Supporting Information

$LaCO_3OH$ Embedded in Carbon Nanofiber Matrix Synchronously as Capturer of Phosphate and Organic Carbon for Starving Bacteria

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Experimental section

Digestion method

(1) Boil 0.01 g of products with 10 mL of aqua regia and 2 mL of $HClO_4$ at 120 ℃ until the products were dissolved; (2) After cooling, add 1mL $HClO_4$ into the solution, evaporate at 160 °C until the residual liquid volume was approximately 1 mL; (3) After cooling, dilute the solution with 2% HNO_3 (MOS grad) to 100 mL.

HA stock preparation and determination

HA stock solution was prepared by dissolving 1 g of HA solid in 500 mL of 0.1 M NaOH, followed by filtration with 0.45 μm glass fiber filters, and was stored at 4 ℃ for later use. The HA stock solution was diluted in gradient and the amounts of HA were measured by TOC analyzer (Multi N/C 2100, Analytik-Jena, Germany) and UV-vis spectrophotometer at the same time. The linear regressions between the values of UV254 absorbance at 254 nm and TOC (TOC-UV254) and between the TOC values and the corresponding multiplicative inverse of dilution ratios were done. And the equations of linear regression were obtained (TOC-1/dilution ratios). In the text, the target concentration solution (mg TOC/L) and the practical concentration (mg TOC/L) were acquired by the linear regression equations of TOC-1/dilution ratios and TOC-UV254, respectively. The results were shown in Figure S1.

Effect of of $LaCO_3OH$ content on the phosphate and HA capture capacity of LCNFs

1 g/L of LCNFs with different $LaCO_3OH$ content were put into 50 mg P/L phosphate solution and shaken. Aliquot of 1 mL solution was sampled at specified time intervals and filtered through a 0.45 μm membrane syringe filter. The filtrate for phosphate concentration

was analysed by Mo-Sb Anti-spectrophotometer method using UV-vis spectrophotometer (HACH, DR5000, America).

100 mg/L of LCNFs with different $LaCO_3OH$ content were used to remove 3 mg TOC/L of HA, respectively. The initial pH of the solutions was adjusted to ~7 with NaOH and HCl. The samples were taken out of the containers at given time internals. The concentrations of HA were determined by UV-vis spectrophotometer.

Figures:

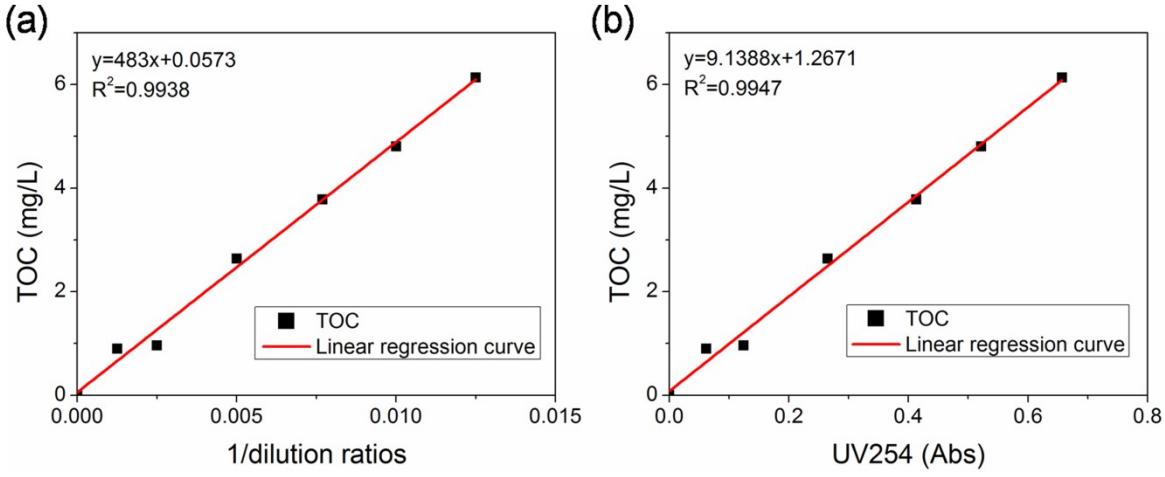

Figure S1. (a) Relationship between the TOC values and the corresponding multiplicative inverse of dilution ratios. (b) Relationship between the TOC values and the UV254 absorbance at 254 nm.

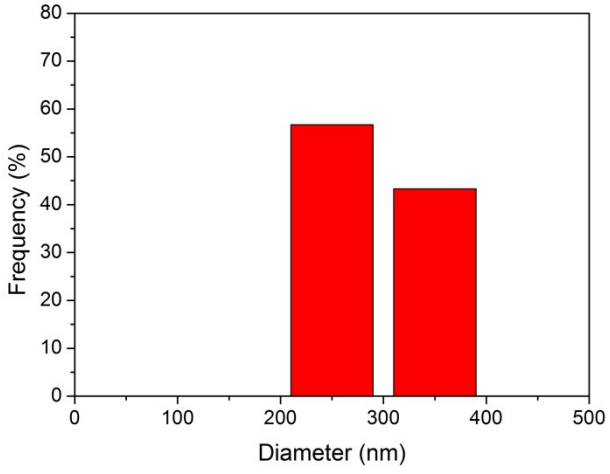

Figure S2. The diameter distribution of LCNFs.

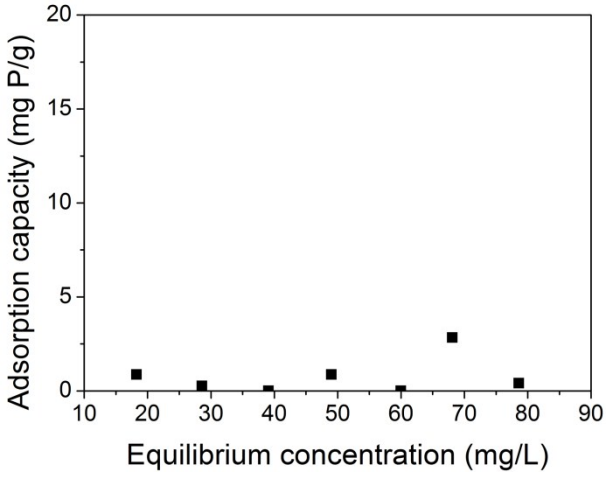

Figure S3. The adsorption isotherms of the phosphate on the LCNFs without *in situ* preparation process，the initial P concentrations and the dosage of LCNFs without *in situ* preparation process were 20~80 mg P/L and was 1 g/L, respectively, and the adsorption time was 24 h.

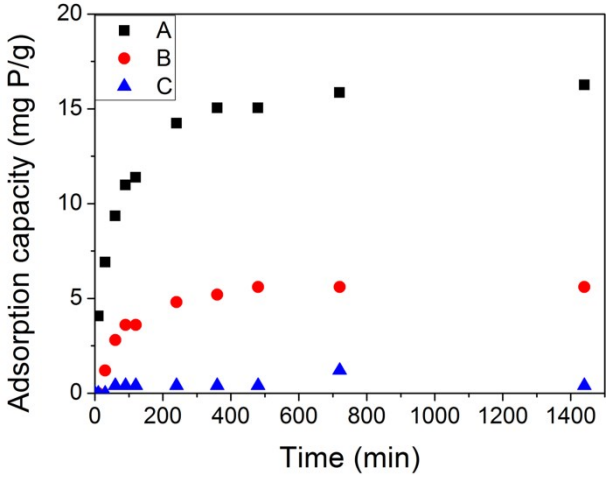

Figure S4. Effect of $LaCO_3OH$ content on the phosphate capture capacity of LCNFs, the initial mass ratios of $La(NO_3)_3 \cdot 6H_2O$ to PAN were (A) 1:3, (B) 1:6 and (C) 1:10, respectively. The initial phosphate concentration and the dosage of LCNFs were 50 mg P/L and 1 g/L, respectively.

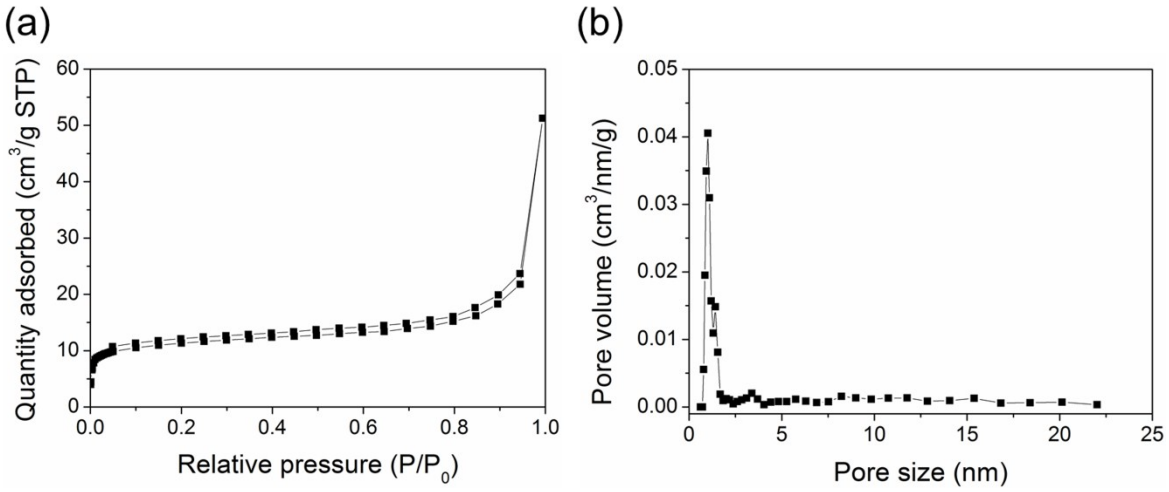

Figure S5. (a) N_2 adsorption–desorption isotherm of LCNFs. (b) Pore size distribution of LCNFs.

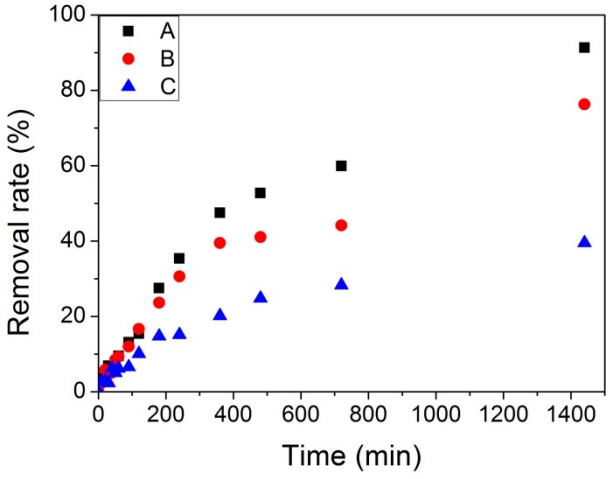

Figure S6. Effect of $LaCO_3OH$ content in LCNFs on the HA removal rate, the initial mass ratios of $La(NO_3)_3 \cdot 6H_2O$ to PAN were (A) 1:3, (B) 1:6 and (C) 1:10, respectively. The initial HA concentration and the dosage of LCNFs were 3 mg TOC/L and 100 mg/L, respectively.

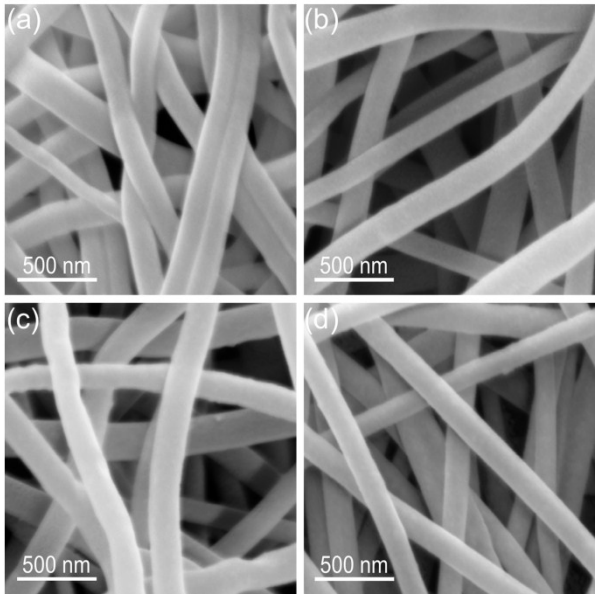

Figure S7. (a-d) are SEM images of LCNFs, CNFs, PLNFs and NFs, respectively.

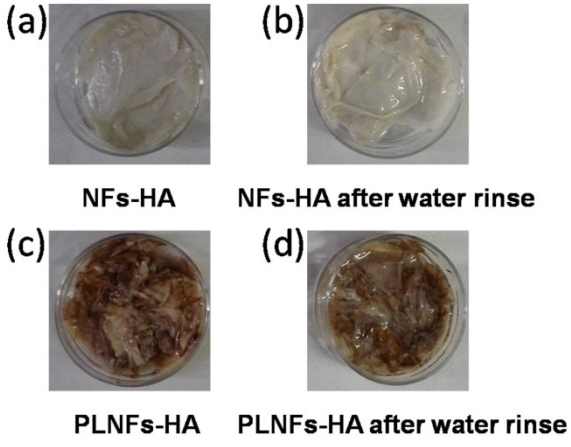

Figure S8. (a) and (c) are the digital pictures of NFs and PLNFs after adsorption of 3 mg TOC/L HA and abbreviated to NFs-HA and LNFs-HA, respectively. (a) and (c) are the digital pictures of NFs-HA and PLNFs-HA after adsorption water rinse for three times.

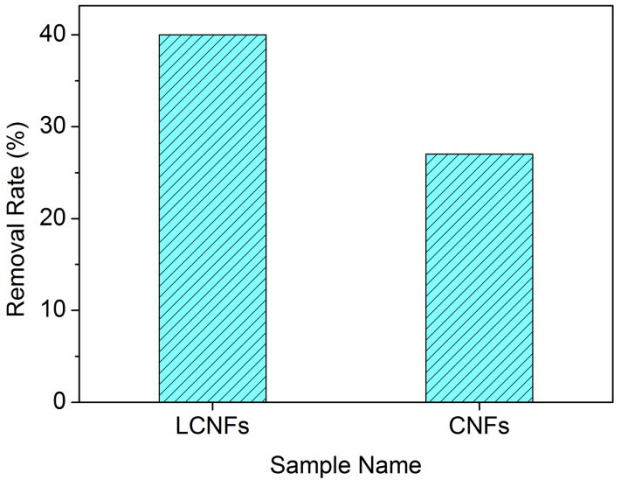

Figure S9. The removal rates of organic matters in tap water by LCNFs and CNFs, respectively. The dosages of LCNFs and CNFs were 0.2 g/L, and the tap water volume was 5 L. The experiments were carried out at 25℃.

Tables:

Table S1 Kinetic model parameters of phosphate adsorption by LCNFs.

Pseudo first-order kinetics			Pseudo second-order kinetics		
k_1 (1/min)	q_e (cal) (mg P/g)	R^2	k_2 (g•mg^{-1}min^{-1})	q_e (cal) (mg P/g)	R^2
0.016	15.22	0.963	0.001	16.62	0.986

Table S2 Equilibrium isotherm model parameters of phosphate adsorption by LCNFs at 25 ℃.

Langmuir			Freundlich		
q_m (mg P/g)	K_L (L/mg)	R^2	1/n	K_F (mg/g)	R^2
18.96	64.59	0.896	0.141	12.17	0.870

Table S3 Surface and pore parameters of CNFs and LCNFs.

	BET specific surface area (m^2/g)	Total pore volume (cc/g)	Micropore volume (cc/g)	Pore width (nm)
CNFs	27.1	0.016	0.011	1.096
LCNFs	41.8	0.034	0.013	1.007