Three-Dimensional Nanoarchitecture of Sn-Sb-Co Alloy as Anode of Lithium-ion Battery with excellent lithium storage performance**

Fu-Sheng Ke a, b, Ling Huang a, Bryan C. Solomon b, Guo-Zhen Wei a, Lian-Jie Xue a, Bo Zhang a, Jun-Tao Li c, Xiao-Dong Zhou b,* and Shi-Gang Sun a,*

a State Key Laboratory of Physical Chemistry of Solid Surfaces, Department of Chemistry, College of Chemistry and Chemical Engineering, Xiamen University, Xiamen, 361005, China.
b Department of Chemical Engineering, University of South Carolina, Columbia 29208, USA.
c School of Energy Research, Xiamen University, Xiamen, 361005, China.
Fax: (+) 86-592-2180181; Tel: (+) 86-592-2180181; E-mail: sgsun@xmu.edu.cn; xiao-dong.zhou@sc.edu

RESULT AND DISCUSSION

1. Electrochemical reduction of CuO NRA

![Figure S1](image)

**Figure S1.** (a) Linear sweep voltammetry of CuO NRA on copper sheet at a scan rate of 0.01 V s⁻¹. 1.0 M Na₂SO₄ was used as the supporting electrolyte. (b) Current-time curves recorded by chronoamperometry for the CuO NRA in 1.0 M Na₂SO₄ at room temperature. The geometric area of the working electrode was 1.0 cm².

During the chronoamperometry experiment, the pH was determined by a test strip. Results show that the pH near the working electrode and counter electrode are 10 and 4, respectively. Air bubbles were
observed on the counter electrode. The electroreduction of CuO NRA into Cu NRA is described by the following reactions:

Cathodic: \[ \text{CuO} + \text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{Cu} + 2\text{OH}^- \]

Anodic: \[ \text{H}_2\text{O} - 2\text{e}^- \rightarrow \frac{1}{2}\text{O}_2 + 2\text{H}^+ \]

2. XRD patterns of CuO NRA and Cu NRA

![XRD patterns of CuO NRA and Cu NRA](image)

**Figure S2.** XRD patterns of the CuO NRA and the Cu NRA. The bottom of the image contains the JCPDS data (JCPDS no. 01-080-0076 and 004-0836) for CuO and Cu, respectively. The XRD pattern confirmed that the CuO was transformed into metallic Cu. It is further confirmed by a visible color change from black to red.
3. Morphology of the 3D array of Sn-Sb-Co alloy

**Figure S3.** SEM images of (a) SnSnCo-1, (b) SnSbCo-2, and (c) SnSbCo-4. The inset shows a corresponding high-magnification image.
4. XPS characteristics of SnSbCo-3

![XPS spectra of Sn 3d, Sb 3d, and Co 2p](image)

**Figure S4.** XPS spectra of a) Sn 3d, b) Sb 3d and c) Co 2p of the SnSbCo-3.

The surface chemical composition of SnSbCo-3 was confirmed by XPS measurements. The XPS spectra indicate the presence of some metal oxides on the surface of the SnSbCo-3 sample. Chemical analysis of the particle surfaces shows that the atomic ratio of Sn:Sb:Co is 54.5:40.5:5.0.
5. SEM and discharge/charge characteristics of 3D array of Sn$_{60}$Sb$_{40}$ alloy and Sn$_{75}$Co$_{25}$ alloy

Figure S5. (a), (b) SEM images of the 3D array of Sn$_{60}$Sb$_{40}$ alloy and Sn$_{75}$Co$_{25}$ alloy electrodes, respectively. The insets show the corresponding high-magnification images. (c) and (d) Plots of the specific capacity versus cycle number of the 3D array of Sn$_{60}$Sb$_{40}$ alloy and Sn$_{75}$Co$_{25}$ alloy electrodes at a rate of 130 mA/g.

Table S1. The cycling performance data of 3D array electrodes

<table>
<thead>
<tr>
<th>sample</th>
<th>$Q_{1st}$ (mAh/g)</th>
<th>$Q_{100th}$ (mAh/g)</th>
<th>$Q_{150th}$ (mAh/g)</th>
<th>$Q_{150th}/Q_{1st}$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SnSbCo-1</td>
<td>712.7</td>
<td>446.4</td>
<td>385.7</td>
<td>54.1</td>
</tr>
<tr>
<td>SnSbCo-2</td>
<td>719.7</td>
<td>403.4</td>
<td>407.6</td>
<td>56.6</td>
</tr>
<tr>
<td>SnSbCo-3</td>
<td>647.9</td>
<td>521.4</td>
<td>512.8</td>
<td>79.1</td>
</tr>
<tr>
<td>SnSbCo-4</td>
<td>567.9</td>
<td>493.2</td>
<td>331.4</td>
<td>58.4</td>
</tr>
<tr>
<td>Sn$<em>{60}$Sb$</em>{40}$</td>
<td>670.0</td>
<td>382.1</td>
<td>181.1</td>
<td>27.0</td>
</tr>
<tr>
<td>Sn$<em>{75}$Co$</em>{25}$</td>
<td>655.7</td>
<td>411.0</td>
<td>330.7</td>
<td>50.4</td>
</tr>
</tbody>
</table>

$Q$ indicates the charge (lithium removal) capacity.
6. Influence of discharge-charge rate on specific capacity

![Graph showing voltage vs. capacity for different rates.]

**Figure S6.** Stabilized discharge/charge voltage profiles of the SnSbCo-3 electrode cycled at different rates.