Electronic Supplementary Information (ESI):

ZnₓCd₁₋ₓS/Bacterial Cellulose Bionanocomposite Foams with Hierarchical Architecture and Enhanced Visible-light Photocatalytic Hydrogen Production Activity

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Fig. S1. SEM images: (a) BC showing the hierarchical architecture of hydrogen-bonded cellulose nanofibers. (b) ZnO/BC showing the hierarchical architecture based on highly networked nanosheets.

Fig. S2. XRD patterns of BC and ZnO/BC.
Table S1. Collection of the BET surface area, mean pore size, pore volume, Cd/Zn molar ratio and H$_2$ evolution rate.

<table>
<thead>
<tr>
<th>Samples</th>
<th>BET (m$^2$ g$^{-1}$)</th>
<th>Mean pore size (nm)</th>
<th>Pore volume (cm$^3$ g$^{-1}$)</th>
<th>Cd/Zn ICP (molar ration)</th>
<th>H$_2$ evolution rate (μmol h$^{-1}$ g$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zn$<em>{0.88}$Cd$</em>{0.12}$S/BC</td>
<td>52</td>
<td>15.4</td>
<td>0.20</td>
<td>0.13</td>
<td>280</td>
</tr>
<tr>
<td>Zn$<em>{0.18}$Cd$</em>{0.82}$S/BC</td>
<td>72</td>
<td>14.4</td>
<td>0.27</td>
<td>4.64</td>
<td>405</td>
</tr>
<tr>
<td>Zn$<em>{0.86}$Cd$</em>{0.04}$S/BC</td>
<td>93</td>
<td>14.3</td>
<td>0.34</td>
<td>5.91</td>
<td>680</td>
</tr>
<tr>
<td>Zn$<em>{0.06}$Cd$</em>{0.94}$S/BC</td>
<td>101</td>
<td>14.1</td>
<td>0.36</td>
<td>9.65</td>
<td>1450</td>
</tr>
<tr>
<td>Zn$<em>{0.02}$Cd$</em>{0.98}$S/BC</td>
<td>87</td>
<td>14.5</td>
<td>0.26</td>
<td>12.35</td>
<td>591</td>
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<tr>
<td>Zn$<em>{0.08}$Cd$</em>{0.92}$S/BC</td>
<td>47</td>
<td>16.4</td>
<td>0.14</td>
<td>29.64</td>
<td>82</td>
</tr>
<tr>
<td>Zn$<em>{0.04}$Cd$</em>{0.96}$S/BC</td>
<td>46</td>
<td>16.2</td>
<td>0.19</td>
<td>14.25</td>
<td>40</td>
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<td>Powder CdS</td>
<td>56</td>
<td>21.9</td>
<td>0.30</td>
<td>-</td>
<td>96</td>
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<tr>
<td>ZnO/BC</td>
<td>92</td>
<td>14.2</td>
<td>0.33</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>BC</td>
<td>166</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
</tbody>
</table>

Fig. S3. Textural properties of BC: (a) N$_2$ adsorption and desorption isotherm. (b) BJH pore size distribution. (c) Hg intrusion porosimetry measurement. (d) Micrometer pore size distribution.
**Fig. S4.** Tracking the structural transformation from ZnO/BC to Zn$_{0.09}$Cd$_{0.91}$S/BC by SEM after 30 min, 1 h, 4 h and 6 h of the ion exchange/seeded growth process under solvothermal conditions in ethanol at 120 °C.

**Fig. S5.** Tracking the structural transformation from ZnO/BC to Zn$_{0.09}$Cd$_{0.91}$S/BC by XRD after 30 min, 1 h, 4 h and 6 h of the ion exchange/seeded growth process under solvothermal conditions in ethanol at 120 °C.
**Fig. S6.** Characterizing the products obtained from solvothermal reaction of a stoichiometric amount Zn/BC, thiourea and ethanol: (a) SEM and (b) XRD.

**Fig. S7.** EDS analysis: (a) Zn$_{0.88}$Cd$_{0.12}$S/BC. (b) Zn$_{0.18}$Cd$_{0.82}$S/BC. (c) Zn$_{0.14}$Cd$_{0.86}$S/BC. (d)
$\text{Zn}_{0.06}\text{Cd}_{0.94}\text{S}/\text{BC}$ and (e) $\text{Zn}_{0.03}\text{Cd}_{0.97}\text{S}/\text{BC}$.

**Fig. S8.** Characterizing the products obtained from solvothermal reactions involving different precursor scaffolds: (a1, a2) SEM and XRD of the product using BC as precursor scaffold, showing unidentified nanoparticles spread around BC. (b1, b2) SEM and XRD of the precursor scaffold prepared by refluxing BC and Zn(AC)$_2$·2H$_2$O in ethanol at 80 °C for 3 h, showing weak diffractions of wurtzite ZnO. (c1, c2) SEM and XRD of the product obtained by solvothermal reaction involving the precursor scaffold (b), showing wurtzite CdS.

**Fig. S9.** Characterization of $\text{Zn}_{0.06}\text{Cd}_{0.94}\text{S}/\text{BC}$: (a) SEM. (b) high magnification TEM. (c) HRTEM. (d) XRD.
Table S2. Band gaps of Zn\textsubscript{x}Cd\textsubscript{1-x}S/BC

<table>
<thead>
<tr>
<th>Samples</th>
<th>UV-vis adsorption edge (nm)</th>
<th>Band gap (eV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZnO/BC</td>
<td>379</td>
<td>3.21</td>
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<tr>
<td>Zn\textsubscript{0.88Cd}_{0.12}S/BC</td>
<td>466</td>
<td>2.66</td>
</tr>
<tr>
<td>Zn\textsubscript{0.18Cd}_{0.82}S/BC</td>
<td>501</td>
<td>2.47</td>
</tr>
<tr>
<td>Zn\textsubscript{0.14Cd}_{0.86}S/BC</td>
<td>526</td>
<td>2.36</td>
</tr>
<tr>
<td>Zn\textsubscript{0.09Cd}_{0.91}S/BC</td>
<td>531</td>
<td>2.33</td>
</tr>
<tr>
<td>Zn\textsubscript{0.06Cd}_{0.94}S/BC</td>
<td>542</td>
<td>2.28</td>
</tr>
<tr>
<td>Zn\textsubscript{0.03Cd}_{0.97}S/BC</td>
<td>550</td>
<td>2.25</td>
</tr>
<tr>
<td>Zn\textsubscript{0.06Cd}_{0.94}S/BC</td>
<td>604</td>
<td>2.05</td>
</tr>
</tbody>
</table>

Fig. S10. UV-vis spectrum of Zn\textsubscript{0.06Cd}_{0.94}S/BC.
Fig. S11. XPS analysis of Zn$_{0.09}$Cd$_{0.91}$S/BC: (a) survey spectrum. (b) Deconvoluted XPS peak of Cd. (c) Deconvoluted XPS peak of S. (d) Deconvoluted XPS peak of Zn.

Fig. S12. Characterizing the commercial CdS powder: SEM and XRD pattern.