Supporting information

Amphiphilic Interface for Constructing Uniform Composite Solid-State Electrolyte towards Long-Life All-Solid-State Sodium Metal Batteries

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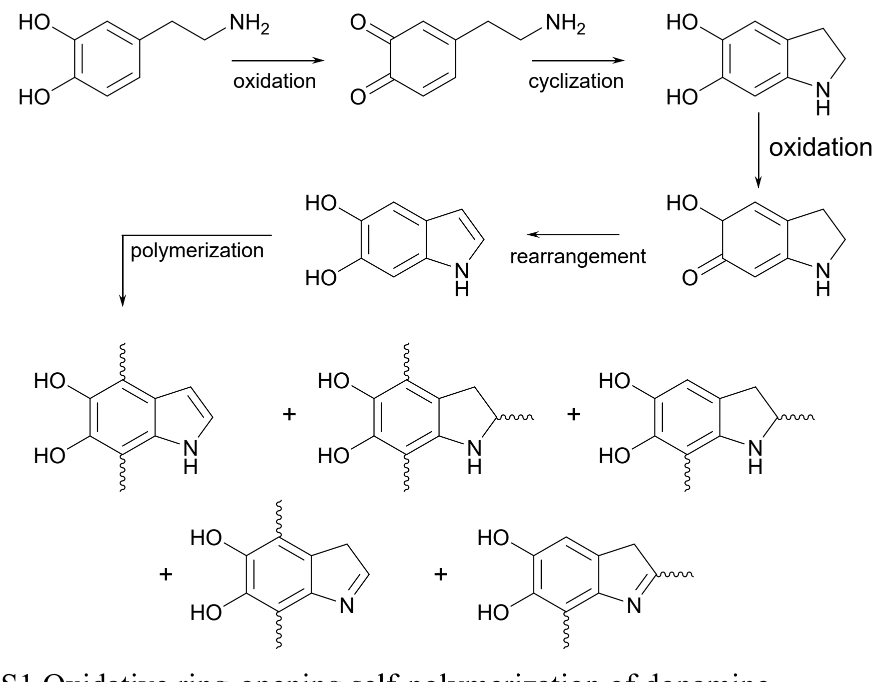

Scheme S1 Oxidative ring-opening self-polymerization of dopamine.

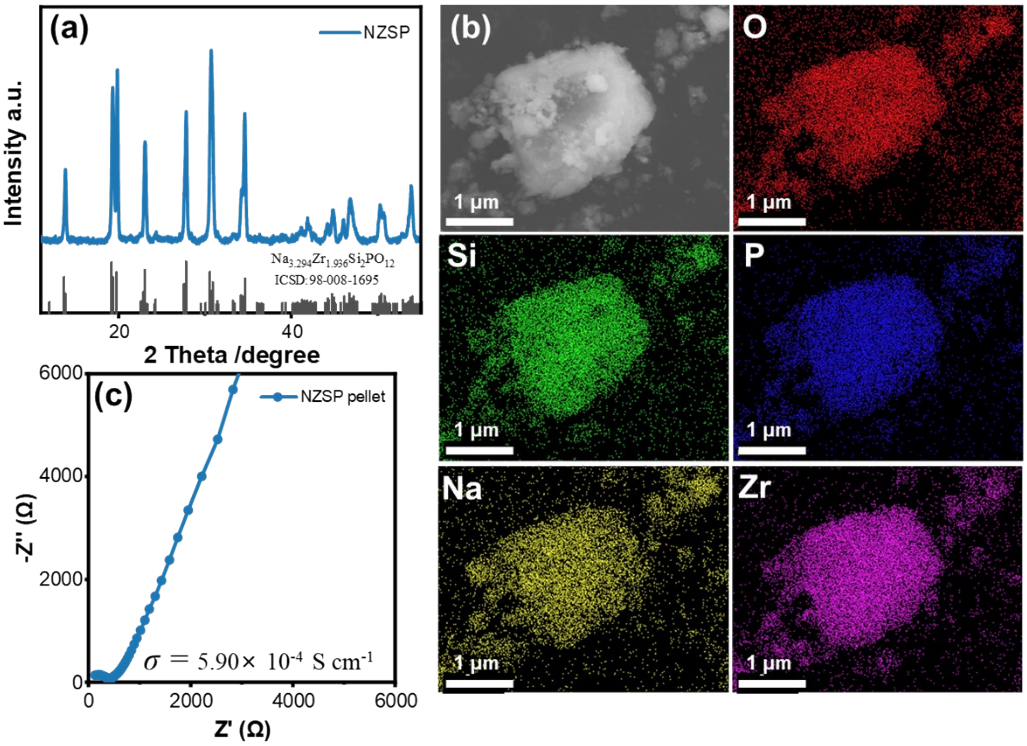

Fig. S1 (a) XRD pattern of sol-gel synthesized NZSP filler; (b) SEM morphology and elements distribution of synthesized NZSP filler; (c) Nyquist plots of synthesized NZSP pellet.

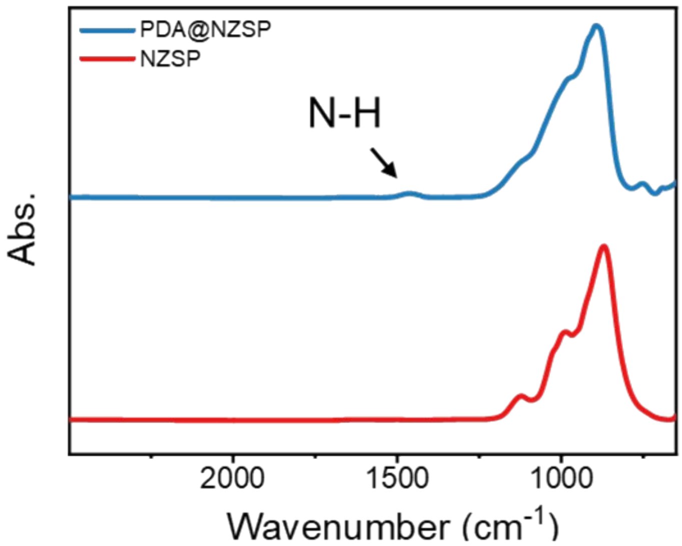

Fig. S2 ATR-FTIR spectra of PDA@NZSP and NZSP.

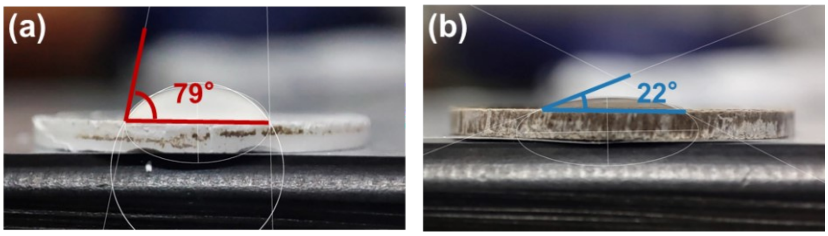

Fig. S3 Contact angle between the PEO acetonitrile solution and NZSP pellet (a) or PDA@NZSP pellet (b).

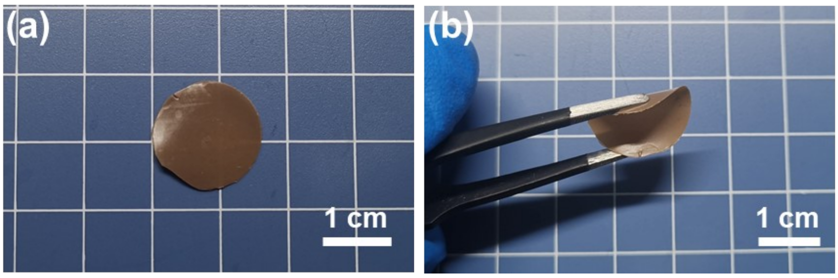

Fig. S4 Optical images of PCSE composite solid-state electrolyte membrane.

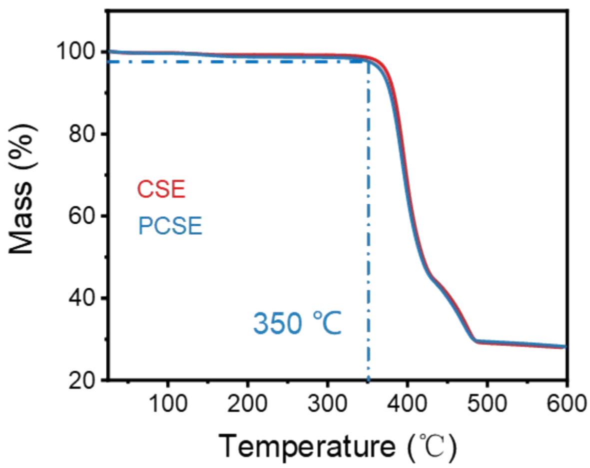

Fig. S5 TGA curves of CSE and PCSE in the temperature range from 25-600°C.

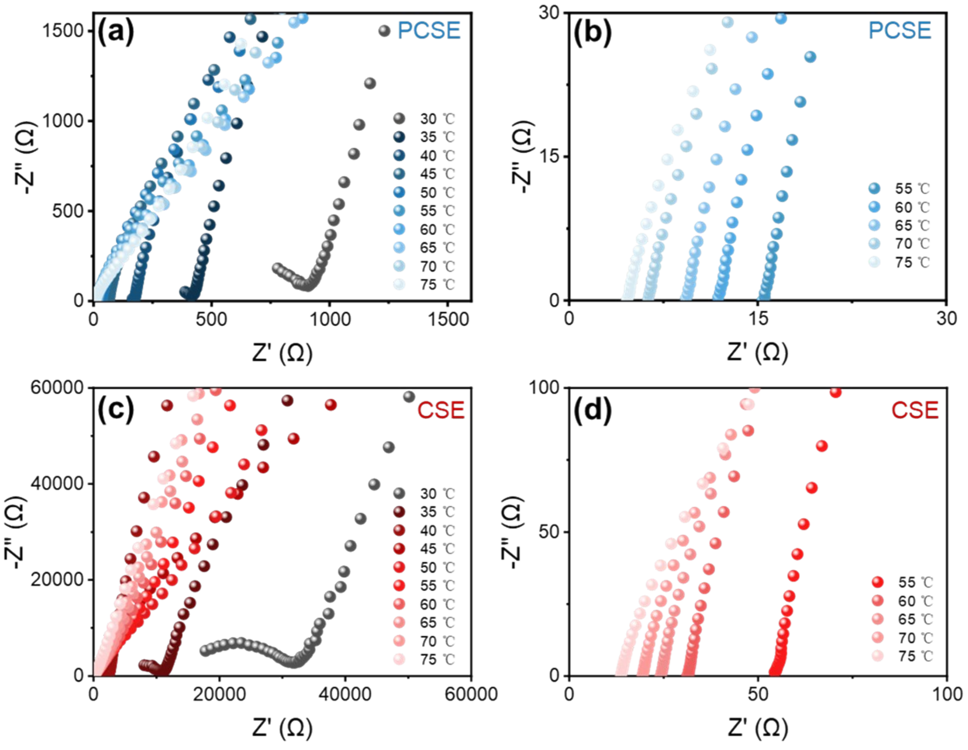

Fig. S6 Nyquist plots of SUS|PCSE|SUS (a, b) and SUS|CSE|SUS (c, d) in the temperature range from 30-75°C.

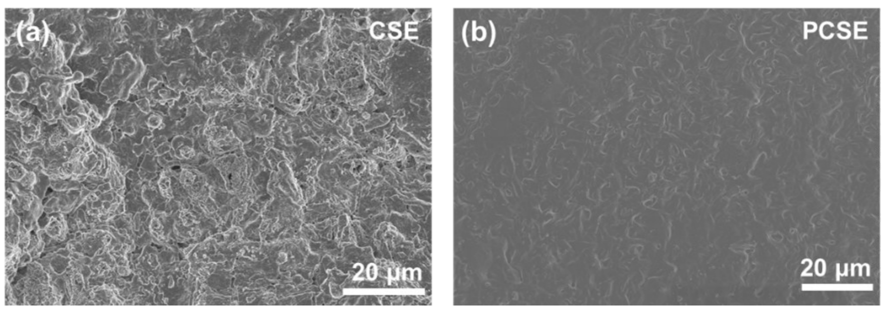

Fig. S7 SEM morphology of the sodium metal anode disassembled from Na|CSE|Na (a) and Na|PCSE|Na (b) after 50 deposition/dissolution cycles.

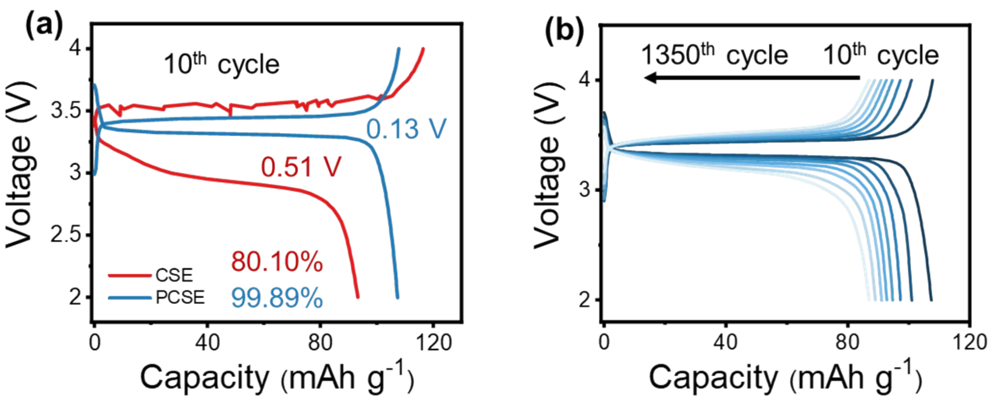

Fig. S8 (a) Charge/discharge profiles of Na|PCSE|NVP and Na|CSE|NVP at 10^{th} cycle with a rate of 1 C; (b) charge/discharge profiles of Na|PCSE|NVP with different number of cycles.

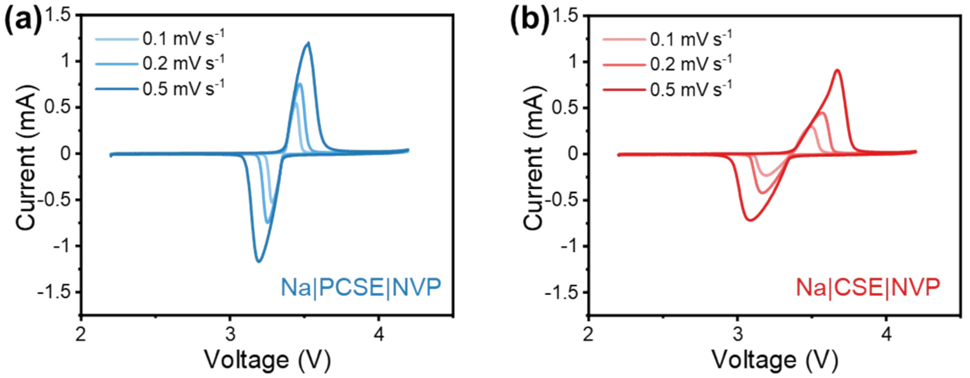

Fig. S9 CV curves of Na|PCSE|NVP and Na|CSE|NVP with different scanning rates.

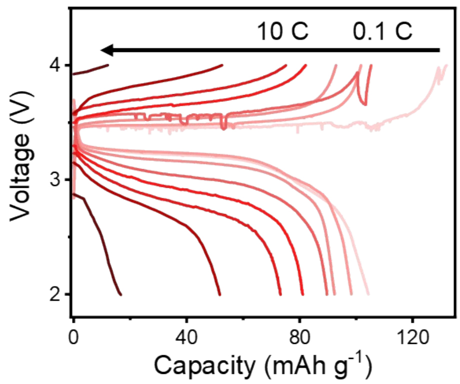

Fig. S10 Charge/discharge profiles of Na|CSE|NVP with different rates.

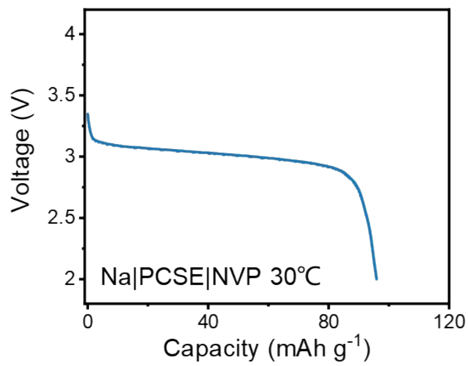

Fig. S11 Discharge profiles of Na|PCSE|NVP at 30℃.

Table S1 Mass ratio of each element in sol-gel product

	Na	Zr	P
Element mass ratio (%)	13.29	37.02	5.67

Table S2 Fitted bulk impedance of SUS|PCSE|SUS and SUS|CSE|SUS at different temperature

Fitted bulk impedance (Ω)										
Temperature (°C)	30	35	40	45	50	55	60	65	70	75
PCSE	908.8	412.6	170.8	62.2	33	15.4	11.9	9.3	6.3	4.6
CSE	31949	11013	2410	718	130.9	54.3	31.2	24.1	19.3	13.6

The thickness of PCSE and CSE membrane was 118 and 98 μm, respectively. The contact area between the electrolyte membrane and the SUS electrode is 1.96 cm^2.

Table S3 Bulk and interfacial impedance of Na|PCSE|Na and Na|CSE|Na before and after 30 cycles

	R_{b0}（Ω）	R_{b1}（Ω）	R_{i0}（Ω）	R_{i1}（Ω）
PCSE	10.99	10.89	52.46	128.07
CSE	16.61	15.79	124.62	188.78

R_b represents the bulk impedance，R_i represents the interfacial impedance，$_0$ indicates initial state，$_1$ indicates after 30 charge/discharge cycles

Table S4 Bulk and interfacial impedance of Na|PCSE|NVP and Na|CSE|NVP before and after 100 cycles

	R_{b0}（Ω）	R_{b1}（Ω）	R_{i0}（Ω）	R_{i1}（Ω）
PCSE	12.64	14.89	65.20	21.73
CSE	16.31	18.98	99.38	105.96

R_b represents the bulk impedance，R_i represents the interfacial impedance，$_0$ indicates initial state， $_{1}$ indicates after 100 charge/discharge cycles

Table S5 A comparison of the conditions and cycling performance of Na|PCSE|NVP with recently published PEO-based sodium solid-state electrolytes (* denotes quasi-solid-state design)

Solid electrolyte	Cathode	Temperature (°C)	Rate (C)	Initial capacity (mAh g^{-1})	Cycles	Capacity retention (%)
1.FMC-ASPE[1]	NVP	80	0.5	107.5	400	89
2.NZ-PEO@IL[*2]	NVP	60	0.5	104.5	150	90
3.PEPA@NC[3]	FeHCF	60	0.2	100	350	77.2
4.BPCE[4]	NVP	50	0.5	107	300	88.5
5.PEO-$NaClO_4$-$Na_3Zr_2Si_2PO_{12}$[5]	MnHCF	60	0.5	109.3	300	83
6.CPE-IL40[*6]	NVP	60	0.1	98	70	86.7
7.SPE[7]	NaNFM	60	0.1	102.4	80	90
8.PEO/NZTO[8]	NVP	80	0.2	95	100	89.4
9.PEO-β-Al_2O_3[9]	NVP	60	0.2	93.1	100	83.6
10.PEO-P-N[10]	NVP	60	1	102	500	87.2
11.ATFPE[11]	NVP	60	1	87.3	1000	78.2
12.2N8D+FEC[*12]	NVP	60	0.5	108	200	50.3
13.CPE[13]	NVP	60	0.5	102	250	86
14.PE-PEO /NaTFSI[14]	NVP	80	0.1	115	200	88.7
15.BSPCE[15]	NVP	60	0.1	115.7	200	86.8
16.PSZ[16]	NVP	80	0.5	92.3	200	95
17.M1[17]	$NaFe(SO_4)_2$	60	0.1	84	60	89.3
This work	**NVP**	**60**	**1**	**107.9**	**1350**	**80.5**

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