Supporting Information

Surface Wettability Guiding In-situ Cultivation Engineering of Hollow Polymer Nanospheres for Persistent Efficient Uranium Extraction

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Formulas in the adsorption experiments:

The following lists the equations of pseudo-first-order (S1), pseudo-second-order (S2) [1].

$$Q_t = Q_e - Q_e e^{-k_1 t} \#S1$$

$$Q_t = \frac{k_2 Q_e^2 t}{1 + k_2 Q_e t} \#S2$$

Q_e (mg g^{-1}) is the adsorption capacity at equilibrium, Q_t (mg g^{-1}) is the adsorption capacity at time t, k_1 (min^{-1}) and k_2 (g mg^{-1} min^{-1}) are adsorption rate constant respectively.

Langmuir (S3) and Freundlich (S4) isotherm models [2]:

$$Q_e = \frac{K_L Q_m C_e}{1 + K_L C_e} \#S3$$

$$Q_e = K_F C^{\frac{1}{n}} \#S4$$

Q_m（mg g^{-1}）is the maximum adsorption capacity. K_L（L mg^{-1}）and K_F（mg L^{-1}）are the adsorption constants of Langmuir and Freundlich equations, respectively. 1/n is the adsorption strength.

Thermodynamic parameters such as enthalpy change (ΔH, kJ mol^{-1}), entropy change (ΔS, J mol^{-1} K^{-1}) and Gibbs free energy change (ΔG, kJ mol^{-1}) are calculated by following equations [3]:

$$K_d = \frac{(C_0 - C_e)V}{mC_e} \#S5$$

$$\Delta G = -RT\ln K \#S6$$

$$\ln K = \frac{\Delta S}{R} - \frac{\Delta H}{RT} \#\#S7$$

Here K_d is the distribution coefficient, and R is the universal gas constant (8.314 $J \cdot K^{-1} \cdot mol^{-1}$).

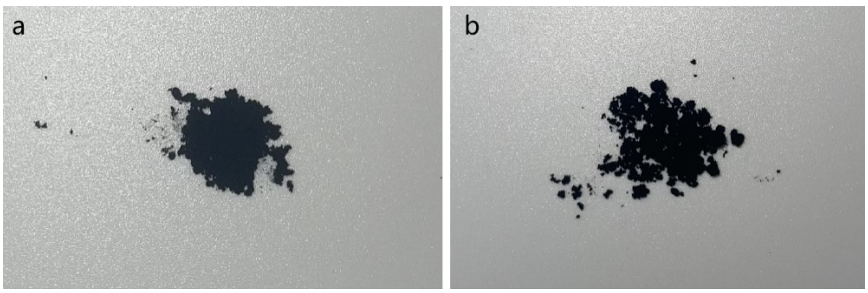

Fig. S1 The macroscopic photos of m-CNTs (a) and m-CNTs@H-PDA-AO (b)

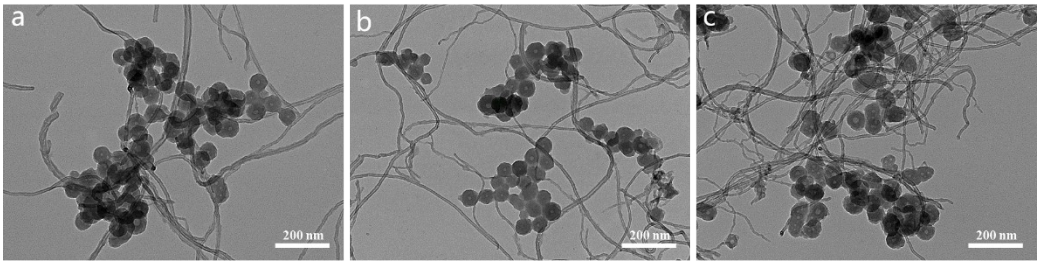

Fig. S2 The TEM images of CNTs@H-PDA after treatments with 100 ℃ hot water (a)、0.1 M HNO_3 (b)、and pH 9.0 NaOH solution (c) for 1.0 h

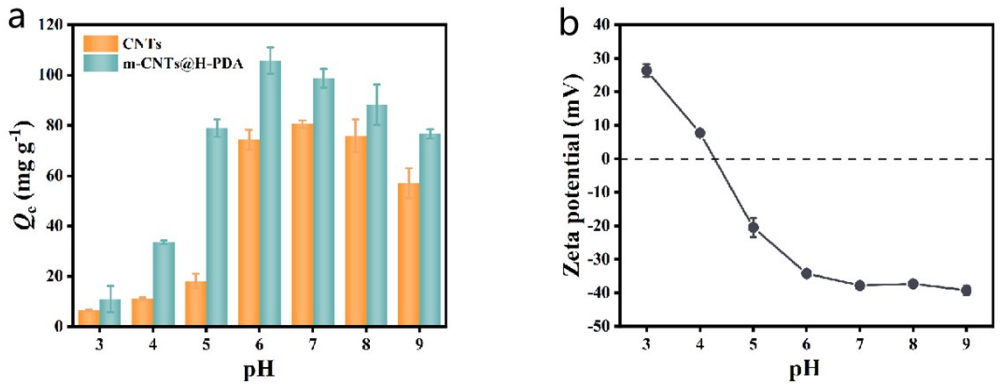

Fig. S3 The effect of initial pH of solution on adsorption of m-CNTs and m-CNTs@H-PDA (a) (C_0 = 10 mg L^{-1}, V = 50 mL, T = 298 K, m = 2.0 mg, t = 60 min, pH = 3.0-9.0); The Zeta potential values of m-CNTs@H-PDA in aqueous solutions at different pH values (b)

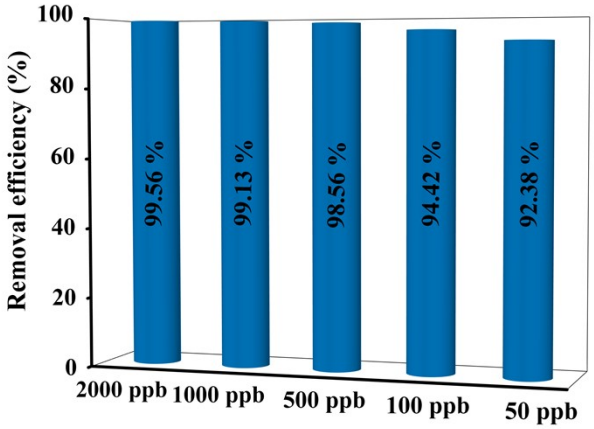

Fig. S4 Removal efficiency of m-CNTs@H-PDA-AO toward uranium with different concentrations (pH=8).

Table S1 The fitting parameters of adsorption kinetics models of m-CNTs@H-PDA-AO for uranyl ion at different solution volumes

Sorbent	V (mL)	Pseudo-first-order			Pseudo-second-order		
m-CNTs@H-PDA-AO	10	$Q_{e,c}$ (mg g^{-1})	k_1 (min^{-1})	R^2	$Q_{e,c}$ (mg g^{-1})	k_2 (g mg^{-1} min^{-1})	R^2
		52.75	0.39	0.812	53.61	0.0210	0.964
	50	$Q_{e,c}$ (mg g^{-1})	k$_1$ (min^{-1})	R^2	$Q_{e,c}$ (mg g^{-1})	k_2 (g mg^{-1} min^{-1})	R^2
		154.20	0.16	0.982	174.20	0.0012	0.992

$Q_{e,c}$ (mg g^{-1}) is the kinetic equation fitting calculated value

Table S2 The fitting parameters of the adsorption equilibrium model of m-CNTs@H-PDA-AO for uranyl ion at different temperatures

T (K)	Langmuir isotherm model			Freundlich isotherm model		
	Q_{max} (mg g^{-1})	k_L (L mg^{-1})	R^2	k_f (mg^{1-n} g^{-1} L^n)	$1/n$	R^2
288	307.10	0.30	0.783	121.80	0.23	0.961
298	381.98	0.28	0.803	138.90	0.26	0.977
308	931.30	0.07	0.875	154.70	0.41	0.975

Table S3 The thermodynamic parameters for uranyl ion on m-CNTs@H-PDA-AO

T (K)	LnK	ΔG (kJ mol^{-1})	ΔH (kJ mol^{-1})	ΔS (J mol^{-1} K^{-1})
288	1.3573	-3.25		
298	1.4348	-3.55	8.36	40.20
308	1.5849	-4.06		

Table S4 Initial concentration (C_0), Equilibrium Concentration (C_e) and Removal Efficiency (E_a) of uranyl ion and other metal ions

Ions	UO_2^{2+}	Fe^{3+}	Ni^{2+}	Pb^{2+}	Co^{2+}	VO_3^-	K^+	Ca^{2+}	Mg^{2+}	Na^+
C_0 (ppb)	330	170	90	73	6.0	282	$0.65*10^6$	$0.92*10^6$	$1.22*10^6$	$10.26*10^6$
C_e (ppb)	50.94	58.09	40.87	35.28	3.78	277	$0.65*10^6$	$0.92*10^6$	$1.22*10^6$	$10.26*10^6$
E_a (%)	84.56%	65.83%	54.59%	51.67%	37%	1.77%	0	0	0	0

References

[1] F. Wu, H. Li, Y. Pan, Y. Sun, J. Pan, 2023. Bioinspired construction of magnetic nano stirring rods with radially aligned dual mesopores and intrinsic rapid adsorption of palladium, J. Hazard. Mater. 441, 129917. https://doi.org/10.1016/j.jhazmat.2022.129917.

[2] X. Bai, Y. Wang, H. Li, X. Tian, Y. Ma, J. Pan, 2021. Stalagmites in karst cave inspired construction: lotus root-type adsorbent with porous surface derived from CO2-in-water Pickering emulsion for selective and ultrafast uranium extraction, J. Hazard. Mater. 419, 126398. https://doi.org/10.1016/j.jhazmat.2021.126398.

[3] J.L. Tang, J.L. Zhao, S.X. Wang, L.B. Zhang, M.H. Zhao, Z. Huang, Y.T. Hu, 2021. Pre-modification strategy to prepare a novel Zr-based MOF for selective adsorption of Palladium(II) from solution, Chem. Eng. J. 407, 127223. https://doi.org/10.1016/j.cej.2020.127223.