Electronic Supplementary Information (ESI)

Adsorption of Hg^{2+} by thiol functionalized hollow mesoporous silica microspheres with magnetic cores

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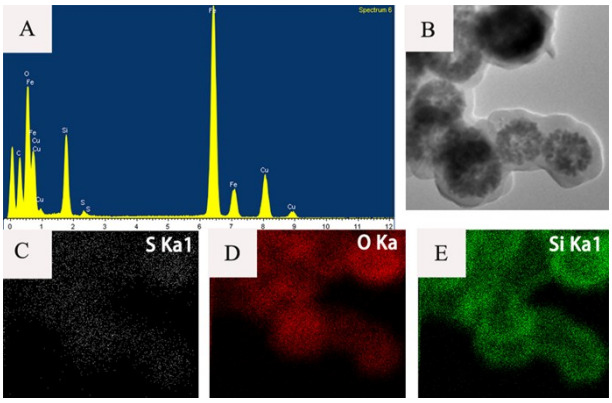

Fig. S1 (a) EDS spectrum of the SH-HMSMCs, (b) TEM image of the SH-HMSMCs, (c-e) The elemental mapping of the SH-HMSMCs from the HRTEM images, based on the S K_{a1}, O K_a and Si K_{a1}.

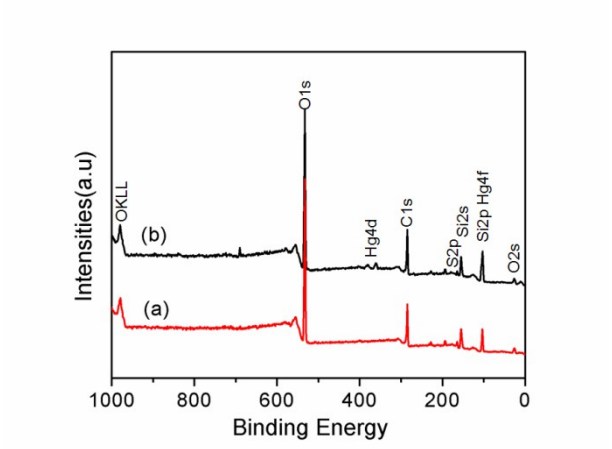

Fig. S2 The full-range XPS spectra of SH-HMSMCs for Hg^{2+} (a) before and (b) after adsorption.

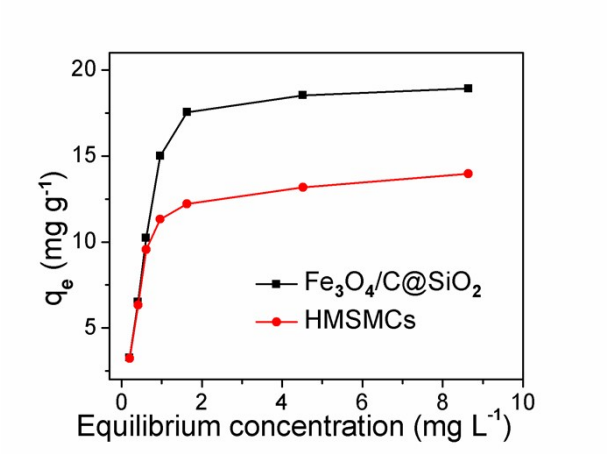

Fig. S3 Adsorption isotherms of Hg^{2+} on the HMSMCs and Fe_3O_4/C@SiO_2。

Table S1 N_2 sorption-derived textural properties of the prepared Fe_3O_4/C@SiO_2, HMSMCs, SH-HMSMCs.

Sample	BET surface area (m^2 g^{-1})	Pore volume (cm^3 g^{-1})	Pore diameter (nm)
Fe_3O_4/C@SiO_2	102.76	0.33	1.70
HMSMCs	420.66	1.11	2.15
SH-HMSMCs	380.75	0.95	1.91

Table S2 The pseudo-second-order rates constant of adsorption kinetics of SH-HMSMCs in aqueous solution of Hg^{2+} at room temperature.

Initial concentration	K_{ad} (g mg^{-1} min^{-1})	R^2
1 mg L^{-1}	3.6×10^{-3}	0.998
6 mg L^{-1}	5.6×10^{-3}	0.999

Table S3 Adsorption capacity of SH-HMSMCs for Hg^{2+}, Pb^{2+}, Cu^{2+}, Zn^{2+} calculated from the data of Table 1.

	Hg^{2+}	Pb^{2+}	Zn^{2+}	Cu^{2+}
adsorption capacity (mmol g^{-1})	0.0848	0.010	0	0.031

Table S4 Elution rate of SH-HMSMCs saturated with adsorbed Pb^{2+} or Cu^{2+} in a solution with or without Hg^{2+}, 50 mg adsorbent saturated Cu^{2+} (Pb^{2+}) was added to 100 ml Hg^{2+} (10 mg L^{-1}) and aqueous solution at room temperature with agitation. The metal concentrations in solution were analyzed by ICP.

	Water solution (PH=6)		Hg^{2+} (10 mg L^{-1}) solution (PH=6)	
	Pb^{2+}	Cu^{2+}	Pb^{2+}	Cu^{2+}
Elution rate	1.2%	1.8%	23.7%	19.5%
Hg^{2+} adsorption capacity	--	--	125.3 mg g^{-1}	119.5 mg g^{-1}

Table S5 The concentrations of metal ions in solutions before and after treated with SH-HMSMCs samples analyzed by ICP-MS. 20 ml single kind of heavy metal ion solution was mixed with 5 mg adsorbent at room temperature with agitation for 12 h.

	Hg^{2+} (μg L^{-1})		Pb^{2+} (μg L^{-1})		Zn^{2+} (μg L^{-1})		Cu^{2+} (μg L^{-1})	
Original solution	500.50	49.41	596.9	61.20	898.40	65.50	700.80	70.80
SH-HMSMCs	0.53	0.56	10.87	3.19	724.09	33.9	68.63	11.66

Table S6 Langmuir and Freundlich isotherms parameters for Hg^{2+} adsorption.

adsorbent	Langmuir model			Freundlich model		
	Q (mg g^{-1})	B (L mg^{-1})	R^2	K_F	n	R^2
SH-HMSMCs-A	118.6	4.90	0.98	1.80	3.28	0.94
SH-HMSMCs-B	110.1	4.96	0.99	1.77	3.50	0.93
SH-HMSMCs	101.5	5.63	0.98	1.75	3.67	0.92
SH-Fe_3O_4/C@SiO_2	62.8	4.40	0.99	1.45	3.45	0.95

Table S7 Comparison the self-made adsorbent with some research results of other researchers that treat Hg^{2+}

Adsorbents	Q_m (mg g^{-1})	Lowest equilibrium concentration	Ref.
Microporous and layered titanosilicates	--	2 μg L^{-1}	[41]
Multifunctional mesoporous material	21.05	50 μg L^{-1}	[42]
Fe_3O_4@C Nanoparticles Modified with -SO_3H and -COOH	83.1	--	[43]
Naphthalimide-functionalized magnetic nanosensor	5.6	--	[44]
Self-made SH-HMSMCs	118.6	0.53 μg L^{-1}	This work