Supporting Information

Preparation and characterization of exfoliated graphene oxide-L-cystine as an effective adsorbent of Hg(II) adsorption

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Materials

The starting material, graphite used in the preparation of GO was procured from Sigma Aldrich. A stock solution of 1000 mg L^{-1} Hg(II) solution was prepared using A. R. grade mercuric chloride and a working solution of 10 mg L^{-1} for batch adsorption was prepared by appropriate dilution with Milli Q water, L-cystine was purchased from Fluka. The other required reagents were procured from Merck chemicals respectively.

Instruments and characterizations

Raman spectra were recorded on a WITec Confocal Raman Microscope Alpha 300R using a 532 nm He-Ne laser with 5 mW. Cross Polarization Magic Angle Spinning Nuclear Magnetic Resonance (^{13}CPMAS-NMR) was analyzed Varian Innova Unity 500 MHz Solid State NMR Spectrometer by superconducting magnet 11.4 Tesla (Proton operating frequency : 500MHz). A Perkin Elmer Fourier Transform Infrared Spectroscopy (FT-IR) spectrum100 spectrometer was used to characterize the material functional groups identifications in the range $400-4000$ cm^{-1} by mixing 0.01g of the material with 0.1g KBr (spectroscopy grade). Kratos Axis Ultra X-ray Photoelectron

Spectroscopy (XPS) instruments were used to record samples, X-Ray Sources: 500 mm Rowland Circle Monochromator Al Mg/Al achromatic Source 450W max power. The spectra were recorded using a monochromatic Al Kα X-ray source (15 mA, 14 KV). The pressure in the analyzer chamber was 1×10^{-8} Torr. The conditions applied for the survey scans includes an energy range 0-1200 eV and the survey spectra were collected at pass energy of 160 eV and a step size of 0.7 eV. High resolution spectra were collected using 40 eV pass energy, spot size of 300 x 700 µm slot and 0.05 eV step size. Ultraviolet visible spectroscopy (UV−visible) was taken out by the use Jasco V-630 UV−visible spectrometer (Jasco, Japan). X-ray diffraction (Pwder-XRD) was carried out on a D8 Discover X-ray diffractometer with Cu Ka radiation (k = 0.1541 nm, Bruker, Germany) was utilized to record the characteristic changes in the diffraction pattern of the adsorbent material. A JEOL JSM-6330TF analyzer were used to observe the morphological changes scanning electron microscope(SEM) were recorded and the energy dispersive X-ray analysis spectrum (EDX) was recorded adsorbent and after the adsorption of Hg(II). The concentration of mercury in the aqueous solution was measured using inductively coupled plasma mass spectrometry (ICP-MS) Perkin-Elmer, Sciex- Elan DRC Plus, Sotware which we used Elan-6100 DRC PLUS respectively. The pH adjustments of the aqueous solutions were done using METTLER TOLEDO pH meter S20.
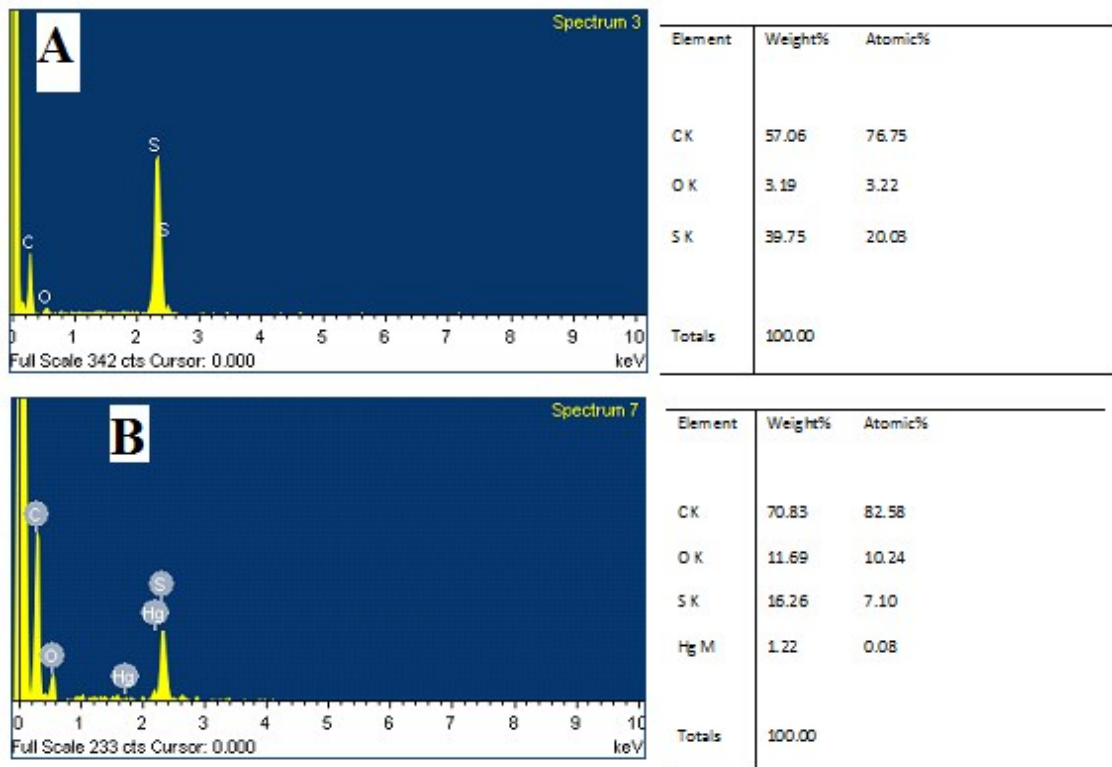
Fig. S1. EDX spectrum of the A) L-cystine functionalized- EGO adsorbent (B) after adsorption of Hg(II) onto the adsorbent.
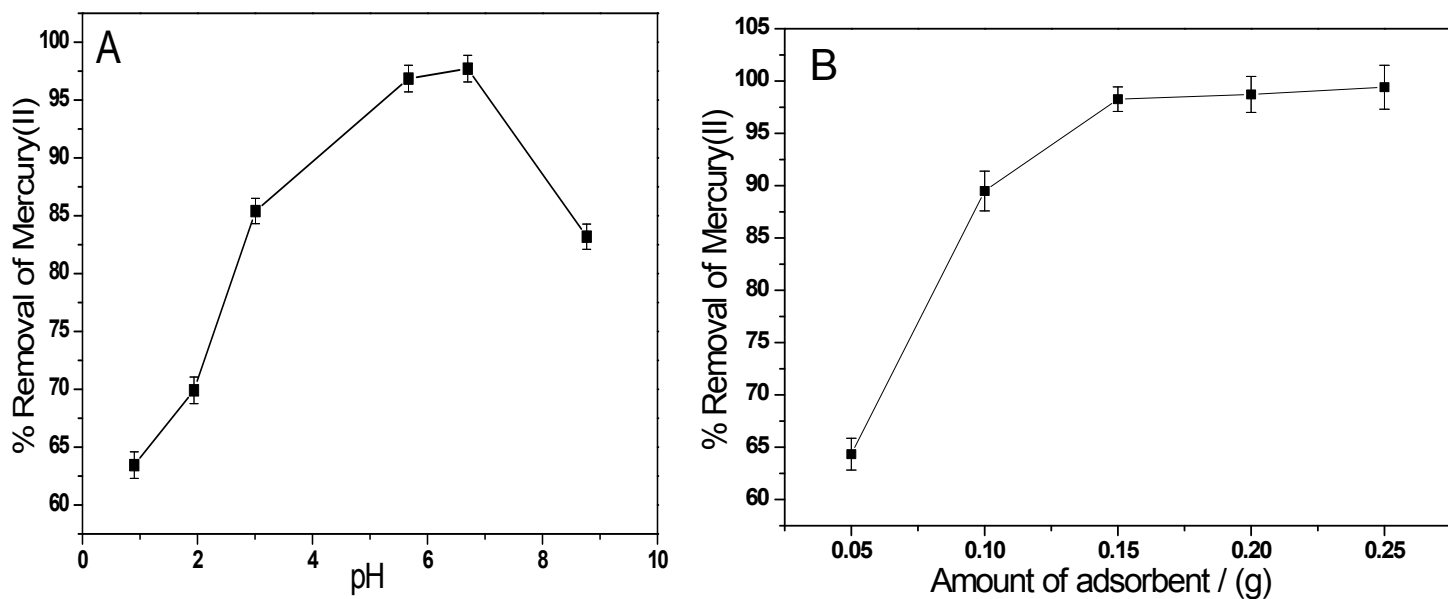

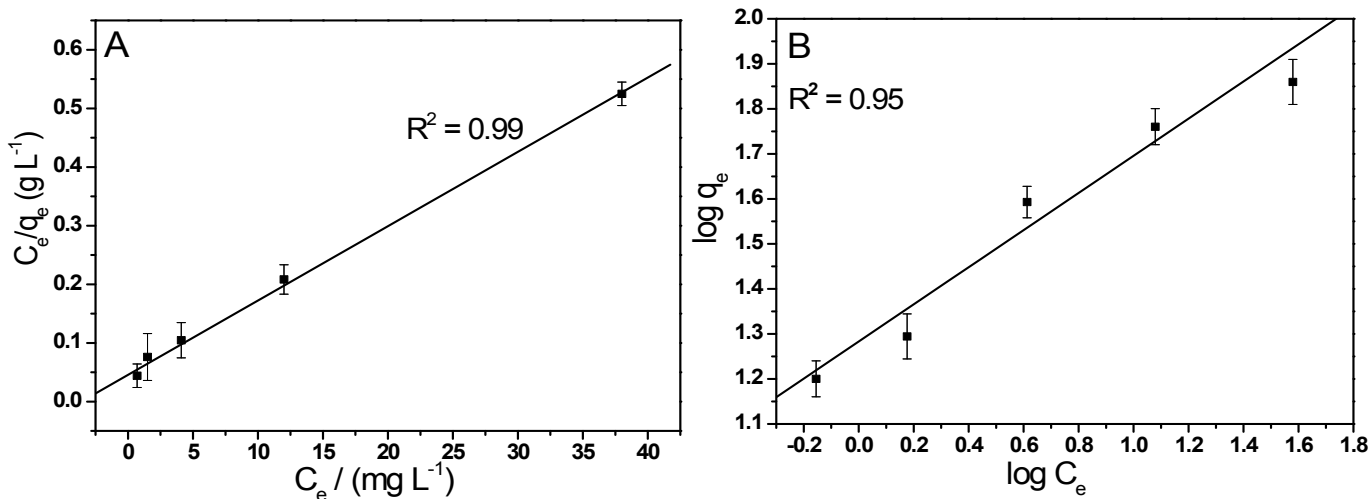**Fig. S2A.** Effect of pH.   B) Amount of adsorbent

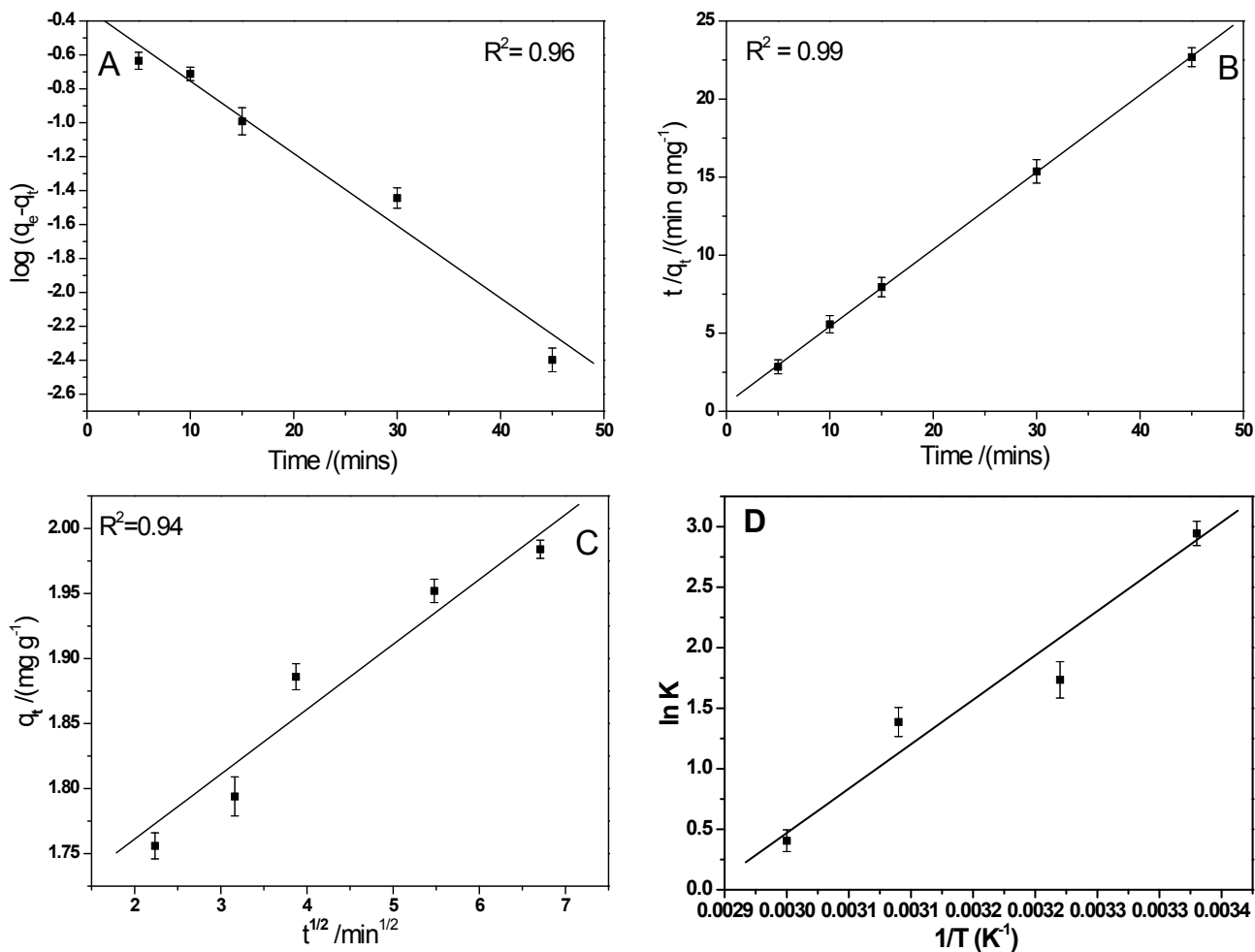**Fig. S3.** A) Langmuir isotherm   B) Freundlich isotherm.

Fig. S4. Effect of (A) Pseudo first order kinetics (B) Pseudo second order kinetics

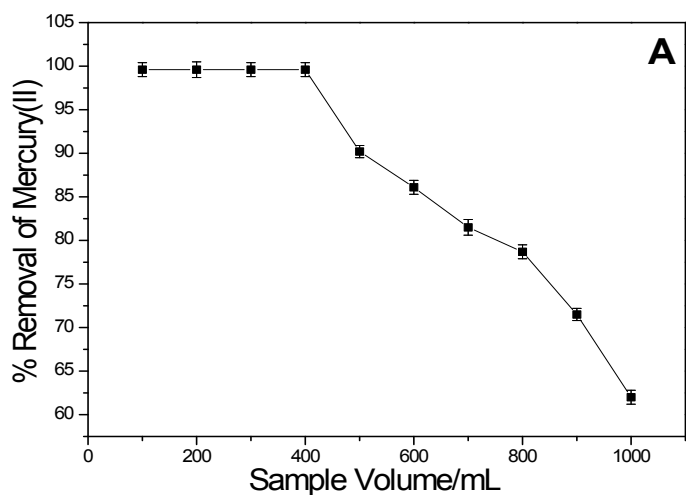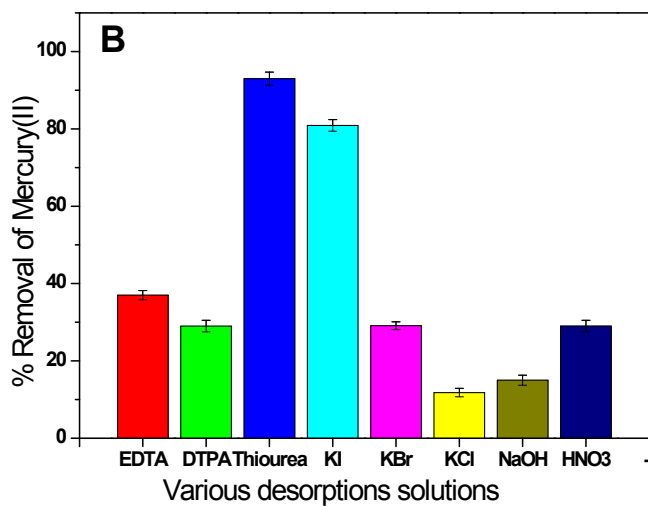(C) Variation of q_t against $t^{1/2}$ (Weber-Morris) plot (D) Van't Hoff Plot.

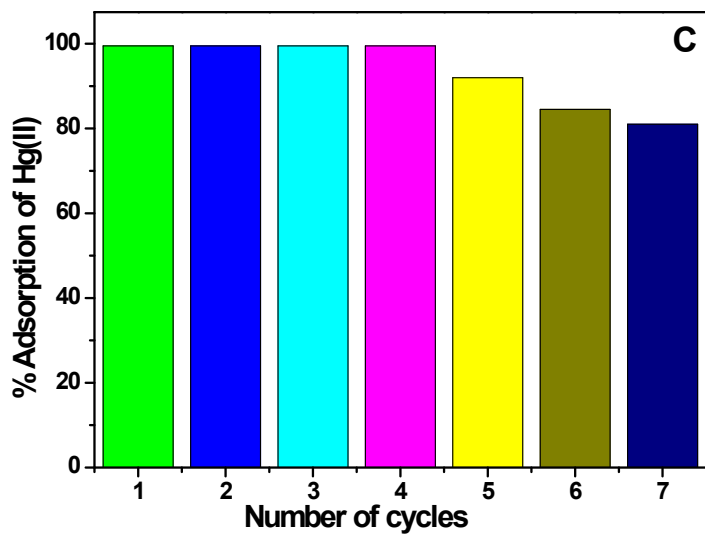**Fig. S5A** Effect of sample volume   **B)** Effect of desorption studies.

Fig. S5C Adsorbent regeneration cycles

Table T1 Operating conditions of ICP-MS analysis

SI.No	ICP-MS plasma	Parameters
1	RF power	1300 W
2	Plasma gas (Ar) flow rate	15 L min^{-1}
3	Auxiliary gas (Ar) flow rate	1.325 L min^{-1}
4	Carrier gas (Ar) flow rate	0.97 L min^{-1}
5	Sampler/skimmer diameter orifice	Nickel 1.0 mm/0.4 mm
6	Data acquisition scanning mode	Peak-hopping
7	Dwell time	50 ms
8	Points per spectral peak	1
9	Isotopes	^{202} Hg
10	Integration mode	Peak area

Table T2. R_L values and type of equilibrium isotherms

Sl.No	R_L value	Nature of equilibrium isotherm
1	$R_L > 1$	Unfavorable
2	$R_L = 1$	Linear
3	$0 < R_L < 1$	Favorable
4	$R_L > 0$	Irreversible

Table T3 Isotherm parameters acquired from various models

Sl. No	Isotherm	Characteristic values	
1	Langmuir	q_o (mg g^{-1})	79.36
		b (L mg^{-1})	0.27
		R_L	0.034
		r^2	0.99
2	Freundlich	K_F (mg $^{1-1/n}$ g^{-1} L$^{1/n}$)	19.1
		n	2.42
		r^2	0.95

Table T4 Adsorption kinetics

Rate constant k_2/(g mg^{-1} min^{-1})	Regression coefficient	Rate constant k_1/ (min^{-1})	Regression coefficient	Intraparticle rate constant k_{int}/(mg g^{-1} min$^{-\frac{1}{2}}$)
0.50	0.99	0.067	0.96	0.049

Table T5. Thermodynamic parameters

Temperature/ (Kelvin)	q_e (mg g^{-1})	ΔG^0/ (kJ mol^{-1})	ΔS^0/ (J mol^{-1} K^{-1})	ΔH^0/ (kJ mol^{-1})
300	1.9	-7.34		
310	1.7	-4.47		
323	1.6	-3.72	-179.08	-60.99
333	1.2	-1.12		

Table T6 Effect of co-existing ions

Sample name	Co-existing ions	Concentration in mg L^{-1}	(%) Removal of Hg(II)
Synthetic mixture - A	Ag, Al, As, Ba, Bi, Ca, Cd, Co, Cr, Cs, Cu, Ga, In, K, Li, Mg, Mn, Na, Ni, Pb, Rb, Se, Sr, Ti, U, V, Zn	10	80.0
Synthetic mixture - B	As, Cd, Co, Cu, Ni, Pb, Se, Zn, Au	100	91.0
Synthetic mixture -C	SO_4^{2-}, NO_3^-, PO_4^{3-}, Cl^-	100	90.0