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Supplementary Information

$CoFe_2O_4$ and $NiFe_2O_4$ @ graphene adsorbents for heavy metal ions – Kinetic and Thermodynamic analysis

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Measurement and Characterization

The crystalline structure of the as-synthesized composite was identified by using a Rigaku Miniflex powder X-ray Diffraction (XRD) (Cu Kα = 1.5406 Å) over 2θ range from 10-80° C. The morphology studies and elements composition of the composite were obtained with FESEM, (Hitachi S-4800) and Energy Dispersive Spectrometry (EDS) mapping. The samples were characterized with Transmission Electron Microscope (TEM) JEOL-2000EX operated at 120 kV. Thermogravimetric analysis (TGA) and Differential Thermogravimetric analysis (DTA) of the samples were done with a SDT Q600 (TA Instruments, Korea) with a heating rate of 5°C min^{-1} from 0° to 1000°C. X-ray Photo Spectroscopy (XPS) analysis was carried out by using a Thermo Scientific Multilab 2000 spectrometer with Mg source. Casa XPS version 2.3.13 software was used for background subtraction and fitting of the curve. Elemental analysis was performed with the CHNOS Vario EL cube analysis. The concentration of metal ions in the solution was analyzed using Perkin-Elmer Analyst 700 Atomic absorption spectrometer (AAS). The porous nature of the samples was investigated using physical adsorption of nitrogen on ASAP 2020 Micrometrics instrument. Prior to measurements, the samples were outgassed at 40°C with a heating rate of 10°C/min for 1 h. Specific surface area was determined by the multipoint Brunauer–Emmet–Teller (BET) method in the relative pressure range of 0.05 to 0.3. The corresponding pore size distribution and total pore volume were determined by the Brunauer Joyner–Hallenda (BJH) method applied to the adsorption branch.

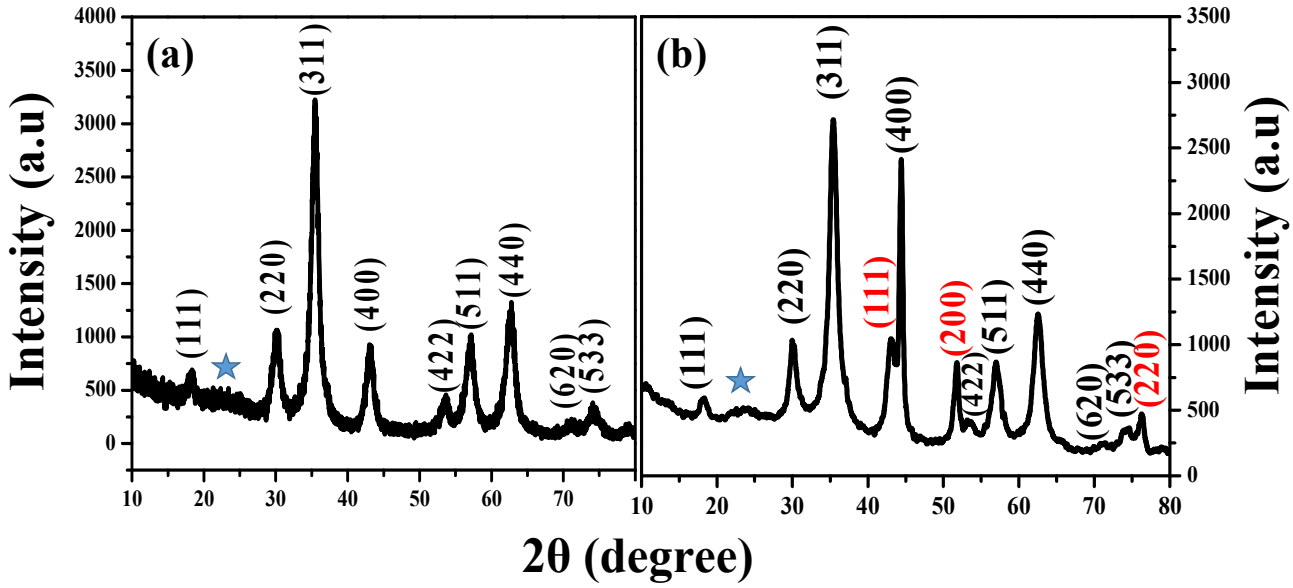

Fig. S1. XRD pattern of (a) $CoFe_2O_4$-G and (b) $NiFe_2O_4$-G.

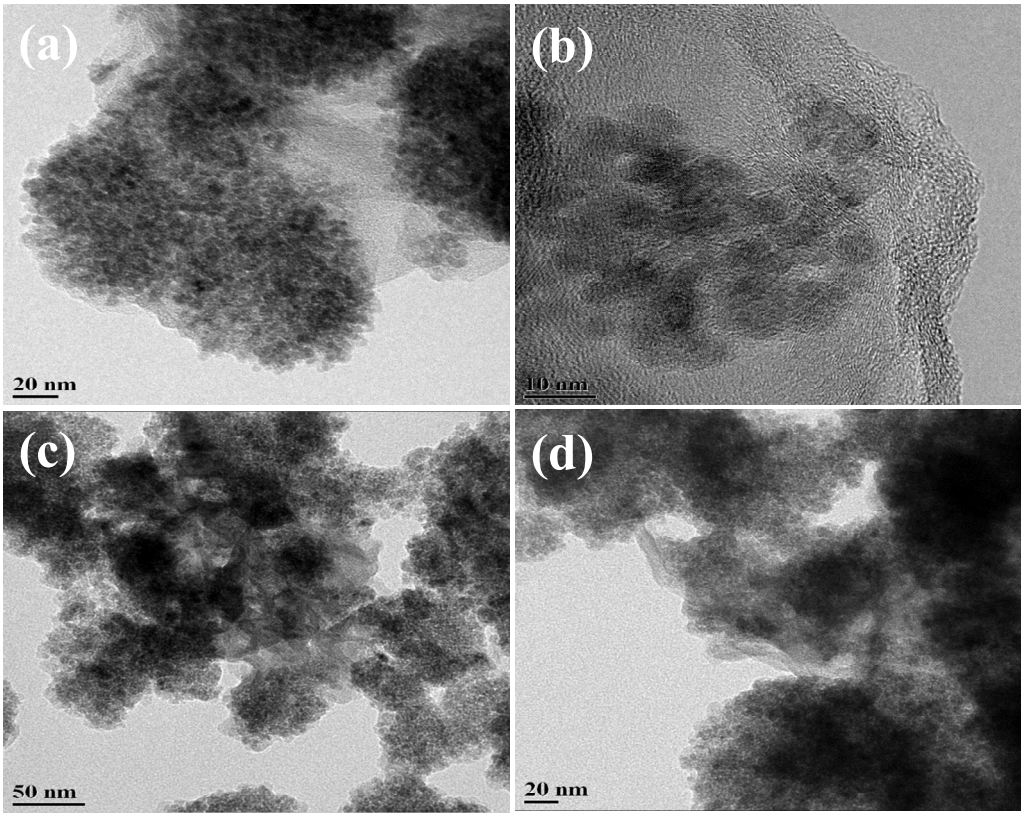

Fig S2. TEM images of (a,b) $CoFe_2O_4$-G and (c,d) $NiFe_2O_4$-G at various magnifications

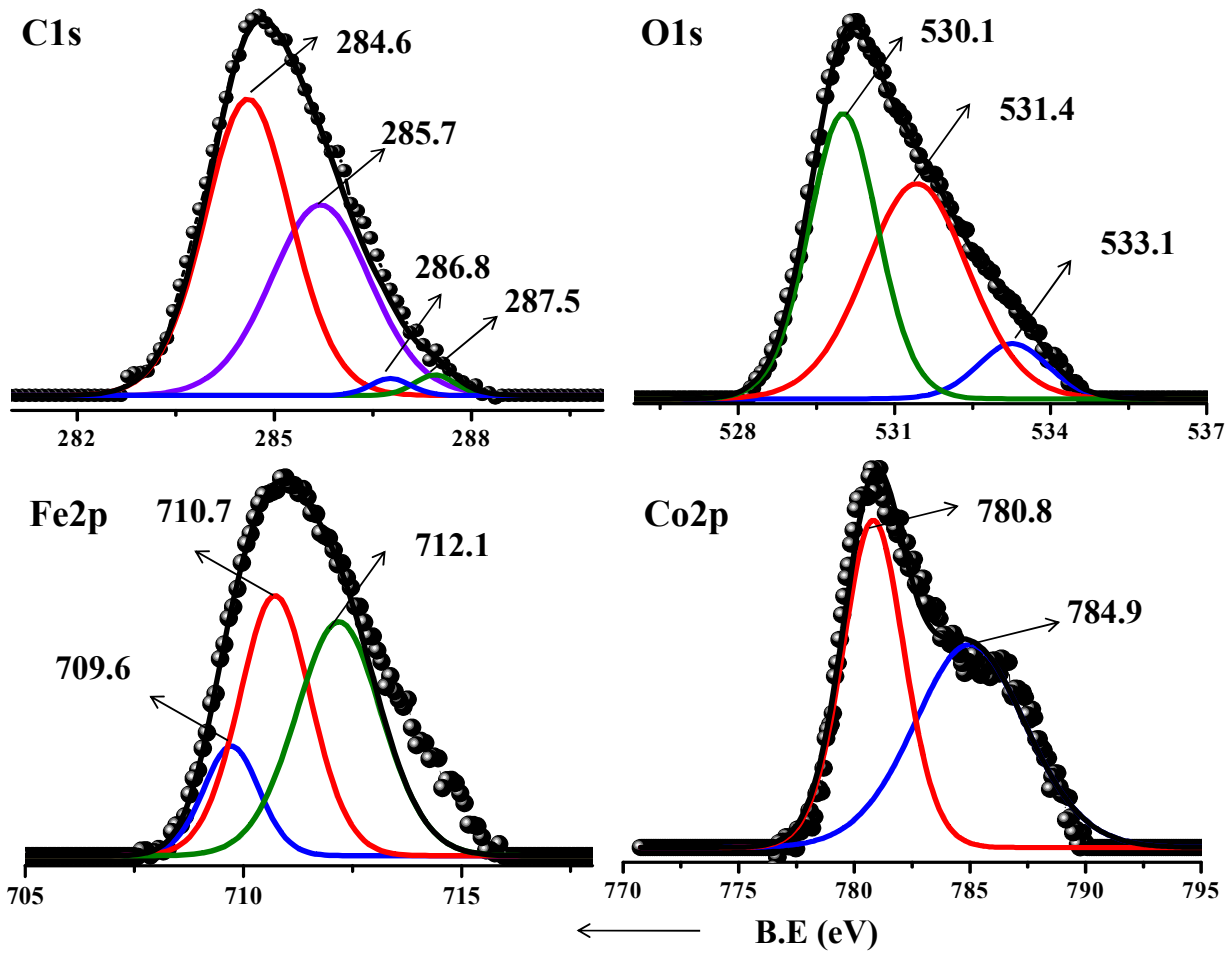

Fig. S3. Deconvolution XPS Spectra of $CoFe_2O_4$-G (a) C1s (b) O1s (c) Fe 2p (d) Co 2p.

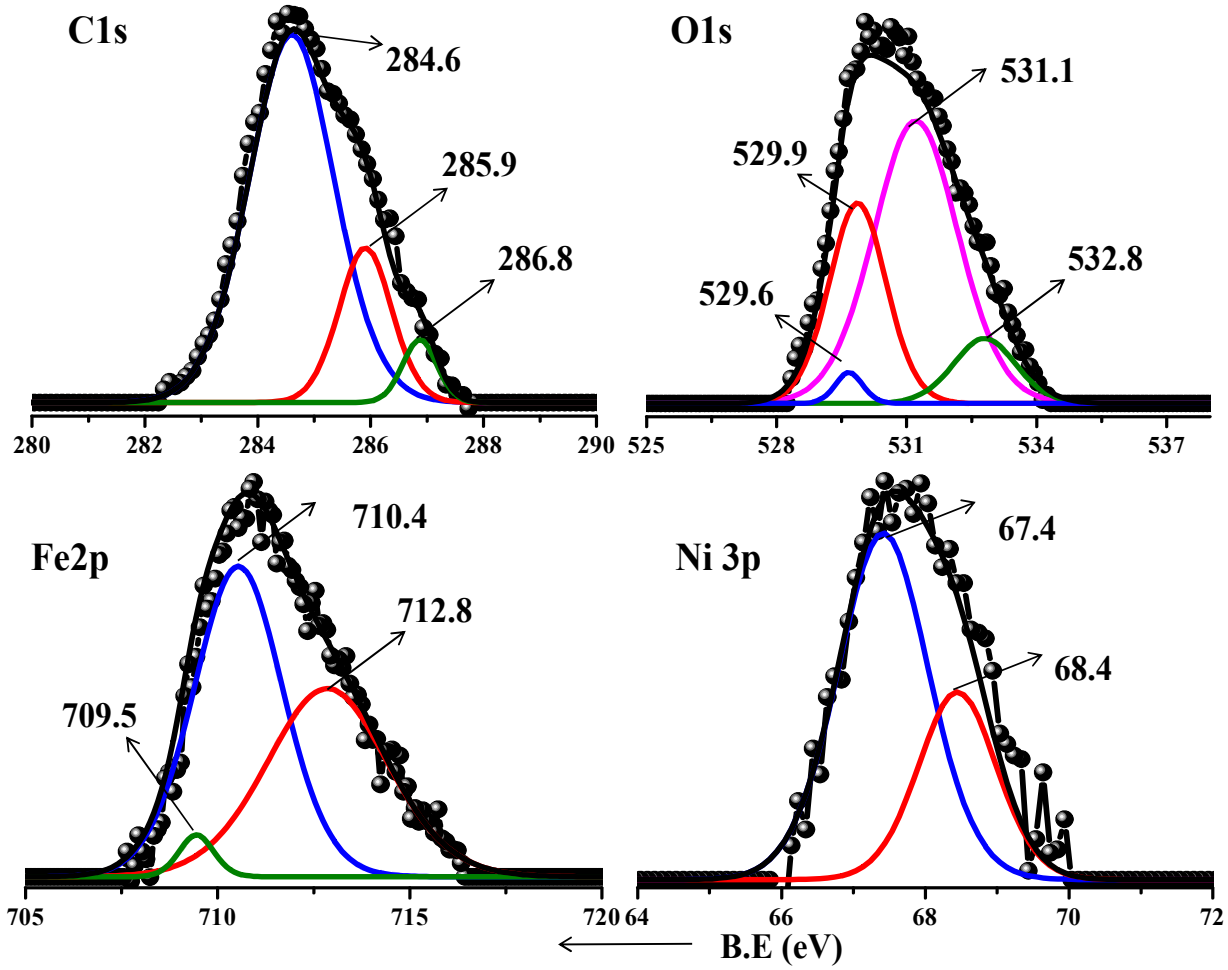

Fig. S4. Deconvolution XPS Spectra of $NiFe_2O_4$-G (a) C1s (b) O1s (c) Fe 2p (d) Ni 3p.

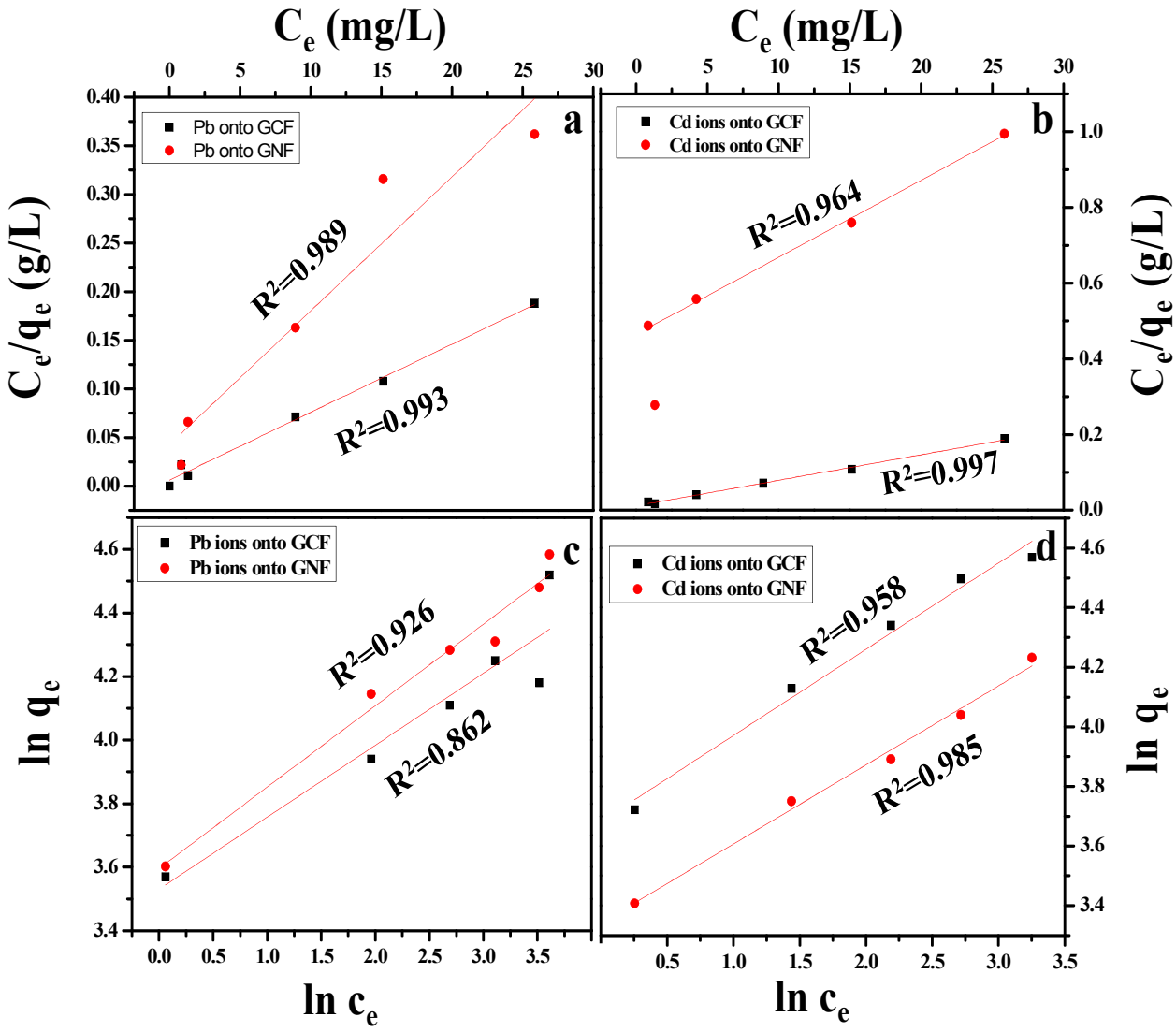

Fig. S5. Langmuir isotherms of (a,b) Pb and Cd ions onto GCF and GNF and Freundlich isotherms of (c,d) Pb and Cd ions onto GCF and GNF

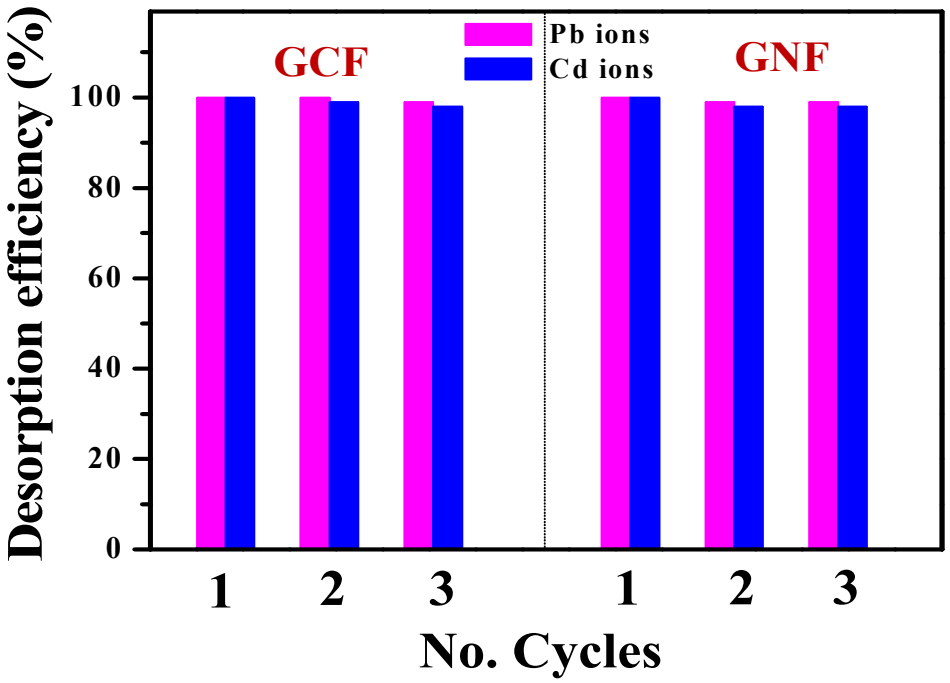

Fig. S6. Desorption studies of $CoFe_2O_4$-G (GCF) and $NiFe_2O_4$-G (GNF).

Table S1. Isotherm models of Pb^{2+} and Cd^{2+} ions onto GCF and GNF.

	GCF						GNF					
Metal ions	Langmuir			Freundlich			Langmuir			Freundlich		
	R^2	q_m (mg/g)	K_d	R^2	K_f (L/g)	n	R^2	q_m (mg/g)	K_d	R^2	K_f (L/g)	n
Pb^{2+}	0.993	142.85	1.1	0.862	68.10	3.95	0.989	111.11	0.33	0.926	40.28	4.32
Cd^{2+}	0.997	105.26	0.3	0.985	39.72	3.45	0.964	74.62	0.16	0.958	17.67	2.80