Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting Information

Dual-phase zinc selenide in-situ encapsulated into size-reduced ZIF-8 derived selenium and nitrogen co-doped porous carbon for efficient triiodide reduction reaction

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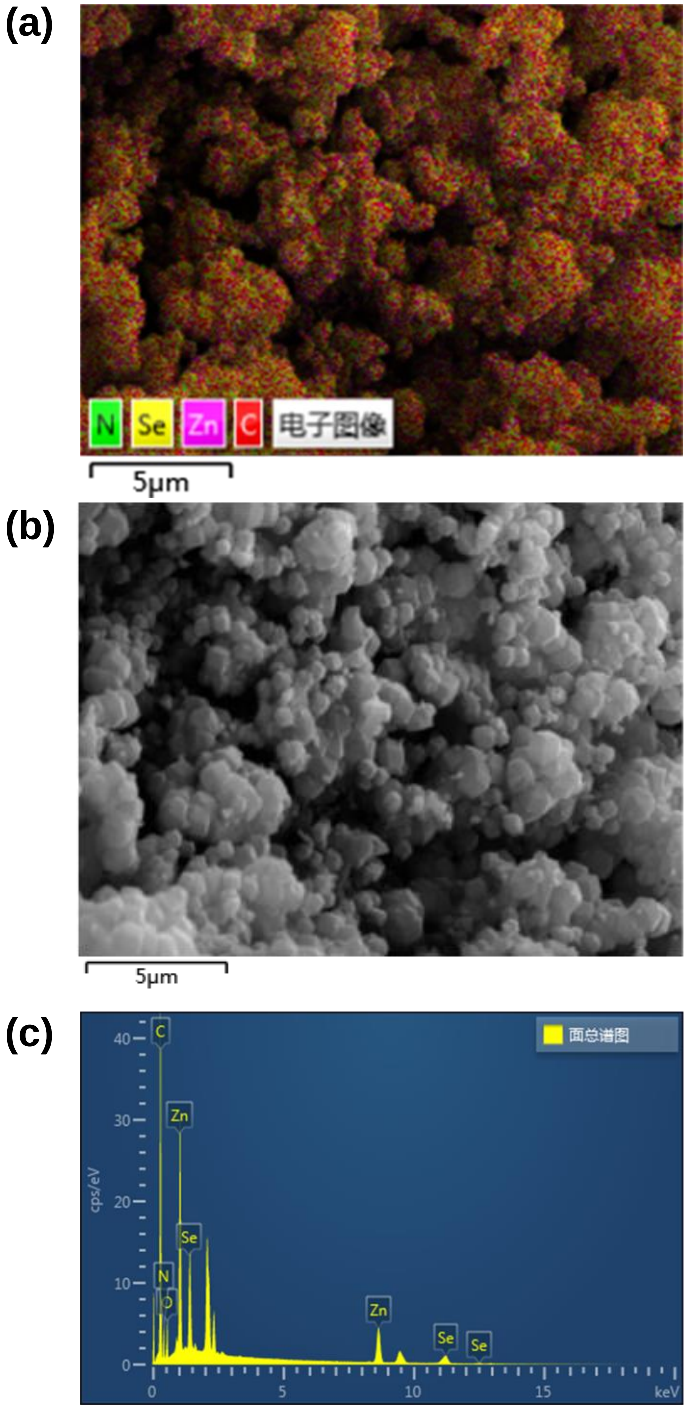

Figure S1. SEM-EDS mapping image (a) with N, Zn, Se, and C elements into PS N-C_{SR}. SEM images (b) and its corresponding SEM-EDS spectrum (c) for PS N-C_{SR}.

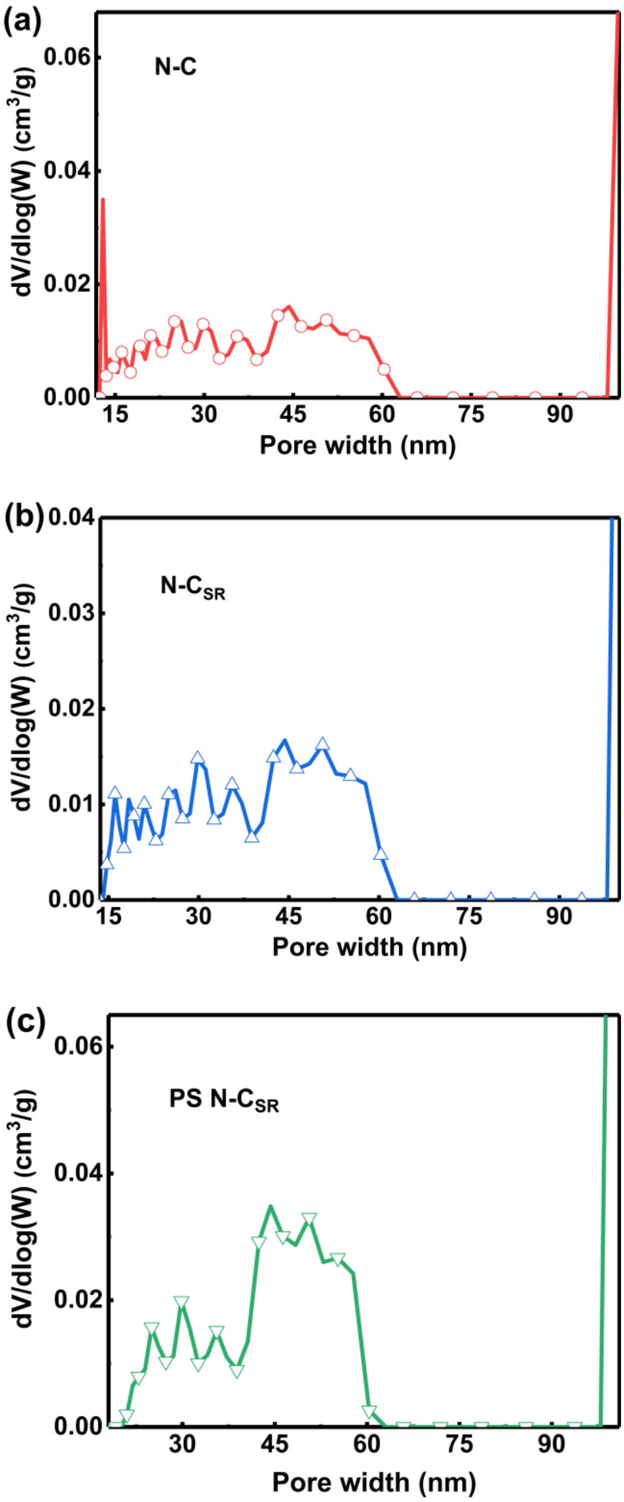

Figure S2. Magnified pore distribution curves at mesoporous regions and macroporous regions for (a) N-C, (b) N-C_{SR} and (c) PS N-C_{SR}.

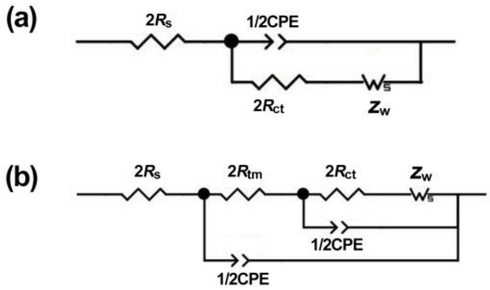

Figure S3. The equivalent circuits to the symmertic celsl with two arcs (a) and three arcs (b) in their EIS plots.

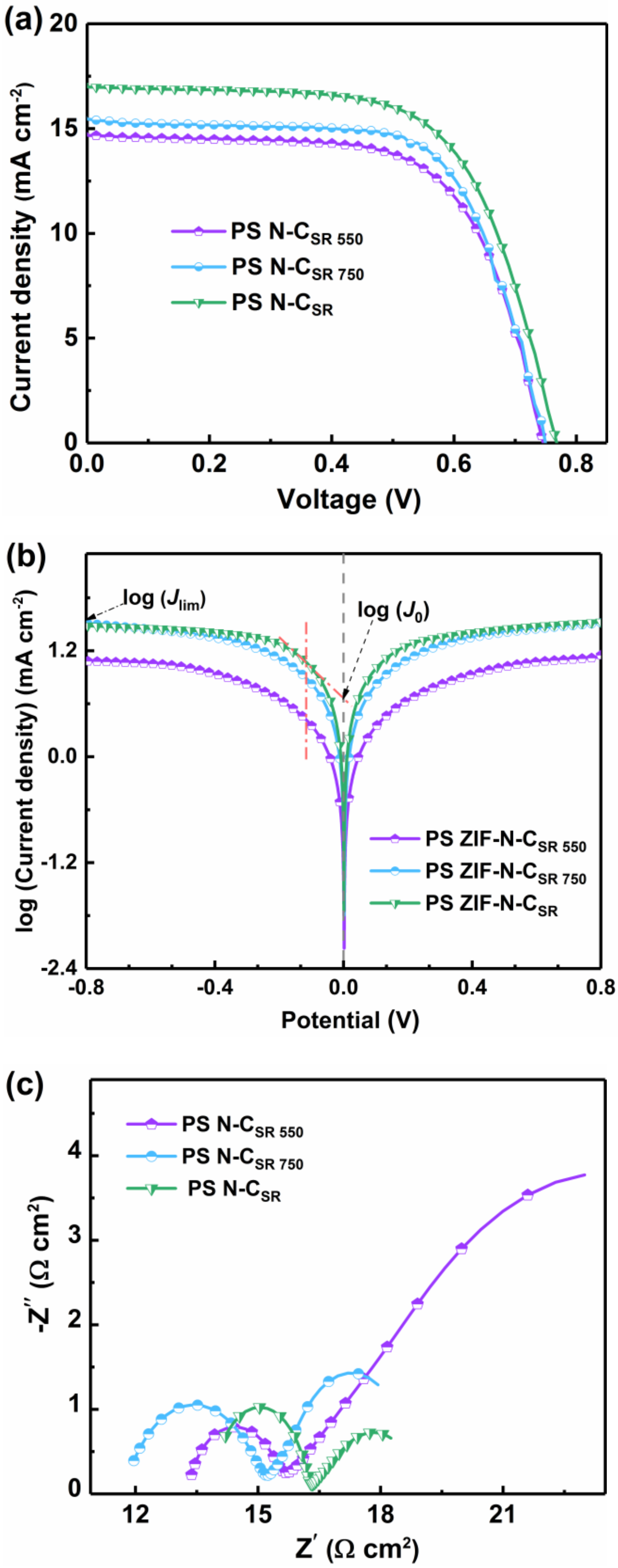

Figure S4. *J-V* plots (a) of the DSSCs using post-selenizing N-C_{SR} catalysts with different selenization temperature, Tafel polarization curves (b), and EIS plots (c) of post-selenizing N-C_{SR} catalysts with different selenization temperature.

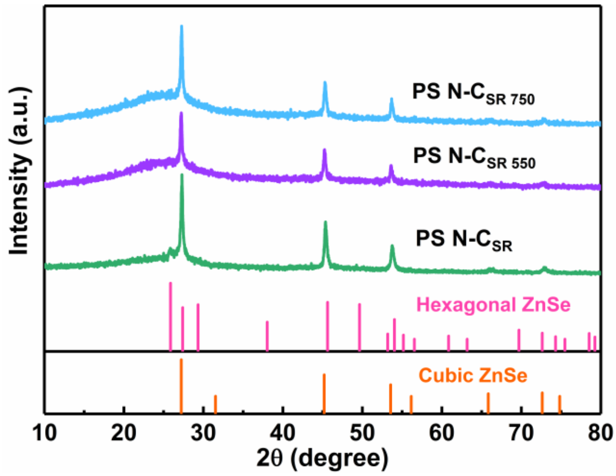

Figure S5. XRD patterns of the selenide hybird catalysts derived from N-C_{SR} under different post-selenization temperatures.

Table S1. Comparison of the elements contents of PS N-C_{SR} from EDS spectrum and XPS survey spectrum.

Methods	Quantitative analysis of elements (at. %)				
	Zn	**Se**	**O**	**N**	**C**
SEM-EDS	3.62	1.50	7.46	19.49	67.94
XPS	3.00	1.85	7.13	13.18	74.85
TEM-EDS	3.08	1.44	14.26	11.74	69.48

Table S2. Exact quantified analyses of PS N-C_{SR} and N-C_{SR} via ICP-OES.

Samples	Zn(wt. %)	Se(wt. %)
PS N-C_{SR}	11.20	7.33
N-C_{SR}	12.47	—

Table S3. Quantitative analysis of N species into PS N-C_{SR} from the high-resolution N 1s spectrum.

Quantitative analysis (at. %)			
Pyridinic N	**Pyrrolic N**	**Graphitic N**	**NO_x**
58.81	28.22	8.14	4.82

Table S4. Comparison of the photovoltaic performances of the DSSCs assembled with the PS N-C_{SR} CE and the previous reported DSSCs using the Pt-free CE catalysts.

CEs	V_{oc} (mV)	J_{sc} (mA cm^{-2})	FF	PCE (%)	References
PS N-C_{SR}	0.77	17.00	0.65	8.48	This work
$NiCo_2S_4$ QD@NCNTs	0.72	15.34	0.69	7.65	[1]
CoSe@NPC/CoSe@CNT	0.70	15.90	0.66	7.39	[2]
$CoSe_2$/CS-2	0.69	15.88	0.69	7.56	[3]
CoSe@NPC/NCNTs-1	0.71	16.00	0.67	7.58	[4]
NiFeCoW@NC800-10-5	0.80	15.04	0.57	6.92	[5]
$NiSe_2$-W	0.74	18.08	0.66	8.78	[6]
ZIF-ZnSe-NC-450℃	0.76	13.60	0.69	7.11	[7]
$CoSe_2$@NC-CNTs	0.75	17.96	0.69	9.25	[8]
$FeCo_2S_4$-5h	0.72	14.2	0.72	7.35	[9]
$ZnMoO_4$/3D-AWC	0.69	16.41	0.67	7.65	[10]

Table S5. Comparison of the electrochemical performances of selenide CEs with different selenization temperatures and the photovoltaic performances of the corresponding assembled DSSCs.

CEs	V_{oc} (mV)	J_{sc} (mA cm^{-2})	FF	PCE (%)	J_{lim} (mA cm^{-2})	J_0 (mA cm^{-2})[a]	R_{ct} (Ω cm^2)
PS N-$C_{SR\ 550}$	0.75	14.67	0.66	7.23	12.02	9.73	1.32
PS N-C_{SR}	0.77	17.00	0.65	8.48	30.20	10.04	1.28
PS N-$C_{SR\ 750}$	0.75	15.47	0.67	7.72	32.66	6.73	1.91

[a]: the J_0 calculated from the **equation 3** in the main text.

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