Supporting information for

Nanoscale zero-valent iron and chitosan functionalized *Eichhornia crassipes* biochar for efficient hexavalent chromium removal

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Table S1. Statistical table of experimental variables and invariants.

<table>
<tr><td rowspan="2">pH</td><td>Invariant</td><td colspan="9">30 ℃, 30 min, 0.01mol/L NaNO3, 100.0mg/L Cr(VI)</td></tr>
<tr><td>Variable</td><td>2.0</td><td colspan="2">3.0</td><td>4.0</td><td>5.0</td><td colspan="2">6.0</td><td>7.0</td><td>8.0</td></tr>
<tr><td rowspan="2">t (min)</td><td>Invariant</td><td colspan="9">pH=2.0, 30 ℃, 0.01mol/L NaNO3, 100.0mg/L Cr(VI)</td></tr>
<tr><td>Variable</td><td>0</td><td>10</td><td>30</td><td>60</td><td>120</td><td>240</td><td>720</td><td>1080</td><td>1440</td></tr>
<tr><td rowspan="2">$NaNO_3$ (mg/L)</td><td>Invariant</td><td colspan="9">pH=2.0, 30 ℃, 30 min, 100.0mg/L Cr(VI)</td></tr>
<tr><td>Variable</td><td>0.0</td><td colspan="2">0.005</td><td colspan="2">0.05</td><td colspan="2">0.5</td><td colspan="2">5.0</td></tr>
</table>

Table S2. Parameters Characterizing the pore structure of the BC, nZVI-BC and C-nZVI-BC.

Sample	SA (m^2/g)	TPV (cm^3/g)	APR (nm)
C-nZVI-BC	833.1	0.61	4.43
nZVI-BC	748.99	0.59	4.85
BC	512.89	0.46	3.97

Table S3. Isotherm parameters obtained by experimental data for the sorption of Cr(VI) by BC, nZVI-BC and C-nZVI-BC.

	Q_e	Langmuir			Freundlich		
		Q_m	K_L	R^2	K_F	n	R^2
C-nZVI-BC	66.12	68.316	0.168	0.994	16.659	0.3	0.959
nZVI-BC	43.78	45.733	0.165	0.998	14.056	0.204	0.926
BC	14.62	27.171	0.179	0.99	4.392	0.277	0.987

Table S4. Kinetic parameters for the adsorption of Cr(VI) onto BC, nZVI-BC and C-nZVI-BC.

	Q_e	Pseudo-first-order			Pseudo-second-order			Elovich		
		q_e	K_1	R^2	q_e	K_2	R^2	a	b	R^2
C-nZVI-BC	52.304	54.184	0.016	0.939	56.8	2.939	0.947	9.658	0.324	0.882
nZVI-BC	34.029	35.023	0.020	0.941	36.408	1.748	0.956	5.589	0.659	0.840
BC	18.258	18.234	0.022	0.916	19.514	0.448	0.986	2.900	0.887	0.911

Table S5. The elemental composition and atom percent of C-nZVI-BC composite before and after Cr(VI) adsorption.

Element	Wt%		Atom percent	
	before	after	before	after
C	69.26	55.18	83.75	72.32
O	20.20	25.59	16.03	22.20
Si	0.11	0.07	0.05	0.04
Cr	-	8.96	-	2.39
Fe	10.43	10.20	3.17	3.05
Total	100.00		100.00	

Table S6. The quantitative XPS analysis of the C-nZVI-BC and nZVI-BC after Cr(VI) adsorption, Cr 2p.

	Cr(III)	Cr(VI)
nZVI-BC	74.74	25.26
C-nZVI-BC	59.95	40.05

Table S7. The maximal sorption capacity of biochars produced from different biomass feedstocks for Cr sorption from aqueous solutions.

Feedstock	Sorption capacity (mg g^{-1})	Reference
Sugar beet tailing	123	1
Coconut coir (250, 350, 500, 600 ℃)	31.1, 10.9, 7.9, 4.1	2
Peanut straw	25	3
Soybean straw	17.2	
Canola straw	14.6	
Rice straw	14	
Chlorella	18.86	4
Peanut hull	77.25	5
corn stack	20.04	6
sawdust	17.7	
wheat straw	14.39	
rice straw fed frass	32.59	7
sugarcane bagasse	43.122	8
corn straw	1.03	9
Rice straw-biochar colloids	10.4	10
Peanut hull	0.9	11
Mentha piperita	6.45	12
Artemisia argyi stem	161.92	13
Wheat straw	24.6	14
Wicker	23.6	
Rice husk	23.1	15
Cherry	16.01	16
Oleaster	24.65	
Eichhornia crassipes	20.6	This work

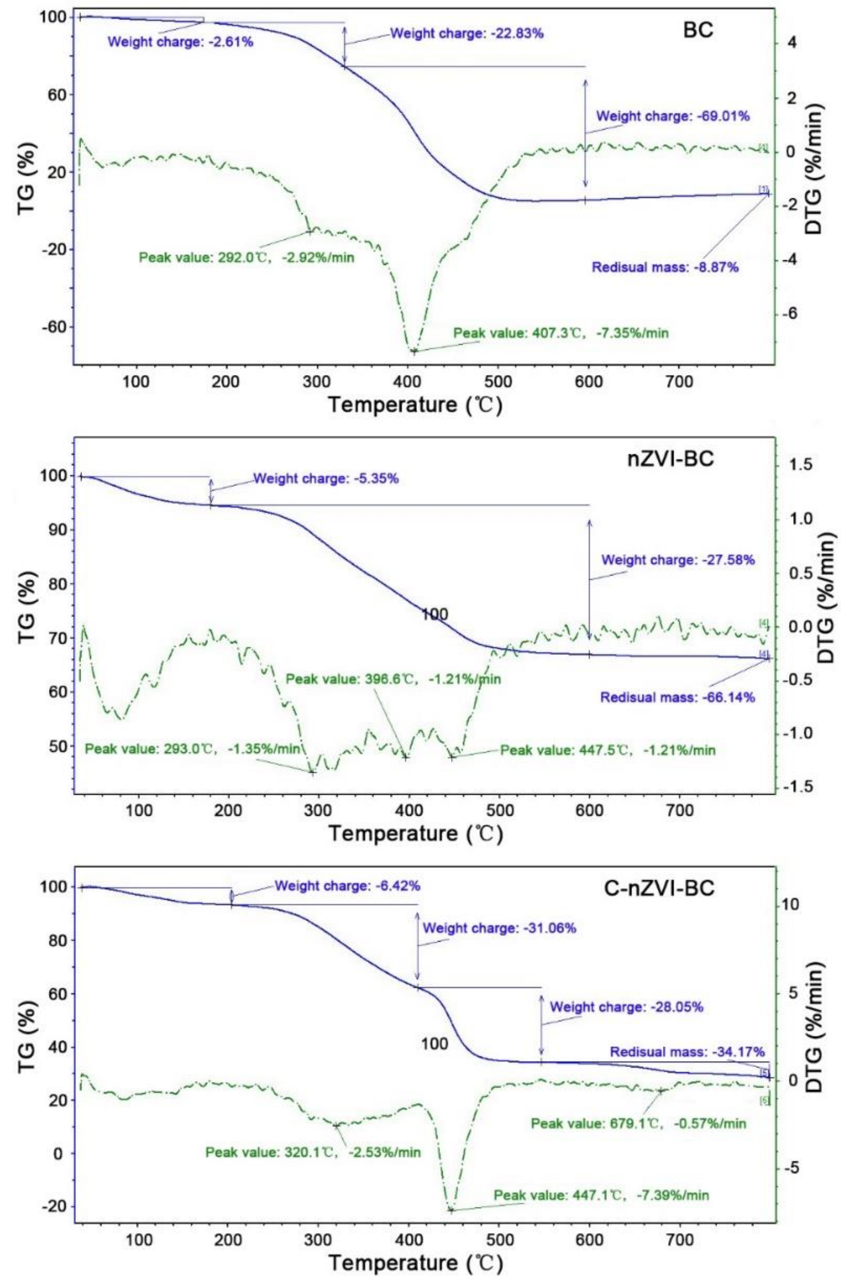

Figure S1. Thermogravimetric curve of BC, nZVI-BC and C-nZVI-BC.

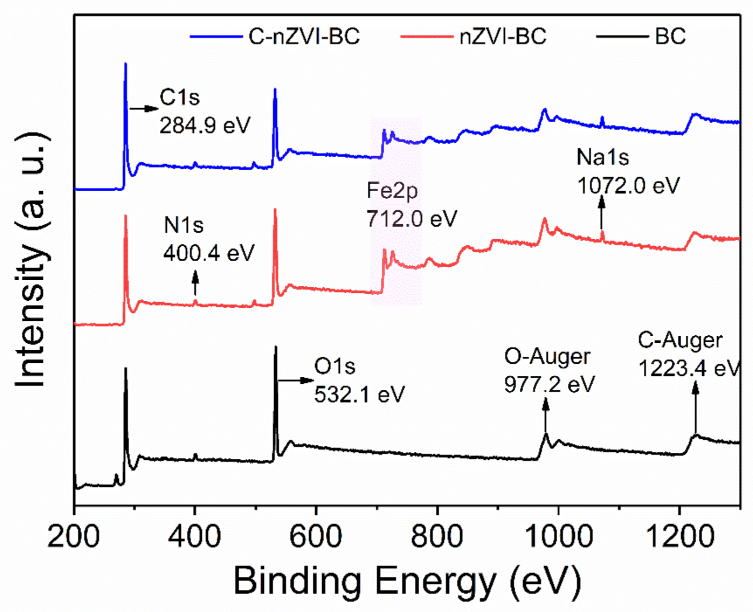

Figure S2. The XPS spectra of BC, nZVI-BC and C-nZVI-BC.

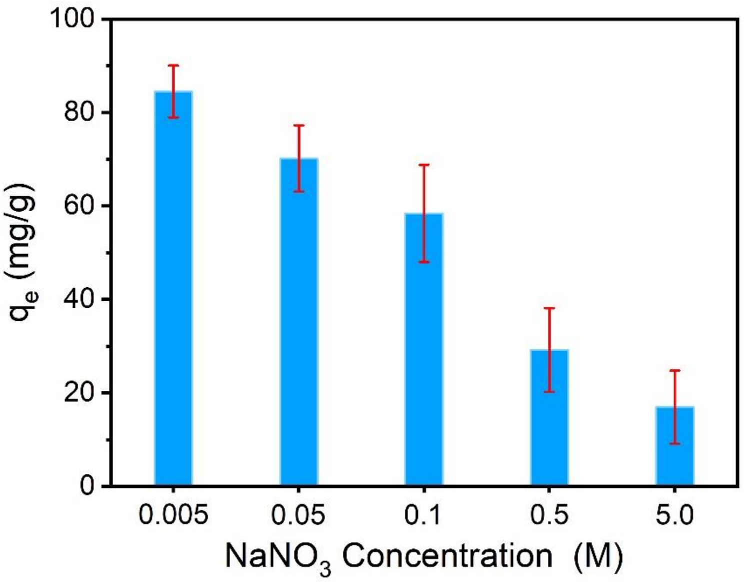

Figure S3. Effect of solubility of background solution (NaNO3) on the Cr(VI) adsorption by C-nZVI-BC. (Reaction conditions: Cr(VI) concentration c0 =100 mg/g; V = 100 mL; m = 100 mg; T = 30℃; pH = 2).

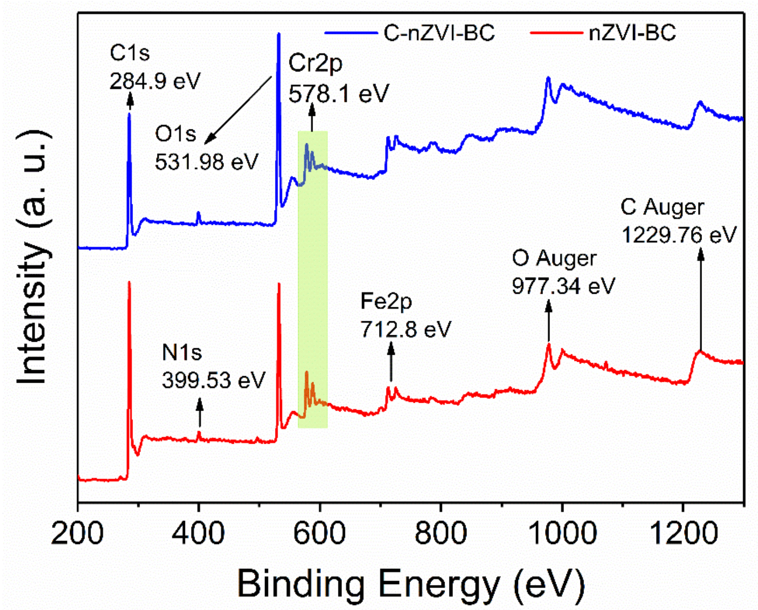

Figure S4. The XPS survey spectra of the nZVI-BC (red) and C-nZVI-BC(blue) after Cr-adsorption.

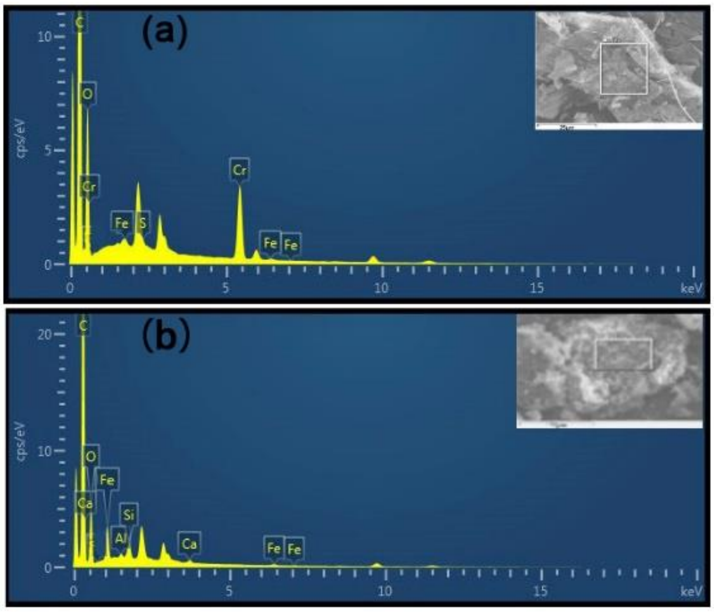

Figure S5. The EDX of C-nZVI-BC composite before (b) and after (a) Cr(VI) adsorption.

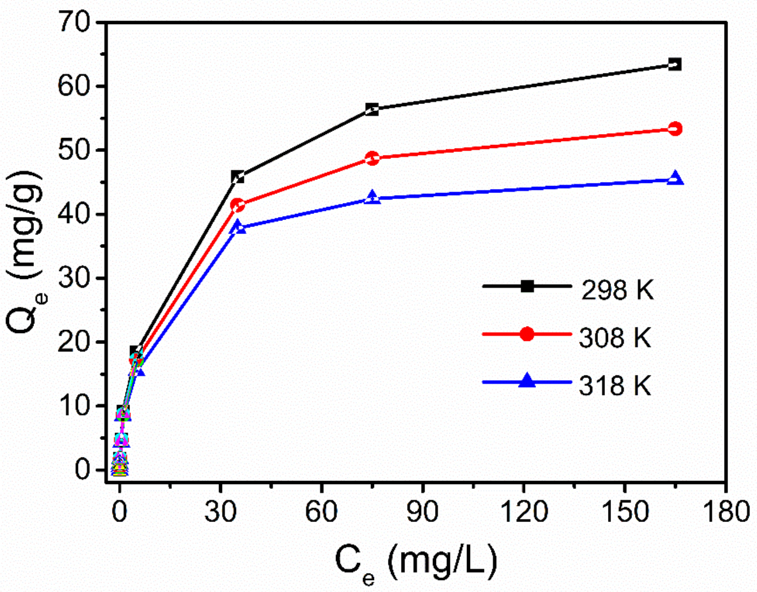

Figure S6. The Effect of temperature on the adsorption of Cr(VI) onto adsorbents.

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