Carbon dots and BiVO$_4$ quantum dots composite for overall water splitting via two-electron pathway
Xiuqin Wu, Juan Zhao, Sijie Guo, Liping Wang, Weilong Shi, Hui Huang,* Yang Liu,* Zhenhui Kang*

1. Quantum efficiency (QE) calculations.

In the photocatalytic water splitting, the catalyst solution was irradiated by a 300W Xe lamp with 420 ± 20 nm band-pass filter for 24h. The light source possesses a focused intensity (about 2.84 mW/cm$^2$) and the irradiation area is 4.27 cm$^2$. The number of incident photons (N) was calculated to be 2.21×10$^{21}$ by Equation S1. The amount of H$_2$ produced in 24 h for 5% CDs/BiVO$_4$QDs as photocatalysts was 11.62 µmol. The quantum efficiency (QE) of 5% CDs/BiVO$_4$QDs was 0.63% as calculated by Equation S2. The QE of CDs/BiVO$_4$QDs were shown in Table S1.

\[
N = \frac{E \lambda}{hc} = \frac{2.84 \times 10^{-3} \times 4.27 \times 24 \times 3600 \times 420 \times 10^{-9}}{6.626 \times 10^{-34} \times 3 \times 10^8} = 2.21 \times 10^{21} \quad \text{Equation S1}
\]

\[
\text{QE} = \frac{2 \times \text{the number of evolved H}_2 \text{ molecules}}{\text{the number of incident photons}} \times 100% = \frac{2 \times 11.62 \times 10^{-6} \times 6.02 \times 10^{23}}{2.21 \times 10^{21}} \times 100% = 0.63% \quad \text{Equation S2}
\]

**Figure S1.** XRD patterns of 1% CDs/BiVO$_4$QDs (black trace), 3% CDs/BiVO$_4$QDs (red trace), 10% CDs/BiVO$_4$QDs (blue trace) and 20% CDs/BiVO$_4$QDs (pink trace).

**Figure S2.** FTIR spectra of CDs (black line), BiVO$_4$ QDs (blue line) and 5% CDs/BiVO$_4$QDs (red line).
Figure S3. Typical TEM image of CDs. The inset is HRTEM image of CDs.

Figure S4. Nitrogen adsorption-desorption isotherms of BiVO₄ QDs (black trace) and 5% CDs/BiVO₄ QDs (red trace).

Figure S5. Survey XPS spectrum of 5% CDs/BiVO₄ QDs.
Figure S6. The FTIR spectrum of 5% CDs/BiVO₄ QDs after 10 cycles of 24 h water splitting.

Figure S7. The LSV curves for CDs (blue line), BiVO₄ QDs (green line) and 5% CDs/BiVO₄ QDs (red line) in 20 mM H₂O₂ solution.

Figure S8. Transient time-resolved PL decay curves of CDs (black line), BiVO₄ QDs (blue line) and 5% CDs/BiVO₄ QDs (red line).

Figure S9. The i-t curves of BiVO₄ QDs (blue line) and 5% CDs/BiVO₄ QDs (red line).
Figure S10. Schematic illustration of photocatalytic water splitting over 5% CDs/BiVO₄ QDs photocatalysts.

Table S1. The photocatalytic activities and calculated electron transfer number (n) of CDs/BiVO₄ QDs with different mass ratios of CDs.

<table>
<thead>
<tr>
<th>Photocatalysts</th>
<th>n</th>
<th>Rate (µmol/h)</th>
<th>Rate ratio</th>
<th>QE at 420 nm (%)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>H₂</td>
<td>O₂</td>
<td>H₂ : O₂</td>
</tr>
<tr>
<td>BiVO₄ QDs</td>
<td>2.03</td>
<td>0.21</td>
<td>3.51</td>
<td>0.06</td>
</tr>
<tr>
<td>0.3% CDs/BiVO₄ QDs</td>
<td>1.98</td>
<td>0.35</td>
<td>1.16</td>
<td>0.30</td>
</tr>
<tr>
<td>1% CDs/BiVO₄ QDs</td>
<td>2.01</td>
<td>0.50</td>
<td>0.89</td>
<td>0.56</td>
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<td>3% CDs/BiVO₄ QDs</td>
<td>2.02</td>
<td>0.85</td>
<td>0.48</td>
<td>1.77</td>
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<td>5% CDs/BiVO₄ QDs</td>
<td>2.08</td>
<td>0.92</td>
<td>0.51</td>
<td>1.80</td>
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<td>10% CDs/BiVO₄ QDs</td>
<td>2.13</td>
<td>0.79</td>
<td>0.43</td>
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<td>20% CDs/BiVO₄ QDs</td>
<td>2.10</td>
<td>0.51</td>
<td>0.25</td>
<td>2.04</td>
</tr>
</tbody>
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References
