Supporting Information

Enhanced electrocatalytic performance in dye-sensitized solar cell via coupling $CoSe_2$@N-doped carbon and carbon nanotubes

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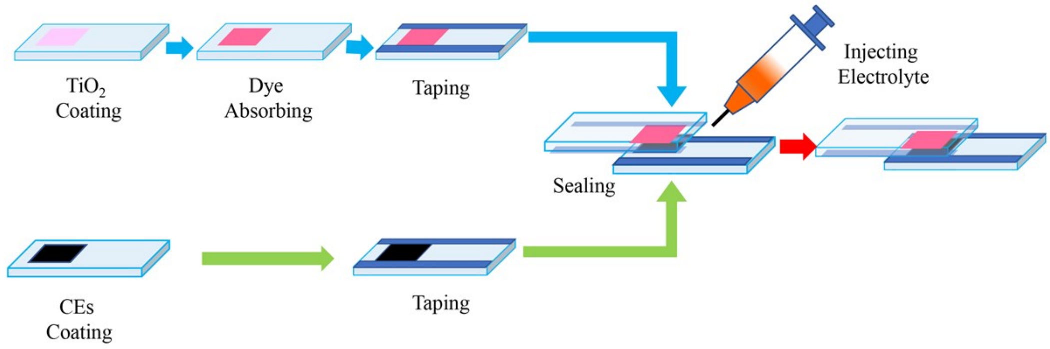

Fig. S1 Schematic illustration of the DSSCs assembly.

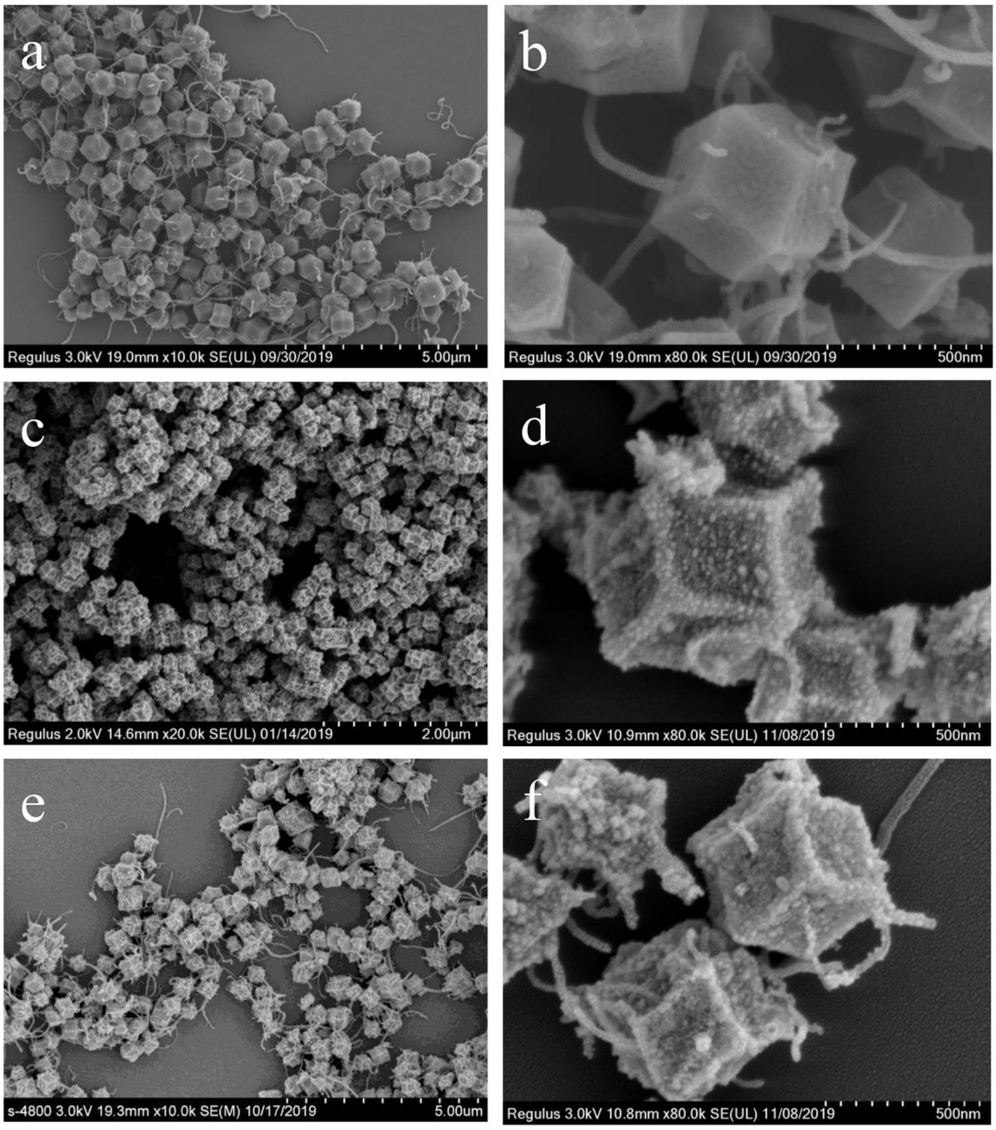

Fig. S2 SEM images of (a, b) ZIF-67-CNTs hybrids, (c, d) $CoSe_2$@NC, (e, f) $CoSe_2$@NC-CNTs hybrids.

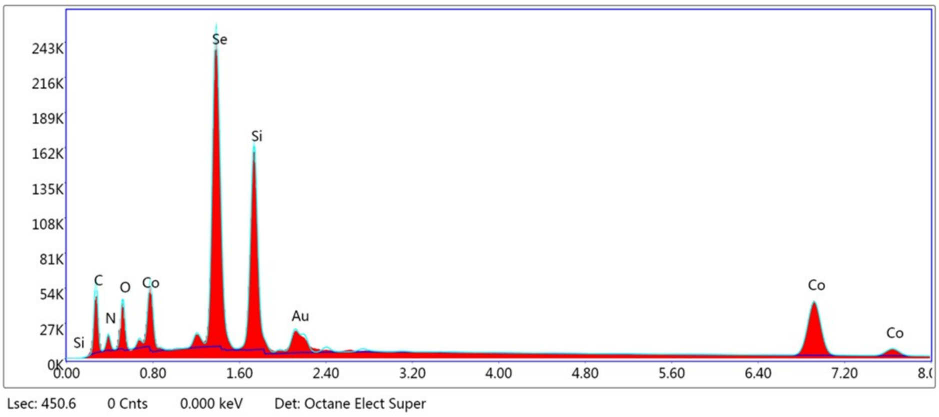

Fig. S3 EDX spectrum of $CoSe_2$@NC-CNTs hybrids.

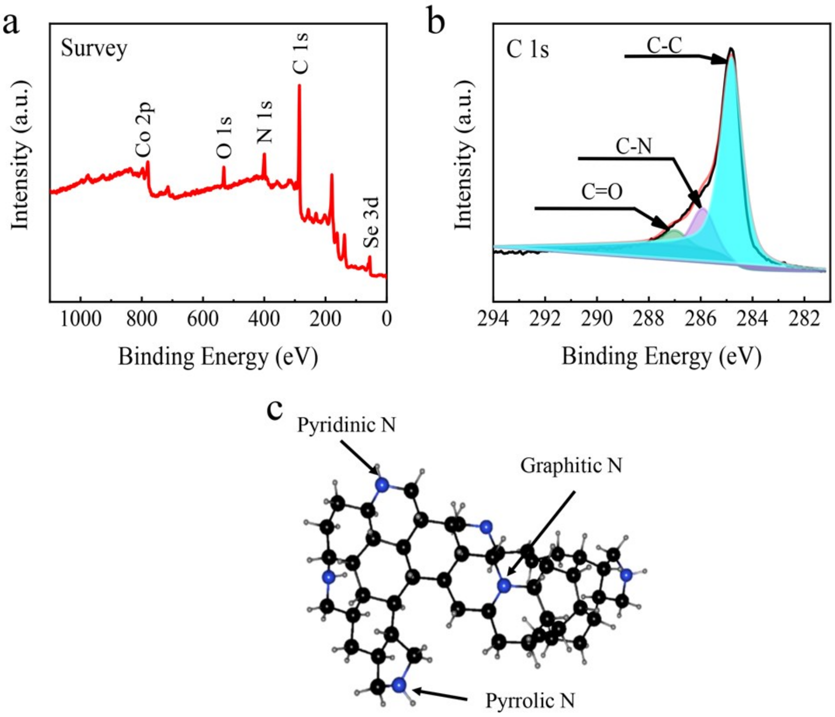

Fig. S4 (a) Full-survey-scan XPS spectrum of $CoSe_2$@NC-CNTs hybrids. (b) High-resolution XPS spectra of C. (c) Schematic illustration of the possible N-bonding configurations.

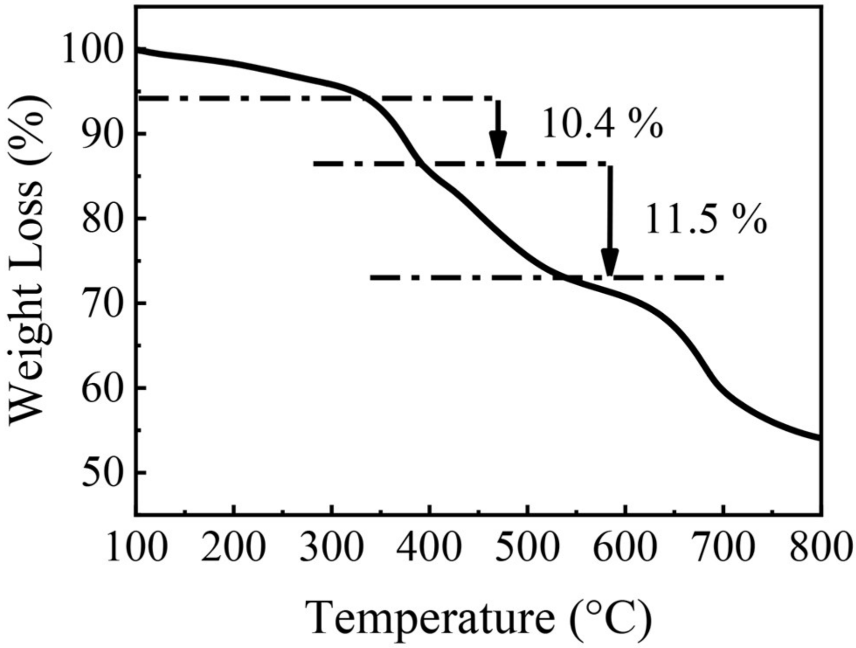

Fig. S5 Thermogravimetric analysis curves of $CoSe_2$@NC-CNTs hybrids.

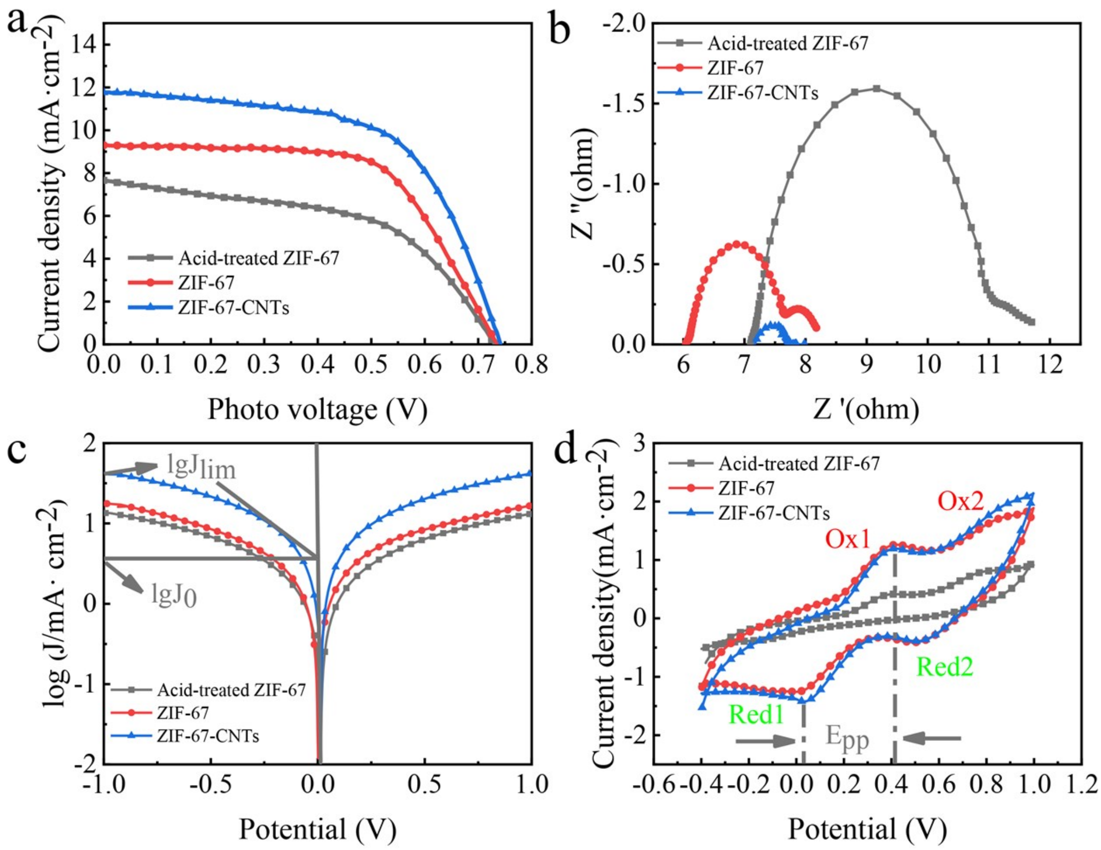

Fig. S6 (a) J-V curves**,** (b) EIS Nyquist plots, (c) Tafel polarization curves, and (d) CV curves of Acid-treated ZIF-67, ZIF-67, and ZIF-67-CNTs hybrids.

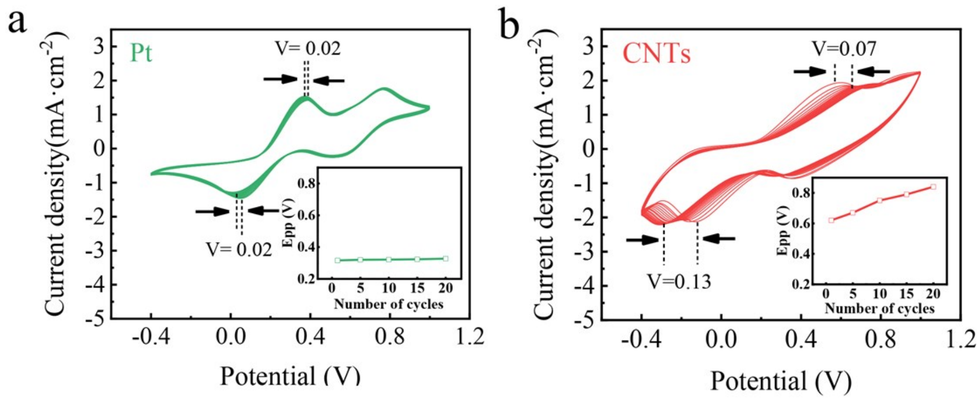

Fig. S7 20 cycles of CV curves to check the stabilization of (a) Pt, and (b) CNTs

Table S1. Related Parameters of Relevant References

CEs	J_{SC} (mA·cm^{-2})	V_{OC} (V)	*FF* (%)	PCE (%)	**Ref.**
Ti_1/rGO	16.53	0.840	64.00	8.83	*Adv. Mater.* ***2020****, 2000478*
ZIF-ZnSe-NC-11 wt%	16.40	0.770	69.00	8.69	*J. Mater. Chem. A* ***2018****, 6 (12), 5107*
CoFeNiMo@NCNT-800-8-5	14.71	0.731	60.00	6.46	*Appl. Catal. B: Environ. 280* ***2021****, 119421*
$CoSe_2$/NC	17.31	0.72	67.00	9.06	*ACS Sustain. Chem. Eng.,* ***2019****, 7, 2784−2791*
$CoSe_2$-160	17.04	0.74	66.20	8.38	*Electrochim. Acta,* ***2015****, 168, 69−75.*

Table S2. PCE Values and Relevant Parameters of Different CEs.

CEs	J_{sc} (mA·cm^{-2})	V_{oc} (V)	FF (%)	PCE (%)
Acid-treated ZIF-67	7.64	0.74	52.14	2.93
ZIF-67	9.29	0.74	58.05	4.19
ZIF-67-CNTs	11.76	0.73	54.38	5.00

Table S3. Electrochemical Performance Parameters for Different CEs.

CEs	R_s ($\Omega\cdot cm^2$)	R_{ct} ($\Omega\cdot cm^2$)	lgJ_0 ($mA\cdot cm^{-2}$)	lgJ_{lim} ($mA\cdot cm^{-2}$)	E_{pp} (V)
Acid-treated ZIF-67	7.10	2.46	1.13	0.16	> 0.70
ZIF-67	7.42	0.79	1.24	0.28	0.39
ZIF-67-CNTs	7.16	0.31	1.60	0.52	0.37