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Parameters	Meaning	Value
D_1	H ⁺ diffusion coefficient	9.31×10^{-5} [cm ² ·s ⁻¹]
D_2	OH ⁻ diffusion coefficient	5.03×10^{-5} [cm ² ·s ⁻¹]
D_3	H ₂ O Diffusion coefficient	2.26×10^{-5} [cm ² ·s ⁻¹]
F_c	Cathode OH ⁻ flux	1.90×10^{-3} [mol·m ⁻² ·s ⁻¹]
F_a	Anode H ⁺ flux	6.25×10^{-3} [mol·m ⁻² ·s ⁻¹]
L_{TiO_2}	Length of TiO ₂ head	4 [μm]
d_{TiO_2}	Diameter of TiO ₂ head	3 [μm]
L_{Si}	Length of Si trunk	6 [μm]
d_{Si}	Diameter of Si trunk	0.8 [μm]

2 **Supplementary Table 1. Typical parameters used in the simulation.**

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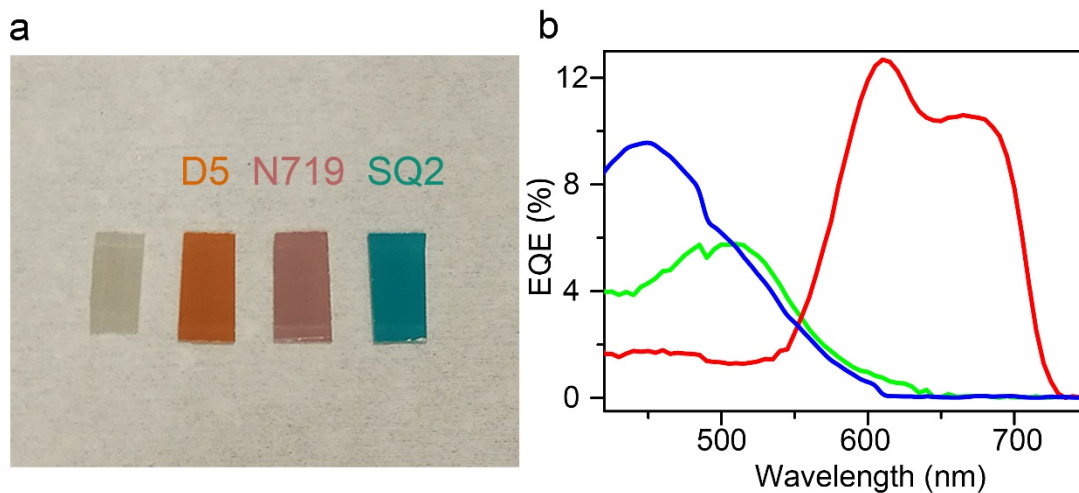
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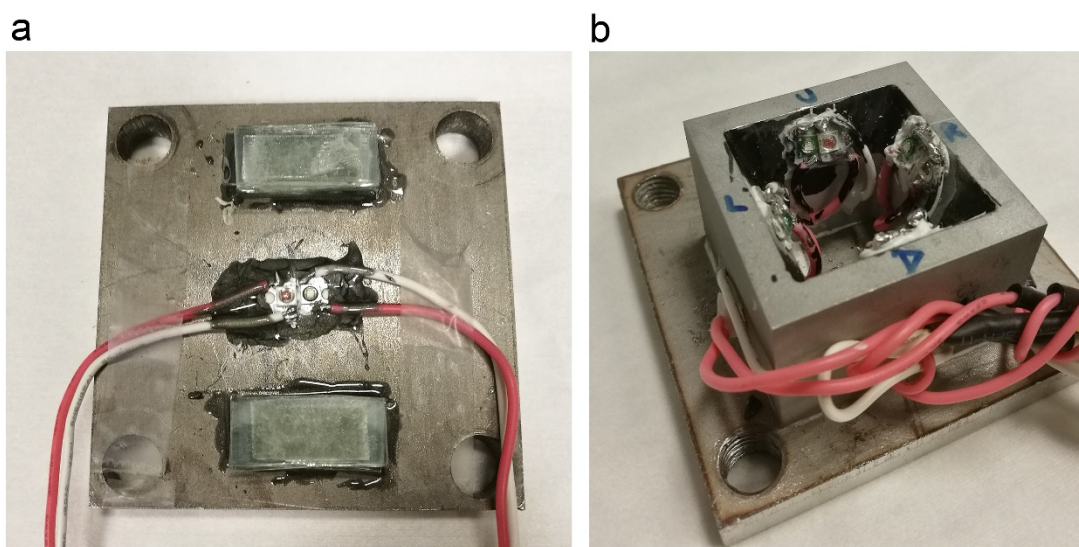
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 12 **Supplementary Figure 1. a.** The photograph of pristine and dye-sensitized TiO₂/FTO samples. **b.**
 13 The external quantum efficiency (EQE) of the nanowire-based dye-sensitized solar cells (D5
 14 (blue), N719 (green) and SQ2 (red)).

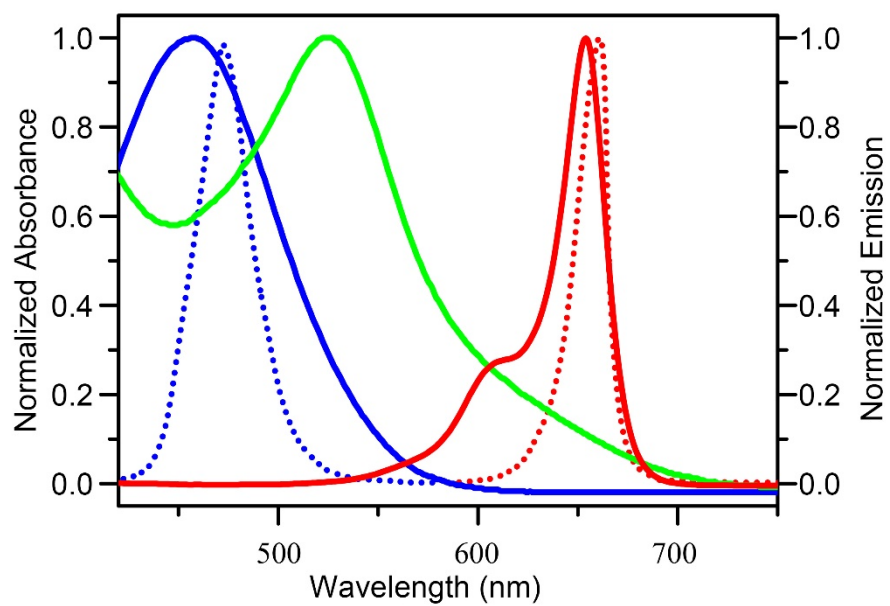
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18 **Supplementary Figure 2. a.** The customized stage for intensity-dependent speed measurement
 19 and multi-channels light manipulation. **b.** Stage with independently controllable red and blue
 20 LEDs over orthogonal directions.



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22 **Supplementary Figure 3.** The normalized absorbance of ethanolic solution of dye (D5 (blue),
23 N719 (green) and SQ2 (red)). The dotted curve indicated the normalized emission spectra of LED
24 (475 nm (blue), 660 nm (red)).