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Supporting information

Polypyrrole Multilayer-Laminated Cellulose for Large-Scale Repeatable Mercury Ion Removal

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1. Adsorption kinetics study

Langmuir and Freundlich isotherms is expressed by equation (S1) and (S2), respectively,

$$q_e = abC_e/(1 + bC_e) \tag{S1}$$

$$q_e = k(C_e)^{1/n} \tag{S2}$$

where q_e is the amount of mercury adsorbed per unit mass of PPy-cellulose absorbent (mg/g), C_e is the equilibrium concentration of mercury ions (mg/L), a is the maximum adsorption capacity (mg/g), b is the constant related to the free energy of adsorption (L/mg). The Freundlich constant, k is an indicator of the relative adsorption capacity of adsorbent (mg/g), and $1/n$ is the adsorption intensity. For the adsorption mechanism study, the various solutions of mercury ions were prepared with the concentrations ranging from 10 to 250 ppm at pH 6 and the adsorption experiments were conducted for 60 min dipping time at room temperature. Subsequently, the mercury removal data were fitted separately according to the Langmuir and Freundlich isotherm models. Langmuir and Freundlich isotherm parameters were obtained through the application of a nonlinear fitting for three different amounts of adsorbent (0.3, 0.4, and 0.5 g).

The mercury uptake kinetics data was treated by using the pseudo-first and pseudo-second order models. The pseudo-second order equation can be written as

$$\frac{1}{q_t} = \frac{k_1}{q_e t} + \frac{1}{q_e} \tag{S3}$$

where k_1 is the pseudo-first order rate constant (min^{-1}) of adsorption, and q_e and q_t (mg/g) are the amounts of metal ion adsorbed at equilibrium and at t (min), respectively. The value of $1/q_e$ was calculated from the experimental results and plotted against $1/t$ (min^{-1}). The linear form of pseudo-second order equation can be written as

$$\frac{t}{q_t} = \left(\frac{1}{k_2 q_e^2}\right) + \left(\frac{1}{q_e}\right)t \qquad \text{(S4)}$$

where 'k_2' is the pseudo-second order rate constant of adsorption (g/(mg·min)).

2. The PPy multilayer lamination on nylon mesh membranes

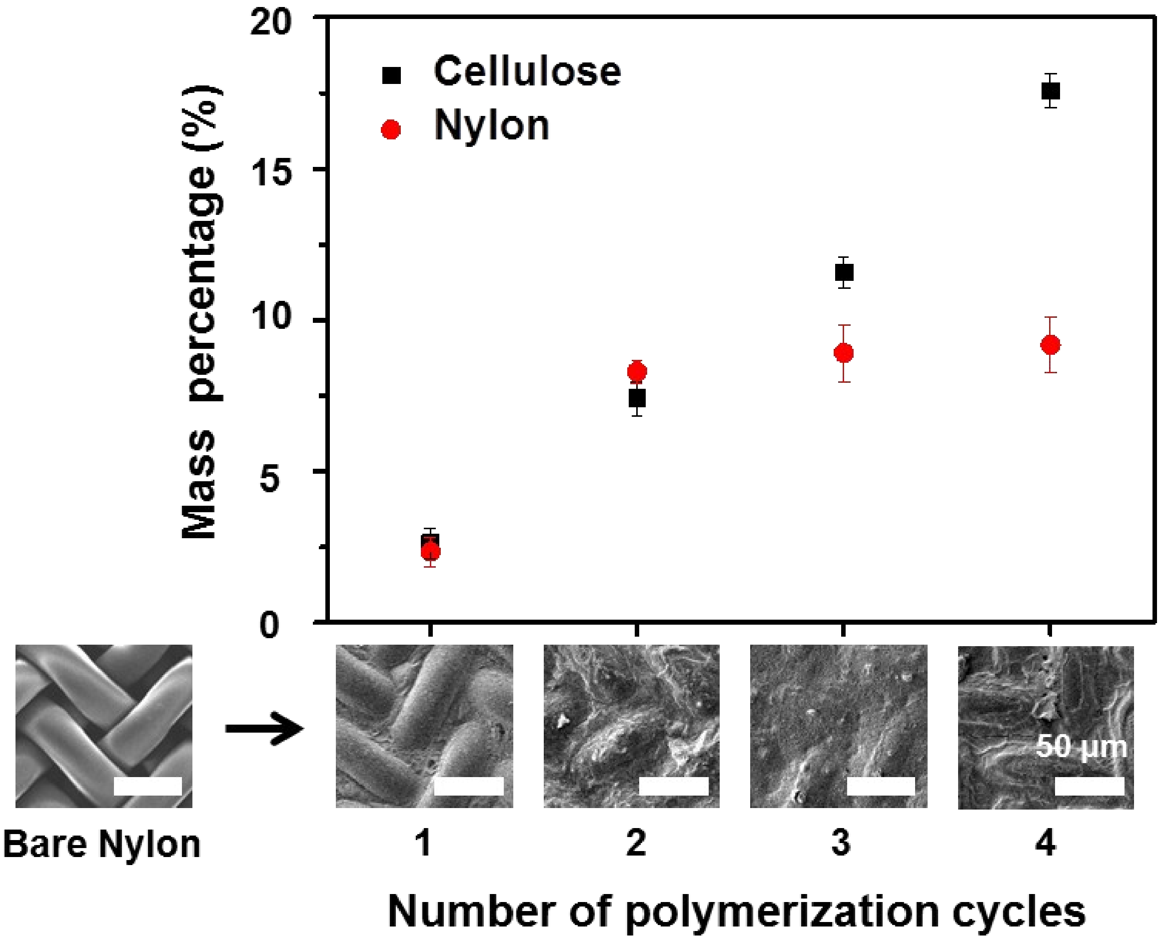

Fig. S1 The plots of mass percentage of PPy as a function of number of vapor polymerization cycles on cellulose (black) and nylon membranes (red). The SEM images show the surface morphology of PPy multilayer-laminated nylon mesh.

3. FT-IR analysis

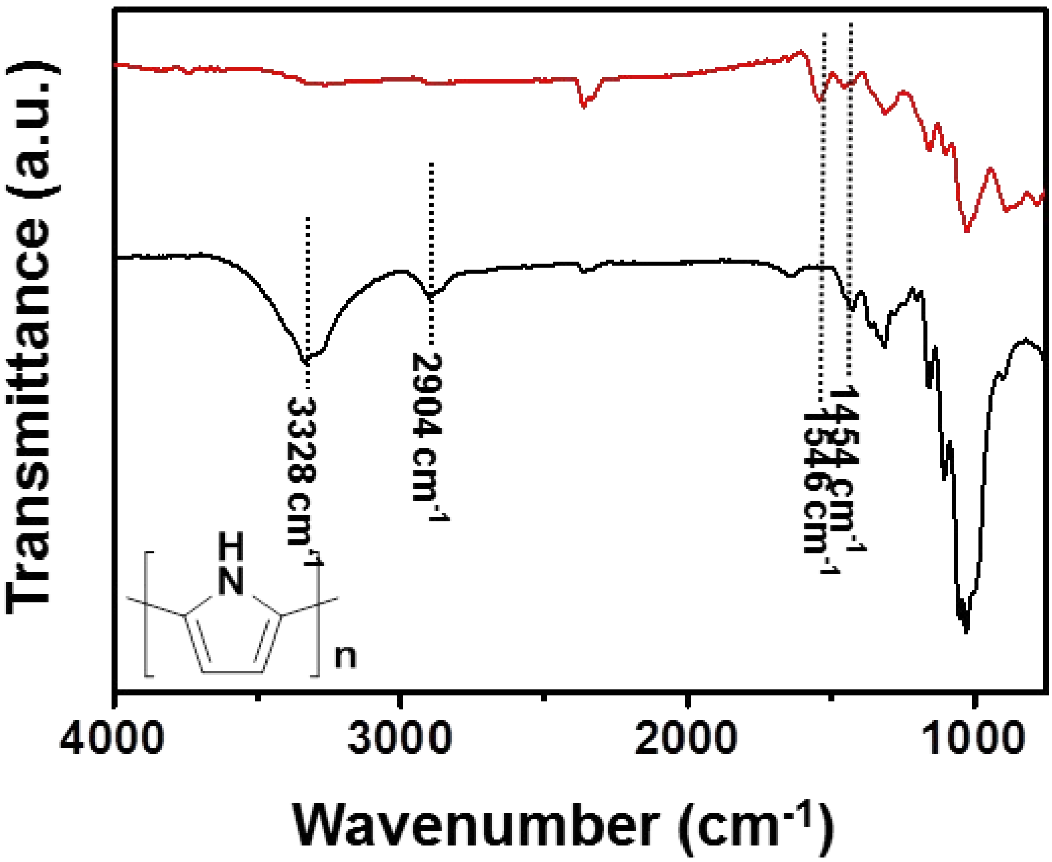

Fig. S2 FT-IR spectra of pristine and PPy-coated cellulose.

4. Mercury removal efficiency using pristine cellulose

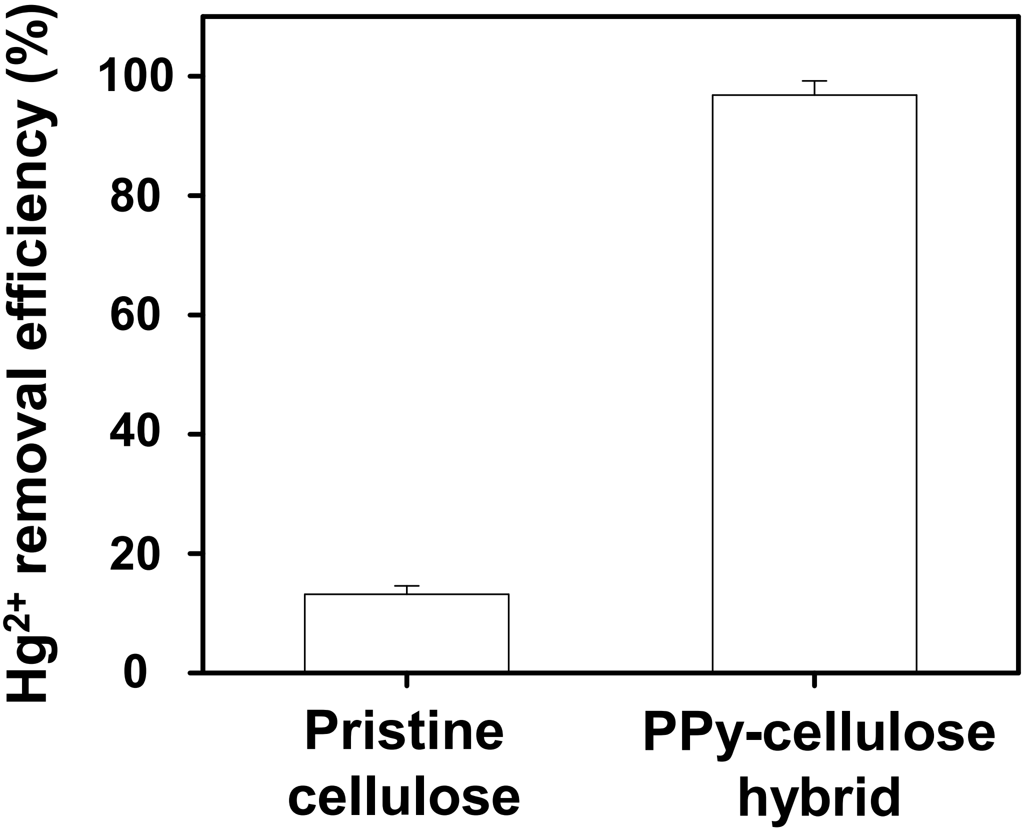

Fig. S3 The comparison of mercury ion removal efficiency between pristine and PPy multilayer-laminated cellulose.

5. Mercury ion removal using aged and harshly mechanically deformed PPy-cellulose hybrid

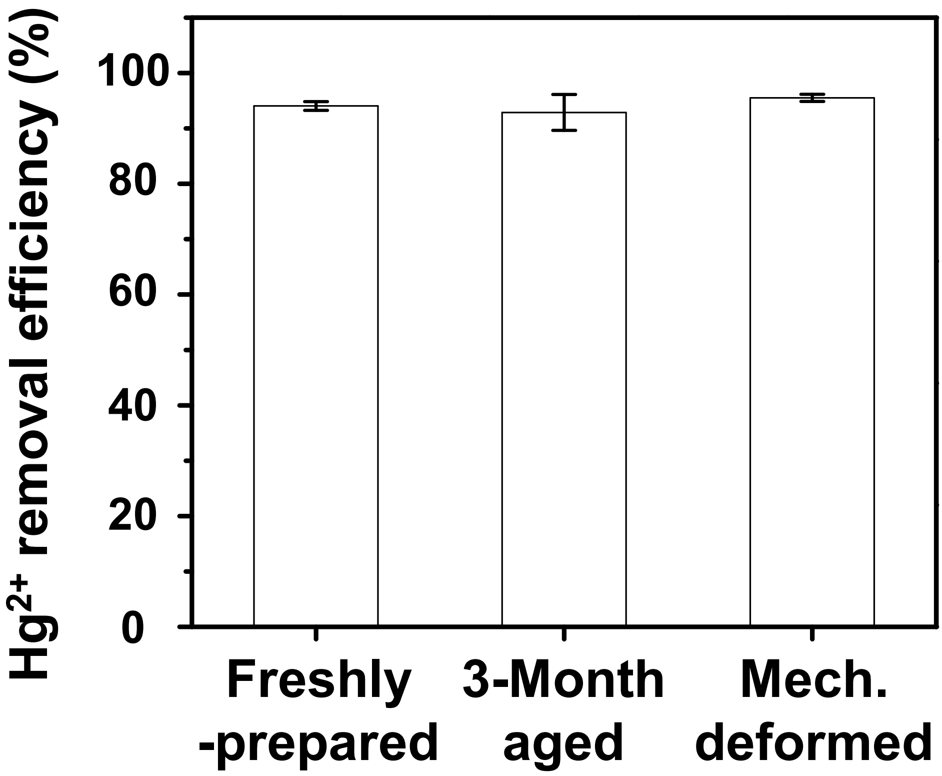

Fig. S4 The mercury ion removal efficiency using freshly-prepared, 3-month aged, harshly mechanically deformed PPy-cellulose hybrid adsorbent (150 ppm, pH 6, room temperature).

pH (initial)	pH (final)
1.05	0.97
2.07	2.05
3.07	2.98
4.00	3.91
5.03	5.00
6.02	5.97

Table S1. The pH of mercury ion solution measured before and after adsorption experiments using the 150 ppm of mercury ion solutions at room temperature.