Supporting Information

Adsorption and reduction transformation behaviors of Cr(VI) on mesoporous polydopamine/titanium dioxide composite nanospheres

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Preparation of mesoporous TiO_2.

Mesoporous TiO_2 materials were obtained by a traditional method. The weight of 2.88 g (0.012 mol) of titanium sulfate and 5.76 g (0.096 mol) urea were added into 150 ml pure water and stirred mildly at room temperature. After the reagents were dissolved completely, 1.212 g (0.000096 mol) of amphiphilic triblock copolymer F127 was put into the pellucid solution with vigorous stirring. The mixed solution was stirred for 30 min**,** and transferred into autoclave with fluoroethylene liner to react at 110 °C for 24 h. After cooling down to room temperature, the mixture was centrifuged, and then the prepared materials were dried overnight, and designed as pure mesoporous TiO_2.

Carbonization of PDA/TiO_2-0.5.

The pre-prepared claret materials using titanium sulfate as the titanium precursor were heated in the mixed gases of 90 % Ar and 10 % H_2 at a rate of 1 °C/min from 20 °C to 260 °C and maintained at the temperature for 1 h, then heated up to 550 °C at a rate of 1 °C/min and maintained 2 h.

Adsorption isotherm models:

Langmuir isotherm model:

$$\frac{C_e}{Q_e} = \frac{1}{Q_{max} K_l} + \frac{C_e}{Q_{max}}$$

Freundlich isotherm model:

$$\ln Q_e = \frac{1}{n} \ln C_e + \ln K_f$$

Tempkin model:

$$Q_e = \frac{RT}{b_T} \ln K_T + \frac{RT}{b_T} \ln C_e$$

Dubinin-Radushkevich model:

$$\ln Q_e = \ln Q_{max} - k\varepsilon^2, \quad \varepsilon = RT \ln\left(1 + \frac{1}{C_e}\right), \quad E = (2k)^{-\frac{1}{2}}$$

where C_e (mg/L) is the equilibrium concentration of Cr (VI) in the solution, Q_e (mg/g) is the equilibrium adsorption ability. Q_{max} (mg/g) is the the maximum adsorption ability of the adsorbent, K_l (L/mg) is a constant, C_o (mg/L) is the initial concentration of Cr (VI) solution, K_f ($mg^{1-n} \cdot L/g$) is a content relate to adsorption capacity, and n is the uniformity coefficient that can be utilized to indicate the heterogeneity of adsorbent. R (8.3145 J/mol/K) is molar gas constant. T (K) is kelvin temperature. b_T is a constant that was associated with adsorption energy. k (mol^2/KJ^2) is a constant and ε is adsorption potential. E (KJ/mol) is mean free adsorption energy.

Adsorption kinetic models:

Pseudo-first-order kinetic model:

$$\ln(Q_e - Q_t) = \ln Q_e - k_1 t$$

Pseudo-Second-order kinetic model:

$$\frac{t}{Q_t} = \frac{1}{k_2 Q_e^2} + \frac{t}{Q_e}$$

Elovich model:

$$Q_t = \frac{1}{\beta}\ln(\alpha\beta) + \frac{1}{\beta}\ln t$$

Webber-Morris model:

$$Q_t = k_{wm} t^{\frac{1}{2}} + C$$

Bangham model:

$$\ln Q_t = \ln k_B + \frac{1}{m}\ln t$$

where Q_e (mg/g) is the equilibrium adsorption capacity, Q_t is the adsorption capacity at time t, and k_1, k_2, k_{wm} (mg/g/min$^{1/2}$) and k_B are the rate constant of models, respectively. α (g/mg/min) and β (g/mg) are initial absorbing rate and desorption constant, severally.

Thermodynamic equations:

$$\Delta G^0 = \Delta H^0 - T\Delta S^0$$

$$\ln K_c = -\frac{\Delta H^0}{RT} + \frac{\Delta S^0}{R}$$

$$K_c = \frac{Q_e}{C_e}$$

where K_c is the equilibrium constant, Q_e and C_e are the equilibrium adsorption capacity and equilibrium concentration, severally.

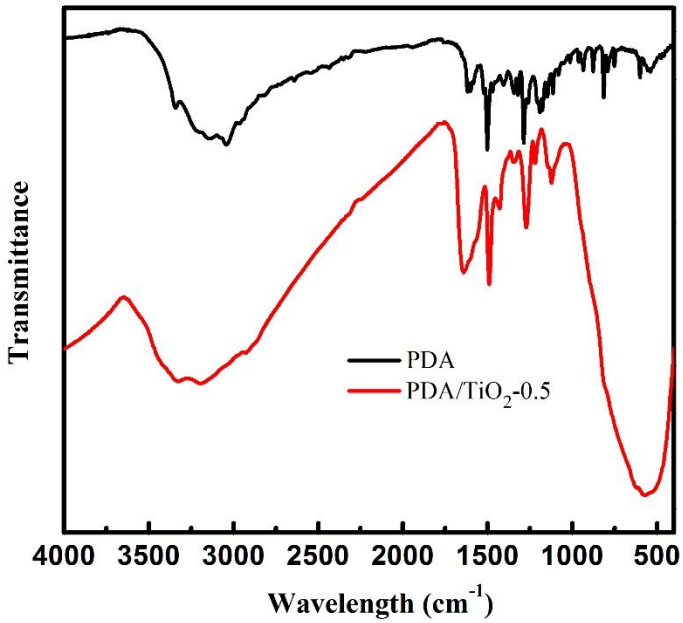
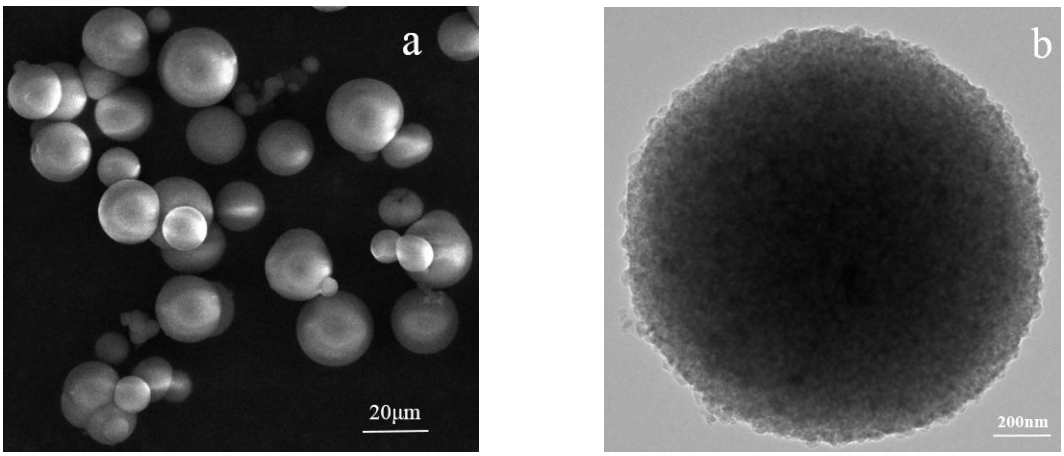


Fig. S1. The FT-IR spectra of pure PDA.



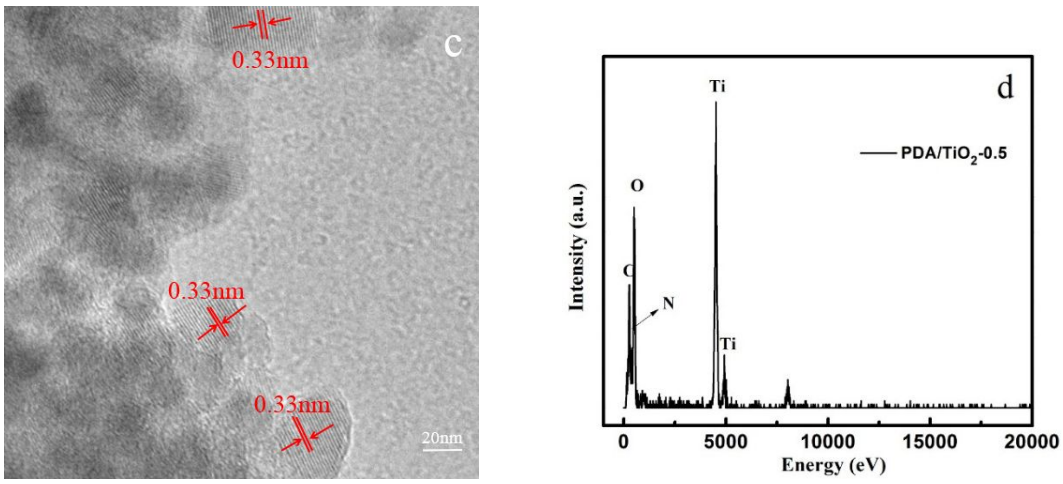


Fig. S2. The SEM (a), TEM (b and c) and EDS (d) images of PDA/TiO_2-0.5.

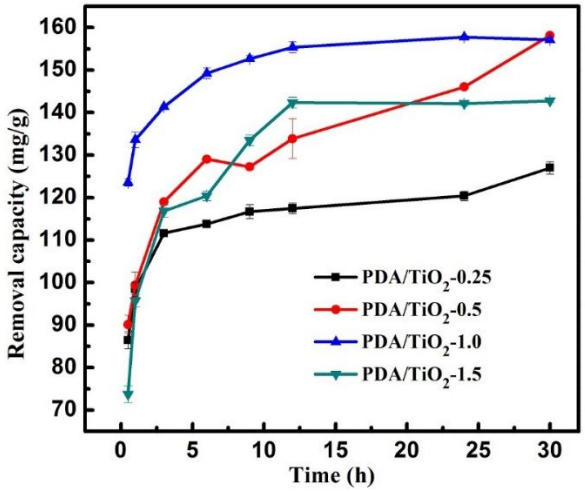


Fig. S3. The removal capacities of PDA/TiO_2-(0.25, 0.5, 1.0, 1.5) with different contact time.

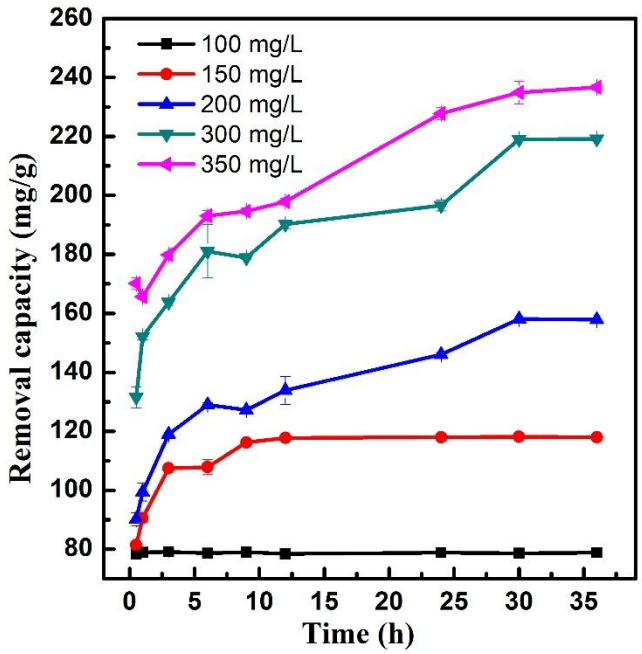


Fig. S4. The removal capacity of PDA/TiO_2-0.5 with different Cr (VI) concentration and contact.

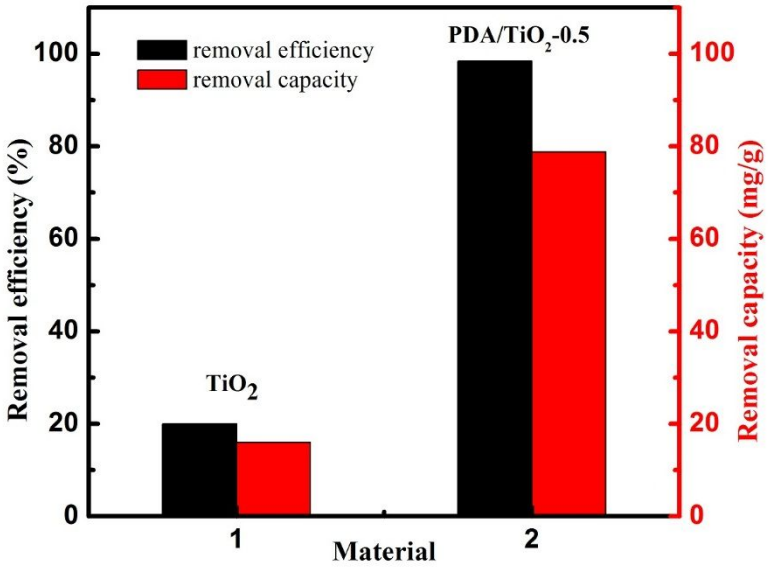


Fig. S5. The removal efficiency and capacity of TiO_2 and PDA/TiO_2- 0.5 at 24 h, 200 mg/l, 1.5 pH.

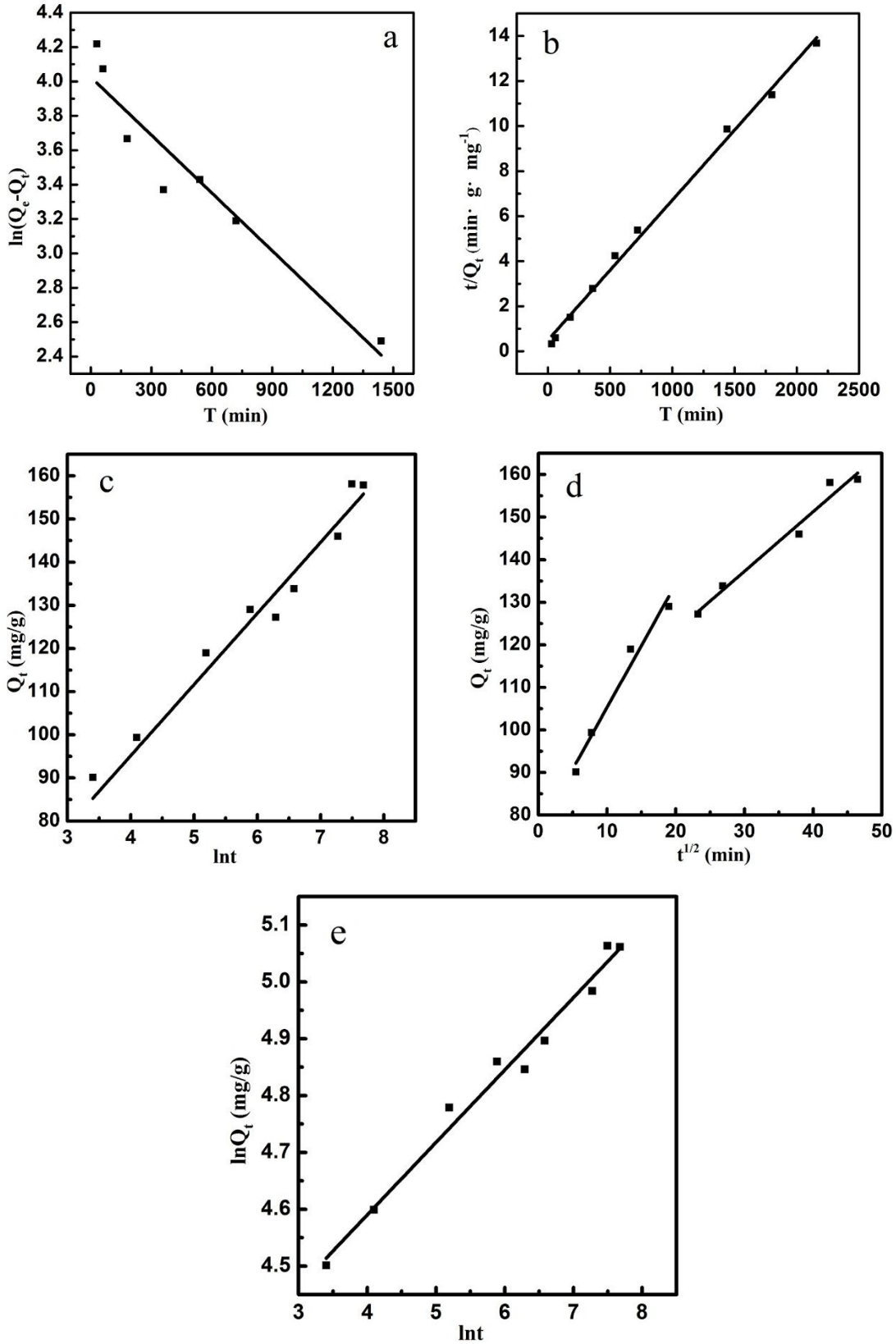


Fig. S6. Adsorption kinetics of Cr(VI) on mesoporous PDA/TiO_2-0.5: (a) Pseudo-first-order kinetic, (b) Pseudo-second-order kinetic, (c) Elovich, (d) Webber-Morris, and (e) Bangham

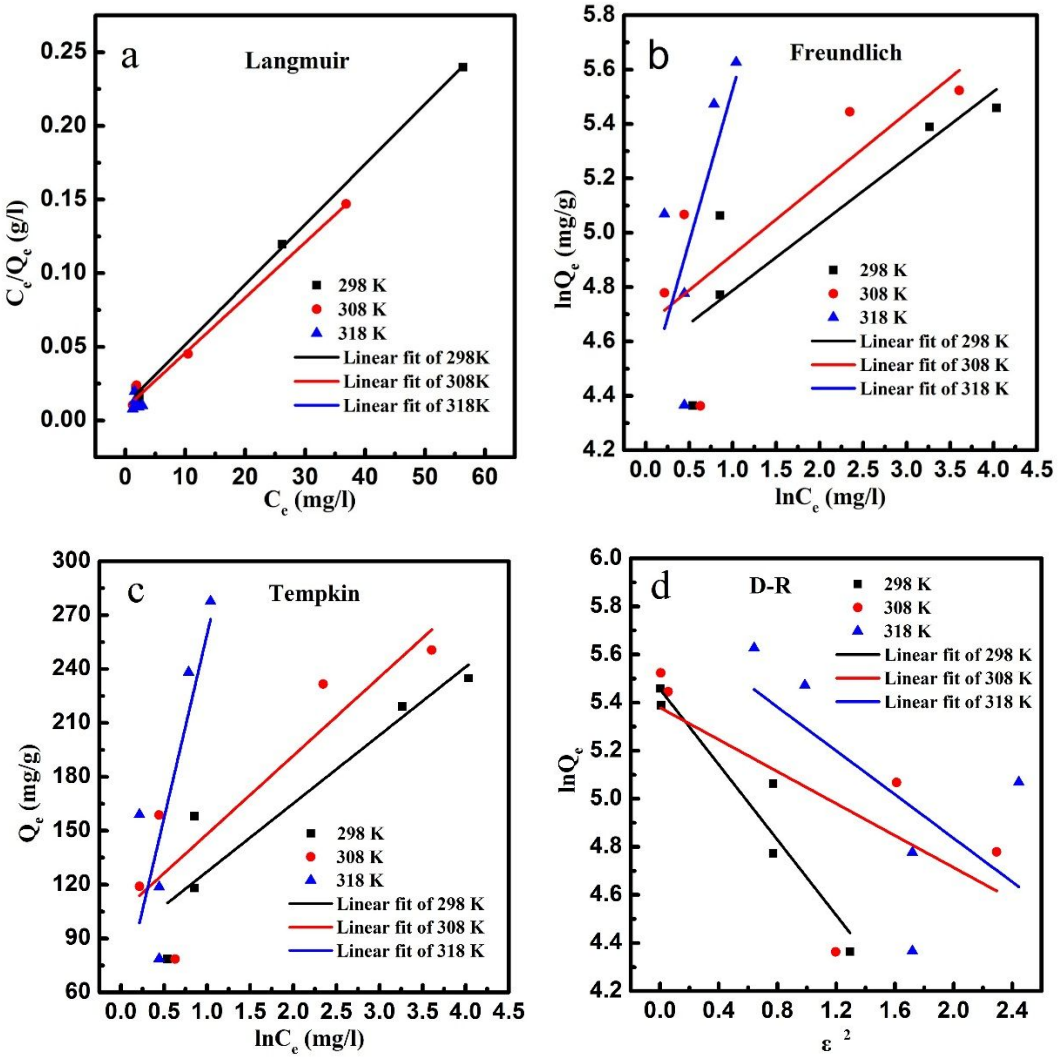


Fig. S7. Adsorption isotherms of Cr(VI) on mesoporous PDA/TiO_2-0.5: (a) Langmuir isotherm, (b) Freundlich isotherm, (c) Tempkin, (d) D-R

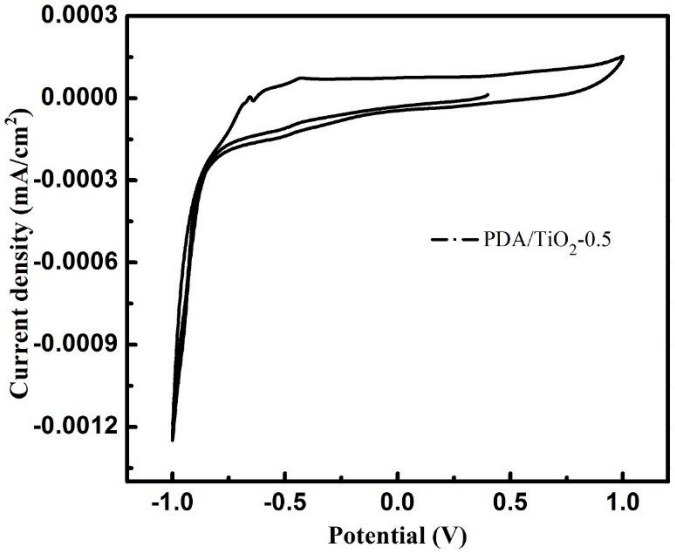


Fig. S8. The CV pattern of PDA/TiO_2-0.5.

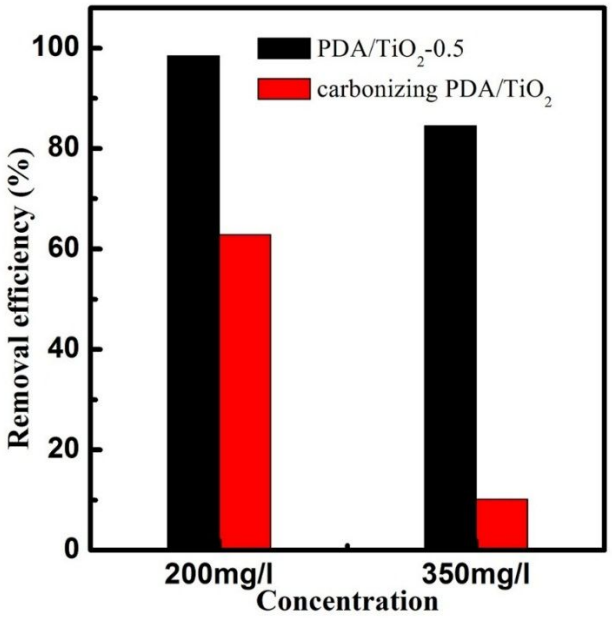


Fig. S9. The removal efficiency of carbonizing PDA/TiO_2-0.5 for Cr (VI)