Carbon dots and BiVO₄ quantum dots composite for overall water splitting via two-electron pathway

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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/cm²) and the irradiation area is 4.27 cm². The number of incident photons (N) was calculated to be 2.21×10^{21} by Equation S1. ^{S1} The amount of H₂ produced in 24 h for 5% CDs/BiVO₄QDs as photocatalysts was 11.62 µmol. The quantum efficiency (QE) of 5% CDs/BiVO₄QDs was 0.63% as calculated by Equation S2. ^{S1,S2} The QE of CDs/BiVO₄QDs were shown in Table S1.

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

$$QE = \frac{2 \times \text{the number of evolved H}_2 \text{ molecules}}{\text{the number of incident photons}} \times 100\%$$

$$= \frac{2 \times 11.62 \times 10^{-6} \times 6.02 \times 10^{23}}{2.21 \times 10^{21}} \times 100\% = 0.63\%$$
 Equation S2



Figure S1. XRD patterns of 1% CDs/BiVO₄QDs (black trace), 3% CDs/BiVO₄QDs (red trace), 10% CDs/BiVO₄QDs (blue trace) and 20% CDs/BiVO₄QDs (pink trace).



Figure S2. FTIR spectra of CDs (black line), BiVO₄ QDs (blue line) and 5% CDs/BiVO₄QDs (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/BiVO₄QDs (red trace).



Figure S5. Survey XPS spectrum of 5% CDs/BiVO₄QDs.



Figure S6. The FTIR spectrum of 5% CDs/BiVO₄QDs after 10 cycles of 24 h water splitting.



Figure S7. The LSV curves for CDs (blue line), $BiVO_4 QDs$ (green line) and 5% CDs/ $BiVO_4QDs$ (red line) in 20 mM H_2O_2 solution.



Figure S8. Transient time-resolved PL decay curves of CDs (black line), BiVO₄ QDs (blue line) and 5% CDs/BiVO₄QDs (red line).



Figure S9. The i-t curves of BiVO₄ QDs (blue line) and 5% CDs/BiVO₄QDs (red line).



Figure S10. Schematic illustration of photocatalytic water splitting over 5% CDs/BiVO₄QDs photocatalysts.

Photocatalysts	n	Rate (µmol/h)		Rate ratio	QE at 420 nm (%)
		H_2	O ₂	$H_2 \colon O_2$	
BiVO ₄ QDs	2.03	0.21	3.51	0.06	0.14
0.3% CDs/BiVO ₄ QDs	1.98	0.35	1.16	0.30	0.20
1% CDs/BiVO ₄ QDs	2.01	0.50	0.89	0.56	0.36
3% CDs/BiVO ₄ QDs	2.02	0.85	0.48	1.77	0.56
5% CDs/BiVO ₄ QDs	2.08	0.92	0.51	1.80	0.63
10% CDs/BiVO4QDs	2.13	0.79	0.43	1.84	0.52
20% CDs/BiVO4QDs	2.10	0.51	0.25	2.04	0.32

Table S1. The photocatalytic activities and calculated electron transfer number (n) of $CDs/BiVO_4QDs$ with different mass ratios of CDs.

References

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S2. Zichao Lian, Pengpeng Xu, Wenchao Wang, Dieqing Zhang, Shuning Xiao, Xin Li, and Guisheng Li, ACS Appl. Mater. Interfaces, 2015, 7, 4533-4540.