Supplemental Information

Strategically designed porous magnetic $Fe/Fe_3C@C$ matrix and its highly efficient uranium(VI) remediation

Tao Wen,[a] Xiangxue Wang,[a] Jian Wang,[a] Zhongshan Chen,[a] Jiaxing Li,[a,b] Jun Hu,[a,b] Tasawar Hayat,[b,c] Ahmed Alsaedi,[c] Bernd Grambow[d] and Xiangke Wang*[a,b,e]

[a]School of Environment and Chemical Engineering, North China Electric Power University, Beijing 102206, P.R. China

[b]NAAM Research Group, Faculty of Science, King Abdulaziz University, Jeddah 21589, Saudi Arabia

[c]Department of Mathematics, Quaid-I-Azam University, Islamabad 44000, Pakistan

[d]Laboratory SUBATECH, UMR Ecole des Mines/CNRS/Universite, 4 rue A. Kastler, BP 20722, 44307, Nantes cedex 03, France

[e]Collaborative Innovation Center of Radiation Medicine of Jiangsu Higher Education Institutions, P.R. China

Corresponding author. Fax: +86-10-61772890; Tel: +86-10-61772890.

*E-mail address: xkwang@ncepu.edu.cn (X.K.W.)

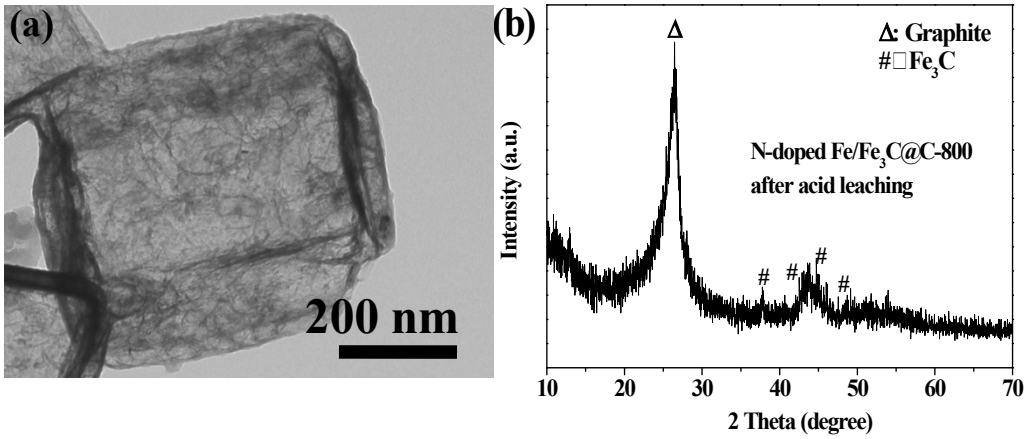

Fig. S1 TEM image and XRD pattern of N-doped Fe/Fe_3C@C sample after acid leaching.

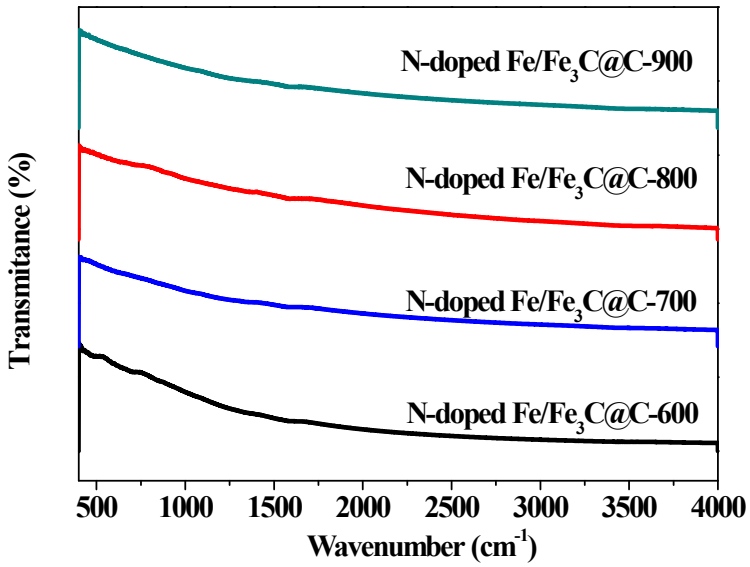

Fig. S2 FTIR spectra of N-doped Fe/Fe_3C@C products at different temperatures.

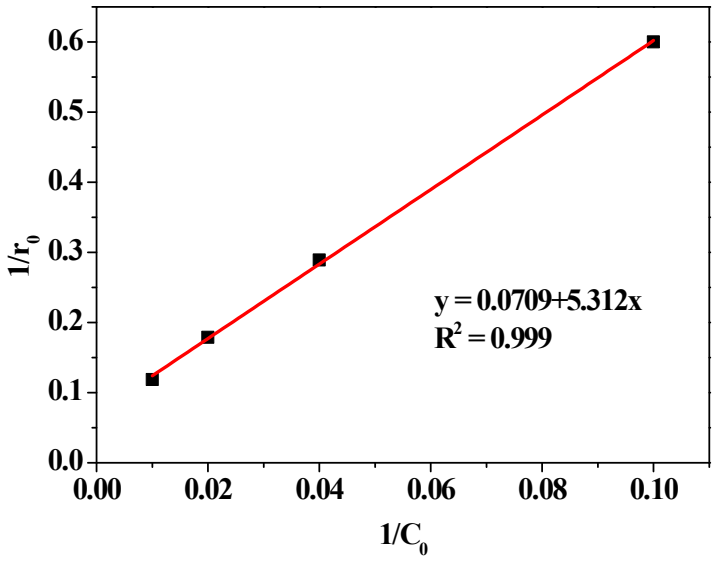

Fig. S3 Linear fit of using a Langmuir-Hinshelwood kinetic model at different initial U(VI) concentrations. All batch experiments were conducted in m/V = 0.1 g L^{-1}, pH = 6.0, 0.1 mM Na_2CO_3, and T = 298 K.

Table S1. Comparison of sorption capacities of U(VI) on N-doped Fe/Fe_3C@C at different temperatures with other different adsorbents.

Adsorbents	Conditions	Q_{max}(mg g^{-1})	References
Activated carbon	pH 3.0, T = 293 K	28.3	1
Manganese oxide coated zeolite	pH 4.0, T = 293 K	15.1	2
Ulva sp.-Na bentonite	pH 3.0, T = 303 K	54.0	3
Magnetite nanoparticles	pH 7.0, T = 293 K	5.0	4
Graphene oxide	pH 5.0, T = 293 K	31.3	5
N-doped Fe/Fe_3C@C-600	pH 6.0, T = 293 K	155	This work
N-doped Fe/Fe_3C@C-700	pH 6.0, T = 293 K	169	This work
N-doped Fe/Fe_3C@C-	pH 6.0, T = 293 K	203	This work

800			
N-doped Fe/Fe_3C@C-900	pH 6.0, T = 293 K	190	This work

Table S2. Kinetic parameters of U(VI) removal on N-doped Fe/Fe_3C@C-800.

Fitted equation	k_r (mg L^{-1} min^{-1})	K (L mg^{-1})	R^2
$\frac{1}{r_0} = 5.312\frac{1}{C_0} + 0.0709$	14.108	0.0133	0.999

Table S3. Components of contaminated groundwater.

Components	$CaCO_3$	$CaSO_4$	$Ca(NO_3)_2$	K_2SO_4	Na_2CO_3	$MgCO_3$	pH
Concentration (mg L^{-1})	0.245	0.122	0.041	0.017	0.212	0.092	6.8

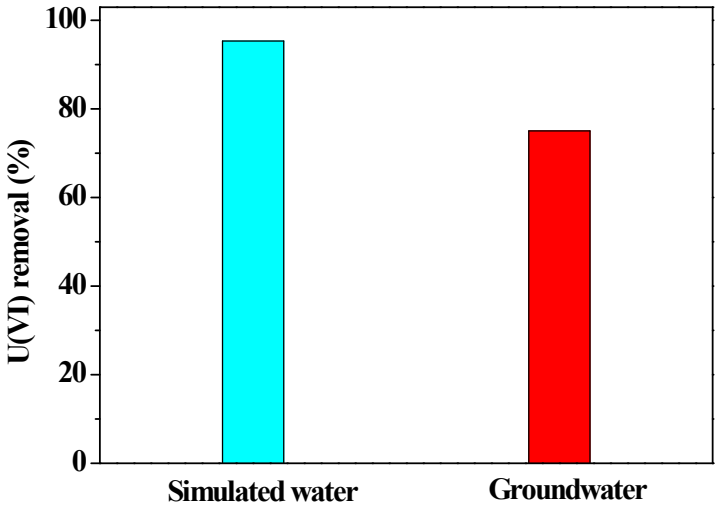

Fig. S4 The removal efficiency of U(VI) by N-doped Fe/Fe_3C@C-800 in simulated water (m/V = 0.1 g L^{-1}, pH = 6.0, I = 0.1 mM Na_2CO_3, T = 25 °C) and contaminated groundwater (m/V = 0.1 g L^{-1}, pH = 6.8, T = 25 °C).

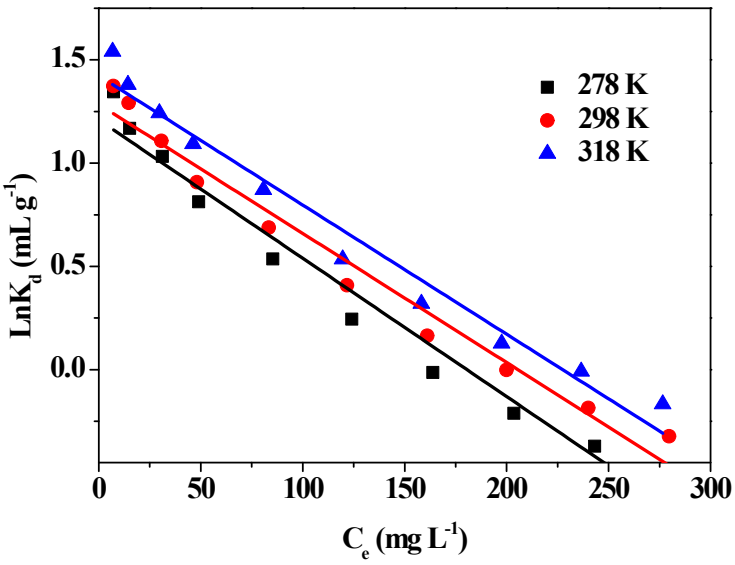

Fig. S5 The linear plots of $\ln K_d$ vs. C_e for U(VI) removal on N-doped Fe/Fe_3C@C-800 at three different temperatures, m/V = 0.1 g L^{-1}, pH =6.0, and I = 0.1 mM Na_2CO_3.

Table S4. Parameters for Langmuir and Freundlich isotherm models of U(VI) removal on N-doped Fe/Fe_3C@C-800 at three different temperatures.

Experimental conditions	Langmuir			Freundlich		
	Q_{max}(mg g^{-1})	b (L mg^{-1})	R^2	k	n	R^2
T = 5 °C	167	0.102	0.996	56.85	5.02	0.961
T = 25 °C	203	0.075	0.990	61.40	4.58	0.962
T = 45 °C	240	0.059	0.992	64.93	4.26	0.974

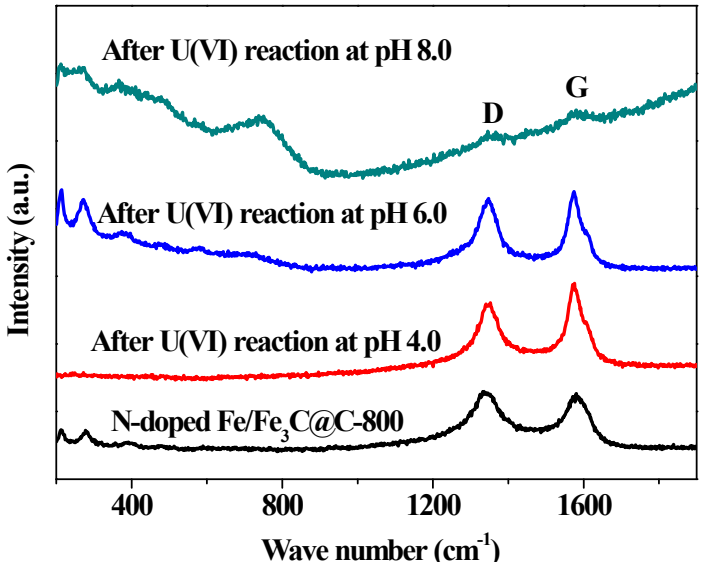

Fig. S6 Raman spectra of N-doped Fe/Fe_3C@C-800 before and after U(VI) reaction at pH = 4.0, 6.0, and 8.0.

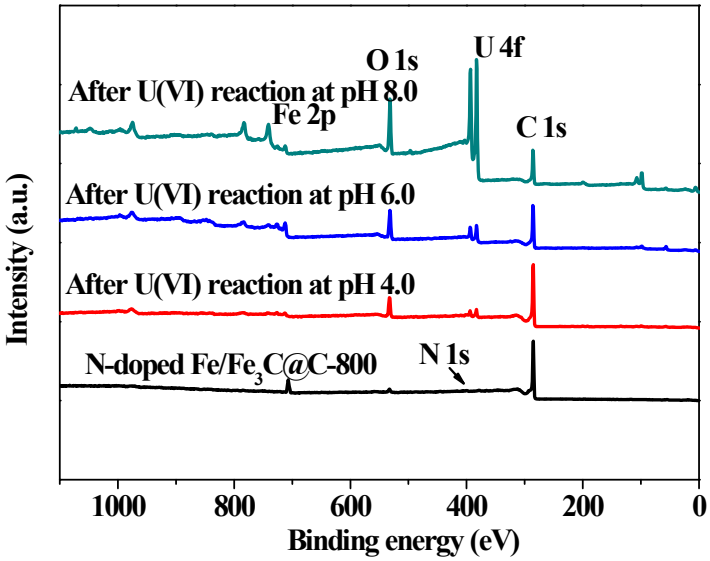

Fig. S7 XPS survey of N-doped Fe/Fe_3C@C-800 before and after U(VI) reaction at pH = 4.0, 6.0, and 8.0.

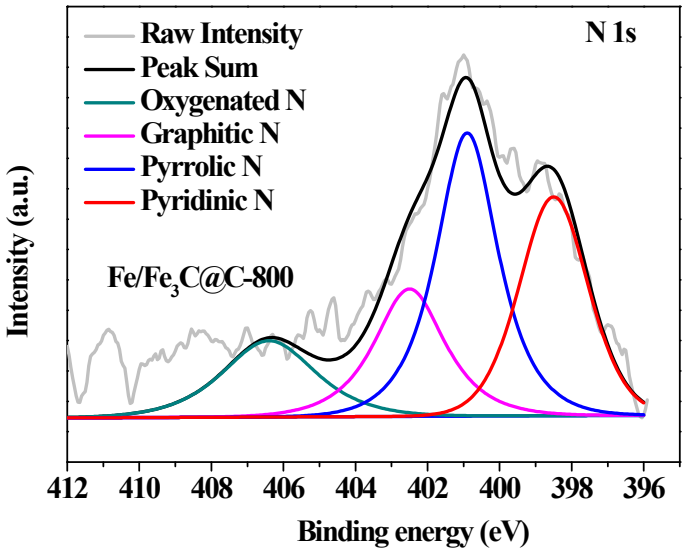

Fig. S8 High resolution N 1s XPS spectrum of N-doped Fe/Fe_3C@C-800.

References

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