Supporting Information

Magnetic poly-o-vanillin functionalized core-shell nanomaterials as a smart sorbent for scavenging of mercury (II) from aqueous solution

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1. Characterisation

The surface feature and size of PoVan/CoFe$_2$O$_4$@mSiO$_2$ were characterised using transmission electron microscopy (TEM, JEOL JEM 2100, Japan) and scanning electron microscopy (SEM, Quanta FEG 250, USA). X-ray diffraction (XRD, D8 Advance, Bruker, Germany) was used to analyse the crystal structure. The functional groups were characterised using Fourier transform infrared spectroscopy (FT-IR, Nicolet 6700, Thermo Scientific, USA). The magnetic strength was measured using a vibrating sample magnetometer (VSM, LakeShore7404, USA). The specific surface area (BET) was obtained using an N$_2$ adsorption-desorption apparatus (ASAP2460, USA). Finally, the binding energy of the elements contained in the materials was obtained using X-ray photoelectron spectroscopy (XPS, Thermo Scientific K-Alpha, USA). Thermal stability was surveyed by a thermogravimetric analyzer (TGA, TG209F1 Libra, Germany), and the derivative thermogravimetry (DTG) was acquired by the differential calculation for TGA.

2. EDS analysis

The EDS mapping was used to analyse the elements in the material. Fig. S1 shows the images of various elements in the material of PoVan/CoFe$_2$O$_4$@mSiO$_2$. From the image, six elements of Co, Fe, C, N, O and Si appear correspondingly and are evenly distributed on the surface of the material, which confirms that the polymer was successfully loaded onto the particles of the magnetic nanomaterial CoFe$_2$O$_4$@mSiO$_2$.
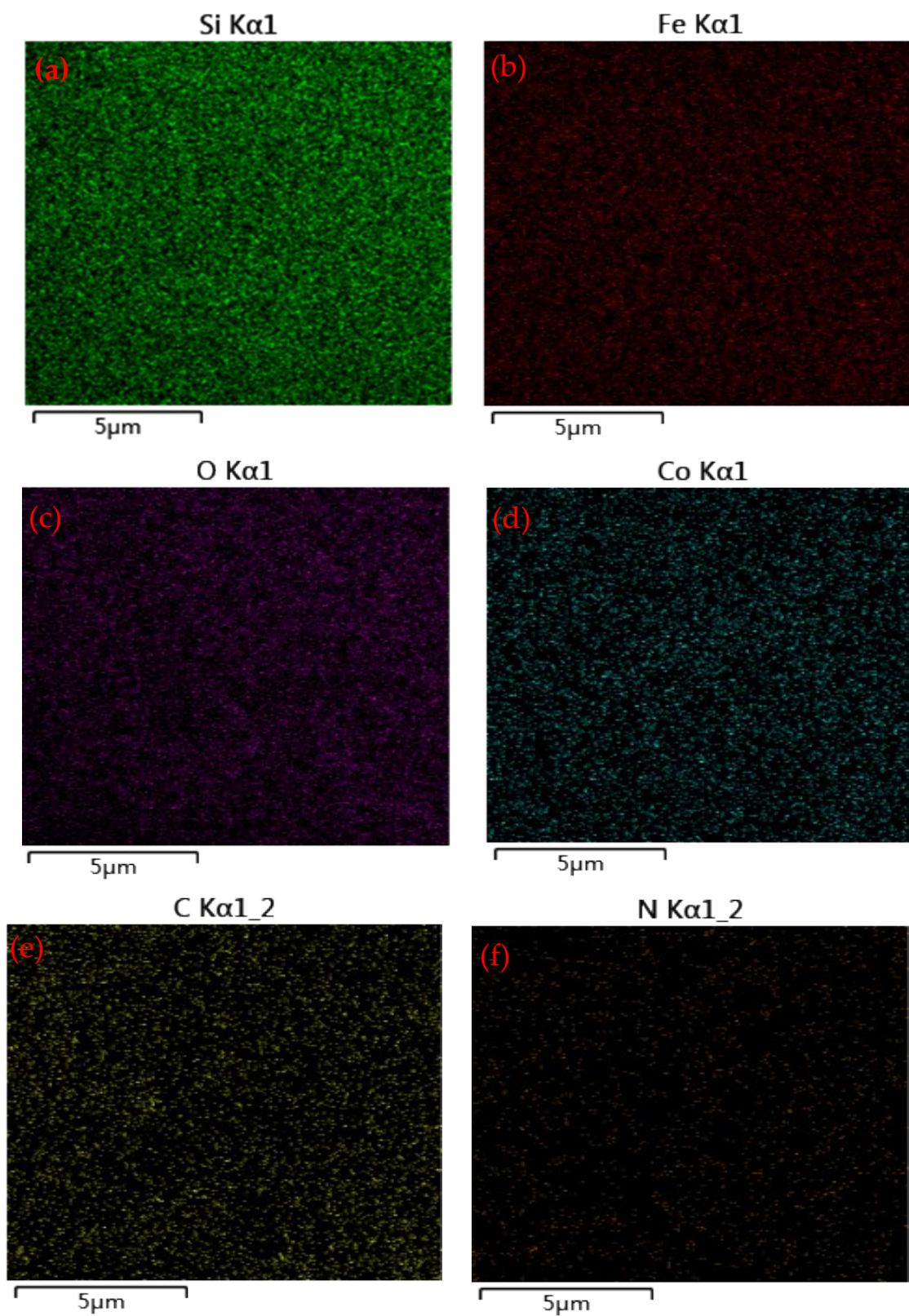
Fig. S1. EDS mappings of Si (a), Fe (b), O (c), Co (d), C (e) and N (f) of PoVan/CoFe$_2$O$_4$@mSiO$_2$.

3. Models of kinetics

Three kinetic models were employed to fit the experimental results: pseudo-first-order model [Eq. (S1)], pseudo-second-order model [Eq. (S2)] and intra-particle diffusion model [Eq. (S3)].

$$\ln\left(q_e - q_t\right) = lnq_e - k_1 t \tag{S1}$$

$$\frac{t}{q_t} = \frac{1}{k_2 q_e^2} + \frac{1}{q_e} \tag{S2}$$

$$q_t = k_d t^{0.5} + C \tag{S3}$$

here, q_t is instantaneous adsorption capability (mg/g); k_1 (min^{-1}), k_2 (g/mg/min) and $k_{d\text{-}i}$ (min^{-1}) are all adsorption rate constants; C_i is the boundary layer thickness (mg/g).

4. Isotherm models

$$\frac{C_e}{q_e} = \frac{C_e}{Q_F} + \frac{1}{Q_F K_L} \tag{S4}$$

$$q_e = k_F C_e^{\frac{1}{nF}} \tag{S5}$$

$$q_e = \frac{RT}{b_t} \ln(K_T C_e) \tag{S6}$$

$$q_e = q_{max} e^{(-\beta \varepsilon^2)} \tag{S7}$$

$$R_L = (1 + K_L C_0)^{-1} \tag{S8}$$

here, Q_F (mg/g) is the maximum adsorption capability. K_L (L/mg), K_F, q_{max} (mg/g) and K_T (L/mg) are Langmuir [Eq. (S4)], Freundlich [Eq. (S5)], Temkin [Eq. (S6)] and Dubinin-Radushkevich [Eq. (S7)] constants. R is gas constant (8.314 J/mol/K). β is a coefficient related with adsorption energy. R_L is the separation constant of the Langmuir isotherm model.