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# Electronic Supplementary Information

## Efficient and Selective Heavy Metal Sequestration from Water by Layered Sulfide $K_{2x}Sn_{4-x}S_{8-x}$ (x=0.65-1; KTS-3)

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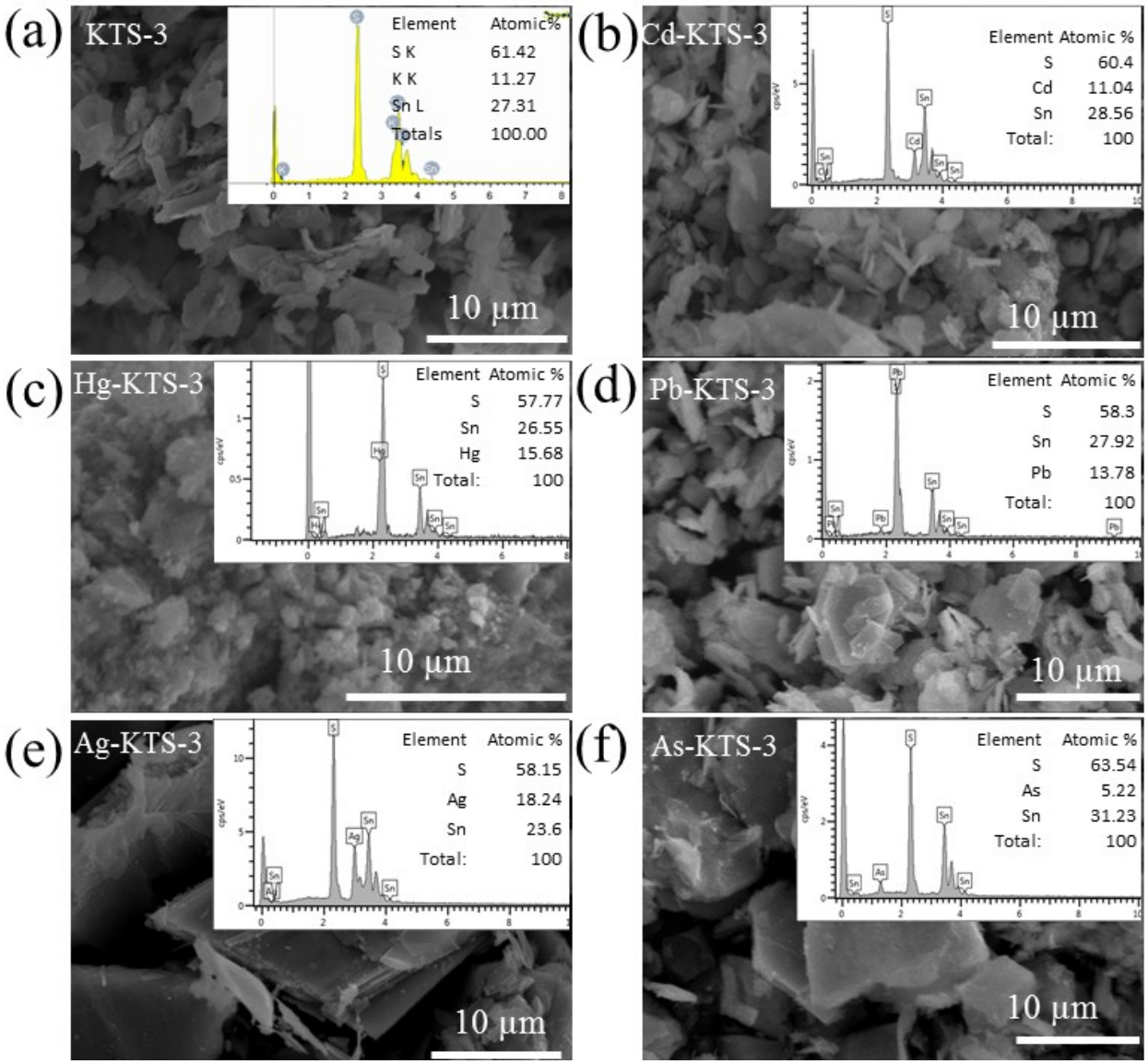


Figure S1. SEM micrograph and EDS data of (a) KTS-3 and the ion-exchanged samples (b) Cd-KTS-3, (c) Hg-KTS-3, (d) Pb-KTS-3, (e) Ag-KTS-3, and (f) As-KTS-3, respectively.

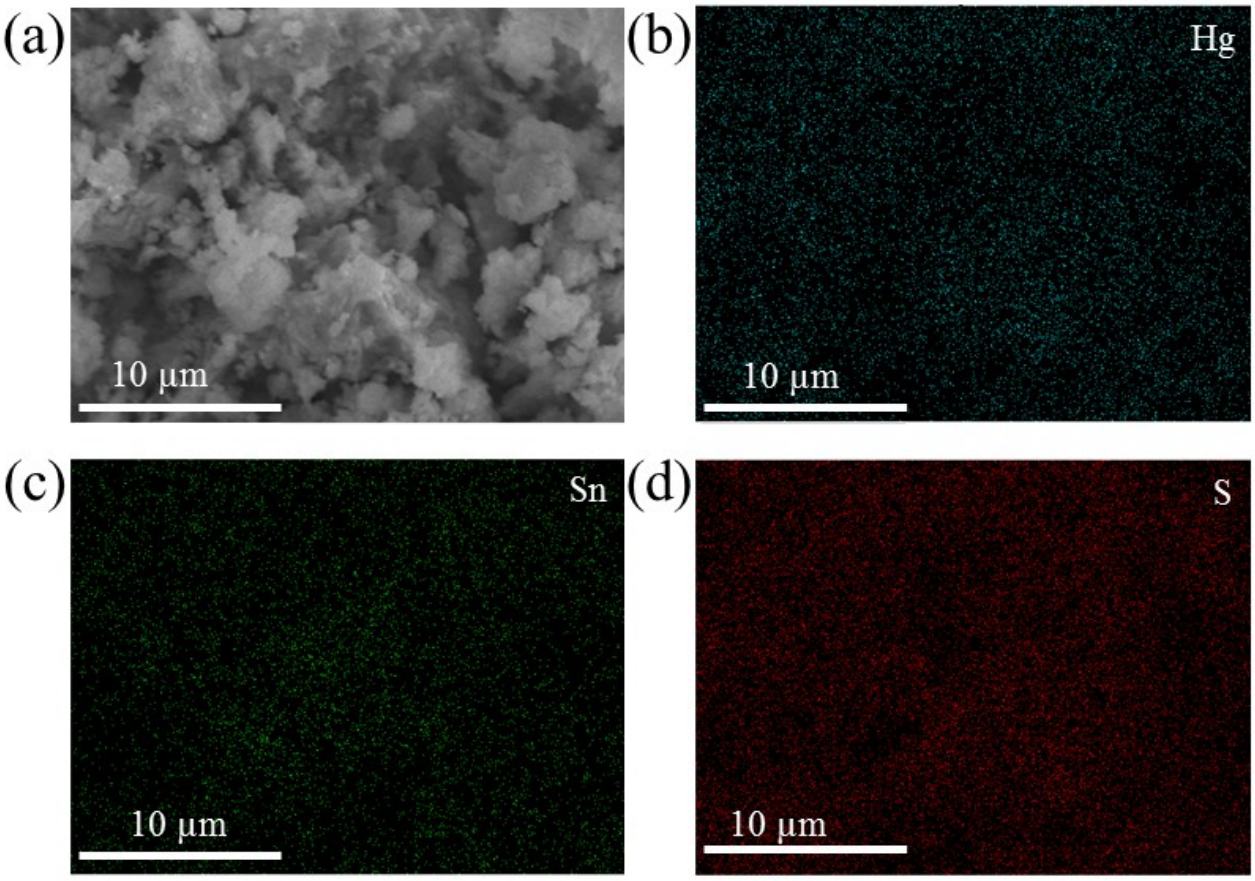


Figure S2. EDS elemental dot map of Hg-KTS-3.

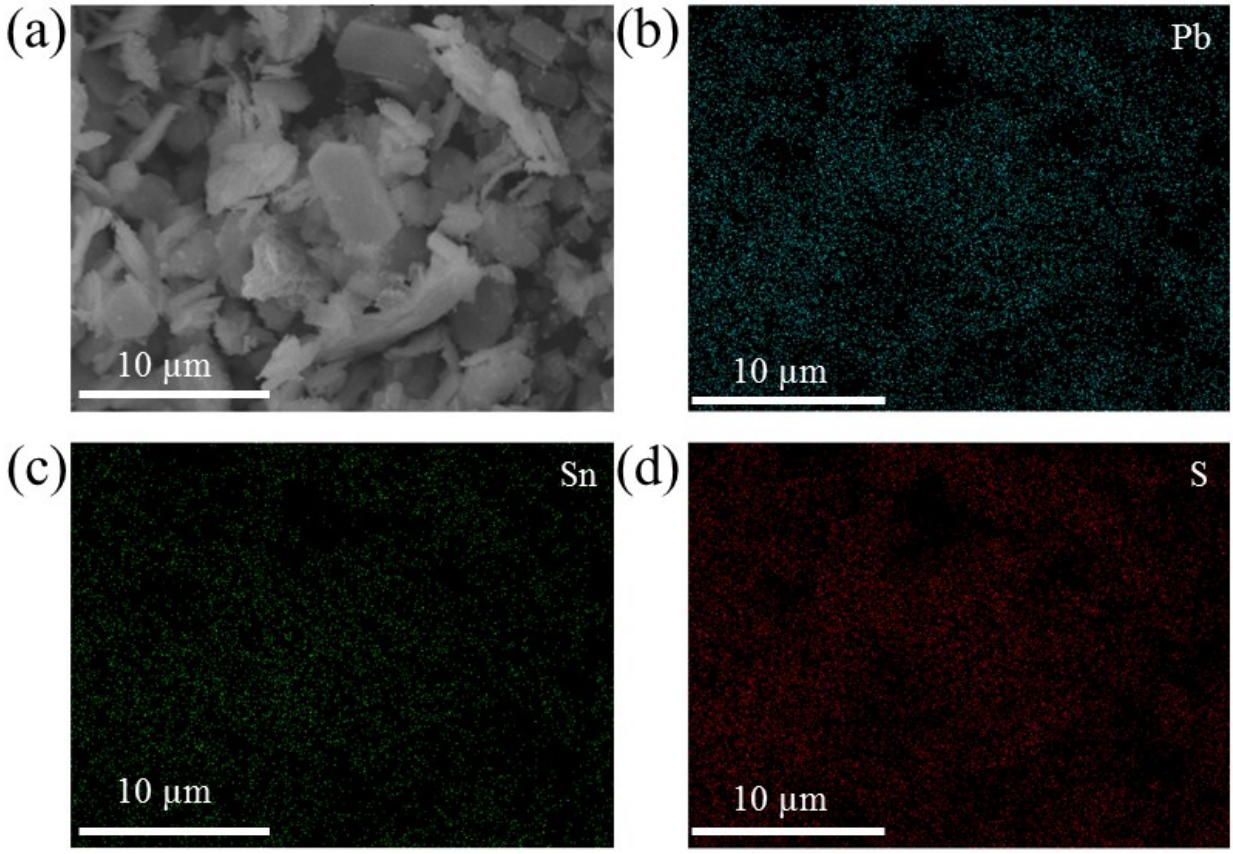


Figure S3. EDS elemental dot map of Pb-KTS-3.

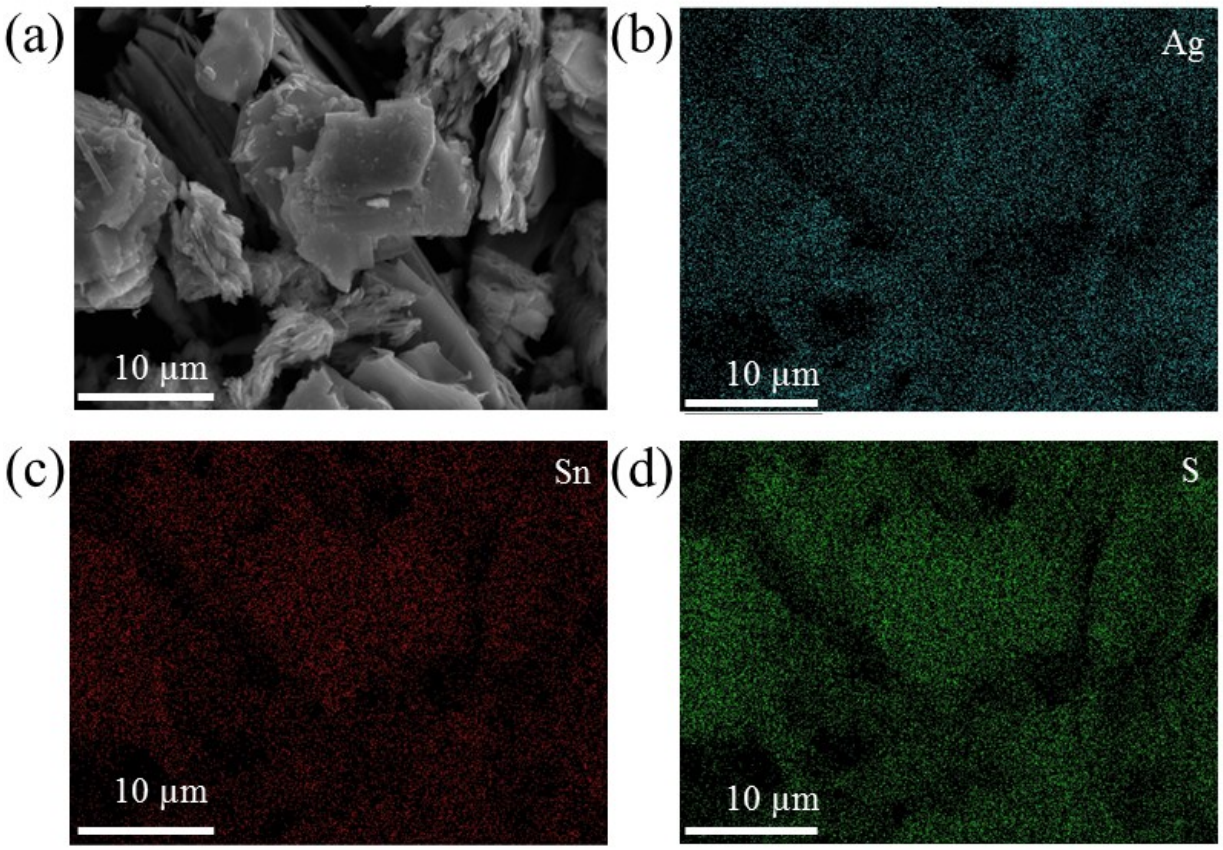

Figure S4. EDS elemental dot map of Ag-KTS-3.

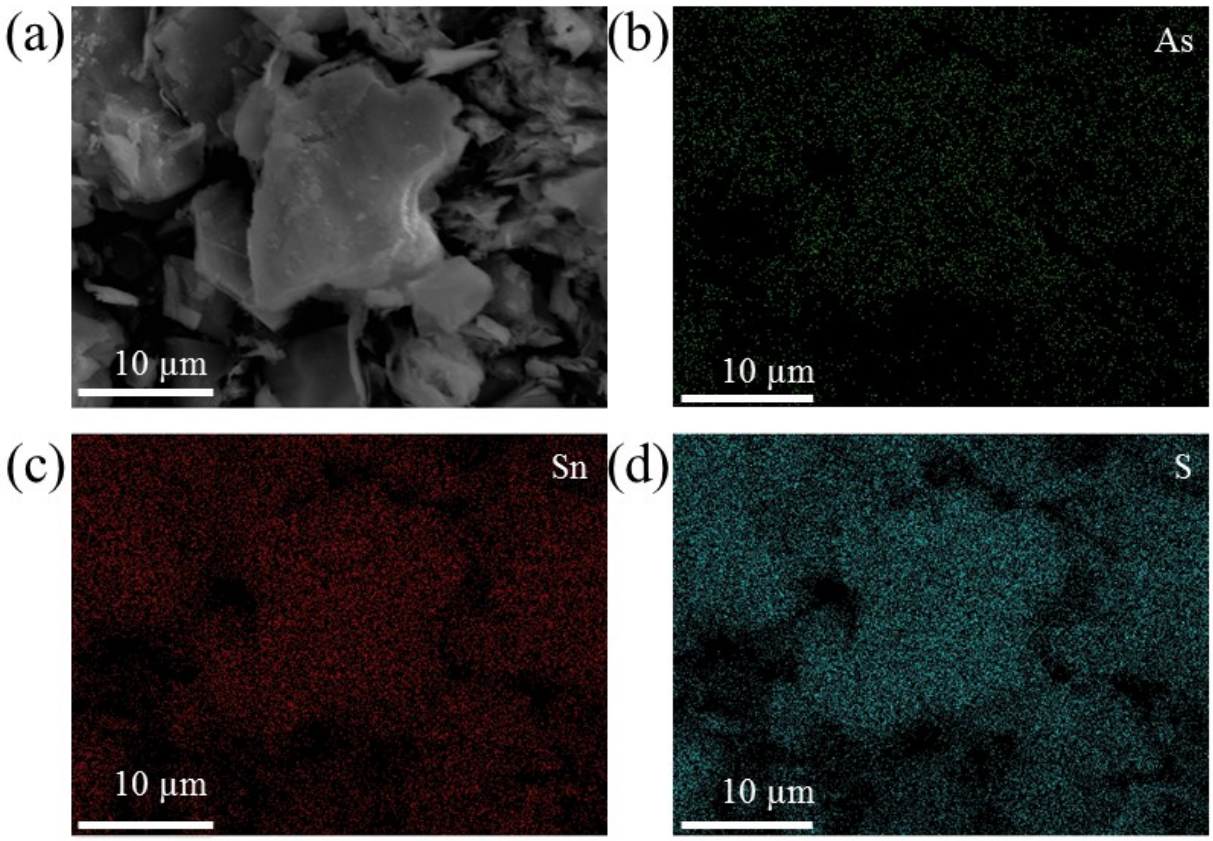


Figure S5. EDS elemental dot map of As-KTS-3.

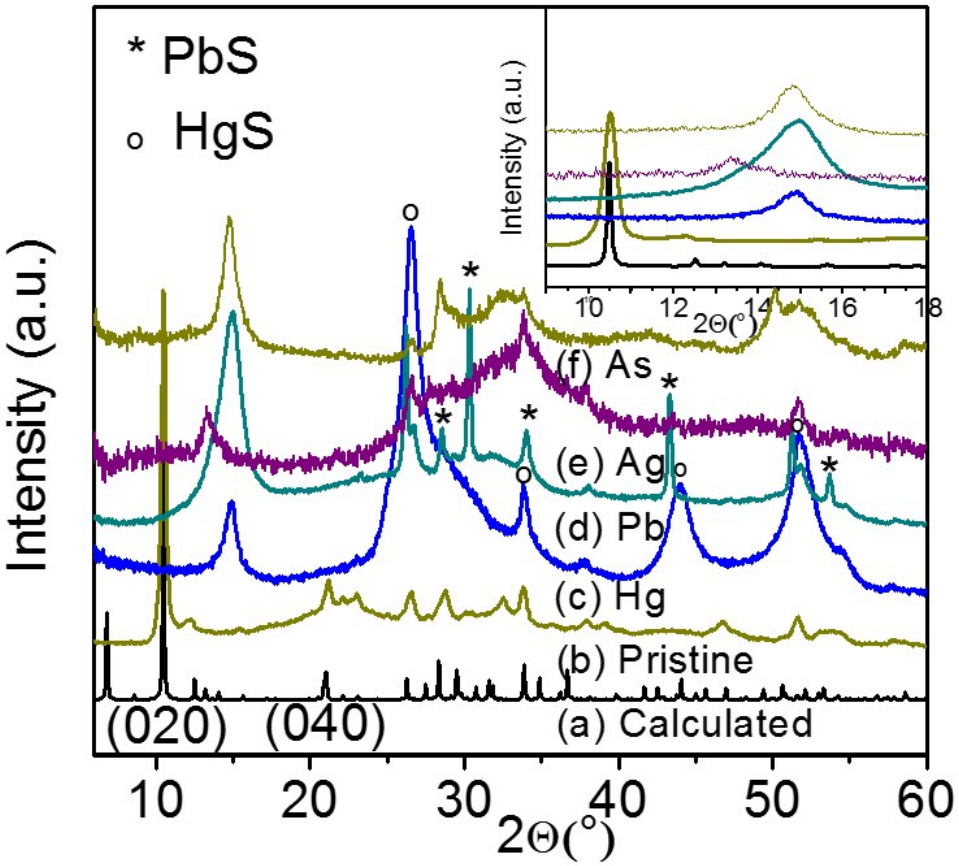


Figure S6. Powder X-ray diffraction patterns of pristine KTS-3 and the heavy metal ion-exchanged materials. The (020) and (040) reflection peaks for the exchanged materials shift towards higher 2θ (lower d spacing) indicates contraction of the interlayer distance.

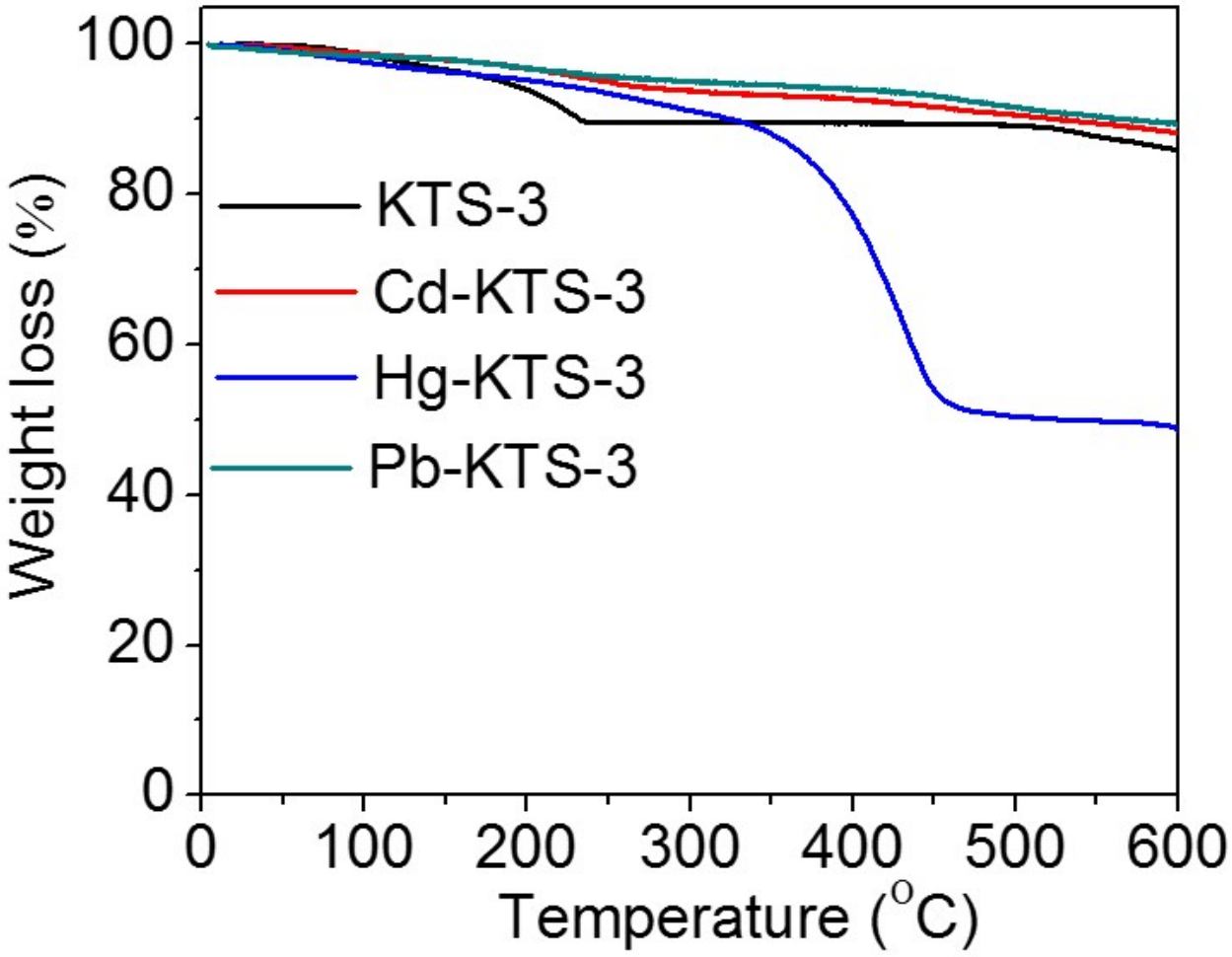


Figure S7. The TG analysis of the ion-exchanged materials.

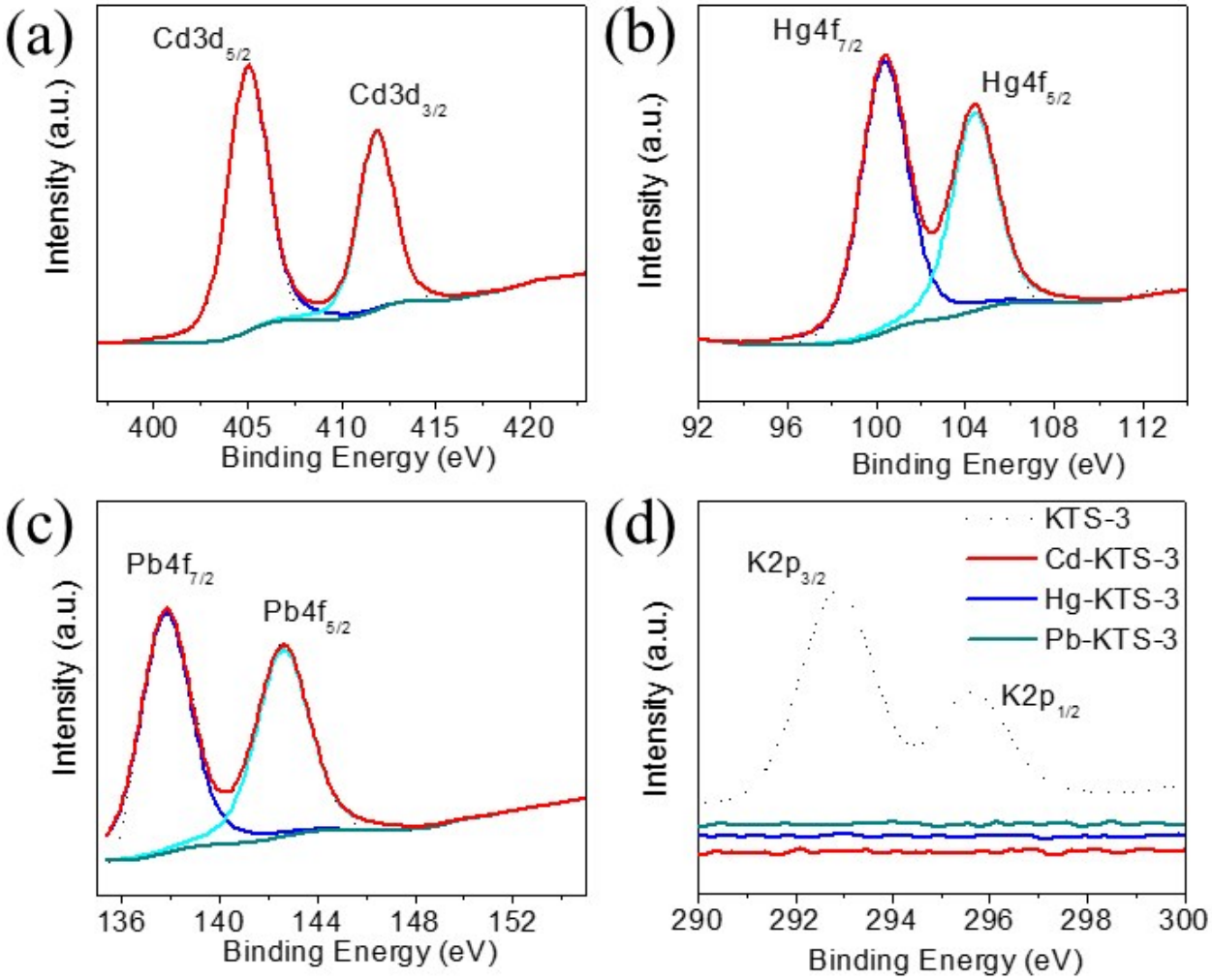


Figure S8. X-ray photoelectron spectra of (a) cadmium, (b) mercury, (c) lead and (d) potassium spectrum for the ion-exchanged materials. Dotted and solid lines represent experimental and deconvoluted spectra, respectively. Please note that no peak was observed for potassium for the heavy metal ion-exchanged materials, confirmation of complete potassium ion-exchange.

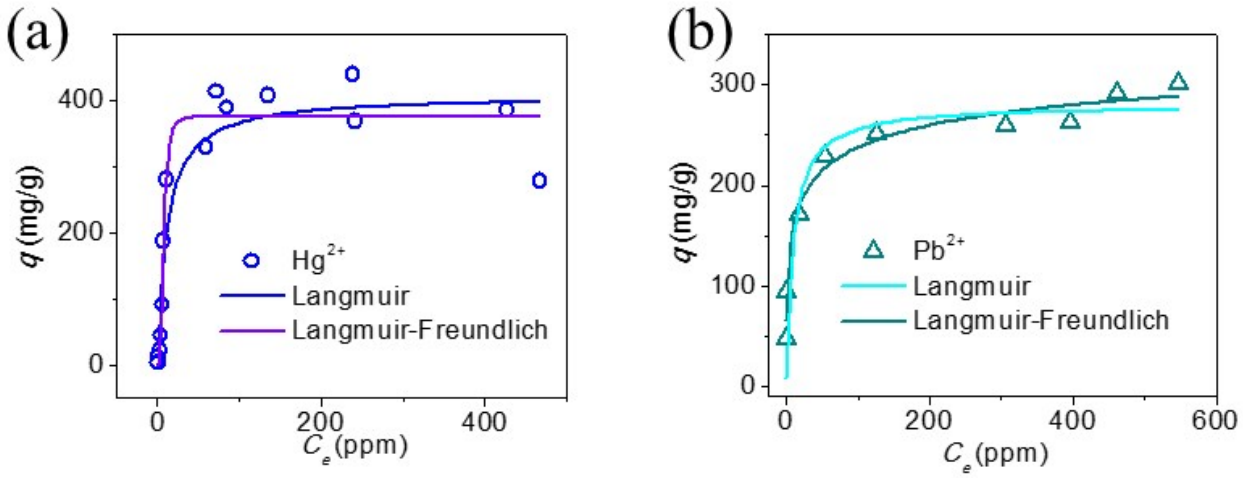


Figure S9. Equilibrium data for $Hg^{2+}$ and $Pb^{2+}$ ion-exchange, the solid data represents the fitted lines by Langmuir and Langmuir-Freundlich isotherm model.

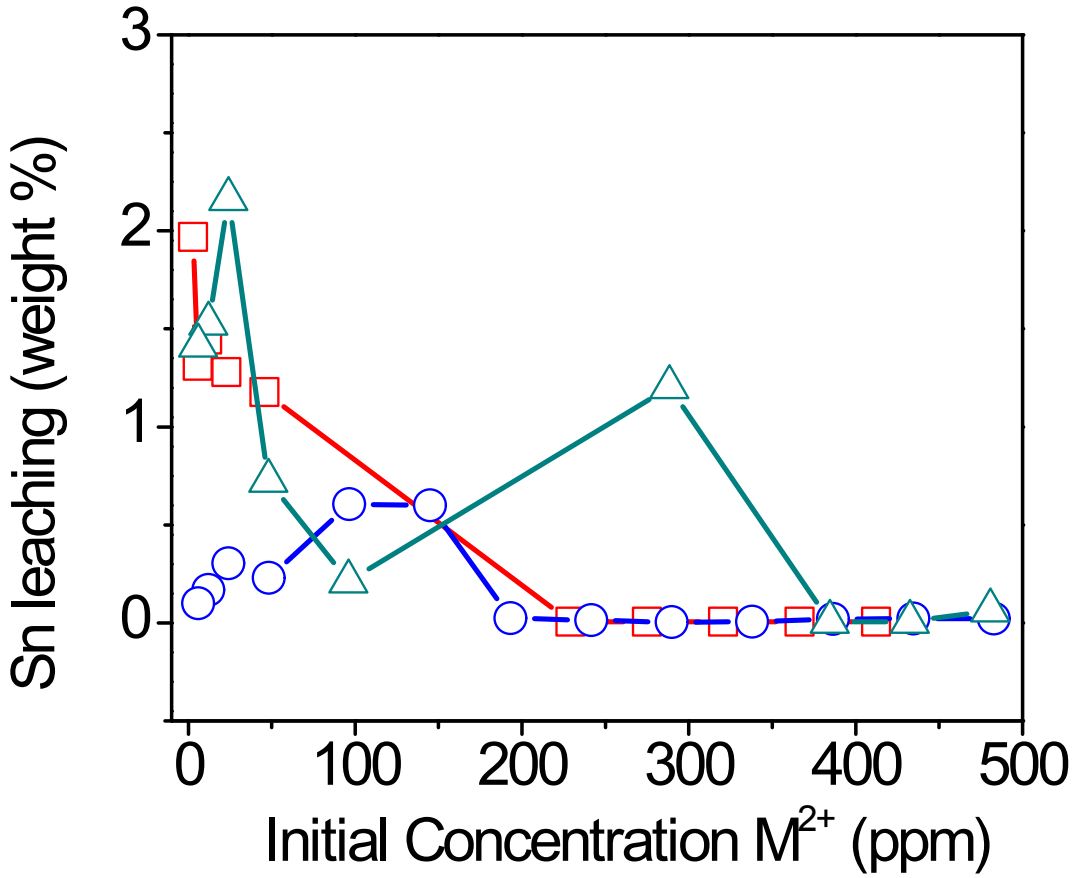


Figure S10. Plot shows the data for tin leaching (weight %) for the heavy metal ion exchange experiments of various concentrations (~5-500 ppm).

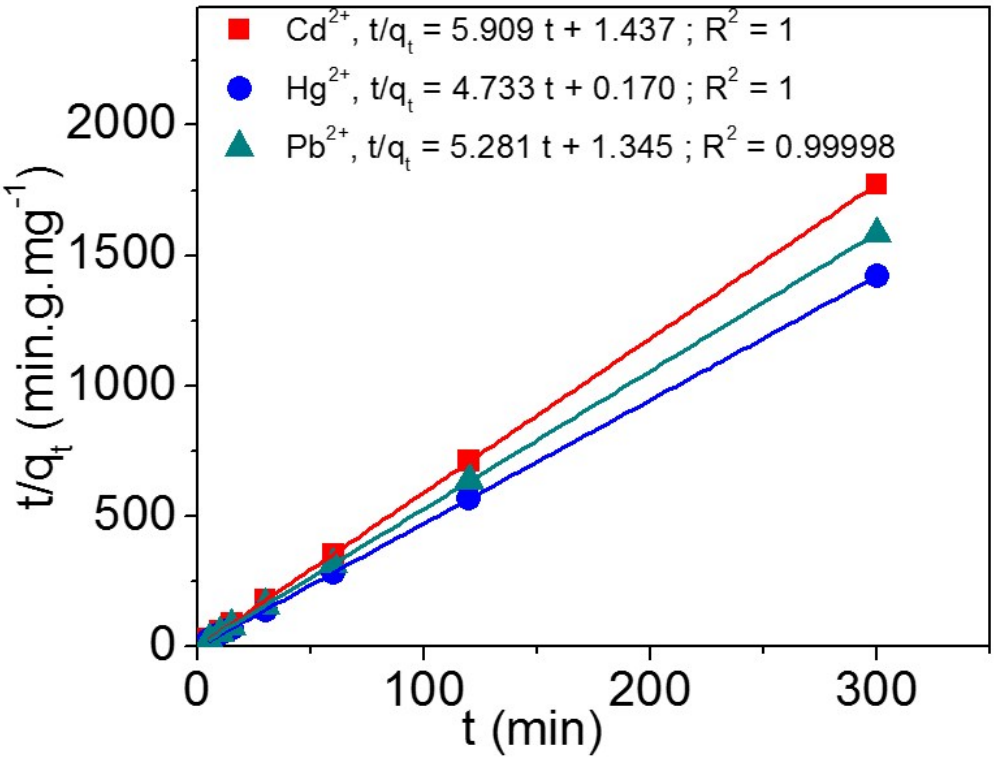


Figure S11. The plot of $t/q_t$ *vs* $t$ for the kinetics data of heavy metal ion absorption by KTS-3, which is fitted satisfactorily with the pseudo-second order kinetic model.

Table ST1. The ion exchange sorption constants obtained by fitting the isotherm data with different models.

| | $Cd^{+}$ ion exchange | | $Hg^{2+}$ ion exchange | | $Pb^{2+}$ ion exchange | |
|---|---|---|---|---|---|---|
| | Langmuir | Langmuir-Freundlich | Langmuir | Langmuir-Freundlich | Langmuir | Langmuir-Freundlich |
| $q_e$(mg/g) | 209 (13) | 204(17) | 408 (25) | 377 (14) | 280 (19) | 391(88) |
| $b$(L/mg) | 0.28 (9) | 0.32(14) | 0.09(3) | 0.14 (1) | 0.11 (6) | 0.04(6) |
| $n$ | - | 0.9 (4) | - | 0.32 (9) | - | 2.9 (7) |
| $R^2$ | 0.890 | 0.877 | 0.894 | 0.945 | 0.825 | 0.964 |

Table ST2. Summary of tin leaching (weight %) for the heavy metal ion exchange experiments of various concentrations (~5-500 ppm) with KTS-3.

| $Cd^{2+}$ | | | $Hg^{2+}$ | | | $Pb^{2+}$ | | |
|---|---|---|---|---|---|---|---|---|
| Initial (ppm) | Final (ppm ) | Sn leaching (wt %) | Initial (ppm) | Final (ppm ) | Sn leaching (wt %) | Initial (ppm) | Final (ppm ) | Sn leaching (wt %) |
| 412.324 | 207.447 | 0.005 | 482.946 | 114.236 | 0.021 | 480.644 | 53.719 | 0.064 |
| 366.51 | 161.785 | 0.005 | 386.357 | 104.497 | 0.019 | 432.58 | 30.052 | 0.005 |
| 320.696 | 122.938 | 0.005 | 338.062 | 31.88 | 0.006 | 384.515 | 7.738 | 0.005 |
| 274.882 | 0.03 | 0.005 | 241.473 | 7.814 | 0.014 | 288.386 | 5.994 | 1.202 |
| 229.069 | 46.354 | 1.176 | 144.883 | 3.241 | 0.599 | 96.128 | 2.052 | 0.21 |
| 45.813 | 5.287 | 1.278 | 48.294 | 1.241 | 0.229 | 48.064 | 1.842 | 0.725 |
| 22.906 | 2.143 | 1.444 | 24.147 | 1.639 | 0.303 | 24.032 | 1.213 | 2.162 |
| 11.4534 | 1.053 | 1.31 | 12.073 | 0.902 | 0.166 | 12.016 | 1.966 | 1.526 |
| 5.726 | 0.421 | 1.968 | 6.0368 | 0.543 | 0.1 | 6.008 | 0.023 | 1.414 |

Table ST3. Removal of $As^{3+}$ and $Ag^{+}$ from solution of various strength (10-100 ppm, V/m = 1000, pH=~7) with KTS-3.

| $As^{3+}$ ion-exchange | | | | | | |
|---|---|---|---|---|---|---|
| SL No. | KTS-3 (mg) | Initial Concentration (ppm) | Final Concentration (ppm) | Removal (%) | $K_d$ (mL/g) | $q$ (mg/g) |
| 1 | 10 | 10 | 0.093 | 99.06 | 105899.3 | 9.9 |
| 2 | 10 | 25 | 0.365 | 98.53 | 67447.5 | 24.63 |
| 3 | 10 | 50 | 3.011 | 93.97 | 15605.75 | 46.98 |
| 4 | 10 | 100 | 34.274 | 65.72 | 1917.62 | 65.72 |
| $Ag^{+}$ ion-exchange | | | | | | |
| ID | KTS-3 (mg) | Initial Concentration (ppm) | Final Concentration (ppm) | Removal (%) | $K_d$ (mL/g) | $q$ (mg/g) |
| 5 | 10 | 10 | <0.005 | >99.5 | >199000 | >9.95 |
| 6 | 10 | 25 | <0.005 | >99.8 | >499000 | >24.95 |
| 7 | 10 | 50 | <0.005 | >99.9 | >999000 | >49.95 |
| 8 | 10 | 100 | <0.005 | >99.95 | >1999000 | >99.95 |