Supporting Information for

Development of an Activated Carbon-Based Electrode for the Capture and Rapid Electrolytic Reductive Debromination of Methyl Bromide from Post-Harvest Fumigations

Yuanqing Li¹, Chong Liu², Yi Cui², Spencer S. Walse³, Ryan Olver⁴, David Zilberman⁴, and William A. Mitch¹,*

¹ Department of Civil and Environmental Engineering, Stanford University, 473 Via Ortega, Stanford, California 94305
² Department of Materials Science and Engineering, Stanford University, McCullough Building, Stanford, California 94305
³ USDA, Agricultural Research Service, San Joaquin Valley Agricultural Sciences Center 9611 South Riverbend Avenue, Parlier CA 93648-9757
⁴ Department of Agricultural and Resource Economics, Giannini Hall, University of California at Berkeley, Berkeley, CA 94720

*Corresponding author: email: wamitch@stanford.edu, Phone: 650-725-9298, Fax: 650-723-7058

18 Pages
8 Figures
2 Tables
Figure S1. Biphasic decay of CH$_3$Br over 15 h of electrolysis

Figure S2. Coulombic efficiency for CH$_3$Br over 15 h of electrolysis

Figure S3. CH$_3$Br removal and bromide yield for different carbon materials

Figure S4. SEM images of electrodes for different particle diameters

Figure S5. Electrodes with different GAC surface loadings

Figure S6. GAC/carbon cloth vs. GAC/carbon felt cathodes

Figure S7. Evaluation of different anodes

Figure S8. Phosphate buffer vs. synthetic seawater

Table S1. Ink formulations (weight percent)

Table S2. Recipe of synthetic seawater
Figure S1. Biphasic decay of CH$_3$Br over 15 h of electrolysis using the GAC/carbon cloth electrode at -1 V and pH 7 with 100 mM phosphate buffer (for 0-2 h, $k_{\text{obs}}=0.77$ h$^{-1}$, for 2-15 h, $k_{\text{obs}}=0.13$ h$^{-1}$). Control = no electrolysis.
Figure S2. Coulombic efficiency for \( \text{CH}_3\text{Br} \) over 15 h of electrolysis using the GAC/carbon cloth electrode at -1 V and pH 7 with 100 mM phosphate buffer.
Figure S3. A) CH$_3$Br removal and B) bromide yield over 2 hours of electrolysis at -1 V using electrodes fabricated by coating carbon cloth with different carbon materials: Fisher GAC, Norit GAC (17.7 mg/cm$^2$) and Sigma Aldrich activated charcoal (SA ACC (14.8 mg/cm$^2$)) with particle sizes ~ 50-100 µm.
Figure S4. SEM images of GAC/carbon cloth electrodes coated with Fisher GAC particles of A) <20 μm (14.2 mg/cm$^2$), B) 20-50 μm (14.3 mg/cm$^2$), and C) 50-100 μm (15.8 mg/cm$^2$).
**Figure S5.** SEM images of Fisher GAC/carbon cloth electrodes with A) 7.8 mg GAC/cm$^2$ and B) 29 mg GAC/cm$^2$. C) Current profiles, D) correlation between current and GAC loading at 1 h, E) CH$_3$Br loss and F) bromide yield over 2 h of electrolysis at -1 V and pH 7 with 100 mM phosphate using GAC/carbon cloth electrodes with different surface loadings of Fisher GAC.

A)
E)

![Bar chart showing CH$_3$Br removal efficiency at different GAC loadings.]
Figure S6. CH$_3$Br loss after 2 h of electrolysis at -1 V and pH 7 with 100 mM phosphate buffer using GAC/carbon cloth (standard) and GAC/carbon felt electrodes as the working electrodes.
Figure S7. CH$_3$Br loss after 2 h of electrolysis at -1 V and pH 7 with 100 mM phosphate using platinum wire (standard), sheet graphite or a GAC/carbon cloth anode.
**Figure S8.** CH$_3$Br loss after 2 h of electrolysis using the GAC/carbon cloth cathode at -1 V at pH 7 with 100 mM phosphate buffer or synthetic seawater at pH 8.2.
Table S1. Ink formulations (weight percent) for different Fisher GAC loadings on carbon cloth.

<table>
<thead>
<tr>
<th>Loading (mg GAC/cm²)</th>
<th>Activated carbon</th>
<th>PVDF</th>
<th>NMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.8</td>
<td>8.30%</td>
<td>1.44%</td>
<td>90.25%</td>
</tr>
<tr>
<td>15</td>
<td>15.33%</td>
<td>1.33%</td>
<td>83.33%</td>
</tr>
<tr>
<td>29</td>
<td>26.59%</td>
<td>1.16%</td>
<td>72.25%</td>
</tr>
</tbody>
</table>
## Table S2. Recipe of synthetic seawater

<table>
<thead>
<tr>
<th>Constituents</th>
<th>Mass (g)</th>
<th>Molar concentration (mM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaCl</td>
<td>24</td>
<td>400.3</td>
</tr>
<tr>
<td>Na$_2$SO$_4$</td>
<td>4</td>
<td>27.5</td>
</tr>
<tr>
<td>KCl</td>
<td>0.67</td>
<td>8.8</td>
</tr>
<tr>
<td>NaHCO$_3$</td>
<td>0.2</td>
<td>2.3</td>
</tr>
<tr>
<td>NaBr</td>
<td>0.08</td>
<td>0.7</td>
</tr>
<tr>
<td>MgCl$_2$</td>
<td>5.1</td>
<td>52.0</td>
</tr>
<tr>
<td>CaCl$_2$</td>
<td>1.1</td>
<td>10.1</td>
</tr>
</tbody>
</table>