Hierarchical $CeVO_4$ hollow microspheres to enable high-efficiency Pb^{2+} adsorbents

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Table S1. The kinetics, isotherms, thermodynamics and energy related equations used in this work.

Equation		*Parameters*
Removal efficiency %R		
$\%R = \frac{(C_0 - C_e)}{C_0} \times 100$	Eq.1	C_0(mg·L^{-1}): initial concentration of Pb^{2+} in solution C_e(mg·L^{-1}): equilibrium concentration of Pb^{2+} in solution
Amount of equilibrium sorption		
$q_e = (C_0 - C_e)\frac{V}{m}$	Eq.2	q_e(mg·g^{-1}): amount of equilibrium sorption V(mL): volume of the solution m(mg): mass of $CeVO_4$
Kinetic models		
Pseudo-first order $q_t = q_e(1 - e^{-k_1 t})$	Eq.3	q_t(mg·g^{-1}): sorption capacity at time t(min) k_1(min^{-1}): Pseudo-first order rate constant
Pseudo-second order $q_t = \frac{k_2 q_e^2 t}{1 + k_2 q_e t}$	Eq.4	k_2(g·mg^{-1}·min^{-1}): Pseudo-second order rate constant
Isotherm models		
Langmuir $q_e = \frac{q_m K_L C_e}{1 + K_L C_e}$	Eq.5	q_m(mg·g^{-1}): maximum sorption capacity in theory K_L(L·mg^{-1}): Langmuir constant
Freundlich $q_e = K_F C_e^n$	Eq.6	K_F(L^n·g^{-1}·mg^{1-n}): Freundlich constant n: heterogeneity factor
Thermodynamics and energy study		
$K_d = \frac{q_e}{C_e}$	Eq.7	K_d(L·g^{-1}): distribution coefficient
$\ln K_e = -\frac{\Delta H^0}{RT} + \frac{\Delta S^0}{R}$	Eq.8	K_e: equilibrium constant, equal to 1,000K_d
$\Delta G^0 = -RT\ln K_e$	Eq.9	ΔH^0(J·mol^{-1}): standard enthalpy change ΔS^0(J·mol^{-1}·K^{-1}): standard entropy change ΔG^0(J·mol^{-1}): standard Gibbs free energy