Electronic Supplementary Material (ESI) for Environmental Science: Nano.

Electronic supplementary information
Highly efficient adsorption of uranium(VI) from aqueous solution by a novel adsorbent: titanium phosphate nanotube

Mengling Tang†, Juan Chen†, Peifang Wang*, Chao Wang, Yanhui Ao*

Key Laboratory of Integrated Regulation and Resource Development on Shallow Lakes, Ministry of Education, College of Environment, Hohai University, No.1, Xikang road, Nanjing, 210098, China

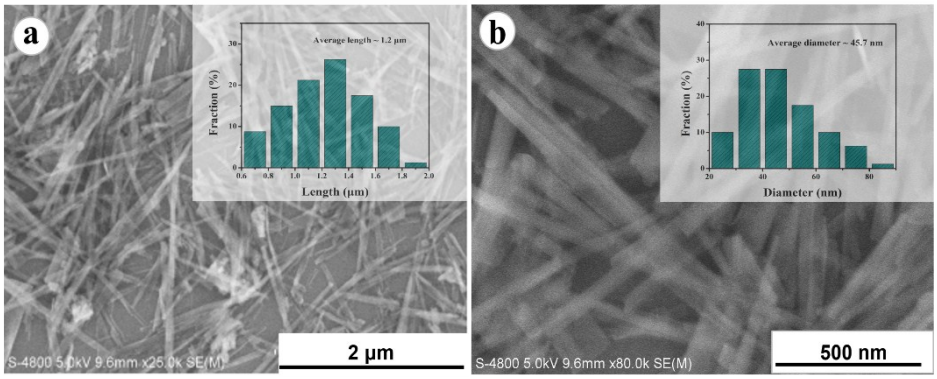

Fig. S1. (a) The low magnification SEM pattern; (b) The high magnification SEM pattern

From these two patterns, we can see that TP nanotube owns almost uniform-sized tubulose-shape. The low magnification SEM image displays that the average length of TP nanotubes is 1.2 μm. The high magnification SEM image identifies the hollow space structure of these tubes and the average diameter of these tubes is 45.7 nm.

* Corresponding author. Tel./ fax: +86 25 83787330,
E-mail address: andyao@hhu.edu.cn (Yanhui Ao); pfwang2005@hhu.edu.cn (Peifang Wang)

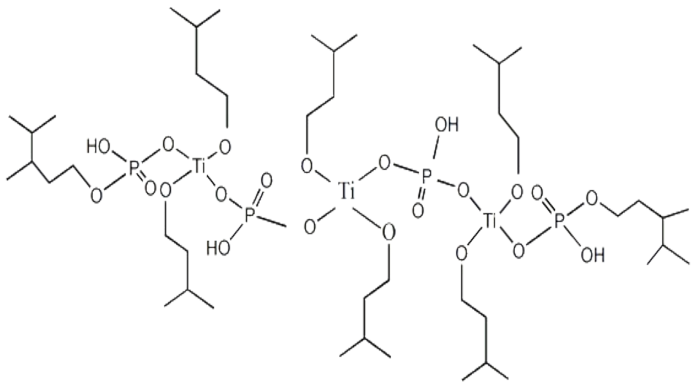

Fig. S2. The molecular structure diagram of TP nanotubes

According to the results of material characterization, the P-OH, P=O, -OH, Ti-O, P-O bonds and Ti-O-P framework exist in the molecular structure of TP nanotubes. By combining the presence of PO_4^{3-} ions, we made the above molecular structure diagram.

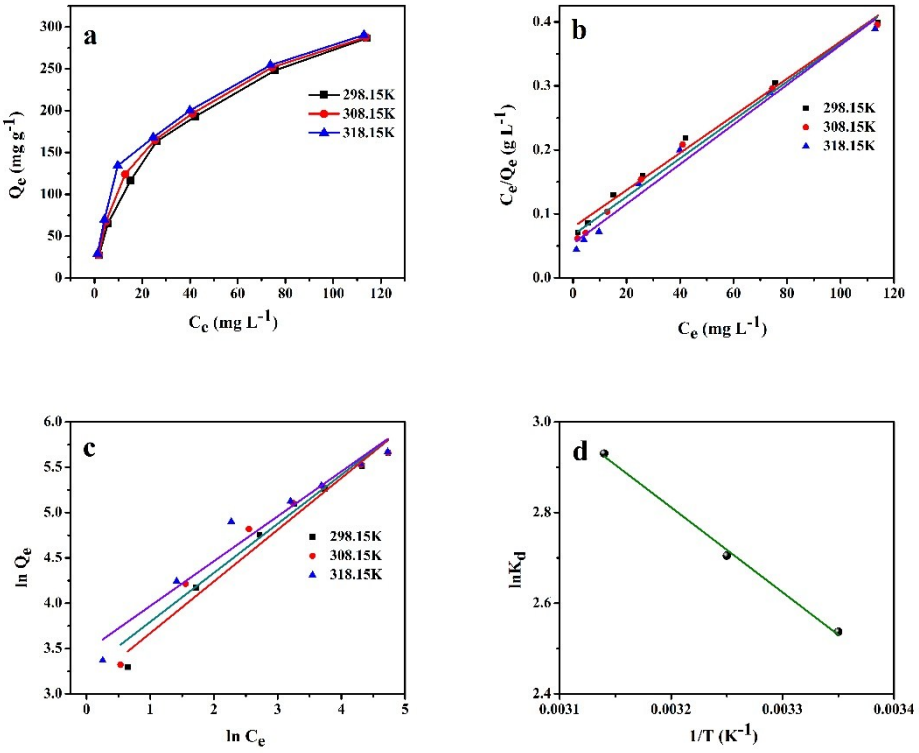

Fig. S3. (a) Experimental equilibrium data of TP nanotube at different temperature; Different isotherms, (b) Langmuir, (c) Freundlich, for U(VI) adsorption by TP nanotube at different temperature; (d) Plot of lnK_d versus 1/T for the adsorption of U(VI) on TP nanotube. (pH = 7, t = 1 h, adsorbent concentration = 300 mg L^{-1})

Table S1. Langmuir and Freundlich Models

	Langmuir			Freundlich		
T(K)	Q_m（mg g^{-1}）	b (L mg^{-1})	R^2	K_f	n	R^2
298.15	344.827	0.0367	0.9906	22.196	1.754	0.9777
308.15	333.333	0.0448	0.9905	25.909	1.851	0.9671
318.15	322.581	0.0581	0.9861	32.298	2.023	0.9555

Table S2. Thermodynamics parameters for U(VI) adsorption on TP nanotube

T(K)	ΔG°（kJ mol^{-1}）	ΔH°（kJ mol^{-1}）	ΔS°（J mol^{-1} K^{-1}）
298.15	-6.289		
308.15	-6.929	15.521	73.1
318.15	-7..750		

Comparing the fitting results of these two isotherm models, the adsorption followed Langmuir model better (Fig. S3b-c and Table S1). From Table S2, the ΔG° values are all negative in 298.15K, 308.15K and 318.15K, implying that the adsorption of U(VI) on TP nanotube is feasible and spontaneous. Furthermore, the value becomes more negative with temperature increasing, indicating that high temperature condition is more conducive to the reaction. The positive ΔH° value suggests that the process was an endothermic process under these experimental conditions. In addition, the positive ΔS° value exhibits a rise in randomness at the solid-liquid interface during the sorption process. Thus, the U(VI) adsorption on TP nanotube is an endothermic and spontaneous process.