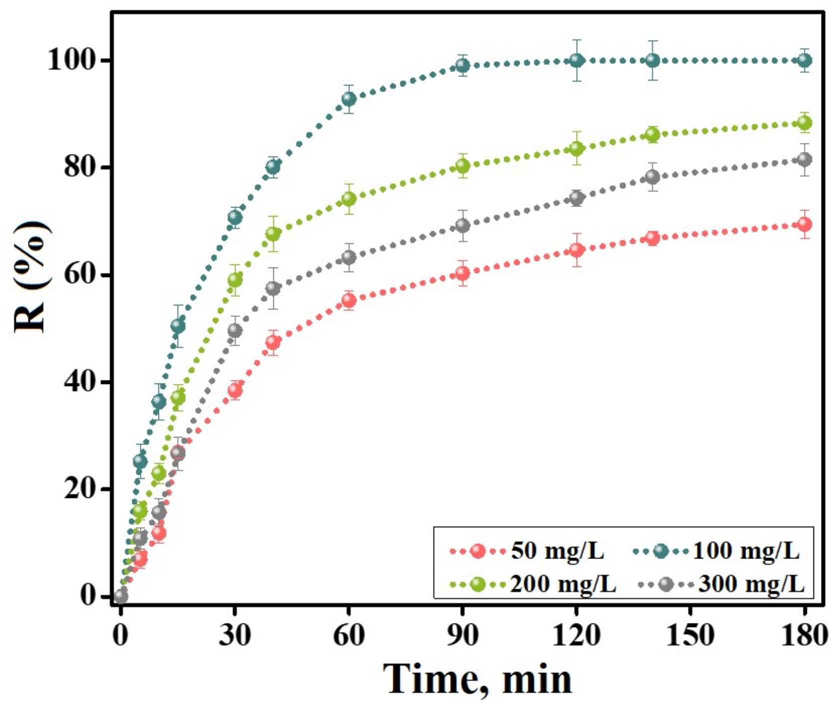

Table S1. Equations of the applied adsorption kinetic models

Kinetic Model	Equation	
Pseudo−First order	$\ln (q_e - q_t) = \ln q_e - (\frac{k_1}{2.303})t$	(1)
Pseudo−Second order	$t/q_t = 1/k_2 q_e^2 + 1/q_e (t)$	(2)
Elovich model	$q_t = \frac{1}{\beta} ln\ (\alpha\beta) + \frac{1}{\beta} \ln (t)$	(3)

Where, q_t and q_e are amounts of adsorbed o-NP at time t and equilibrium, respectively. k_1 and k_2 are the rate constants of Pseudo first order and Pseudo second order, respectively. α and β are Elovich coefficients that represent the initial adsorption rate and the desorption coefficient, respectively, also related to the extent of surface coverage and activation energy for chemisorption.

Table S2: Equations of the applied adsorption isotherm models

Model	Equation	
Langmuir	$\frac{C_e}{q_e} = \frac{1}{K_L\, q_{max}} + \frac{C_e}{q_{max}}$	(4)
Freundlich	$\ln q_e = \ln K_f + \frac{1}{n} \ln C_e$	(5)
Temkin	$q_e = B\ lnK_T + B \ln C_e$	(6)
DR	$Ln\ q_e = Ln\ q_s - K_{DR}\varepsilon^2$, $\varepsilon = RT\ Ln\left(1 + \frac{1}{C_e}\right)$	(7, 8)

Where, q_e and C_e are the adsorption capacity and the concentration of the un-adsorbed o-NP at equilibrium, respectively. q_{max} and K_L are the monolayer adsorption capacity and Langmuir constant, respectively. n and K_f are Freundlich constants. K_T is the equilibrium binding constant and $B = \frac{RT}{b}$, b is Temkin constant related to heat of adsorption. R is the gas constant (8.314 J/mol.k) and T is the absolute temperature. Q_s is the saturation capacity, ε is the Polanyi potential and K_{DR} is a constant related to the mean free energy of adsorption per mole of the adsorbate.

Table S3: Elemental composition of the pure and recyclable of Kaol/SLS-$BC_{0.5}$/β-$CD_{0.5}$ composite.

Elements	Atomic % of pure composite	Atomic % of recyclable composite
Si	13.15	12.86
Al	11.87	11.15
C	19.45	18.93
S	3.31	3.27
O	52.22	52.78
N	–	1.01