Glycine-assisted evolution of palygorskite via one-step hydrothermal process as an efficient adsorbent for capturing Pb(II) ions

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I. Supplementary Figures, Tables and discussion

Table S1 The content of PAL samples elements (C, H and N)

Sample	N (%)	C (%)	H (%)
RPAL	0.06	0.20	1.523
GLY-PAL	0.4	0.99	1.181

The EDS analysis and Elemental mapping

The content of main elements was determined by element energy spectrum analysis and elemental mapping. Fig.S1, S2, S3 and S4 showed the EDS analysis and Elemental mapping of GLY-PAL and RPAL samples. By comparing with them, it can be seen that the N element became obvious after modification. The result indicated that the GLY molecules successfully reacted with PAL.

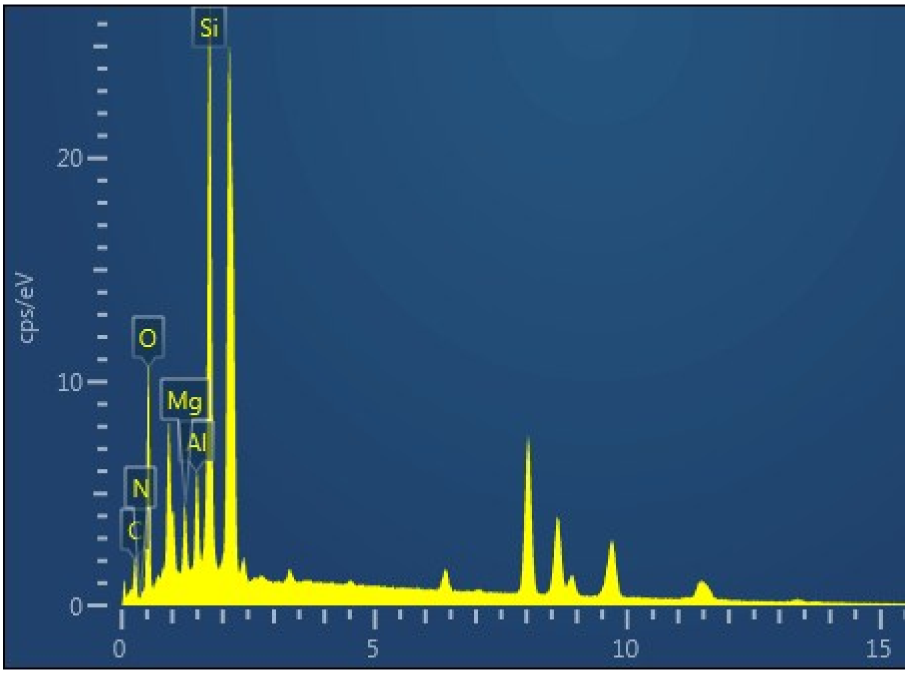


Fig. S1 The EDS analysis of GLY-PAL samples

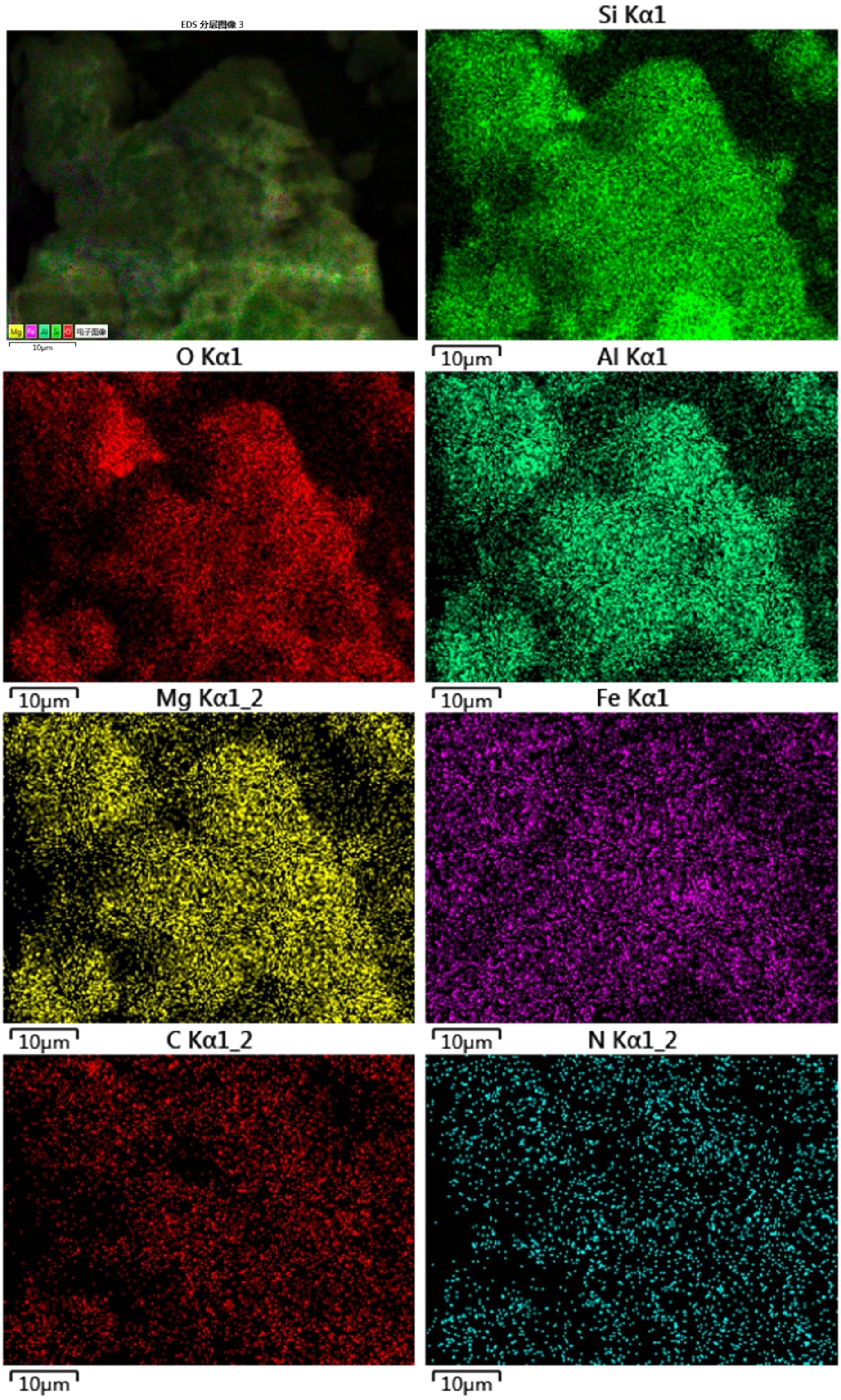


Fig. S2 The Elemental mapping of GLY-PAL sample

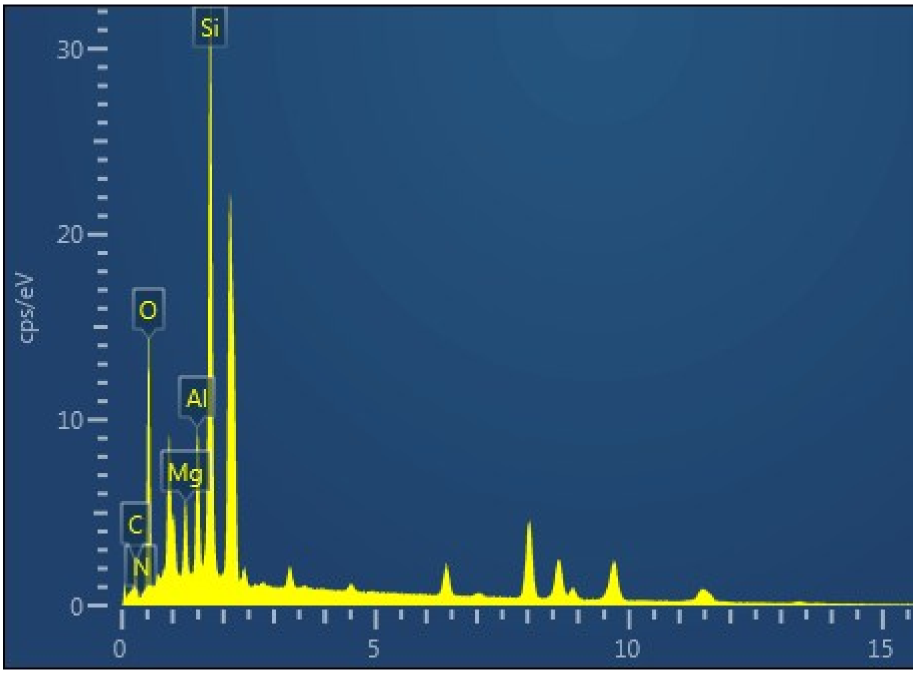


Fig. S3 The EDS analysis of RPAL samples

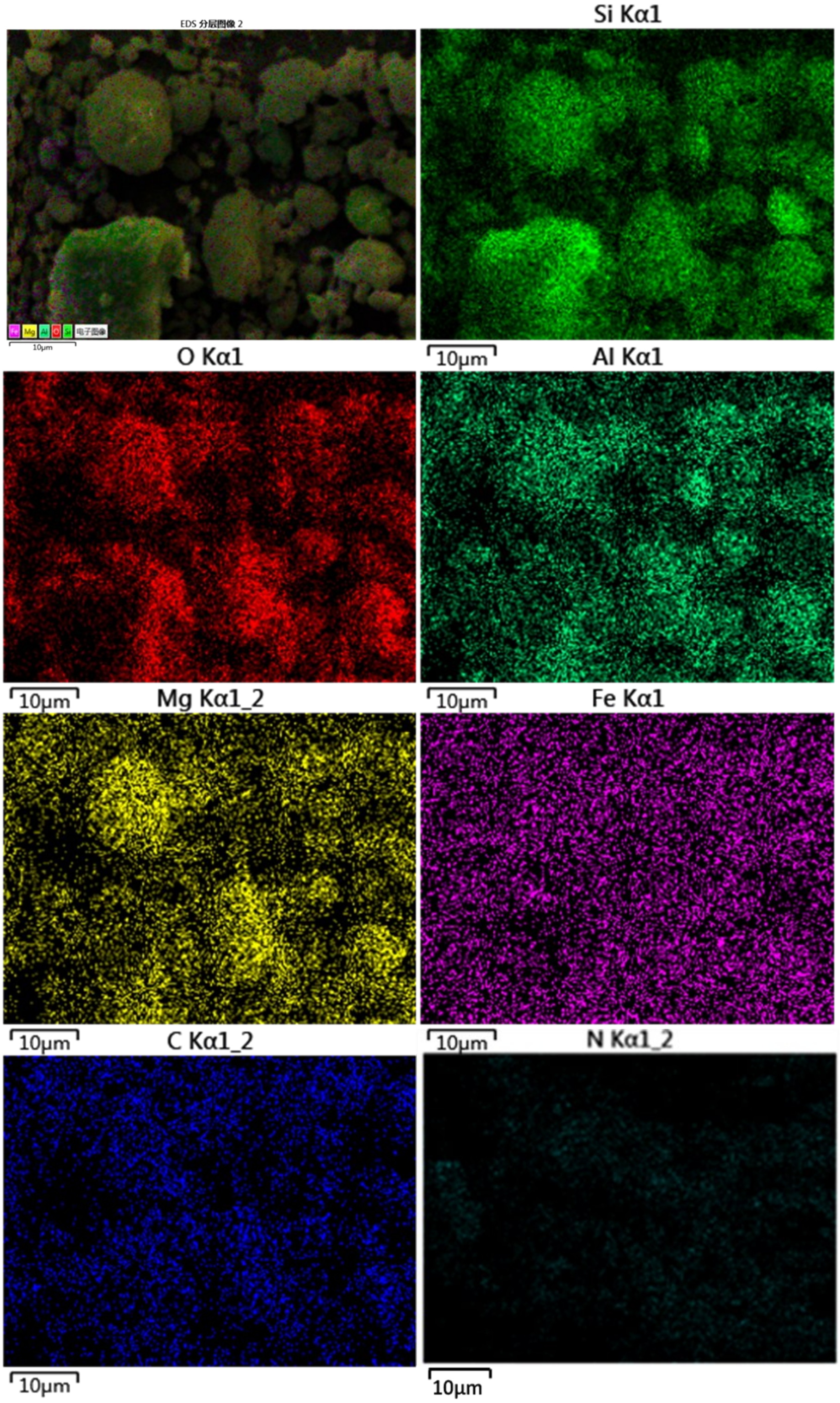


Fig. S4 The Elemental mapping of RPAL samples

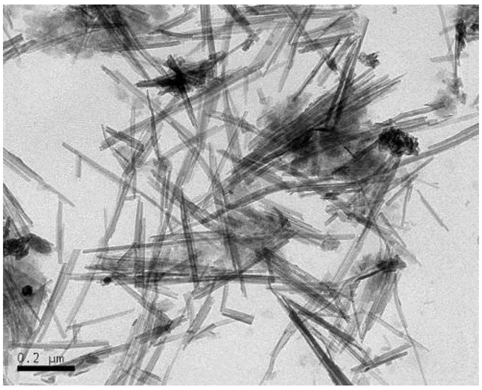
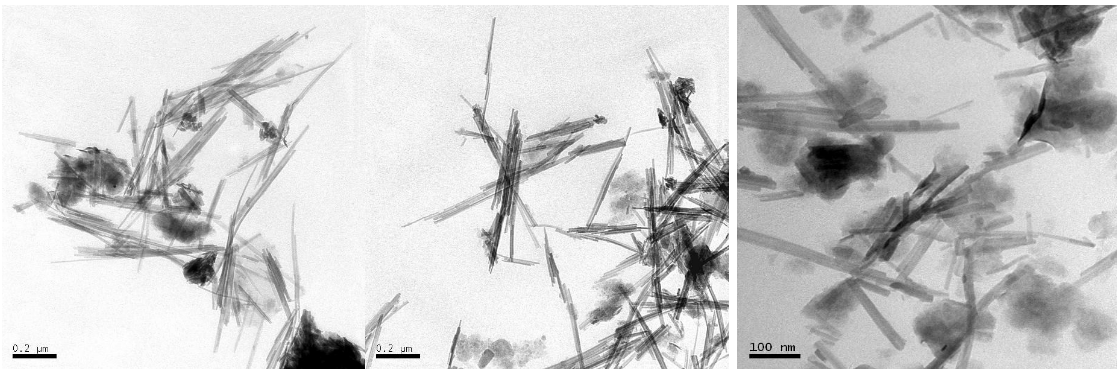


Fig. S5 TEM image of BPAL (PAL treated by direct hydrothermal process at pH 12, without adding GLY)



pH 4 pH 7 pH 9

Fig. S6 The TEM images of the PAL after hydrothermal treatment at pHs 4, 7 and 10 in the solution of 0.5 mol/L.

Control experiments

The experiment procedure is similar to that described in section 2.2 in the main document except without adding GLY (the prepared sample was marked as BPAL). The adsorption capacity of BPAL for Pb(II) ions is 63.06 mg/g (Fig. S7).

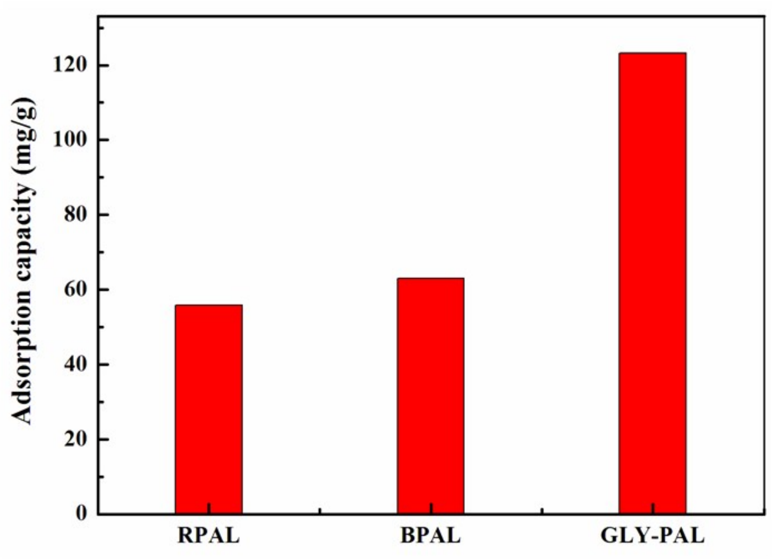


Fig. S7. The adsorption of different samples for Pb(II) ions

Selective adsorption

The experiment procedure is similar to that described in section 2.3 in the main document, while the test methods of Cu (II) and Zn (II) are used to detect Cu (II) and Zn (II) ions in the solution, respectively. The adsorption capacity of GLY-PAL for Cu (II) and Zn (II) ions is 27.56 mg/g and 27.63 mg/g (Fig. S8).

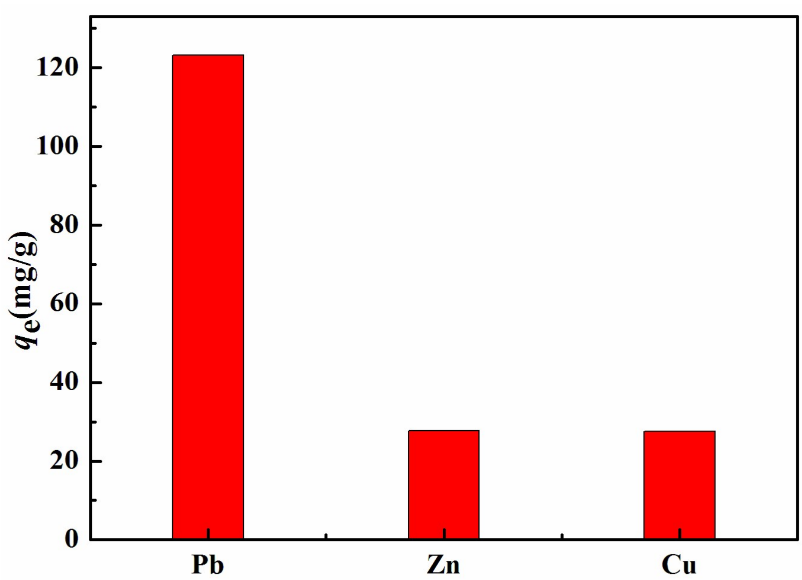


Fig. S8. The adsorption of GLY-PAL samples for Pb(II), Cu (II) and Zn (II) ions

The BET analysis

The N_2 adsorption-desorption isotherm of GLY-PAL before and after adsorbing Pb(II) ions was measured and the microstructure parameters calculated by BJH method were listed in Table S2. The S_{BET} of GLY-PAL is 148.75 m^2/g, with the micropore surface area (S_{micro}) of 26.98 m^2/g and external surface area (S_{ext}) of 121.77 m^2/g. The average pore size (PZ) is 7.07 nm, the pore volume (V_{total}) is 0.2630 cm^3/g and the micropore volume (V_{micro}) is 0.0137 cm^3/g. After adsorbing Pb(II) ions, all the microstructure parameters decrease. And the S_{BET}, S_{micro}, S_{ext}, PZ, V_{total} and V_{micro} values decrease to 113.96 m^2/g, 16.45 m^2/g, 97.52 m^2/g, 6.62 nm, 0.1886 cm^3/g and 0.0088 cm^3/g. The results indicate Pb(II) ions interact with GLY-PAL and block the pore or tunnel in the GLY-PAL.

Table S2 Microstructure parameters of GLY-PAL samples after adsorbing Pb(II) ions

Sample	S_{BET}/(m^2/g)	S_{micro}/(m^2/g)	S_{ext}/(m^2/g)	V_{total}/(cm^3/g)	V_{micro}/(cm^3/g)	PZ/(nm)
RPAL	180.61	48.65	131.95	0.2647	0.0214	5.86
GLY-PAL	148.75	26.98	121.77	0.2630	0.0137	7.07
GLY-PAL-Pb	113.96	16.45	97.52	0.1886	0.0088	6.62

Fig.S9 and Fig.S10 presented the content of N element and mapping to identify the adsorption of Pb(II) ions onto GLY-PAL. As can be seen, the Pb element can be found on the sample after adsorption. The *Elemental Mapping* clearly indicates the adsorption of Pb(II) ions onto the GLY-PAL.

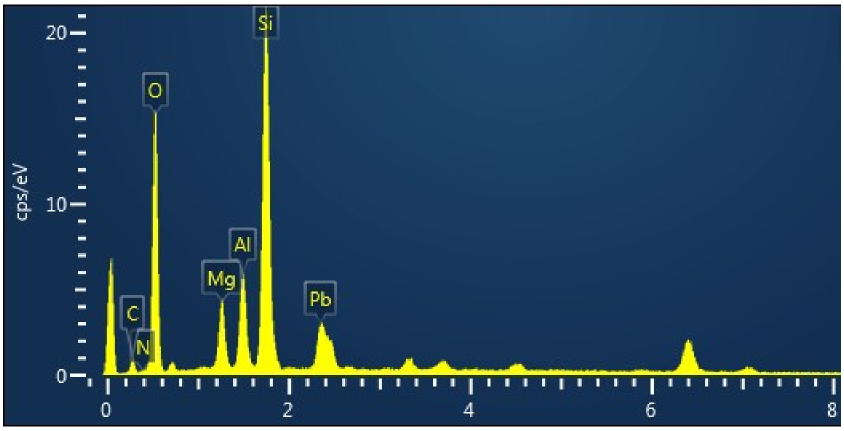


Fig. S9 The EDS spectrum of the GLY-PAL sample after adsorption Pb(II) ions

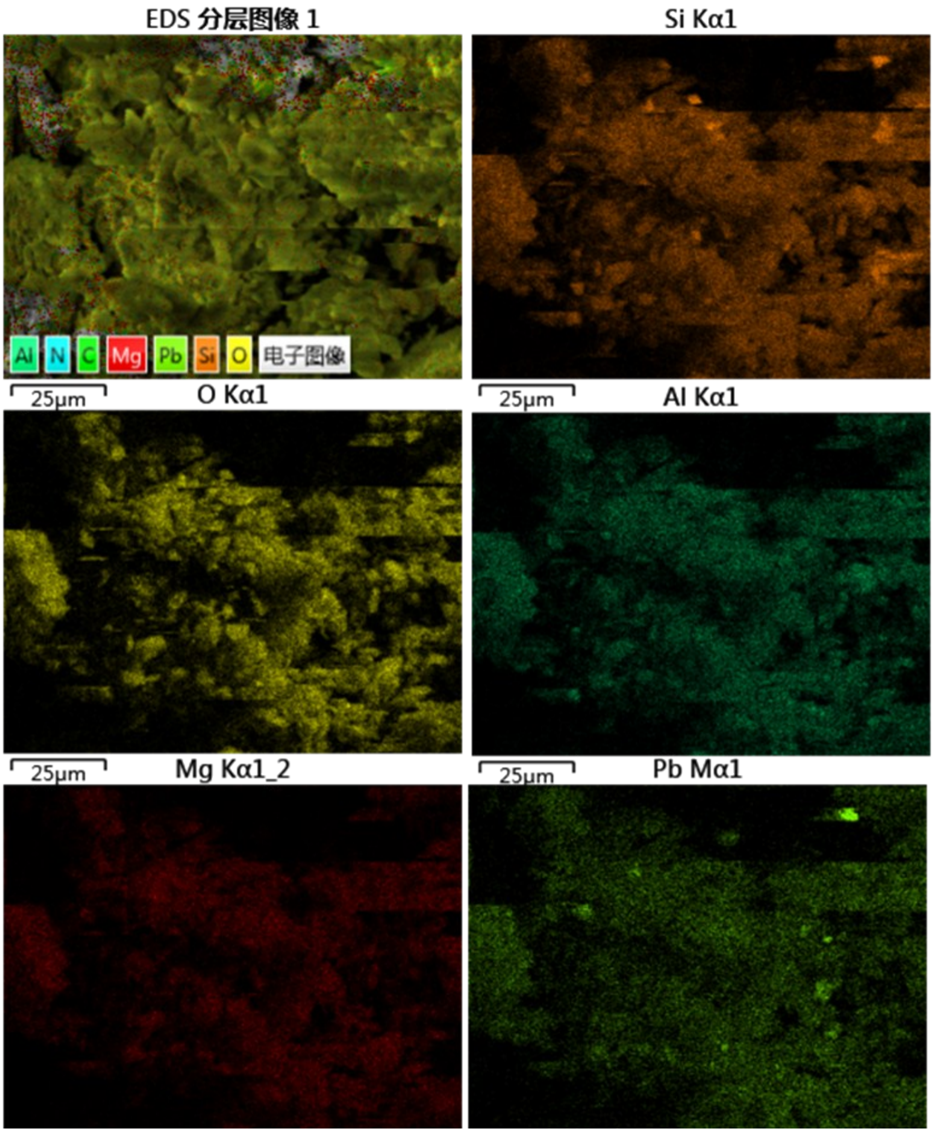


Fig. S10 The Elemental mapping of samples after adsorption of Pb(II) ions