Supporting Information For

Functionalization of biomass carbonaceous aerogels and its application as electrode materials for electro-enhanced recovery of metal ions

Jie Li\textsuperscript{ab}, Xiangxue Wang\textsuperscript{a}, Hongqing Wang\textsuperscript{c}, Suhua Wang\textsuperscript{a,d}, Tasawar Hayat\textsuperscript{d}, Ahmed Alsaedi\textsuperscript{d}, and Xiangke Wang\textsuperscript{abcd*}

\textsuperscript{a} College of Environmental Science and Engineering, North China Electric Power University, Beijing 102206, P. R. China.

\textsuperscript{b} Collaborative Innovation Center of Radiation Medicine of Jiangsu Higher Education Institutions, School for Radiological and Interdisciplinary Sciences, Soochow University, Suzhou 215123, P. R. China

\textsuperscript{c} School of Chemistry and Chemical Engineering, University of South China, 28 Changsheng West Road, Hengyang, Hunan 421001, P. R. China

\textsuperscript{d} NAAM Research Group, Faculty of Science, King Abdulaziz University, Jeddah 21589, Saudi Arabia

* Corresponding author. Email: xkwang@ncepu.edu.cn or xkwang@ipp.ac.cn
CDI decontamination test

The electrosorption capacity of the CDI system was conducted in a continuously recycling system including a home-made single CDI unit, an electrical power supply, a conductivity meter (Type 308A, Leici company), a peristaltic pump (BT100-2J, Baoding LanGe constant Flow Pump Co., Ltd, China) and a water tank. In each experiment, the CuCl$_2$ solution was continuously pumped from the pump into the cell and the effluent was returned to the water tank. In detail, the flow rate was set constant to 25 mL/min and the total solution volume was 200 mL in the system. The distance of 2 mm between the electrodes and a direct voltage were applied. The CDI electrodes were prepared as following: 80 mg electrode materials with 10 mg carbon black and 10 mg PTFE were dispersed into 5 mL ethanol solution under ultrasonic treatment for 5 min to form dispersion. Then, this dispersion was dropped onto the center of a nickel foam plate. After that, the resultant electrodes were dried at 140 °C overnight. The hole with a diameter of 5 mm was punched in the prepared electrode to allow the water flowing through the CDI device.
**Fig. S1** TEM mapping of the CAs/TiO$_2$.

**Fig. S2** FTIR spectra of CAs and CAs/MO hybrids.
**Fig. S3** Nitrogen adsorption–desorption isotherms (A); and their corresponding cumulative distribution curve (B) of the CAs/CeO₂ and CAs/Fe₂O₃ hybrids.

**Fig. S4** The SAED patterns of the as-obtained CAs/MO hybrids.

**Fig. S5** TEM images of the CAs/TiO₂ hybrids with different added amount of Ti³⁺ precursor: 5 mg (A) and 15 mg (B) Ti³⁺ precursor in 15 mL aqueous solution containing 30 mg of CAs.
**Fig. S6** CAs/TiO$_2$ electrodes in different CuCl$_2$ concentrations at a scan rate of 20 mV/s.

**Fig. S7** Water contact angle measurements of the prepared electrodes.
**Fig. S8** The actual CDI device.

**Fig. S9** Cu(II) removal capacity and pH value of decontamination experiments for 50 mg/L CuCl$_2$ solution at various applied potentials.
**Fig. S10** Cu 2p high resolution XPS spectra of the CAs/TiO$_2$ electrodes after the experiments at open circuit and applied voltage of 1.2 V.

**Fig. S11** The removal efficiency of these electrodes with different initial concentration of Cu(II).
Fig. S12 Current transient curve for CAs/TiO$_2$ in a 200 mg/L Cu(II) solution at 1.2 V.

The charge efficiency $\Lambda$ is obtained from the formula:\(^1\)

$$\Lambda = \frac{\Gamma \times F}{\Sigma}$$

in which $\Gamma$ is the deionization capacity (mol/g), $F$ is the Faraday constant (96485 C/mol) and $\Sigma$ (charge, C/g) is calculated through integrating the current. Base on the formula, the charge efficiency of CAs/TiO$_2$ was calculated to be 0.44.

Fig. S13 SEM image of the CAs/TiO$_2$ hybrids after cycling three times.
**Fig. S14** Underlying mechanism of the CDI process for Cu(II) removal in the presence of NaCl.
<table>
<thead>
<tr>
<th>Sample Type</th>
<th>$C_{\text{max}}$ (mg/g)</th>
<th>$b$ (L/mg)</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAs/TiO$_2$, 0 V</td>
<td>19.280</td>
<td>0.430</td>
<td>0.993</td>
</tr>
<tr>
<td>CAs, 1.2 V</td>
<td>30.353</td>
<td>0.309</td>
<td>966</td>
</tr>
<tr>
<td>CAs/Fe$_2$O$_3$, 1.2 V</td>
<td>41.424</td>
<td>0.268</td>
<td>0.996</td>
</tr>
<tr>
<td>CAs/CeO$_2$, 1.2 V</td>
<td>49.281</td>
<td>0.238</td>
<td>0.990</td>
</tr>
<tr>
<td>CAs/TiO$_2$, 1.2 V</td>
<td>57.134</td>
<td>0.337</td>
<td>0.989</td>
</tr>
</tbody>
</table>

Reference