Electronic Supporting Information (ESI)

Selective and ppb Level Removal of Hg(II) from Water: Synergistic Role of Graphene Oxide and SnS_2

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Table S1: Elemental identification and quantification by EDAX spectra analysis.

GO@SnS_2			**Hg-GO@SnS_2**		
Element	Wt %	At %	Element	Wt %	At %
C	10.92	21.40	C	23.98	55.37
O	41.49	61.03	O	11.48	19.90
Sn	15.19	11.15	Sn	38.2	8.93
S	32.39	6.42	S	16.74	14.48
Hg	0	0	Hg	9.61	1.33
Total	100	100	Total	100	100

Table S2: Nitrogen adsorption and desorption results.

Material	**Surface Area (m^2/g)**	**Pore volume (cc/g)**	**Pore diameter (nm)**
GO	174.02	0.115	3.1
GO@SnS_2	19.54	0.046	3.9
Hg-GO@SnS_2	11.75	0.037	3.4

Table S3: Summary of the removal of $Hg^{(II)}$ using GO@SnS_2 composite.

Initial concentration (ppm)	Final concentration (ppm)	% Removed	q (mg/g)	K_d (mL/g)
3.42	2.61	23.6	0.8	3.08×10^2
6.81	2.61	61.7	4.2	1.61×10^3
9.59	2.45	74.5	7.1	2.92×10^3
14.27	2.54	82.2	11.7	4.62×10^3
17.67	3.60	79.6	14.1	3.91×10^3
27.41	1.57	94.3	25.8	1.64×10^4
78.44	4.38	94.4	74.1	1.69×10^4
132.39	11.31	91.5	121.1	1.07×10^4
190.17	16.95	91.1	173.2	1.02×10^4
296.32	46.08	84.5	250.2	5.43×10^3
449.84	144.17	67.9	305.7	2.12×10^3
844.43	521.40	38.2	323.0	6.20×10^2
912.51	585.60	35.8	326.9	5.58×10^2
1043.34	715.20	31.4	328.1	4.59×10^2
1789.79	1460.00	18.4	329.8	2.26×10^2
2080.00	1745.00	16.1	335.0	1.92×10^2

Table S4. Sn^{2+} leaching study at different time for SnS_2 and GO@SnS_2 during Hg removal.

Time (min)	Sn Leaching in mmole/L	
	SnS_2	GO@SnS_2
5	4.6×10^{-3}	7.6×10^{-5}
50	8.5×10^{-3}	12.7×10^{-5}
200	8.8×10^{-3}	27.9×10^{-5}

Table S5. Selected data for adsorption studies in different pH.

pH	Initial concentration (ppm)	Final concentration (ppm)	% Removed	q (mg/g)	K_d (mL/g)
0.46	89.43	3.52	96.1	85.1	2.42 X 10^4
1.04	85.04	3.038	96.4	81.2	2.67 X 10^4
2.38	70.23	1.217	98.3	68.3	5.61 X 10^4
2.7	80.64	1.545	98.1	79.1	5.12 X 10^4
3.82	84.76	2.176	97.4	83.4	3.83 X 10^4
5.05	91.78	1.195	98.7	88.8	7.43 X 10^4
6.6	85.37	3.937	95.4	79.8	2.03 X 10^4
7.3	87.18	3.24	96.3	83.9	2.59 X 10^4
8.6	93.02	0.01	96.8	89.1	2.98 X 10^4
10.06	92.57	1.114	98.8	89.7	8.05 X 10^4
11.24	104.4	30.71	70.6	72.2	2.35 X 10^3
12.41	95.5	35.59	62.7	59.3	1.67 X 10^3
13.96	161.9	62.84	61.2	99.1	1.58 X 10^3

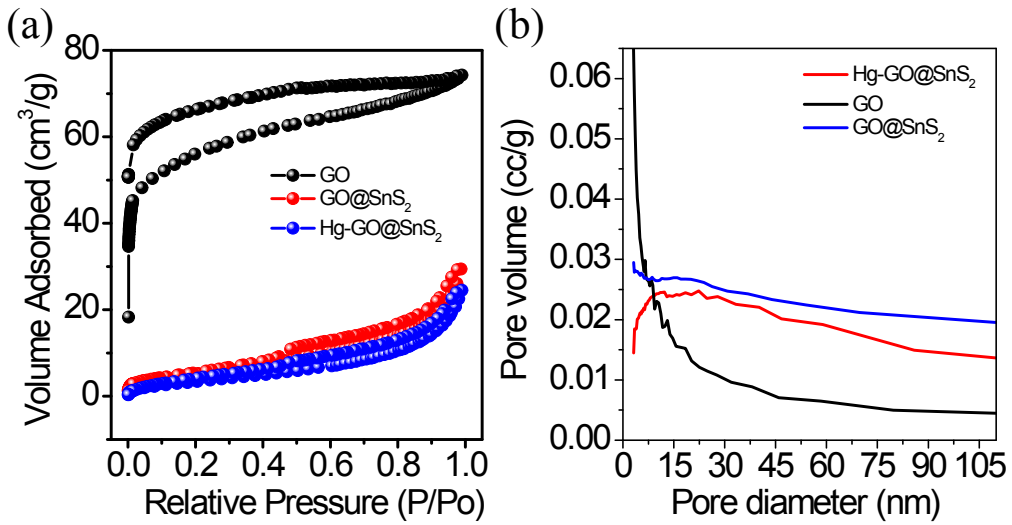

Fig. S1 (a) N_2 adsorption and desorption isotherms at 77 K and (b) pore width distribution of GO, GO@SnS_2 and Hg adsorbed GO@SnS_2.

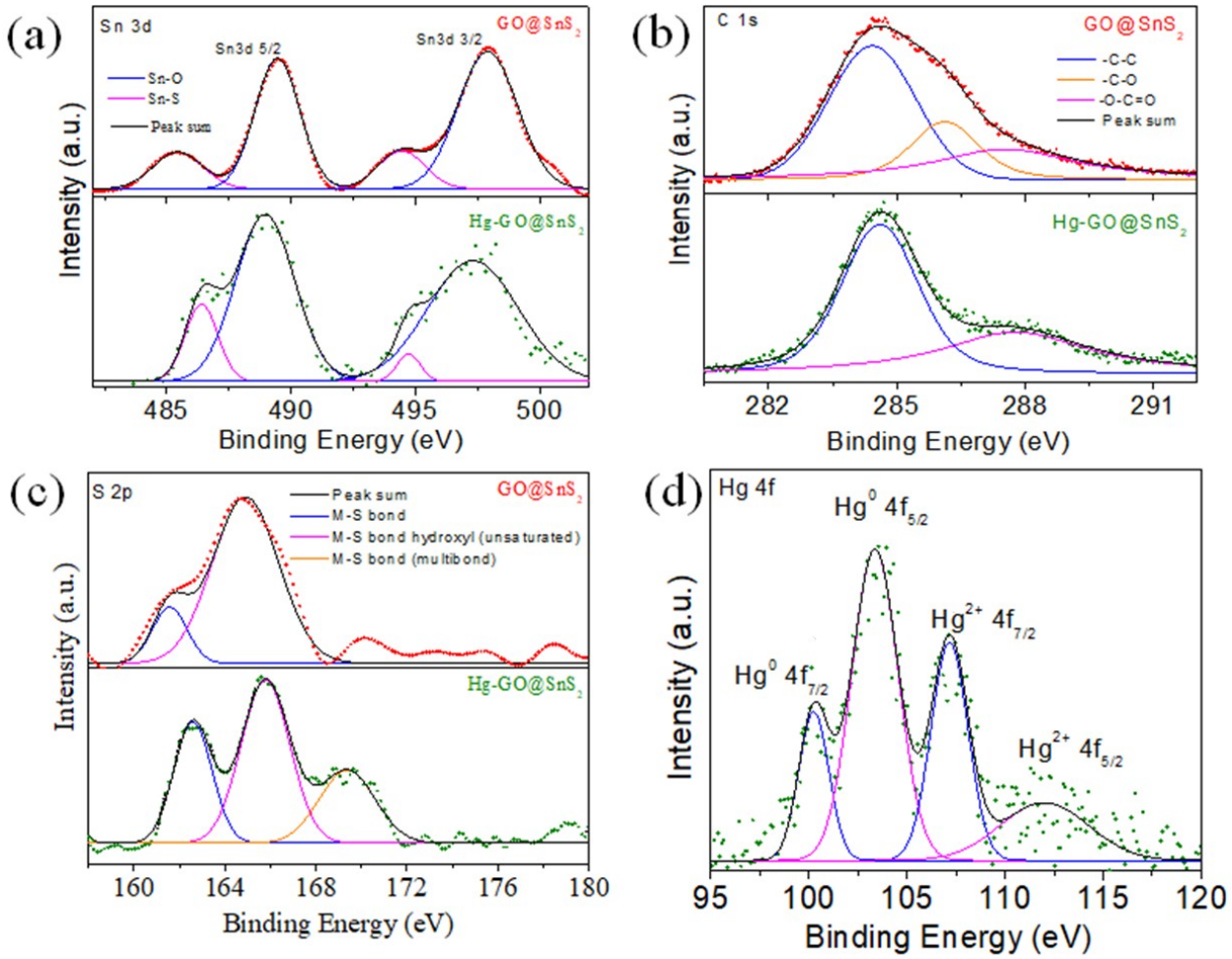

Fig. S2 XPS spectra of (a)Sn 3d , (b) C 1s, (c) S 2p of GO@SnS_2 and Hg-GO@SnS_2; and (d) Hg 4f of Hg-GO@SnS_2.

Sn $3d_{5/2}$ (and Sn $3d_{3/2}$) were de-convoluted to two peaks which can be attributed to the tin in the Sn(IV)-S and Sn(IV)-O at ~ 485.38 eV and 489.48 eV in case of GO@SnS_2, which further confirms binding of SnS_2 with GO through Sn-O type bond.[1] After adsorption of Hg, the Sn-O binding energy slightly decreases to 488.96 eV and Sn-S binding energy increases to 486.37 eV in case of Hg-GO@SnS_2, indicating Hg is binding to mainly S. We also observed that -C-O binding modes disappears in Hg-GO@SnS_2 (Fig S2b) due to -C-O-Hg binding. There is appearance of new M-S type bonds in S 2p XPS spectra, arising due to sorption of Hg. Fig S2 (d) spectra shows the two features at 106.0 eV and 110.0 eV can be assigned to Hg $4f_{7/2}$ and Hg $4f_{5/2}$, respectively of the Hg^{2+} bound to GO@SnS_2 and Δ eV is ~ 4eV. The remaining two features at 100.01 eV and 103.5 eV are due to the presence of Hg^0.[2] Both Hg^0 and Hg^{2+} are adsorbed on GO@SnS_2.

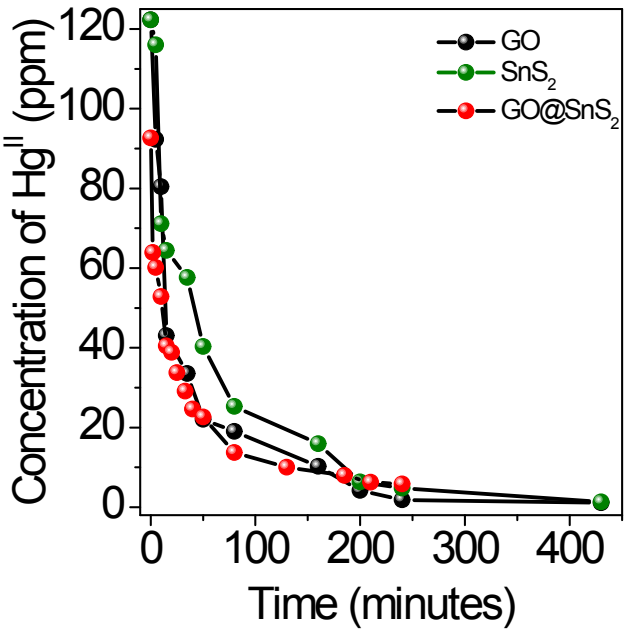

Fig. S3 Comparison of uptake of Hg with time by GO, SnS_2 and GO@SnS_2.

References:

1 P. V. Prikhodchenko, D. Y. W. Yu, S. K. Batabyal, V. Uvarov, J. Gun, S. Sladkevich, A. A. Mikhaylov, A. G. Medvedev and O. Lev, *J. Mater. Chem. A*, 2014, **2**, 8431-8437.

2 S. Barman and M. Sadhukhan, *J. Mater. Chem.*, 2012, **22**, 21832-21837.