Supplementary Information

Feasible Strategy to Prepare Quantum Dot-Incorporated Carbon Nanofiber as Free-standing Platforms

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Fig. S1 Absorbance and PL spectra of various QDs: (a) CdSe, (b) PbS, (c) InP, (d) CuInS₂, (e) CdS, (f) InP/ZnS, (g) CuInS₂/ZnS, (h) CuSe/ZnS, (i) CdZnSeS/ZnS, and (j) CdZnS/ZnS.
Fig. S2 Low magnification SEM images of QD-coated CNFs: (a) CdSe, (b) PbS, (c) InP, (d) CuInS₂, (e) CdS, (f) InP/ZnS, (g) CuInS₂/ZnS, (h) CdSe/ZnS, (i) CdZnSeS/ZnS, and (j) CdZnS/ZnS.
Fig. S3 Low magnification SEM images of CdSe-CNF with different concentrations of QD: (a) 20 mg ml\(^{-1}\), (b) 50 mg ml\(^{-1}\), and (c) 100 mg ml\(^{-1}\). High magnification SEM images of CdSe-CNF with different concentrations of QDs: (d) 20 mg ml\(^{-1}\), (e) 50 mg ml\(^{-1}\), and (f) 100 mg ml\(^{-1}\).
**Fig. S4** SEM-EDS mapping of C, Cd, and Se for CdSe-CNF 20.

**Fig. S5** TEM images of CdSe-CNF with different concentrations of QD: (a) 20 mg ml\(^{-1}\), (b) 50 mg ml\(^{-1}\), and (c) 100 mg ml\(^{-1}\).
**Fig. S6** TEM-EDS mapping of single component QD-coated CNFs: (a) PbS, (b) InP, (c) CuInS$_2$, and (d) CdS.

**Fig. S7** XRD patterns of (a) InP-CNF, and (c) CuInS$_2$-CNF with the QD concentration of 20 mg ml$^{-1}$.

**Fig. S6** TEM-EDS mapping of single component QD-coated CNFs: (a) PbS, (b) InP, (c) CuInS$_2$, and (d) CdS.
Fig. S8 TEM-EDS elemental mapping images of (a) CdSe-CNF 20, (b) CdSe-CNF 50, and (c) CdSe-CNF 100.
**Fig. S9** CV curve of CdSe-CNF. The electrochemical measurement was analyzed using Metrohm Potentiostat/galvanostat (Interface 1000, Gamry). Pt disk electrode, Ag/AgCl and Pt-wire loop were used as working, quasi-reference, and counter electrodes, respectively. After fixing the electrodes to the cell, tetrabutylammonium perchlorate (171 mg) and CdSe QDs, dispersed in 5ml of dichloromethane (1mg ml⁻¹), were put in the cell. Then the potential with Ag/AgCl reference electrodes was calibrated with respect to the normal hydrogen electrode (NHE) with scan rate of 100 mV/s. The cathodic and anodic peaks at -1.06 V and 1.02 V were observed. Consequently, the HOMO level and LUMO level are -5.52 eV and -3.44 eV, respectively.

**Fig. S10** UPS spectrum of the CNF using He I excitation.
Fig. S11 Transient PL decay curves of (a) InP-CNF and (b) CuInS$_2$-CNF with the QDs concentration of 20 mg ml$^{-1}$.

Fig. S12 Transient PL decay curves of CdSe-CNF with different QDs concentrations from 5 mg ml$^{-1}$ to 100 mg ml$^{-1}$. 
Fig. S13 Stability test of photocatalytic hydrogen evolution of the CdSe-CNФ 20 in 0.25 M Na2S/0.35 M Na2SO3 aqueous solution under visible light (λ ≥ 420 nm)
Table S1 Average size of various QDs.

<table>
<thead>
<tr>
<th></th>
<th>Avg. size [nm]</th>
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<th>Avg. size [nm]</th>
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<tbody>
<tr>
<td>CdSe</td>
<td>3.78</td>
<td>InP/ZnS</td>
<td>5.39</td>
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<tr>
<td>PbS</td>
<td>3.29</td>
<td>CuInS₂/ZnS</td>
<td>4.03</td>
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<td>InP</td>
<td>2.76</td>
<td>CdSe/ZnS</td>
<td>5.63</td>
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<tr>
<td>CuInS₂</td>
<td>2.59</td>
<td>CdZnSeS/ZnS</td>
<td>11.74</td>
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<tr>
<td>CdS</td>
<td>2.93</td>
<td>CdZnS/ZnS</td>
<td>11.26</td>
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Table S2 The wt% of Cd, Se, and CdSe in different concentrations of CdSe-CNF.

<table>
<thead>
<tr>
<th></th>
<th>Cd [wt%]</th>
<th>Se [wt%]</th>
<th>CdSe [wt%]</th>
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**Fig. S14** (a) Schematic illustration on optoelectrical experiment. (b) Current-voltage (I-V) curve for CdSe-CNF 20 in dark and illumination. (c) The current ratios (I_{ph}/I_{dark}) of CdSe-CNF 20 depended on time under 5 Hz of laser on/off frequency at 1 V. The optoelectrical data (I-V curve and response time measurement) were carried out according to following information. The QD-CNF samples were carefully contacted by two Au coated tip probes controlled by micro-positioners. The gap distance between the two tip probes was set to 80 μm. And 520 nm laser source (8.5 mW) was irradiated to the gap size (50 μm²) by defocusing 20 objective lens (NA 0.40). The on/off illumination for response time was chopped by an optical chopper system (300CD, Scitec Instruments). All of dark current, photocurrent and transient current were measured using a low-noise current preamplifier (SR570, Stanford Research Systems) at room temperature in the dark room.
<table>
<thead>
<tr>
<th></th>
<th>InP</th>
<th>In hexane</th>
<th>On glass</th>
<th>InP-CNF 20</th>
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<tr>
<td>20 mg ml(^{-1})</td>
<td>4.56</td>
<td>1.25</td>
<td>5.81</td>
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<td>50 mg ml(^{-1})</td>
<td>7.72</td>
<td>2.12</td>
<td>9.84</td>
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<tr>
<td>100 mg ml(^{-1})</td>
<td>10.95</td>
<td>2.97</td>
<td>13.92</td>
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**Table S3** Fitting details on transient PL decay curves demonstrated in Figure S11.

<table>
<thead>
<tr>
<th></th>
<th>InP</th>
<th>In hexane</th>
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<th>CuInS(_2)-CNF 20</th>
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<tr>
<td>(\tau_1) [ns]</td>
<td>20.28</td>
<td>10.0</td>
<td>8.43</td>
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<td>(f_1) [%]</td>
<td>50.73</td>
<td>61.9</td>
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<tr>
<td>(\tau_2) [ns]</td>
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<td>(f_2) [%]</td>
<td>49.27</td>
<td>38.1</td>
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<tr>
<td>(\tau_{avg}) [ns]</td>
<td>59.27</td>
<td>29.55</td>
<td>23.47</td>
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<table>
<thead>
<tr>
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<tr>
<td>(\tau_1) [ns]</td>
<td>86.51</td>
<td>38.33</td>
<td>9.14</td>
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<tr>
<td>(f_1) [%]</td>
<td>37.38</td>
<td>53.09</td>
<td>45.86</td>
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<tr>
<td>(\tau_2) [ns]</td>
<td>440.77</td>
<td>171.24</td>
<td>105.18</td>
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Table S4 Fitting details on transient PL decay curves demonstrated in Figure 5b.

<table>
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<th>CdSe-CNF 10</th>
<th>CdSe-CNF 5</th>
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<tr>
<td>$\tau_1$ (ns)</td>
<td>0.97</td>
<td>0.76</td>
<td>0.84</td>
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<tr>
<td>$f_1$ (%)</td>
<td>58.53</td>
<td>72.15</td>
<td>75.68</td>
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<tr>
<td>$\tau_2$ (ns)</td>
<td>16.32</td>
<td>15.25</td>
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<tr>
<td>$f_2$ (%)</td>
<td>41.47</td>
<td>27.85</td>
<td>24.32</td>
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<tr>
<td>$\tau_{avg}$ (ns) $^{[a]}$</td>
<td>7.34</td>
<td>4.80</td>
<td>3.98</td>
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$a$ Indicates the average lifetime.