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Extensive removal of thallium by graphene oxide functionalized with aza-crown ether

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Table.S1 Kinetic parameters of FGO for Tl(I) removal fitted by pseudo-first order and pseudo-second order models

Kinetic model	Parameters	Initial Tl concentration ($mg \cdot L^{-1}$)		
		10	100	200
Pseudo-first order model $Q_t = Q_e(1-e^{-k_1 t})$	Q_e ($mg \cdot g^{-1}$)	77.10	311.68	449.26
	K_1 (min^{-1})	9.12	6.05	11.09
	R^2	0.994	0.975	0.976
Pseudo-second order model $Q_t = \frac{k_2 q_e^2 t}{1+q_e k_2 t}$	Q_e ($mg \cdot g^{-1}$)	81.75	338.12	475.12
	K_2 ($g \cdot mg^{-1} \cdot min^{-1}$)	0.197	0.026	0.043
	R^2	0.988	0.997	0.984

Where Q_e and Q_t represent the adsorption capacity at equilibrium and at time t (min), respectively; k_1 and k_2 are the pseudo-first and pseudo-second order rate constants, respectively.

Table.S2 Fitting parameters of FGO for Tl(I) removal fitted by the intraparticle diffusion model.

Tl(I) initial concentration ($mg \cdot L^{-1}$)	K_{p1} ($mg \cdot g^{-1} \cdot min^{-1/2}$)	C ($mg \cdot L^{-1}$)	R^2	K_{p2} ($mg \cdot g^{-1} \cdot min^{-1/2}$)	C ($mg \cdot L^{-1}$)	R^2	K_{p3} ($mg \cdot g^{-1} \cdot min^{-1/2}$)	C ($mg \cdot L^{-1}$)	R^2
10	147.04	0.68	0.99	26.67	54.56	0.83	1.659	75.678	0.98
100	514.27	3.262	0.988	199.09	127.38	0.88	20.103	290.297	0.84

200	1011.074	7.184	0.96	93.816	358.76	0.69	71.389	353.51	0.99

K_{p1}, K_{p2}, K_{p3}($mg \cdot g^{-1} \cdot min^{-1/2}$) are the intraparticle diffusion rate coefficient.

Table.S3 The Langmuir, Freundlich and Temkin isotherm parameters for Tl(I) removal by the FGO process.

Langmuir model $Q_e = (\frac{Q_m K_L C_e}{1 + K_L C_e})$			Freundlich model $Q_e = K_F C_e^{1/n}$			Temkin model $Q_e = (\frac{RT}{b}) \log(K_T C_e)$		
Q_{max} ($mg \cdot g^{-1}$)	K_L ($L \cdot mg^{-1}$)	R^2	K_F ($L \cdot mg^{-1}$)	n	R^2	K_T ($L \cdot mg^{-1}$)	b ($Kj \cdot mol^{-1}$)	R^2
2368.59	0.0015	0.991	17.653	1.53	0.990	0.073	0.0094	0.88

Where Q_e and Q_m represent the equilibrium and maximum adsorption capacity, respectively; C_e refers to the equilibrium concentration of sorbate; K_L is the Langmuir coefficient; K_F is the Freundlich indicator of the adsorption capacity; n is the dimensionless heterogeneity factor; K_T is the Temkin isotherm constant and b is the Temkin constant related to the heat of adsorption; R (8.314×10^{-3} $kJ \cdot mol^{-1} \cdot K^{-1}$) denotes as the universal gas constant, and T is the absolute temperature in Kelvin.