Electronic Supplementary Material (ESI) for Environmental Science: Advances.

Supplementary file

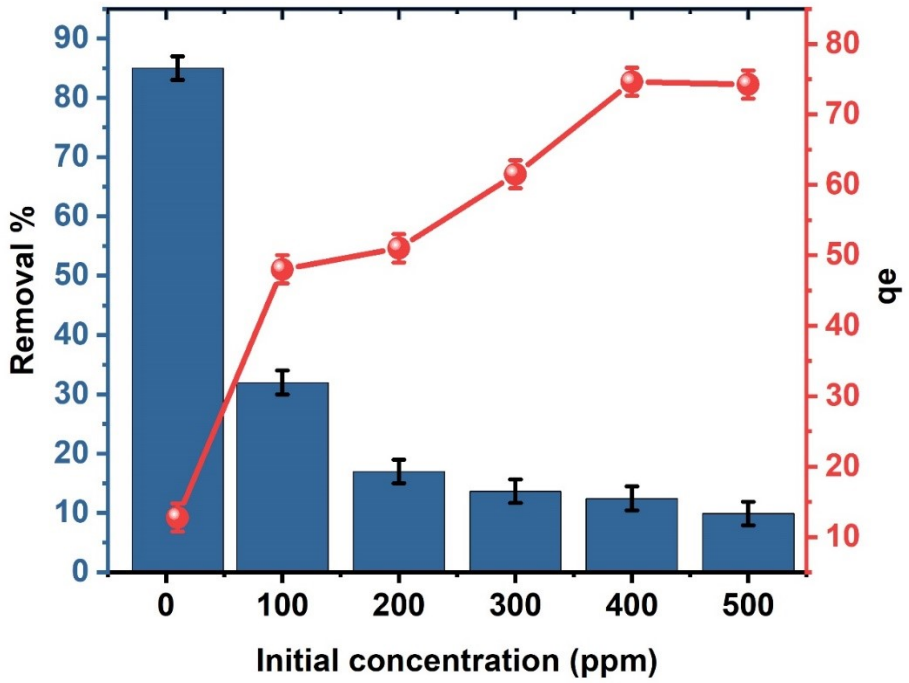

Fig. S1 Effect of initial Cr(VI) concentration on adsorption capacity and removal efficiency by Zn-Hap

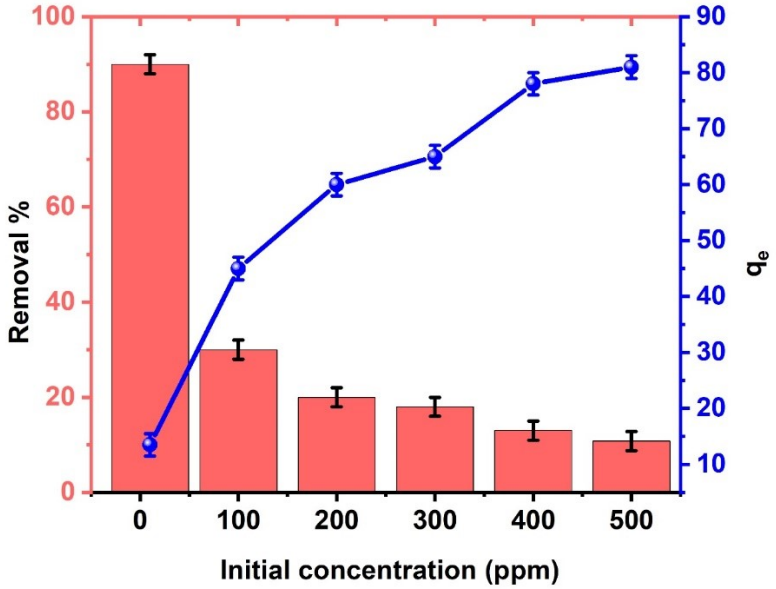

Fig. S2 Effect of initial Pb(II) concentration on adsorption capacity and removal efficiency by Zn-Hap

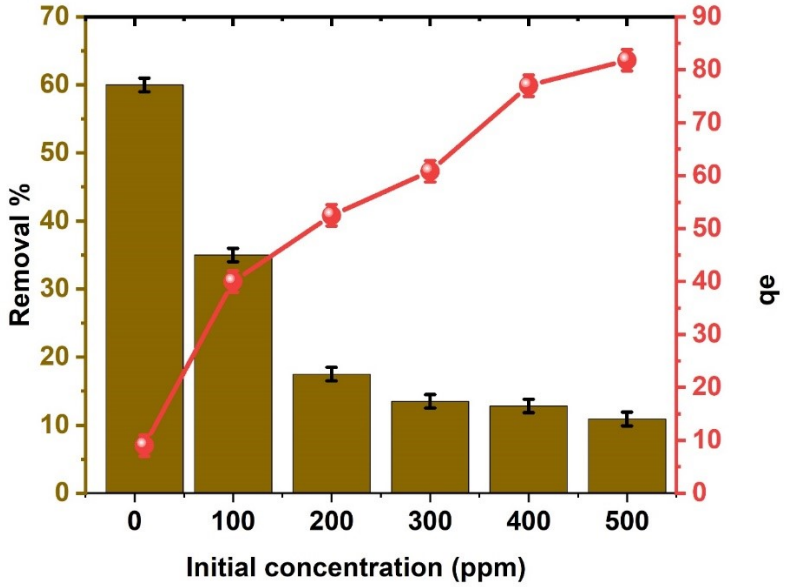

Fig. S3 Effect of initial Cr(VI) concentration on adsorption capacity and removal efficiency by Graphene oxide (GO)

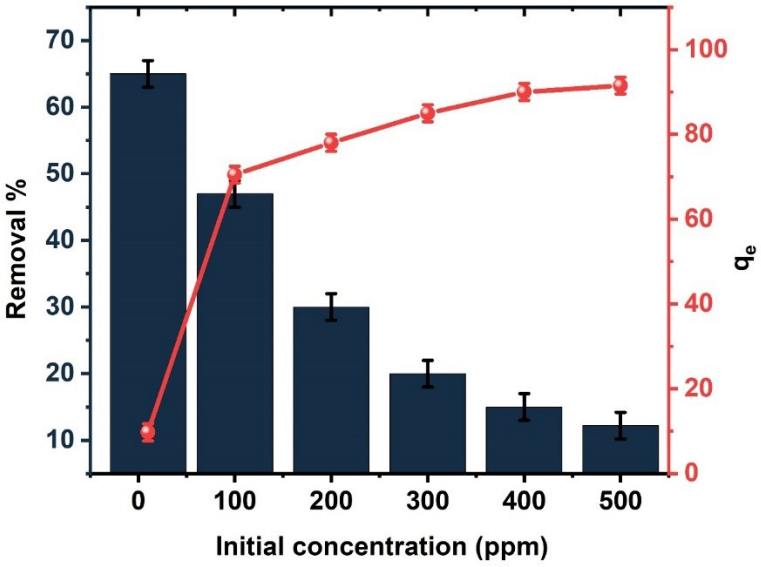

Fig. S4 Effect of initial Pb(II) concentration on adsorption capacity and removal efficiency by Graphene oxide (GO)

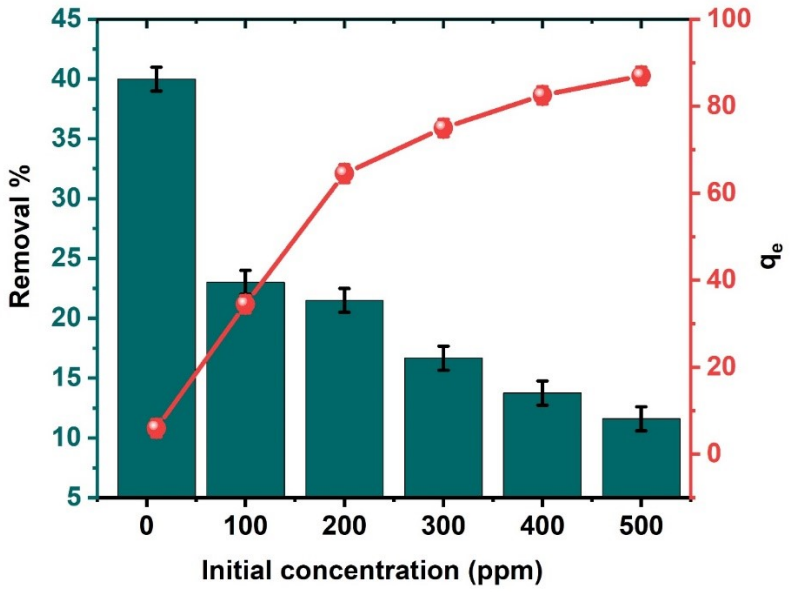

Fig. S5 Effect of initial Cr(VI) concentration on adsorption capacity and removal efficiency by Cellulose acetate (CA) membrane

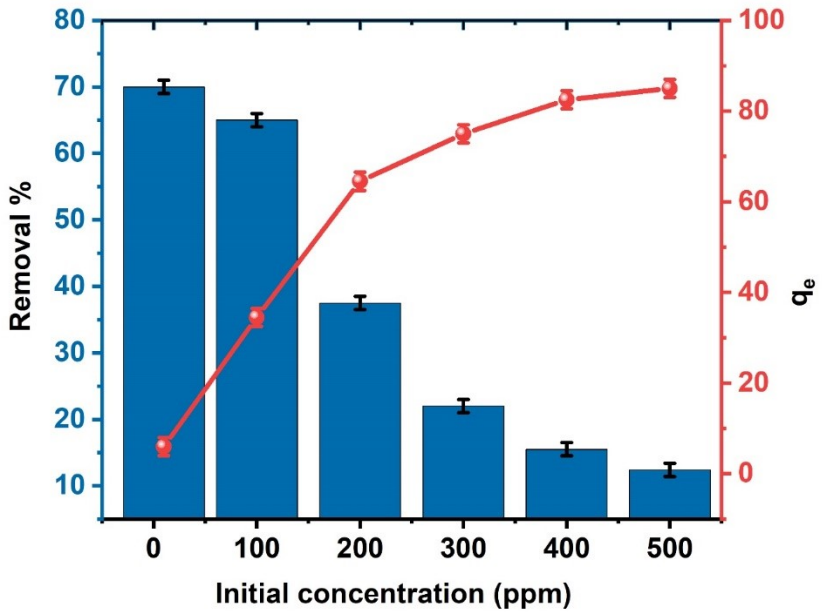

Fig. S6 Effect of initial Pb(II) concentration on adsorption capacity and removal efficiency by Cellulose acetate (CA) membrane

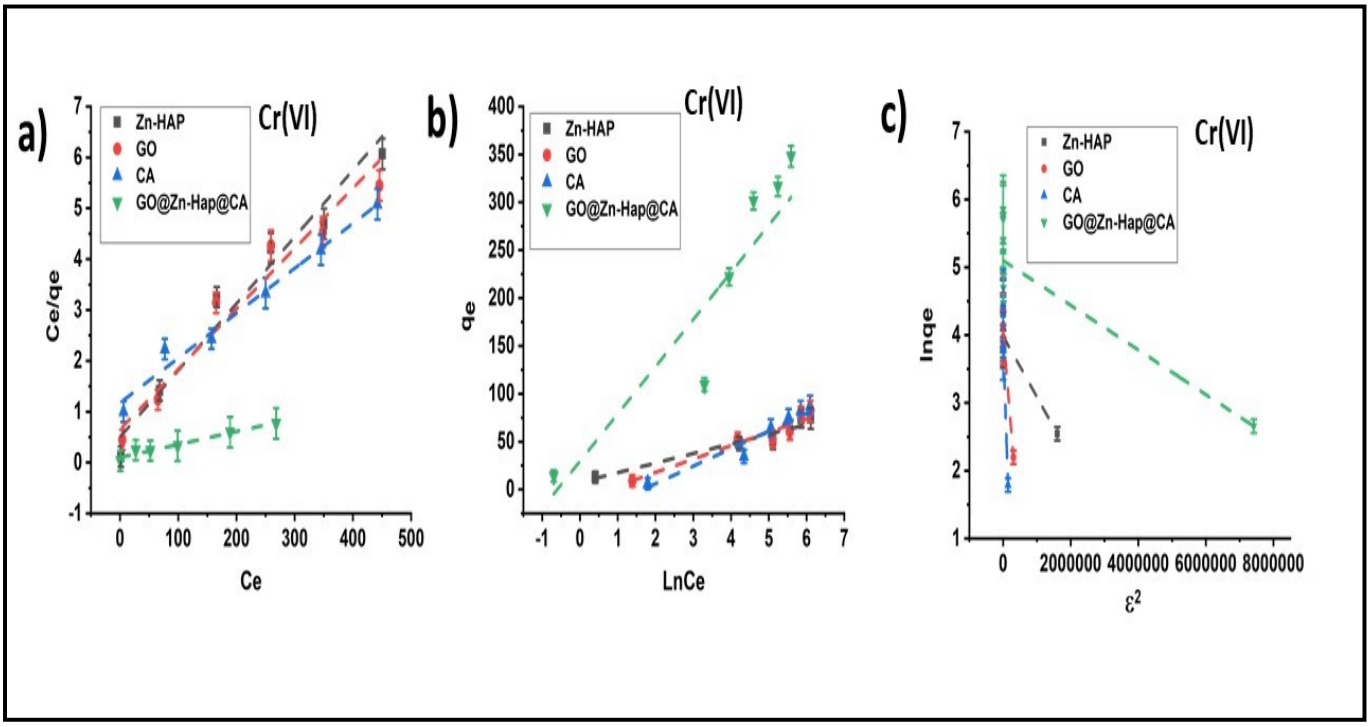

Fig. S7 Linear fit Langmuir isotherm (a), Temkin isotherm (b), D-R isotherm of Zn-Hap, GO, CA and GO@Zn-Hap@CA for Cr(VI). (pH =2, dose 0.05g; contact time:100 minutes)

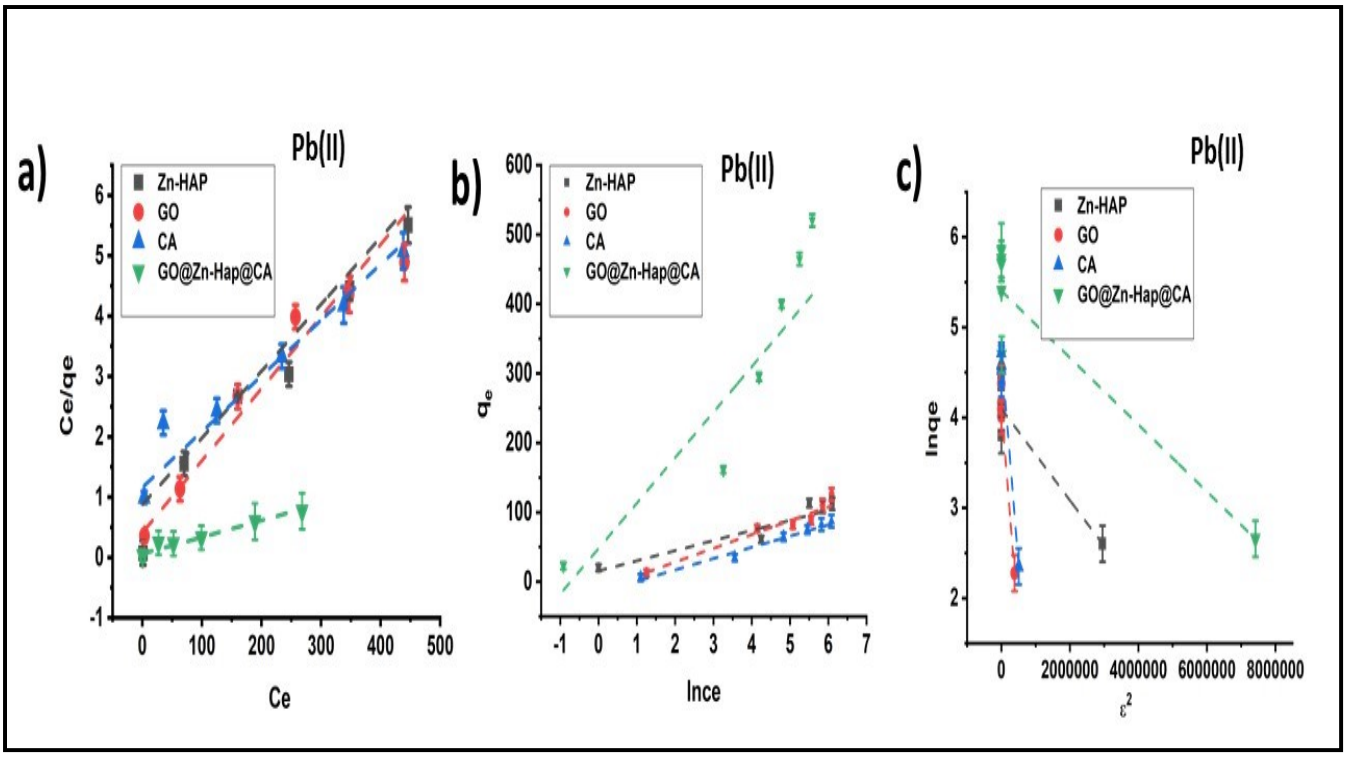

Fig. S8 Linear fit Langmuir isotherm (a), Temkin isotherm (b), D-R isotherm of of Zn-Hap, GO, CA and GO@Zn-Hap@CA for Pb(II). (pH=5, dose 0.05g; contact time:100 minutes)

Frendulich isotherm				
Parameters	Zn-Hap	GO	CA	GO@Zn-Hap@CA
	Chromium			
K_f (mg/g)	12.47	9.5	4.93	43.64
n	3.3	2.85	2.08	2.63
R^2	0.9639	0.92951	0.96372	0.94287
	Lead			
K_f (mg/g)	12.39	21.13	9.26	40.41
n	3.44	4	2.70	2.44
R^2	0.9693	0.8890	0.97055	0.92267

Table S1. Nonlinear isotherm parameters and regression coefficient values

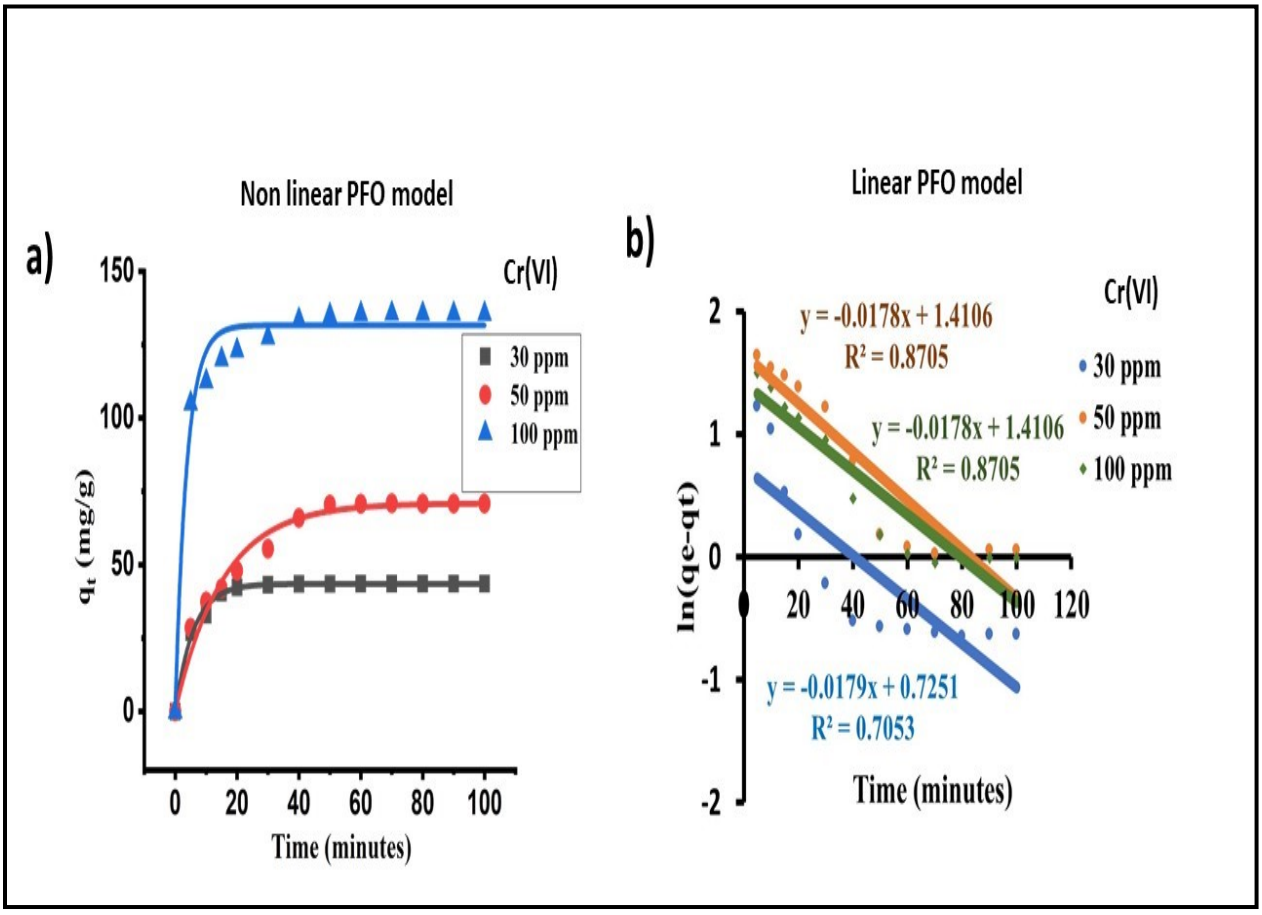

Fig. S9 Non-linear Fit Pseudo first order model (a) for Cr(VI), linear fit Pseudo first order model (b) for Cr(VI)

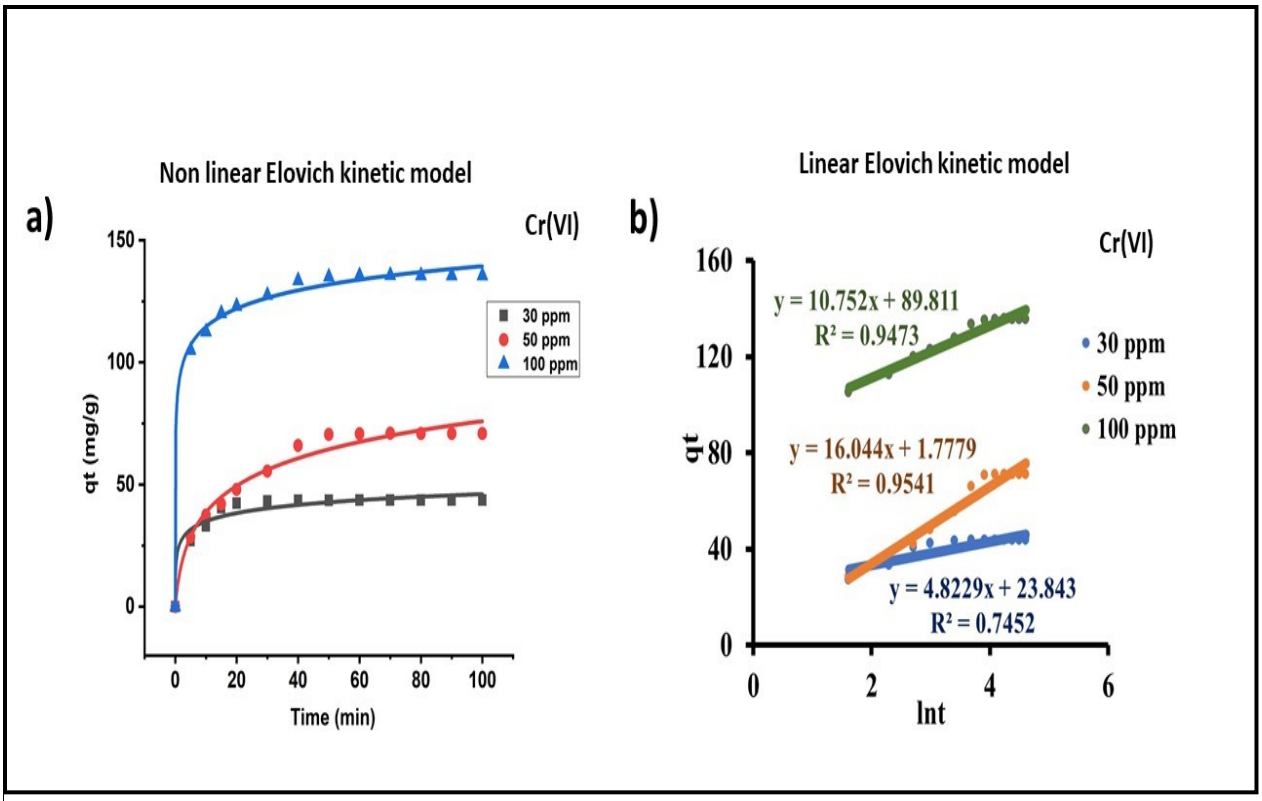

Fig. S10 Non-linear Fit Elovich model (a) for Cr(VI), linear fit Elovich model (b) for Cr(VI)

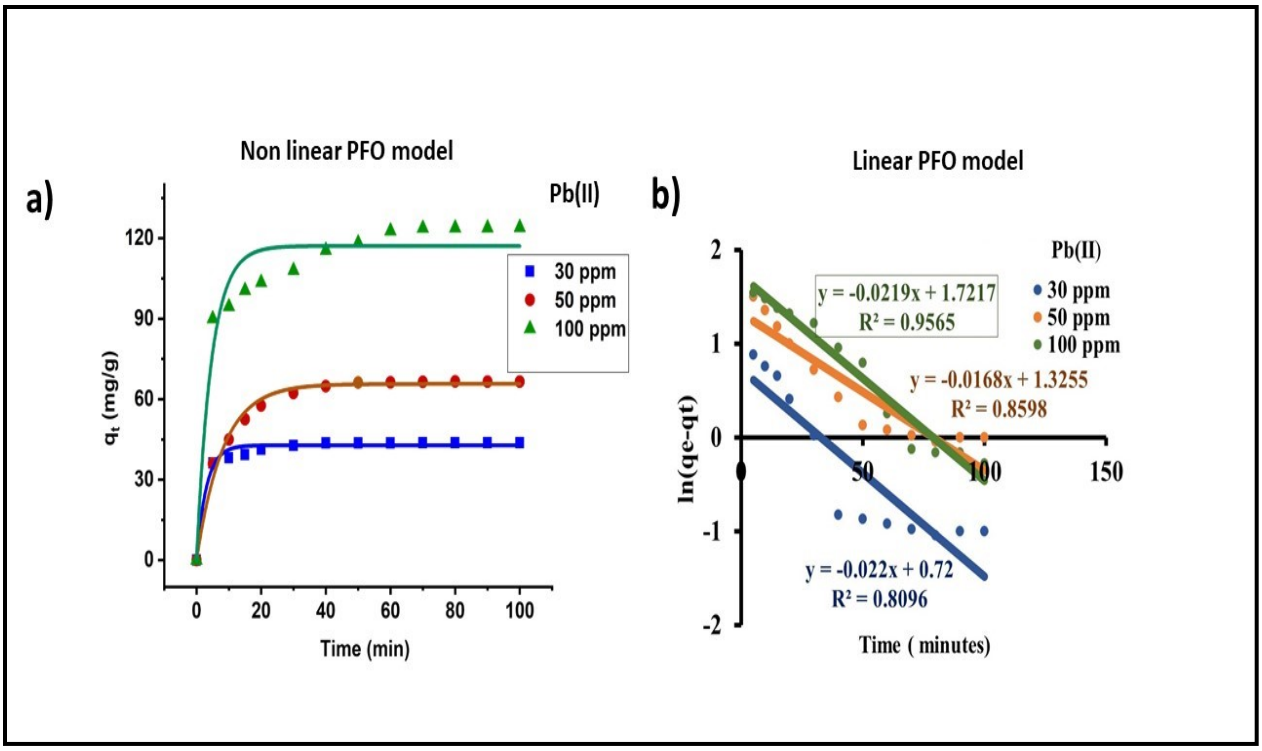

Fig. S11 Non-linear Fit Pseudo first order model (a) for Pb(II), linear fit Pseudo first order model (b) for Pb(II)

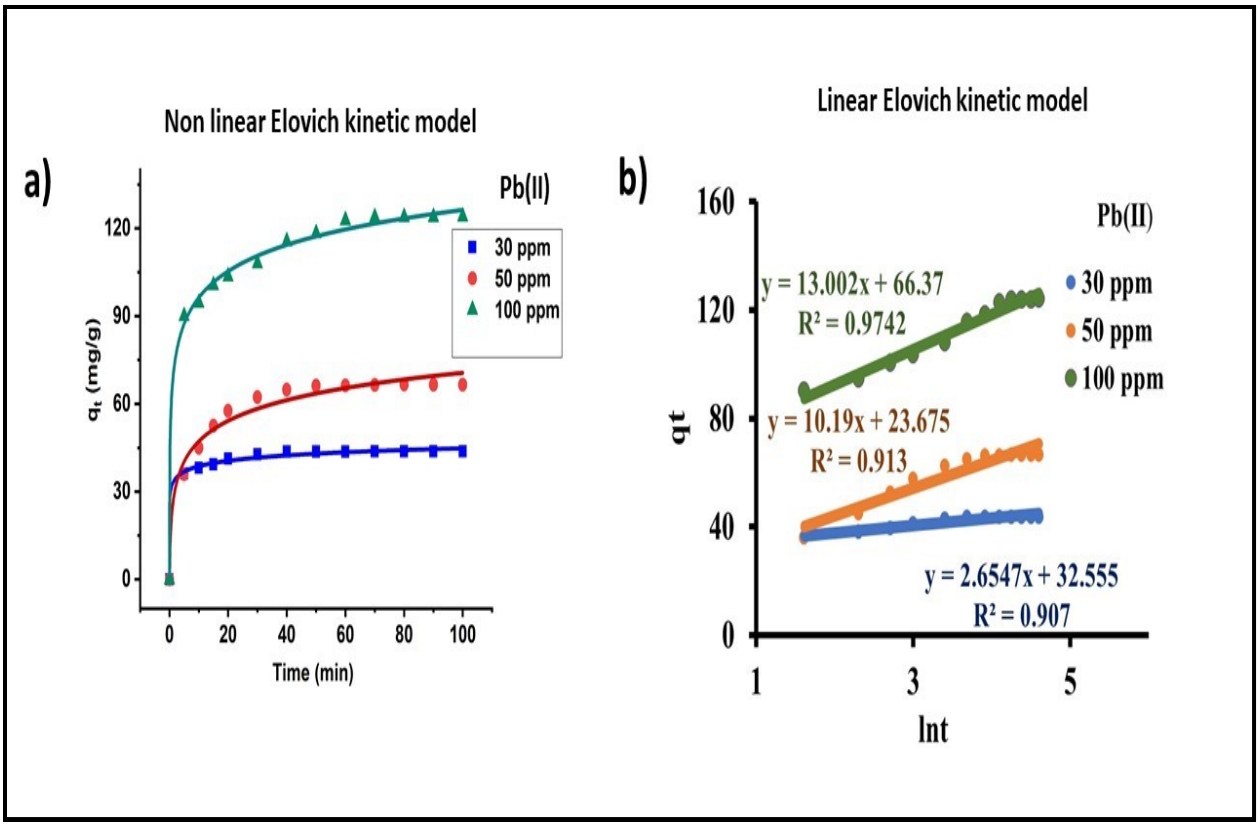

Fig. S12 Non-linear Fit Elovich model (a) for Pb(II), linear fit Elovich model (b) for Pb(II)

Table S2. Non-linear kinetic model parameters for Cr(VI) and Pb(II) adsorption

Kinetic model and parameters	Chromium			Lead		
	30 ppm	50 ppm	100 ppm	30 ppm	50 ppm	100 ppm
Experimental q_e (mg/g)	43.8	72	136.5	43.8	67.5	124.5
	Pseduo first order (PFO)					
$q_{e\ cal.}$(mg/g)	43.4	70.4	131.61	42.7	65.64	117.07
K_1 (1/min)	0.171	0.065	0.268	0.3301	0.1226	0.2171
R^2	0.9879	0.9753	0.9741	0.9822	0.98712	0.93814
	Pseduo second order (PSO)					
$q_{e\ cal.}$(mg/g)	46.17	82.17	137.97	44.37	71.48	124.80
K_1 (g/mg.min)	0.0683	0.001	0.00388	0.016	0.00271	0.00296
R^2	0.9889	0.9839	0.9953	0.9965	0.99607	0.98932
	Elovich kinetic model					
α (mg g-1 min-1)	678.73	14.99	45629	562245	103.017	2134.97
β (g mg-1)	0.2074	0.05924	0.09301	0.3766	0.09802	0.07688
R^2	0.9571	0.9781	0.9878	0.9888	0.97739	0.9875

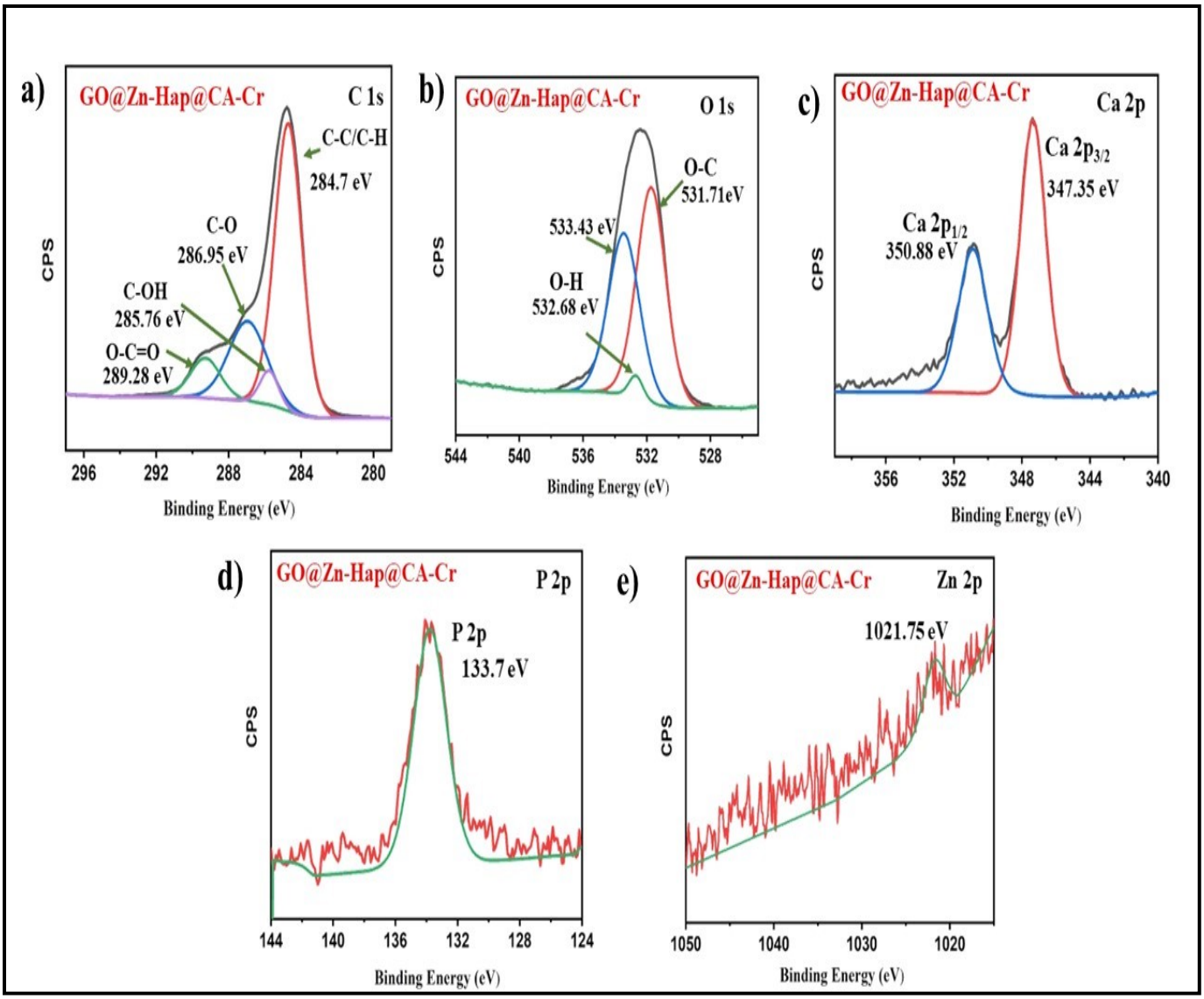

Fig. S13 XPS deconvoluted C 1s spectra (a), O 1s spectra (b), Ca 2p spectra (c), P 2p spectra (d) Zn 2p (e) spectra of chromium loaded GO@Zn-Hap@CA

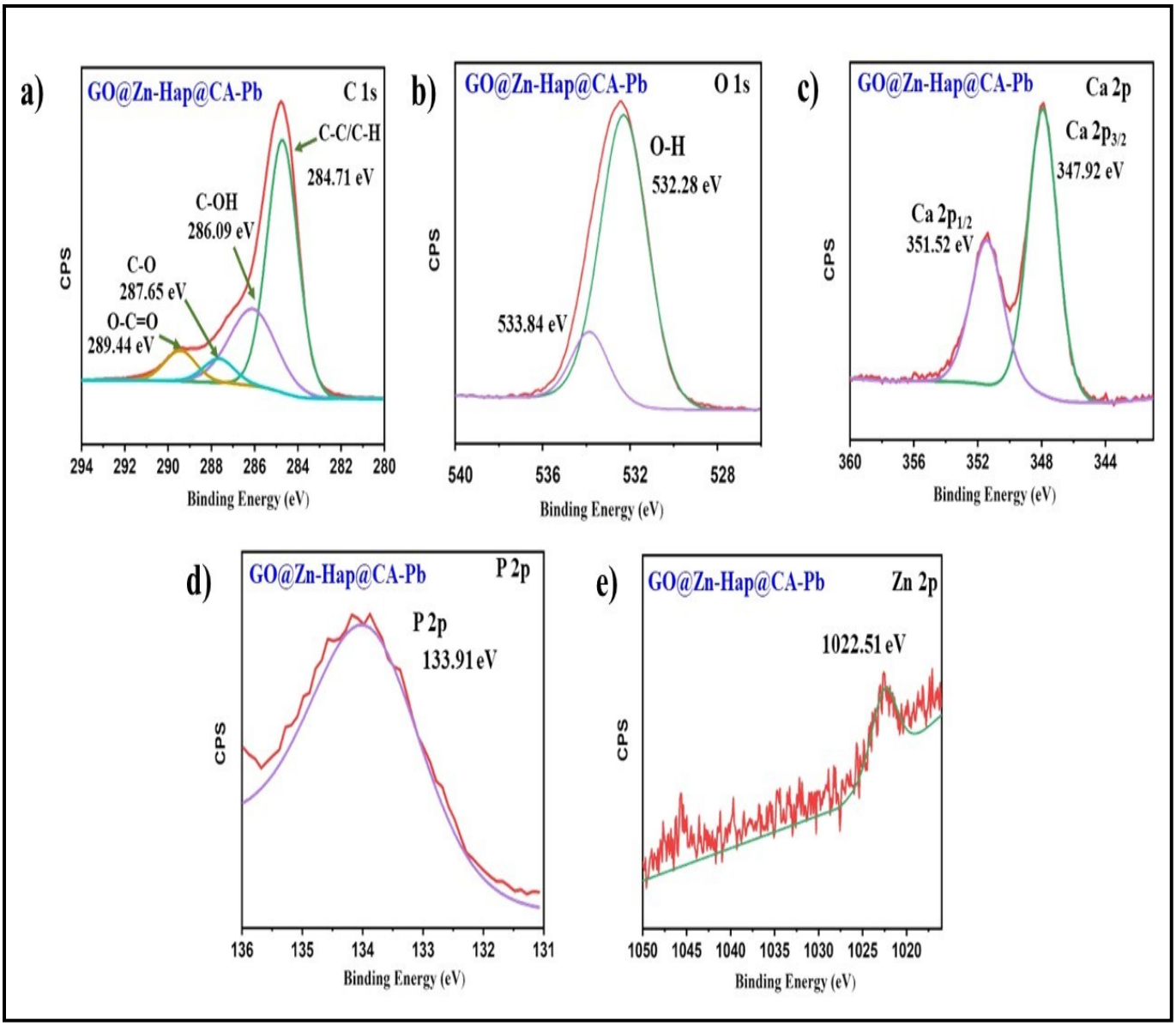

Fig. S14 XPS deconvoluted C 1s spectra (a), O 1s spectra (b), Ca 2p spectra (c), P 2p spectra (d) Zn 2p (e) spectra of lead loaded GO@Zn-Hap@CA

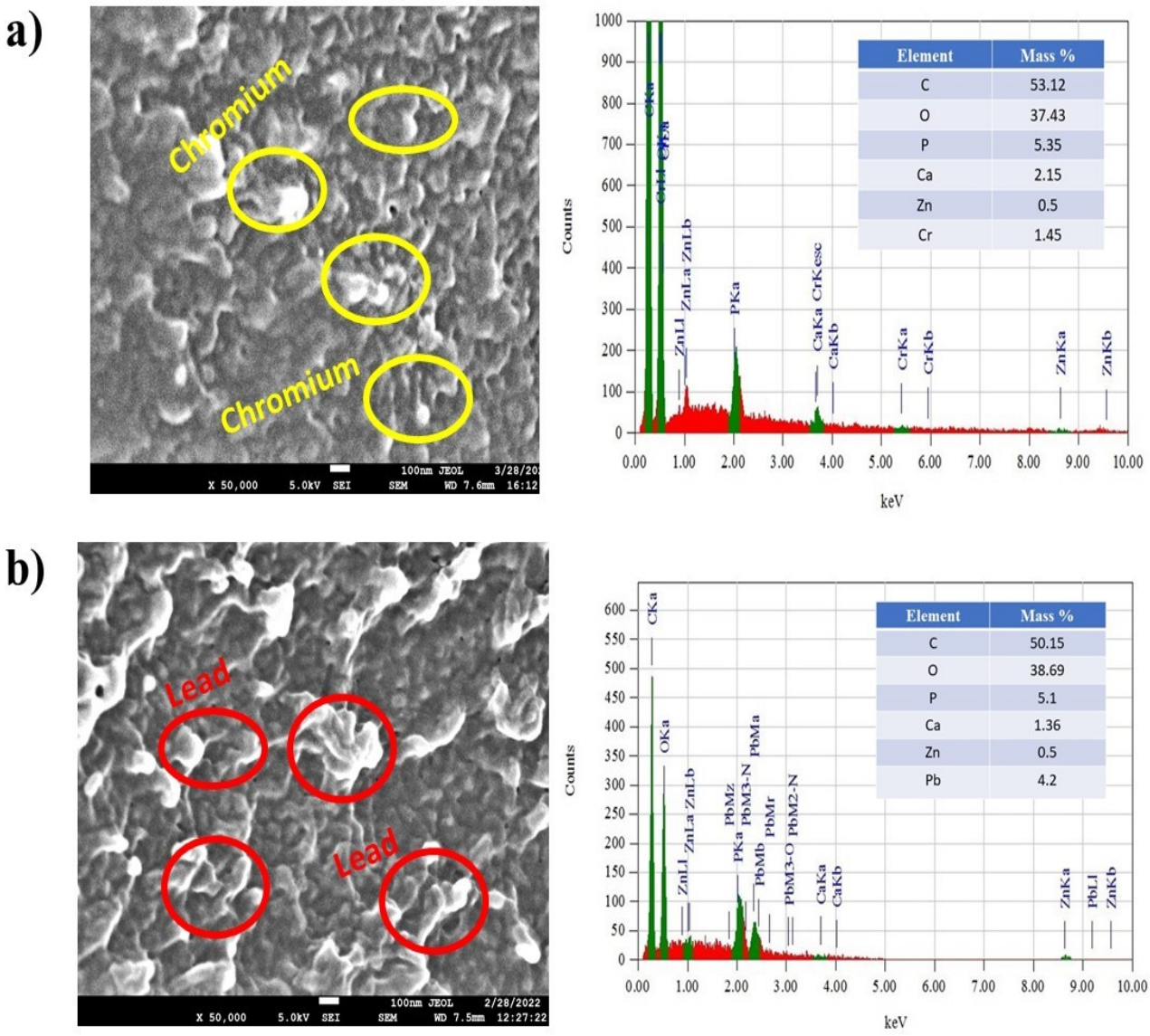

Fig. S15 FESEM-EDX analysis of chromium(a) and lead(b) adsorbed on GO@Zn-Hap@CA