Electronic Supplementary Material (ESI) for Dalton Transactions.

Supporting Information

Lanthanide Metal-Organic Frameworks as Selective Microporous Materials for Adsorption of Heavy Metal Ions

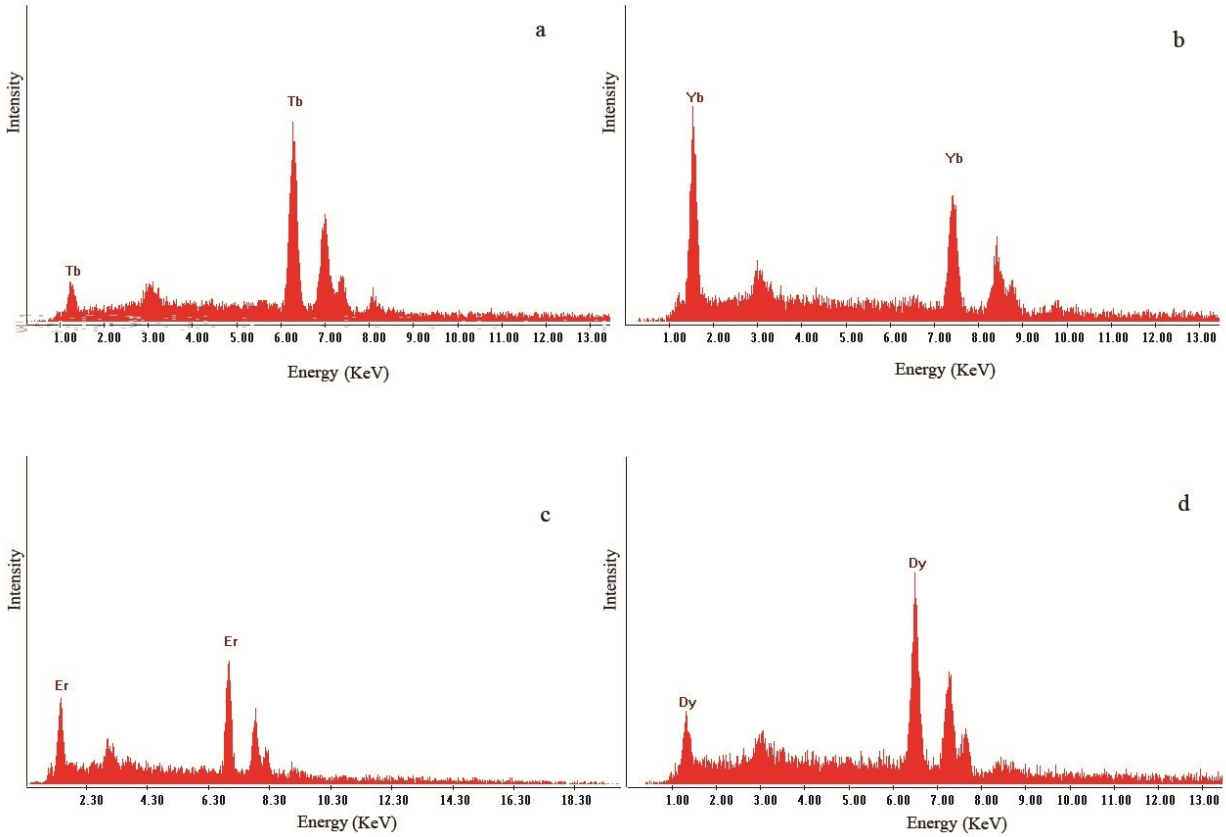


Figure S1. Energy dispersive spectroscopy of lanthanide metal-organic frameworks; a) Tb-MOF, b) Yb-MOF, c) Er-MOF, d) Dy-MOF

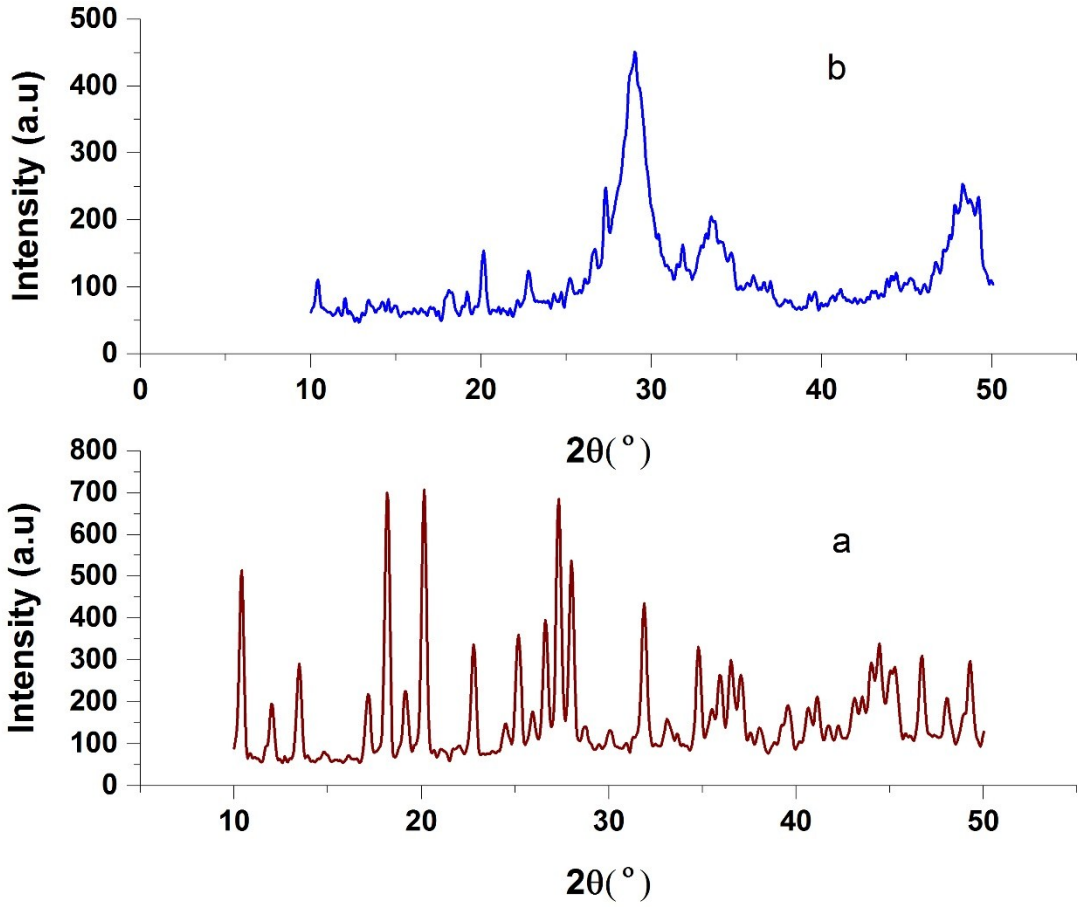


Figure S2. a) XRD pattern of synthesized Tb-MOF; b) XRD pattern of Tb-MOF after exposure to water

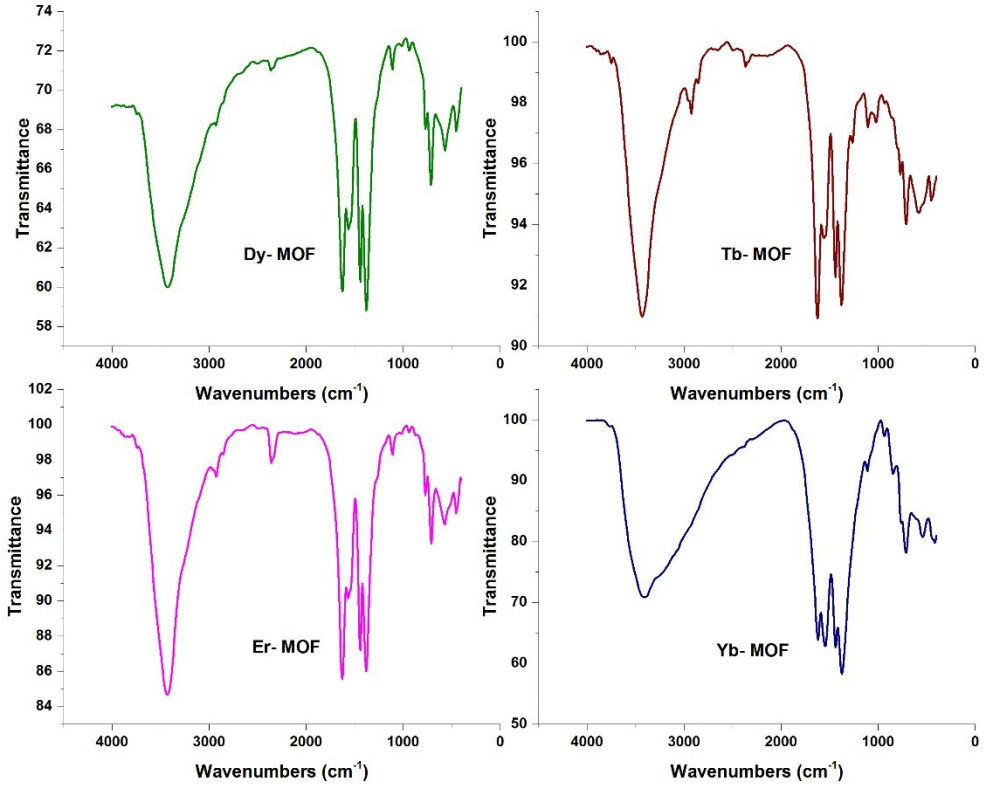


Figure S3. FT-IR spectra of lanthanide metal-organic frameworks

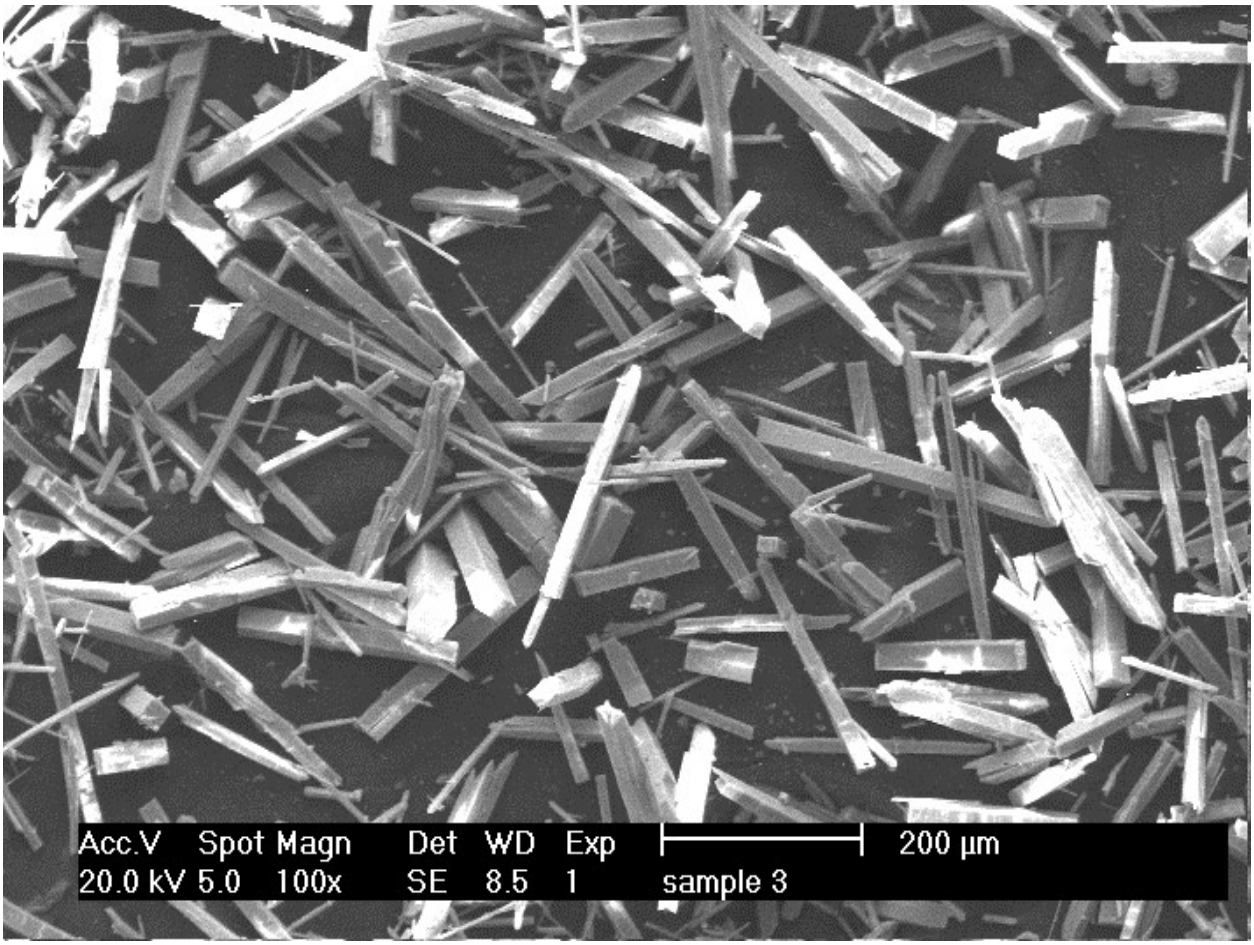


Figure S4. SEM image of dysprosium based metal-organic framework

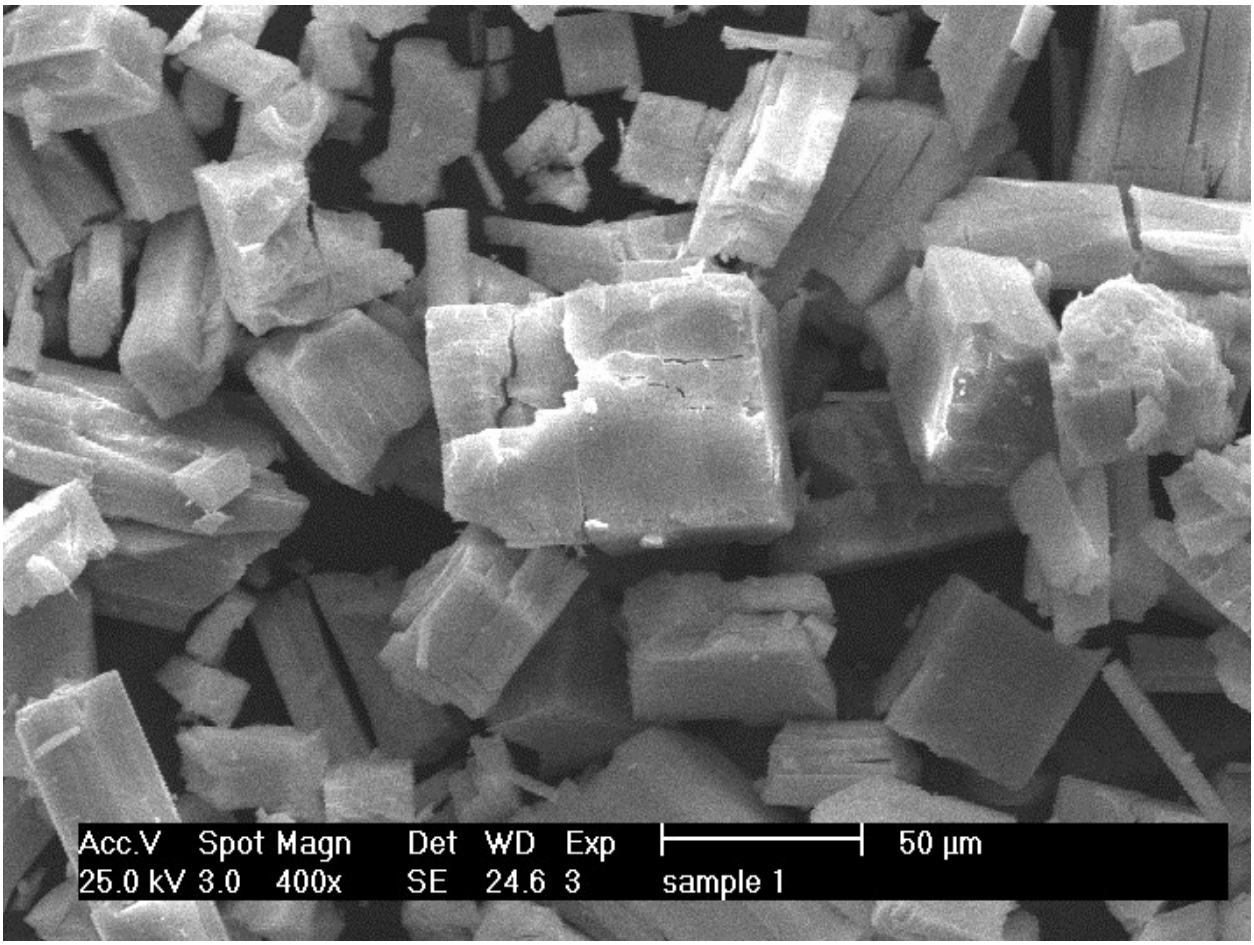


Figure S5. SEM image of terbium based metal-organic framework

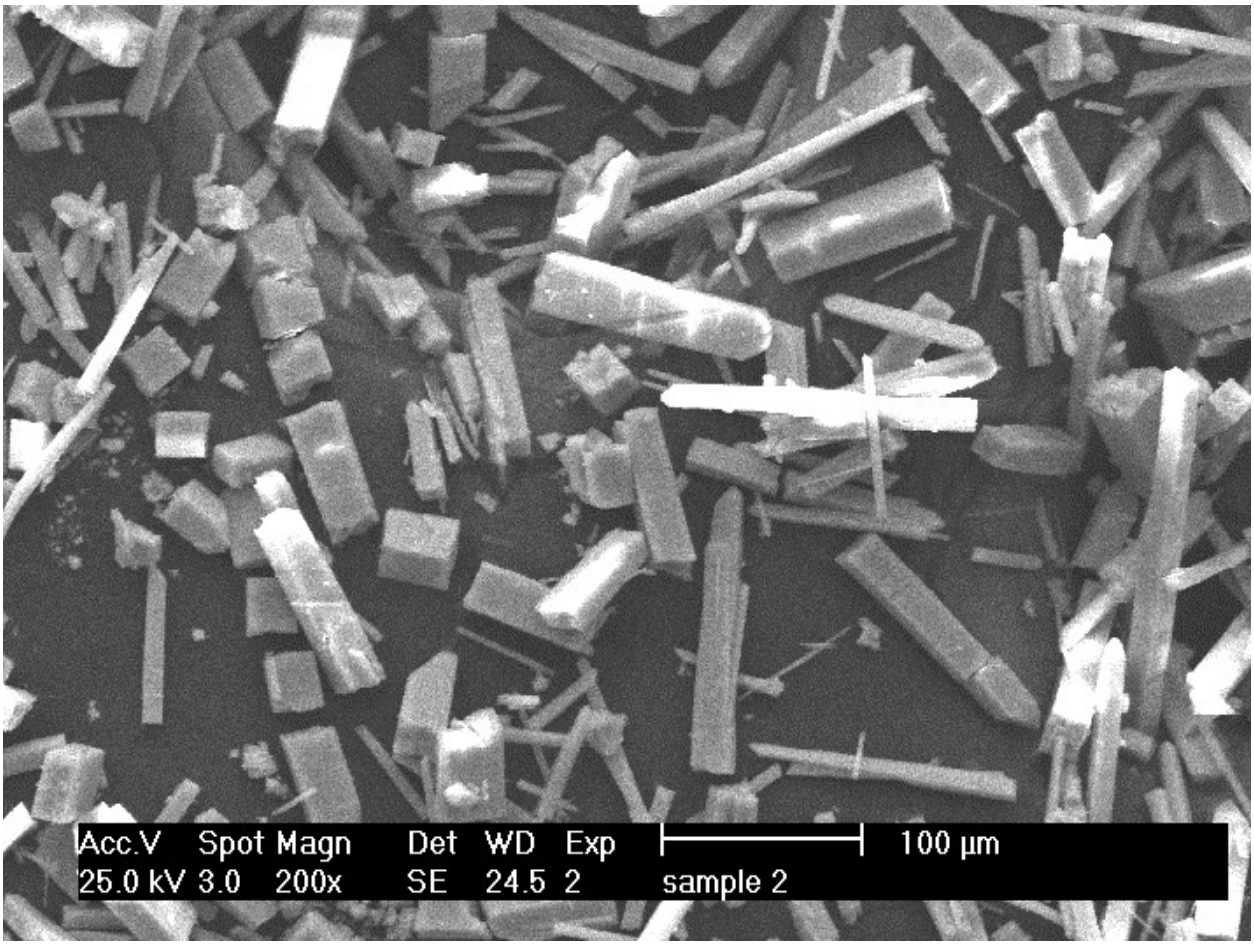


Figure S6. SEM image of erbium based metal-organic framework

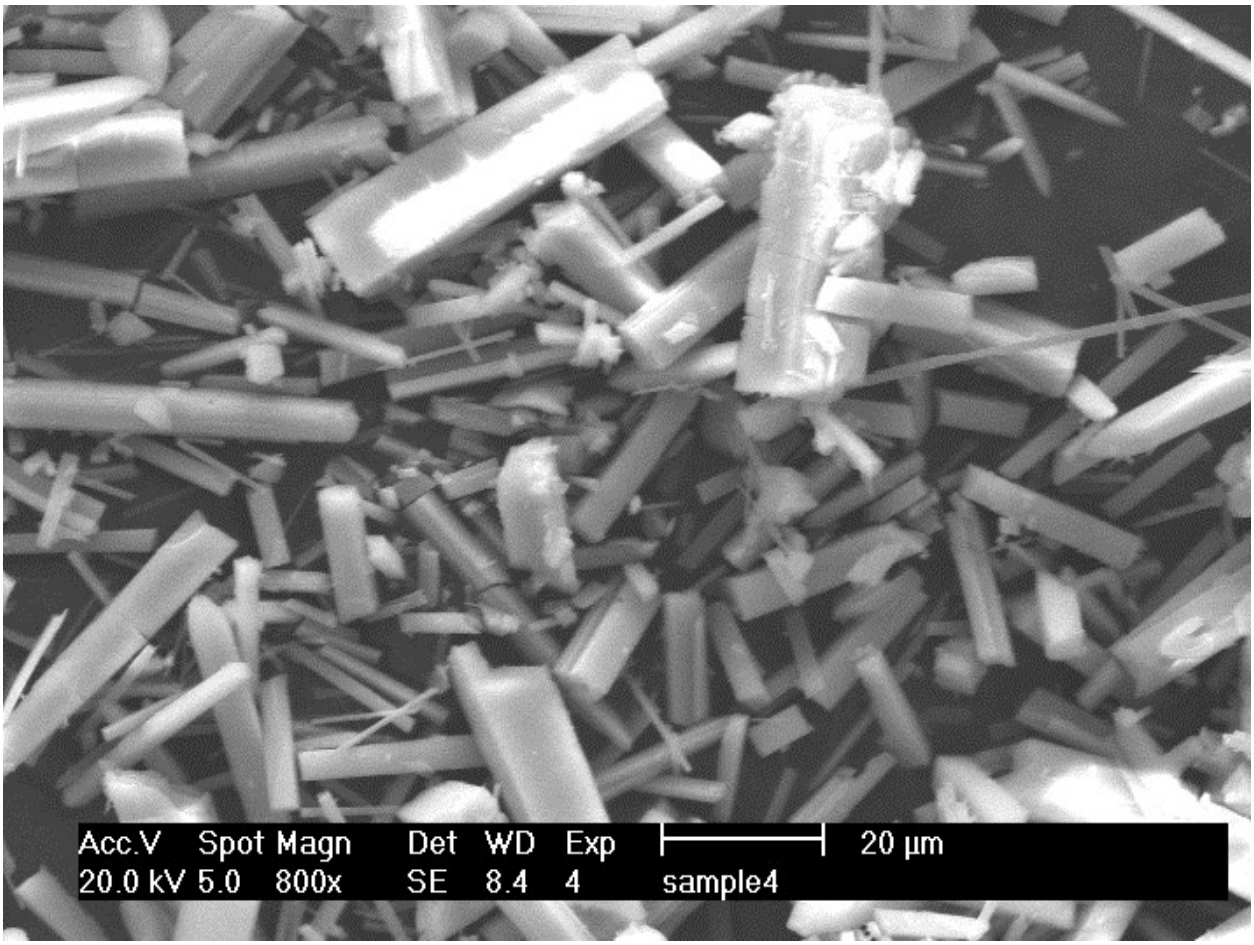


Figure S7. SEM image of ytterbium based metal-organic framework

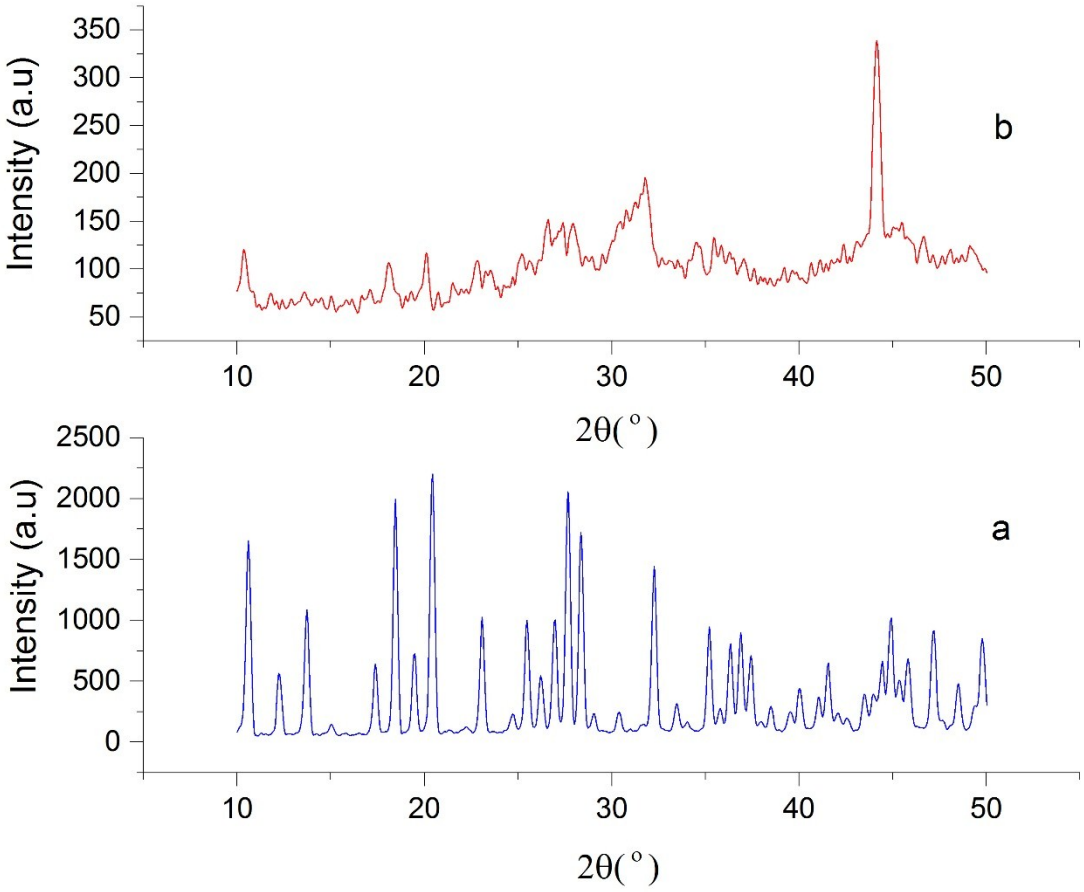
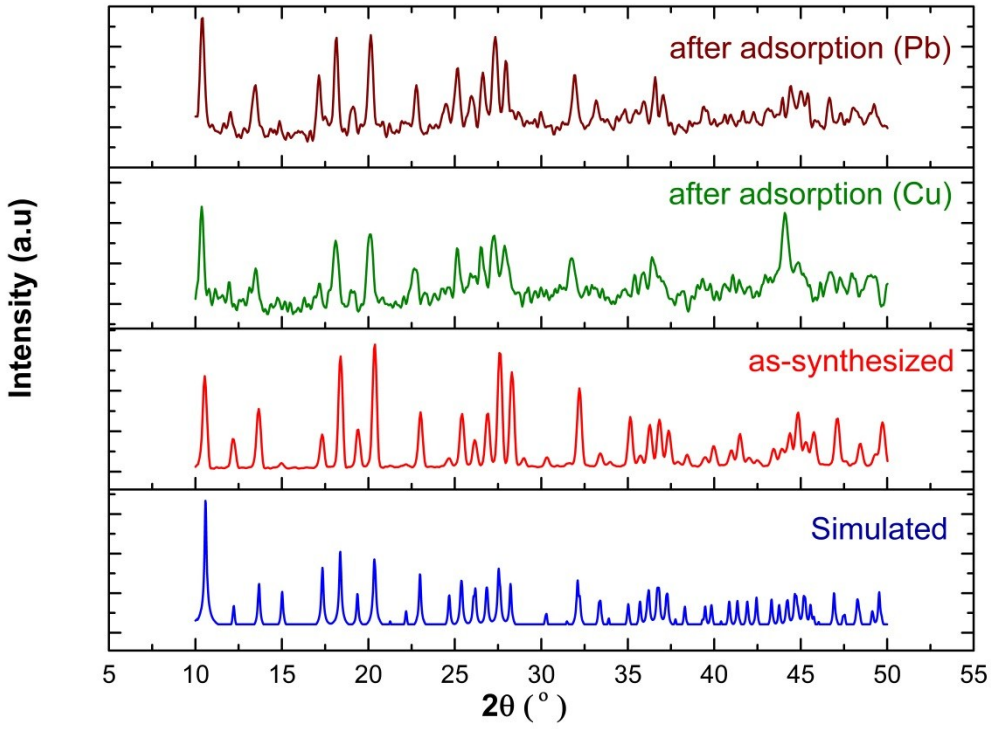
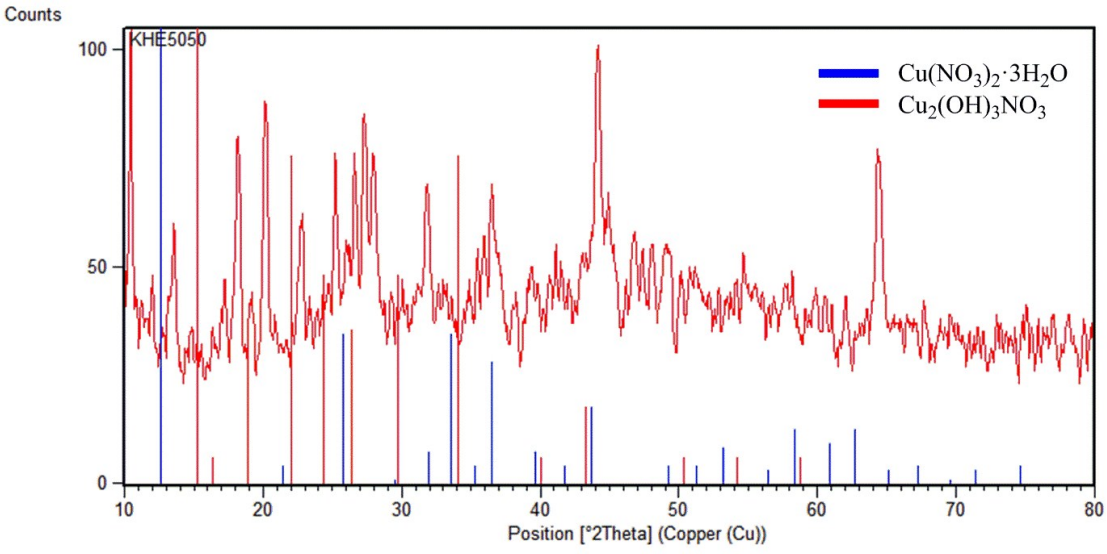


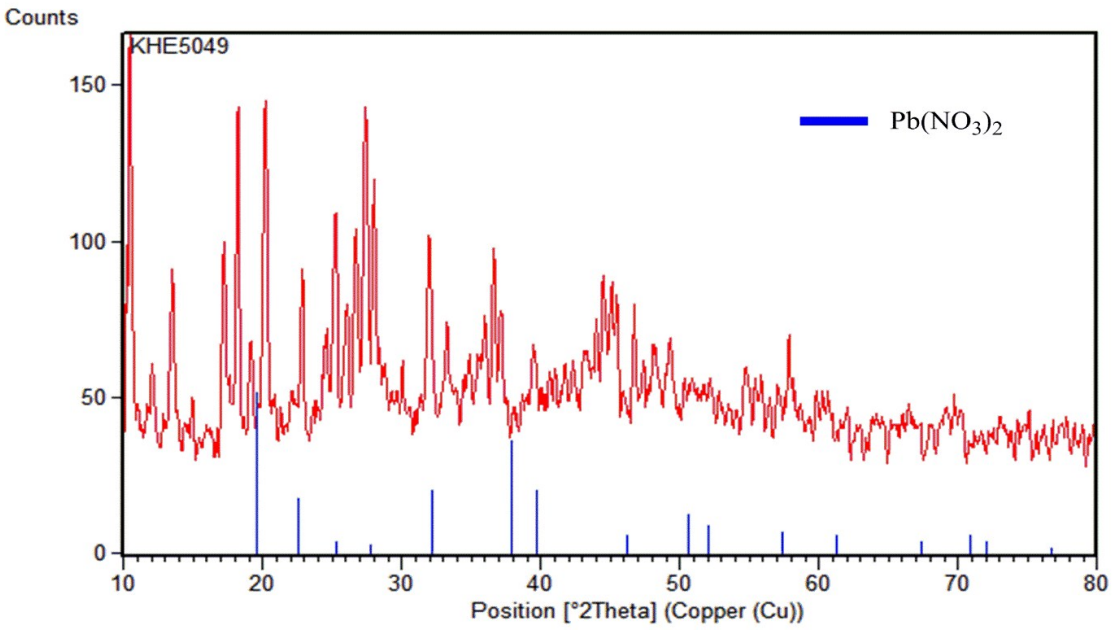
Figure S8. a) XRD pattern of Dy-MOF b) XRD pattern of Dy-MOF in high acidic solution (pH=3.5)


after adsorption (Pb)
after adsorption (Cu)
as-synthesized
Simulated
Intensity (a.u)
5
10
15
20
25
30
35
40
45
50
55
2θ (°)

(a)


Counts
KHE5050
100
50
0
Cu(NO3)2·3H2O
Cu2(OH)3NO3
10
20
30
40
50
60
70
80
Position [°2Theta] (Copper (Cu))

(b)



(c)

Figure S9. Simulated, as-synthesized and after adsorption XRD patterns of Dy-MOF (a) Dy-MOF after adsorption of copper(II) nitrate, related copper nitrate hydrate oxide and copper nitrate hydroxide PXRD patterns were shown under the framework PXRD pattern (b) Dy-MOF after adsorption of lead(II) nitrate, related Lead(II) nitrate PXRD pattern was shown under the framework PXRD pattern (c).

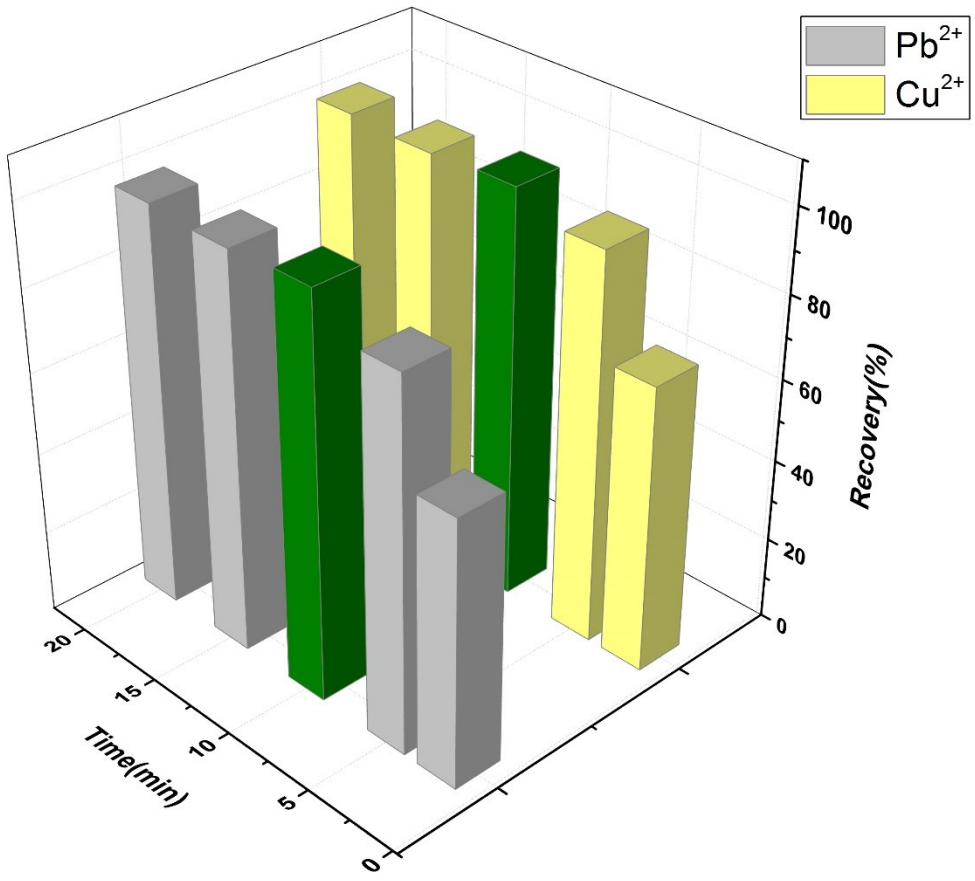


Figure S10. Effect of adsorption time on extraction efficiency. Extraction conditions: sample solution, 50 mL of 100 μg L^{-1} target metal ions at pH 6.5; eluent, 2 mL of 0.1 M HNO_3; extraction time, 10 min; desorption time, 5 min.

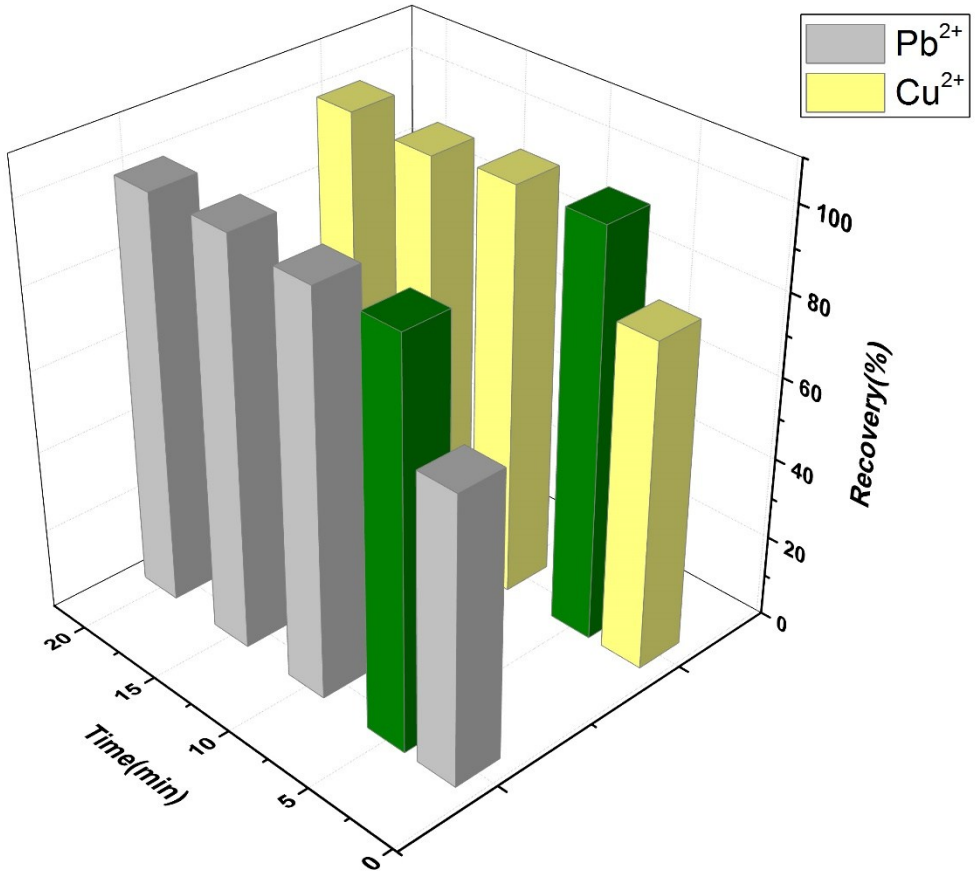


Figure S11. Effect of desorption time on extraction efficiency. Extraction conditions: sample solution, 50 mL of 100 μg L^{-1} target metal ions at pH 6.5; eluent, 2 mL of 0.1 M HNO_3; extraction time, 10 min; desorption time, 5 min.

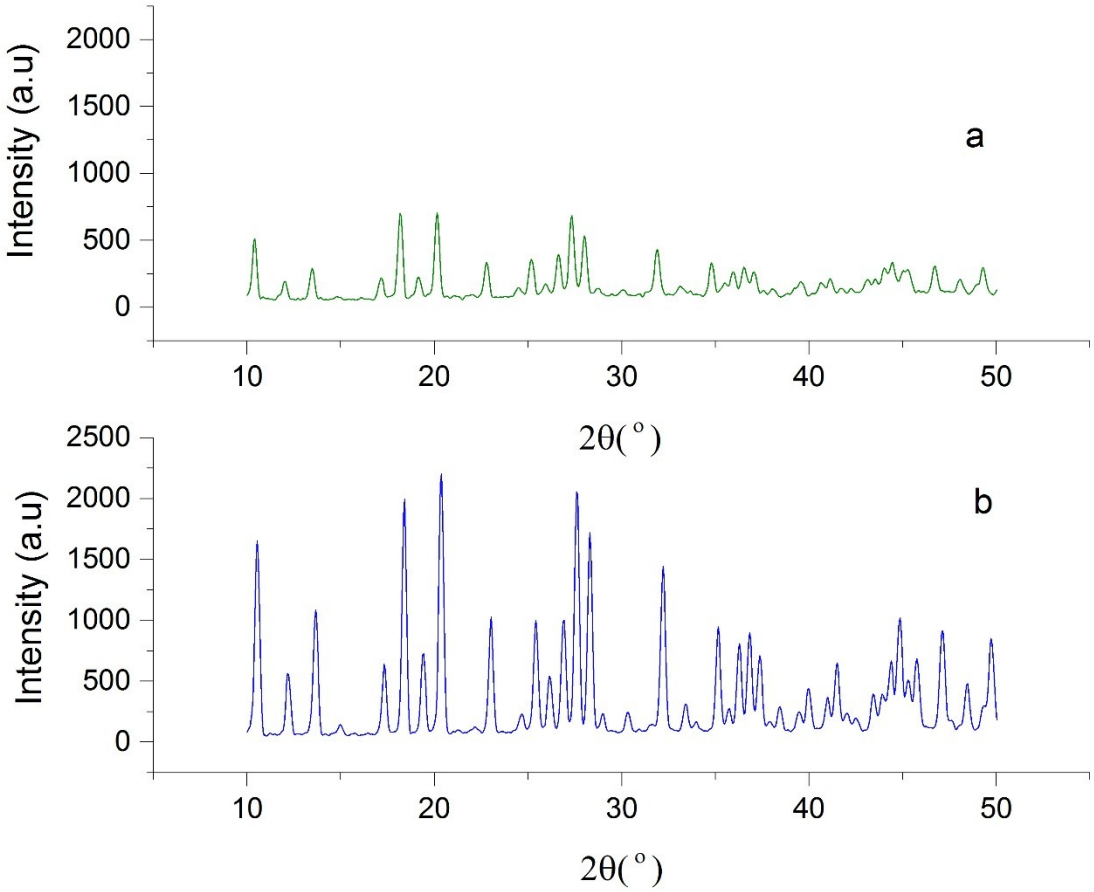


Figure S12. a) XRD pattern of Dy-MOFs after desorption of heavy metal ions. b) XRD pattern of Dy-MOF

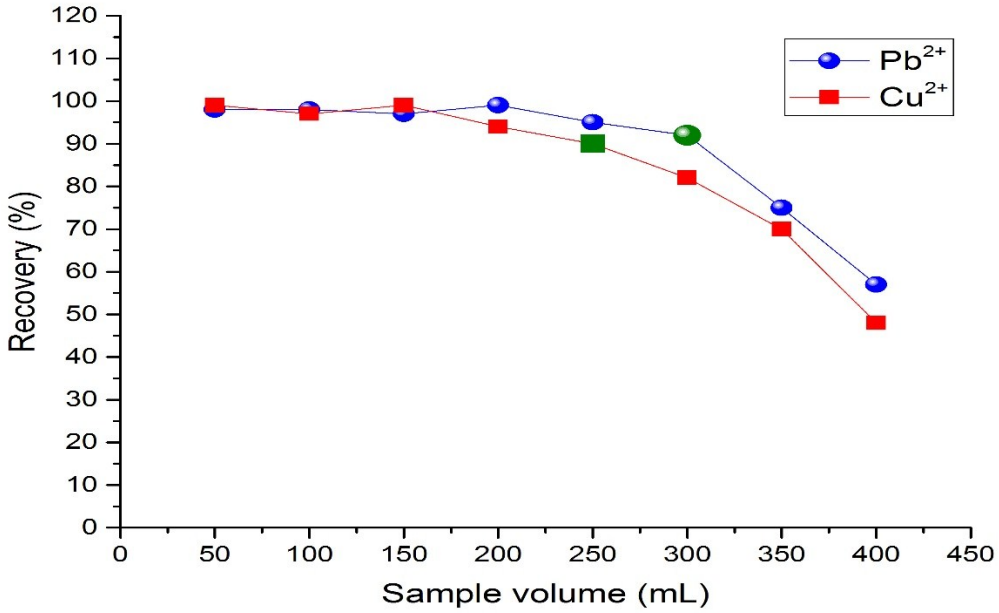


Figure S13. Effect of sample volume. Extraction conditions: sample solution, 100 μg L^{-1} target metal ions at pH 6.5; eluent, 2 mL of 0.1 M HNO_3; extraction time, 10 min; desorption time, 5 min.

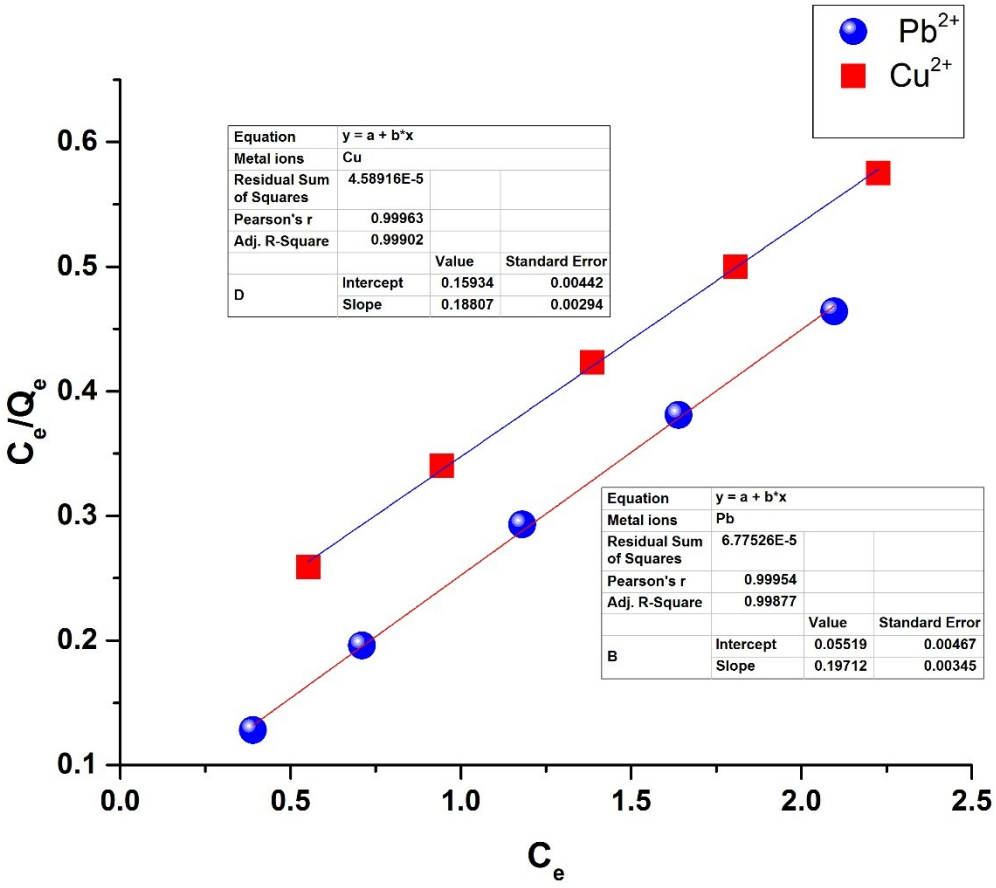


Figure S14. Langmuir isotherm for Pb(II) and Cu(II) ions

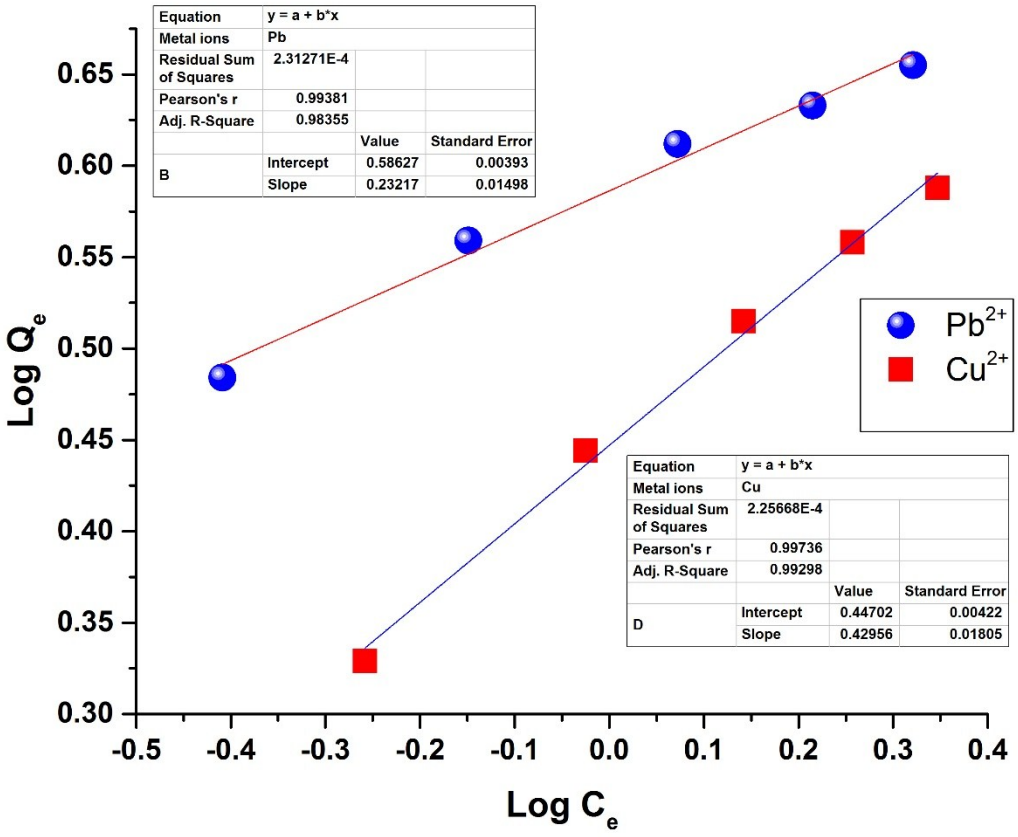


Figure S15. Freundlich isotherm for Pb(II) and Cu(II) ions

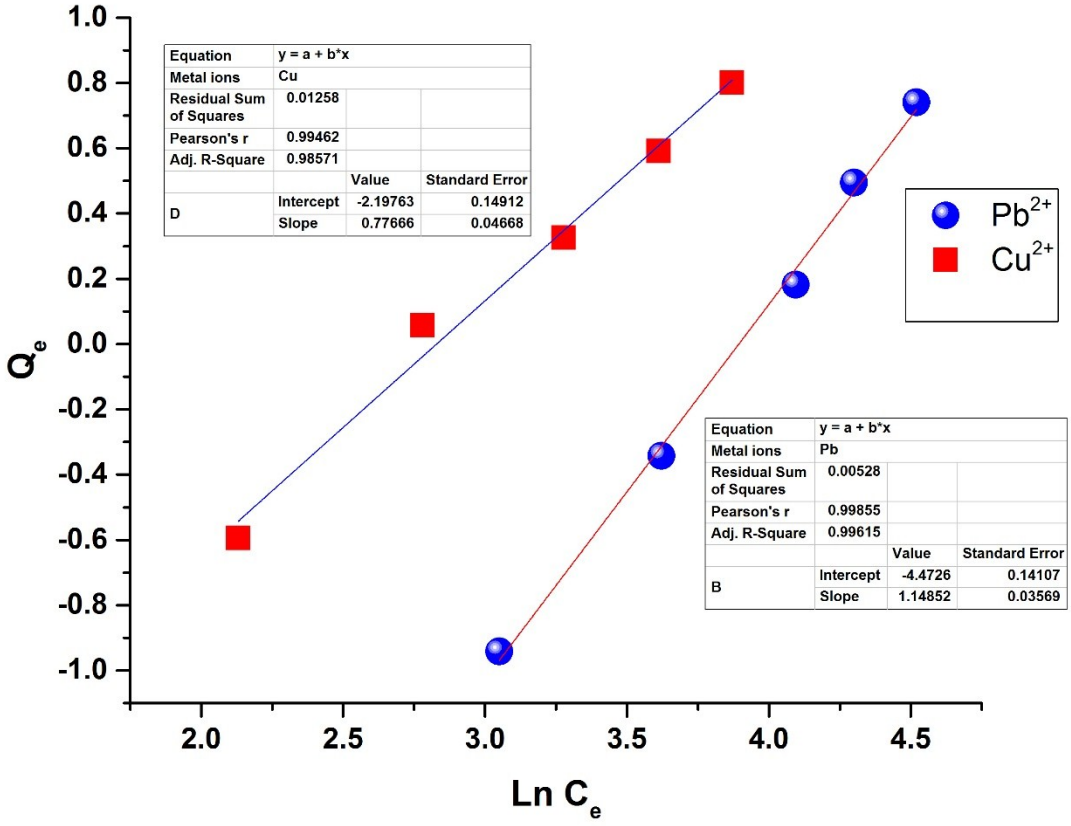


Figure S16. Temkin isotherm for Pb(II) and Cu(II) ions

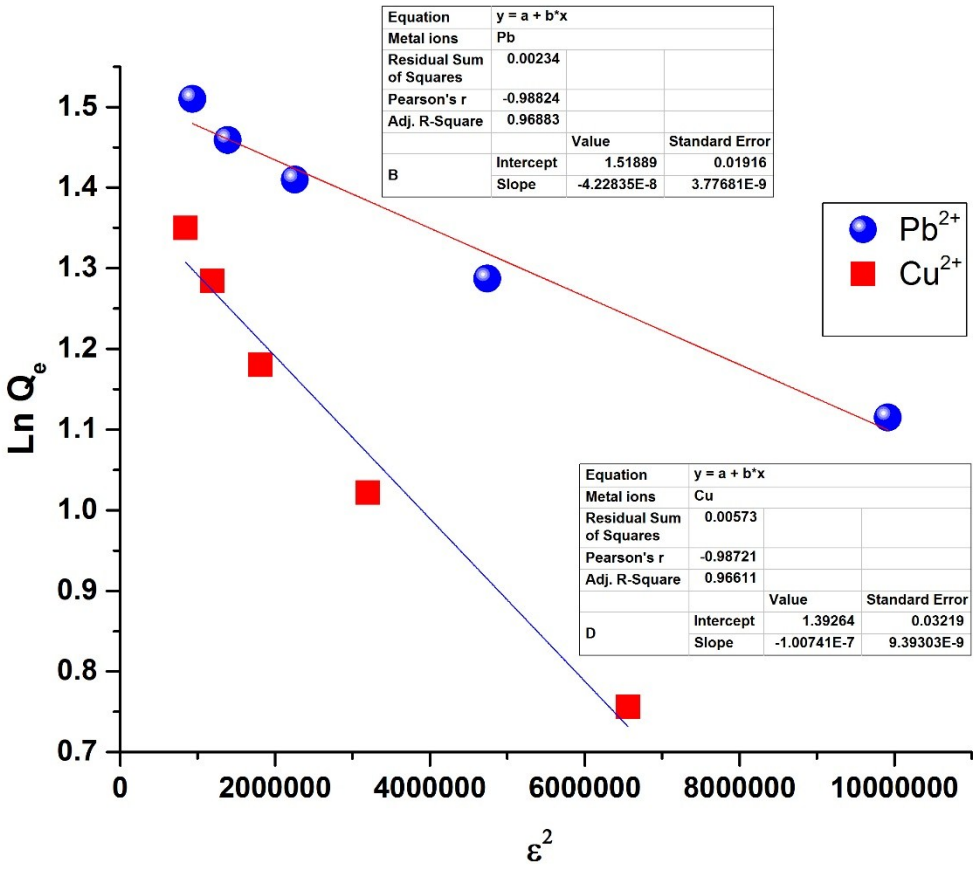


Figure S17. Dubinin–Radushkevich isotherm for Pb(II) and Cu(II) ions

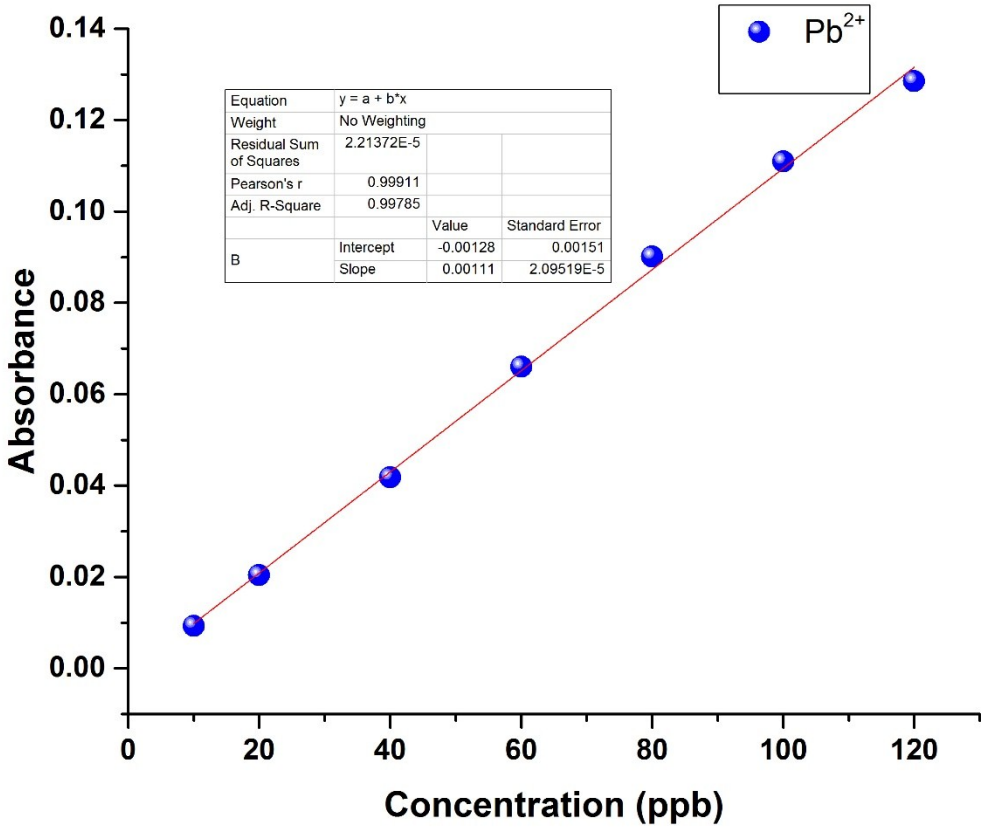


Figure S18. Calibration curve of Pb(II)

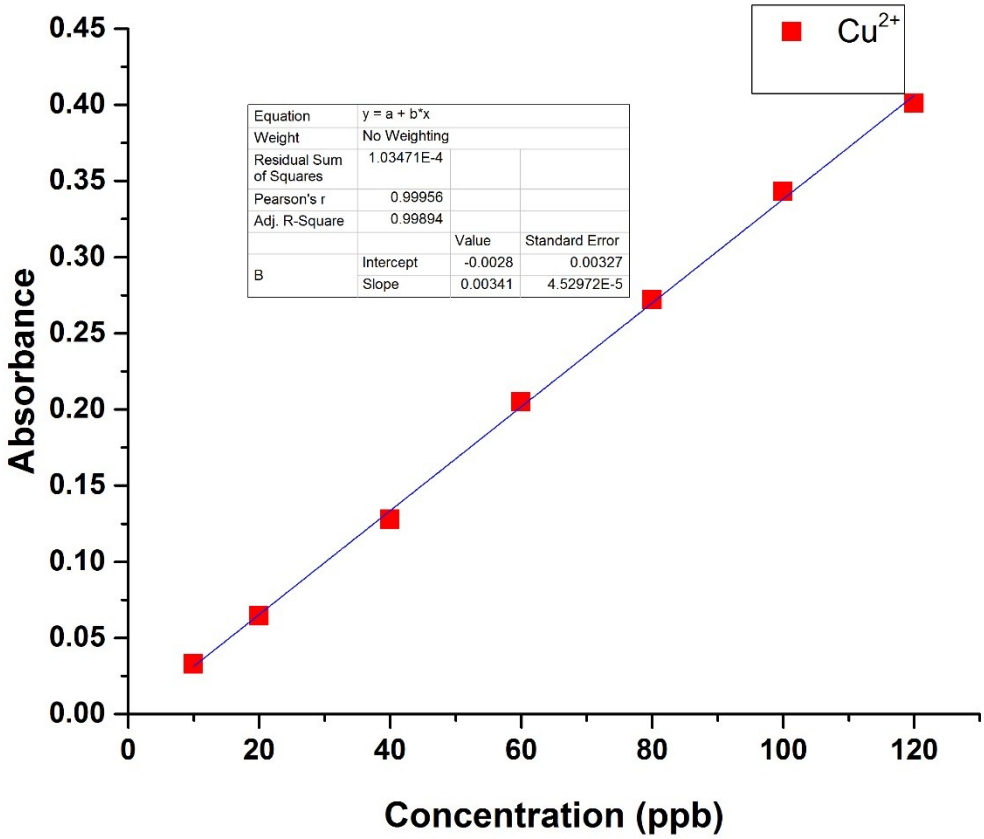


Figure S19. Calibration curve of Cu(II)

Table S1. Parameters for plotting Langmuir, Freundlich, Temkin and Dubinin-Radushkevich Adsorption Isotherms of Pb(II) ion

C_0(mg/L)	C_e(mg/L)	Q_e(mg/g)	C_e/Q_e (g/L)	$LogC_e$	$LogQ_e$	LnC_e	LnQ_e	ε^2
1	0.390	3.050	0.128	-0.409	0.484	-0.942	1.115	9914779
1.5	0.710	3.622	0.196	-0.149	0.559	-0.342	1.287	4742567
2	1.200	4.095	0.293	0.079	0.612	0.182	1.410	2255235
2.5	1.640	4.300	0.381	0.215	0.633	0.495	1.459	1391287
3	2.096	4.520	0.464	0.321	0.655	0.740	1.510	934027

Table S2. Parameters for plotting Langmuir, Freundlich, Temkin and Dubinin-Radushkevich Adsorption Isotherms of Cu(II) ion

C_0(mg/L)	C_e(mg/L)	Q_e(mg/g)	C_e/Q_e (g/L)	$LogC_e$	$LogQ_e$	LnC_e	LnQ_e	ε^2
1	0.552	2.13	0.259	-0.258	0.329	-0.594	0.756	6559705
1.5	0.944	2.78	0.340	-0.025	0.444	-0.058	1.022	3203166
2	1.386	3.276	0.423	0.142	0.515	0.326	1.187	1811197
2.5	1.806	3.612	0.500	0.257	0.558	0.591	1.284	1191875
3	2.226	3.87	0.575	0.347	0.588	0.800	1.350	845056