Supporting Information for

“Sea Anemone”-like CeFe Oxides for High-efficient Phosphate Removal

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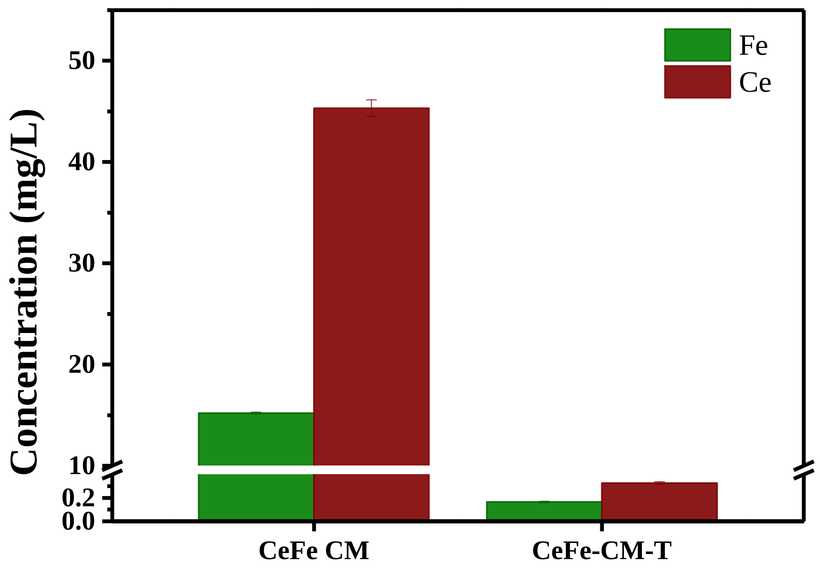

Figure S1. Ions releasing of the as-prepared CeFe based materials (CeFe-CM and CeFe-CM-T) at the same solid/aqueous rate with adsorption of 10 mg/60 mL.

Table S1. Langmuir and Freundlich model parameters

Samples	Langmuir			Freundlich		
	Q^0 (mg/g)	***b*** (L/mg)	***R^2***	***K_f***	***N***	***R^2***
CeFe-CM-T	16.99±0.83	2.90±1.10	0.73	10.39±0.28	0.16±0.01	0.97
CeO_2	3.99±0.15	25.32±7.47	0.82	2.88±0.14	0.14±0.02	0.83
Fe_3O_4	0.99±0.02	0.31±0.03	0.97	0.36±0.03	0.26±0.02	0.91

The Langmuir model: $Q = Q^o bC_e/(1+bC_e)$, The Freundlich model: $Q = K_f C_e^N$, Q is the amount sorbed per unit weight of sorbent, mg/g; C_e is the equilibrium concentration, mg/L; K_f [(mg/kg)/(mg/L)^N] is the Freundlich capacity coefficient, and N is isotherm curvature; Q^o (mg/g) is the adsorption capacity coefficient, and b (L/mg) is the adsorption rate coefficient; and n and R^2 are fitting parameter.

Table S2. Regression parameters of the three kinetic models

Samples	Pseudo-first-kinetic [1]			Pseudo-second-kinetic[2]			Elovich model [3]		
	q_e (mg g^{-1})	K_1 (h^{-1})	R^2	q_e (mg g^{-1})	K_2 (mg g^{-1} h^{-1})	R^2	α (mg g^{-1} h^{-1})	β (g mg^{-1})	R^2
CeFe-CM-T	14.03±0.36	$2.55\times10^{-2}\pm0.27\times10^{-2}$	0.96	15.18±0.28	$2.24\times10^{-3}\pm0.23\times10^{-3}$	0.99	1.81±0.62	0.42±0.04	0.92
CeO_2	3.65±0.08	0.11±0.01	0.75	3.82±0.06	$5.02\times10^{-2}\pm0.63\times10^{-2}$	0.89	37.54±25.06	2.75±0.24	0.85
Fe_3O_4	0.65±0.03	0.10±0.02	0.48	0.70±0.02	0.22±0.05	0.77	3.12±1.48	13.63±0.90	0.93

[1] The pseudo-first-order parameters (q_e and K_1) were calculated using the logarithmic form of the equation $q_t = q_e$ (1- e^(- $K_1 t$)), where q_t is the amount sorbed per unit weight of sorbent at t time, mg g^{-1}; t is the time, h; q_e (mg g^{-1}) is the adsorption capacity coefficient at equilibrium time, and K_1 (h^{-1}) is the rate constant; R^2 is the regression coefficient.

[2] The pseudo-second-order parameters (q_e and K_2) were calculated using the logarithmic form of the equation $q_t = K_2\, q_e{}^2 t/(1+ K_2\, q_e\, t)$, where q_t is the amount sorbed per unit weight of sorbent at t time, mg g^{-1}; t is the time, h; q_e (mg g^{-1}) is the adsorption capacity coefficient at equilibrium time, and K_2 (mg g^{-1} h^{-1}) is the rate constant; R^2 is the regression coefficient.

[3] The Elovich parameters (β and α) were calculated using the logarithmic form of the equation $q_t = (1/\beta)\ln(\beta\alpha) + (1/\beta)\ln(t)$, where q_t is the amount sorbed per unit weight of sorbent at t time, mg g^{-1}; t is the time, h; β (g mg^{-1}) is the desorption constant, and α (mg g^{-1} h^{-1}) is the initial adsorption rate. R^2 is the regression coefficient.

Table S3. Regression Parameters of the Weber-Morris model

Samples	K_{i1} (mg/(g min$^{0.5}$))	R^2	K_{i2} (mg/(g min$^{0.5}$))	R^2	K_{i3} (mg/(g min$^{0.5}$))	R^2
CeFe-CM-T	1.5194±0.0953	0.99	0.3719±0.0900	0.94	0.0251±0.0247	0.26
CeO_2	0.2853±0.0501	0.84	0.1067±0.0447	0.59	0.0146±0.0451	0.72
Fe_3O_4	0.0231±0.0034	0.92	0.0194±0.0019	0.96	0.0134±0.0019	0.82

Weber Morris model: $Q_t = k_i t^{0.5}+C$, Q_t is the amount sorbed per unit weight of sorbent at t time, mg/g; k_i is the diffusion rate constant during different stages, mg/g·min$^{0.5}$; t is the time, min; C is a constant and R^2 is the regression coefficient.

Table S4. Atomic rates of different states deconvoluted from O1s XPS spectrum of CeFe-CM-T before and after phosphate adsorption

Samples	**O_{latt} (%)**	**O_{surf} (%)**	**Adsorbed H_2O (%)**
CeFe-CM-T	77.40	19.13	3.47
CeFe-CM-T-P	44.66	34.58	20.77