Electronic Supplementary Information

Ethylenediamine-Modified Amyloid Fibrils of Hen Lysozyme with Stronger Adsorption Capacity as Rapid Nano-biosorbents for Removal of Chromium(VI) Ions

Wai-Hong Leung, Pui-Kin So, Wai-Ting Wong, Wai-Hung Lo and Pak-Ho Chan*

State Key Laboratory of Chirosciences, Department of Applied Biology and Chemical Technology, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, P. R. China

*Corresponding Author

E-mail: pakho999@yahoo.com.hk

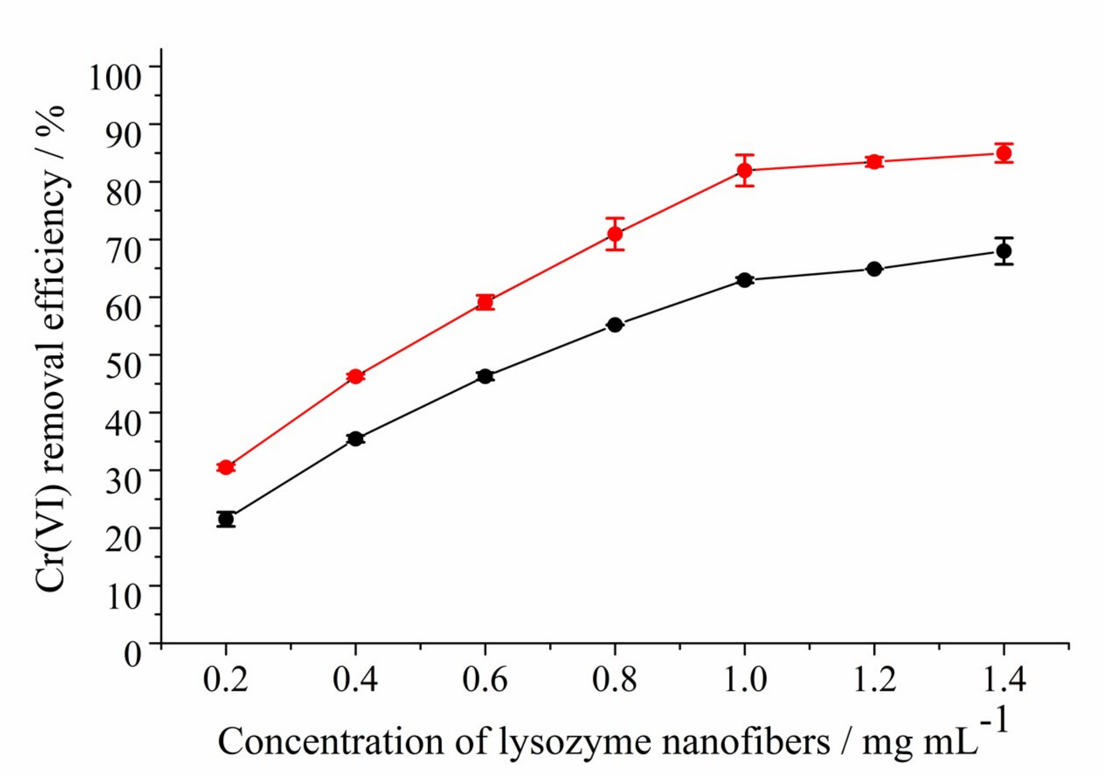

Fig. S1 Profiles of Cr(VI) removal efficiencies against different concentrations of ethylenediamine-modified lysozyme nanofibers and unmodified lysozyme nanofibers. Red curve: Cr(VI) adsorption by modified lysozyme nanofibers; black curve: Cr(VI) adsorption by unmodified lysozyme nanofibers. Initial Cr(VI) concentration = 3.0 mg L^{-1}; pH = 7.0. The concentration of Cr(VI) after adsorption was determined using acidified diphenylcarbazide (DPC) as the probing agent.

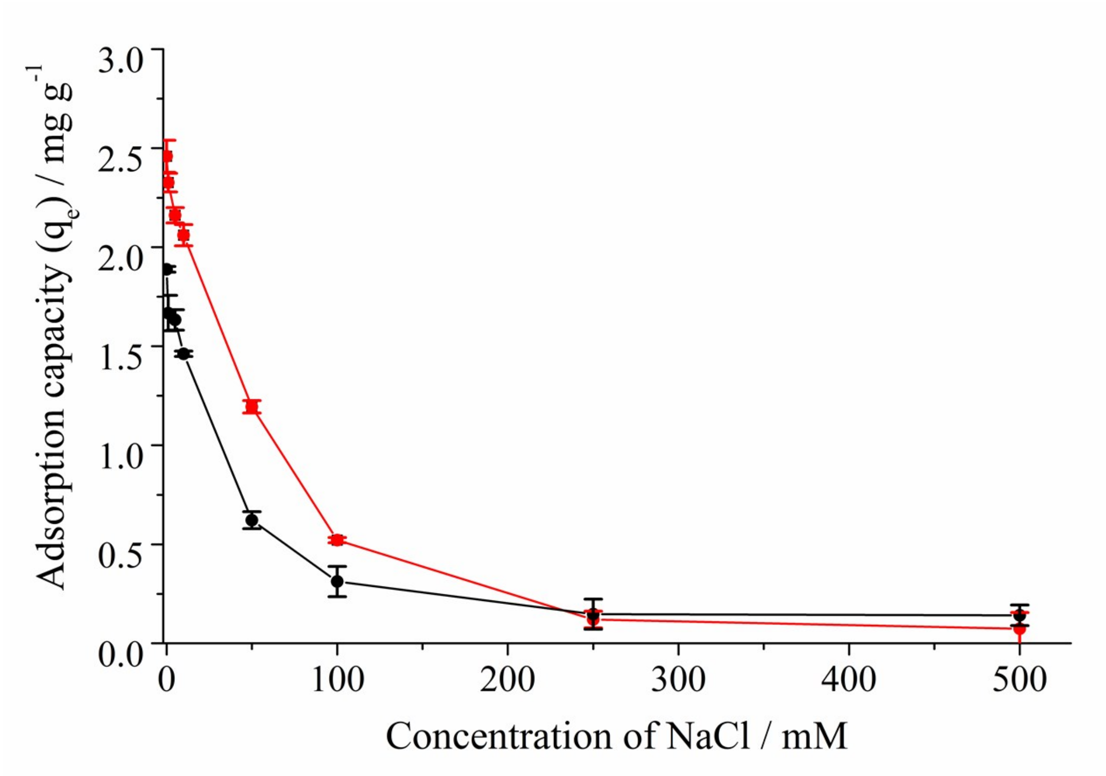

Fig. S2 Profiles of Cr(VI) adsorption capacities of ethylenediamine-modified lysozyme nanofibers and unmodified lysozyme nanofibers with and without NaCl. Red curve: Cr(VI) adsorption by modified lysozyme nanofibers; black curve: Cr(VI) adsorption by unmodified lysozyme nanofibers. The concentrations of Cr(VI) and lysozyme nanofibers (modified and unmodified forms) were 3.0 mg L^{-1} and 1.0 mg mL^{-1} (respectively); pH = 7.0.

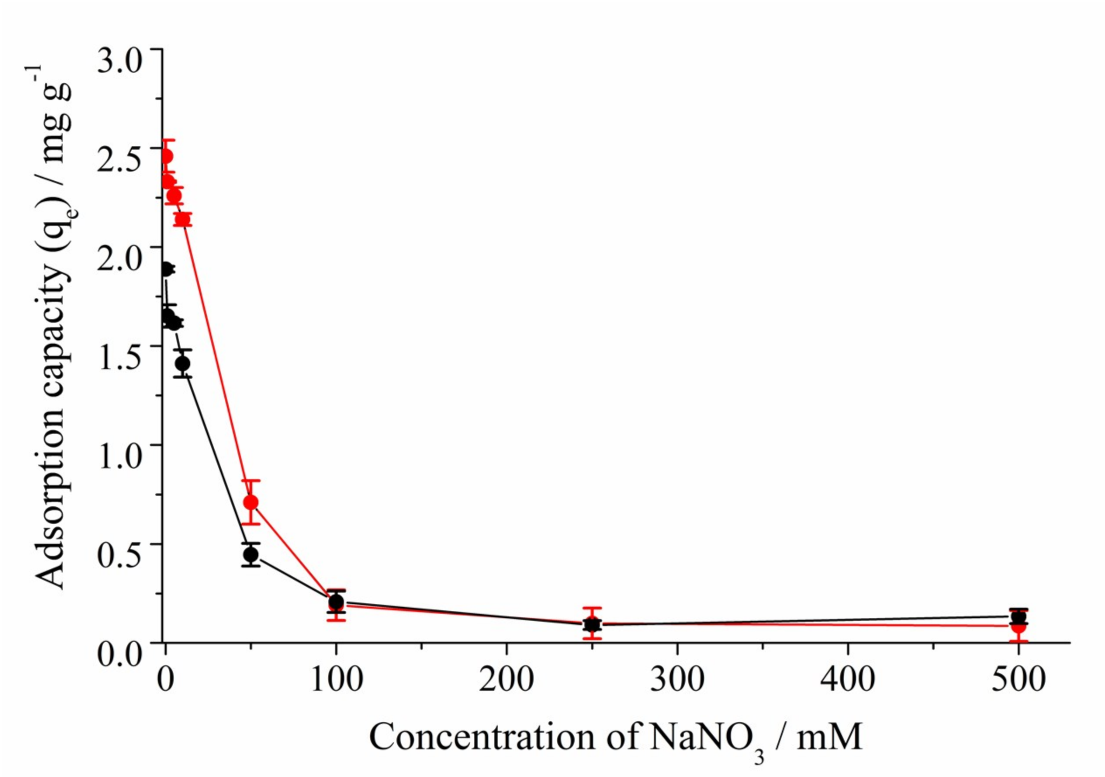

Fig. S3 Profiles of Cr(VI) adsorption capacities of ethylenediamine-modified lysozyme nanofibers and unmodified lysozyme nanofibers with and without $NaNO_3$. Red curve: Cr(VI) adsorption by modified lysozyme nanofibers; black curve: Cr(VI) adsorption by unmodified lysozyme nanofibers. The concentrations of Cr(VI) and lysozyme nanofibers (modified and unmodified forms) were 3.0 mg L^{-1} and 1.0 mg mL^{-1} (respectively); pH = 7.0.

Table S1 Physical parameters of previously reported biomasses for Cr(VI) adsorption

	Adsorption equilibrium time	**References**
Bacillus cereus (dead)	2 h	S. Sultan, K. Mubashar, M. Faisal, *African Journal of Microbiology Research*, 2012, 6, 3329-3336.
Inactivated fungal *Termitomyces clypeatus*	24 h	L. Ramrakhiani, R. Majumder, S. Khowala, *Chemical Engineering Journal*, 2011, 171, 1060-1068.
Bio-chars from pyrolysis of *P. terebinthus* L. and alumina	900 min	H. Deveci, Y. Kar, *Journal of Industrial and Engineering Chemistry*, 2013, 19, 190-196.
Acid treated macroalgae *Sargassum muticum*	5 h	M. Lopez-Garica, P. Lodeiro, R. Herrero, M. E. S. de Vicente, *Journal of Industrial and Engineering Chemistry*, 2012, 18, 1370-1376.
Beal fruit (*Aegle marmelos correa*) shell activated carbon	240 min	J. Anandkumar, B. Mandal, *Journal of Hazardous Materials*, 2009, 168, 633-640.
Silver impregnation groundnut husk	5 h	S. P. Dubey, K. Gopal, *Journal of Hazardous Materials*, 2007, 145, 465-470.
Sunflower stem	120 min	M. Jain, V. K. Garg, K. Kadirvelu, *Journal of Environmental Management*, 2010, 91, 949-957.
Autoclaved *Aspergillus flavus*	135 min	K. K. Deepa, M. Sathishkumar, A. R. Binupriya, G. S. Murugesan, K. Swaminathan, S. E. Yun, *Chemosphere*, 2006, 62, 833-840.

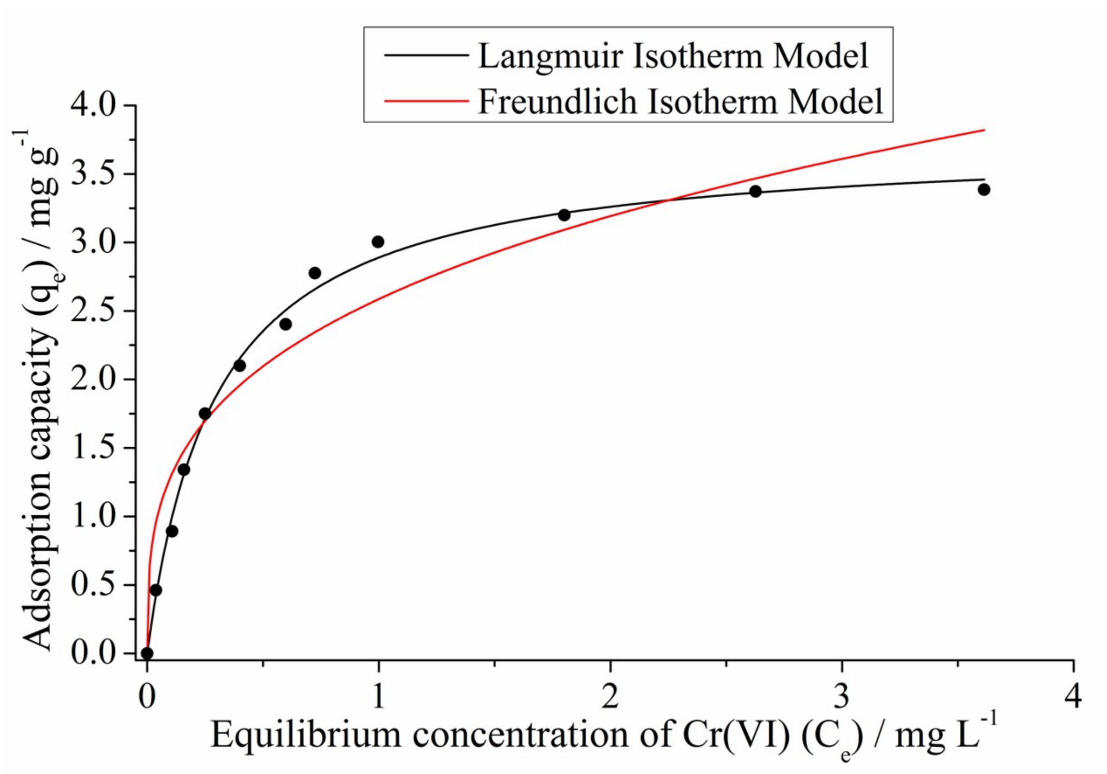

Fig. S4 Langmuir isotherm and Freundlich isotherm fittings for the adsorption of Cr(VI) by ethylenediamine-modified lysozyme nanofibers. Black curve: Langmuir isotherm model; red curve: Freundlich isotherm model. Concentration of modified lysozyme nanofibers = 1.0 mg mL^{-1}; pH = 7.0.

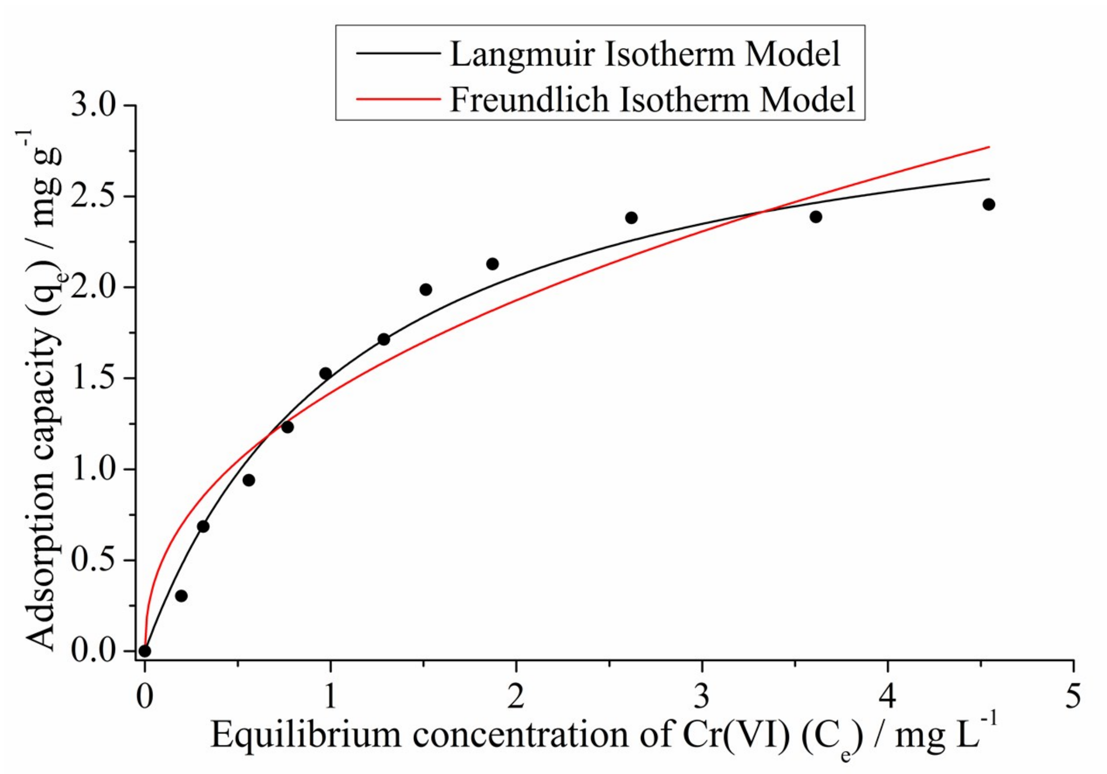

Fig. S5 Langmuir isotherm and Freundlich isotherm fittings for the adsorption of Cr(VI) by unmodified lysozyme nanofibers. Black curve: Langmuir isotherm model; red curve: Freundlich isotherm model. Concentration of unmodified lysozyme nanofibers = 1.0 mg mL^{-1}; pH = 7.0.

Table S2 Results of the Langmuir isotherm and Freundlich isotherm studies on the adsorption of Cr(VI) by ethylenediamine-modified lysozyme nanofibers and unmodified lysozyme nanofibers.

Ethylenediamine-modified lysozyme nanofibers

	Langmuir isotherm model		**Freundlich isotherm model**
q_{max} (mg g^{-1})	3.74	n	3.29
K_L (L mg^{-1})	3.39	K_F (mg g^{-1})(L mg^{-1})$^{1/n}$	2.59
R^2	0.9959	R^2	0.9289

Unmodified lysozyme nanofibers

	Langmuir isotherm model		**Freundlich isotherm model**
q_{max} (mg g^{-1})	3.26	n	2.26
K_L (L mg^{-1})	0.86	K_F (mg g^{-1})(L mg^{-1})$^{1/n}$	1.42
R^2	0.9843	R^2	0.9319

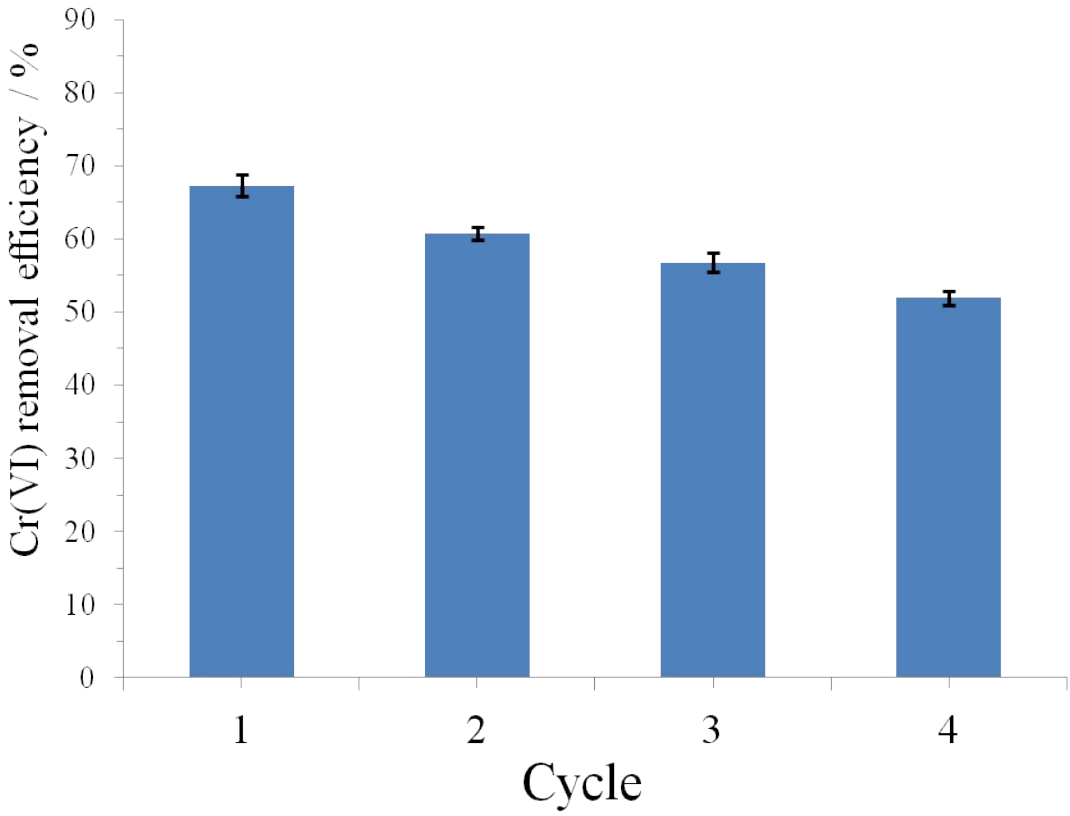

Fig. S6 Reusability study of ethylenediamine-modified lysozyme nanofibers in the removal of Cr(VI) ions. In each cycle, the modified lysozyme nanofibers underwent Cr(VI) adsorption and then Cr(VI) desorption using 500 mM NaCl (4.0 mL) and subsequently deionized water (4.0 mL) as the desorbing agent. The Cr(VI) removal efficiency of the modified lysozyme nanofibers was then determined after adsorbing Cr(VI) ions. The concentrations of Cr(VI) and modified lysozyme nanofibers were 3.0 mg L^{-1} and 1.0 mg mL^{-1} (respectively); pH = 7.0.

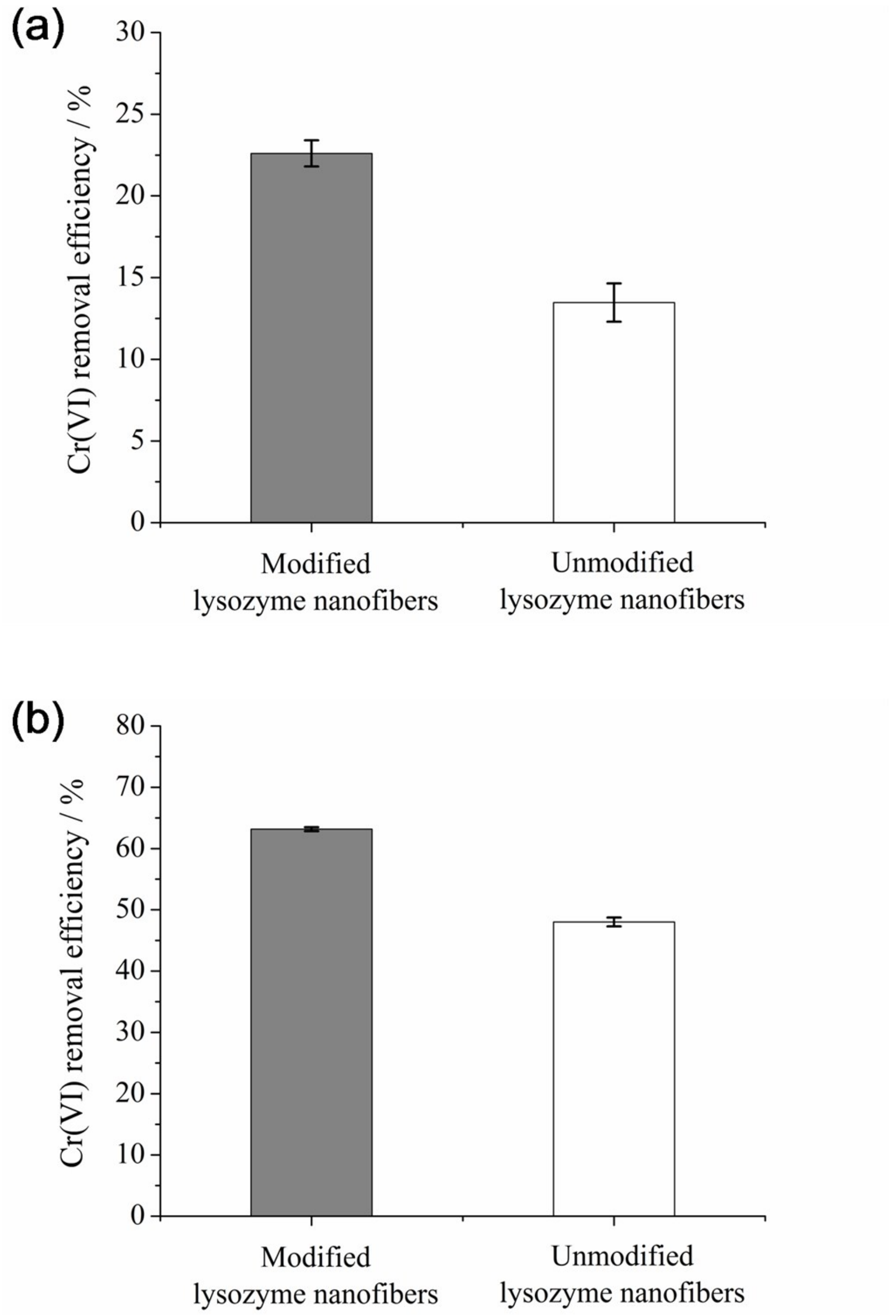

Fig. S7 Cr(VI) removal efficiencies of ethylenediamine-modified lysozyme nanofibers and unmodified lysozyme nanofibers in industrial wastewater and river water. **(a)** Cr(VI) removal efficiencies of modified and unmodified lysozyme nanofibers in industrial wastewater; **(b)** Cr(VI) removal efficiencies of modified and unmodified lysozyme nanofibers in river water. The concentrations of Cr(VI) and lysozyme nanofibers (modified and unmodified forms) were 3.0 mg L^{-1} and 1.0 mg mL^{-1}, respectively.