Supporting information

$NaBH_4$-Poly(ethylene oxide) Composite Electrolyte for All-Solid-State Na-Ion Batteries

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Table of Figures

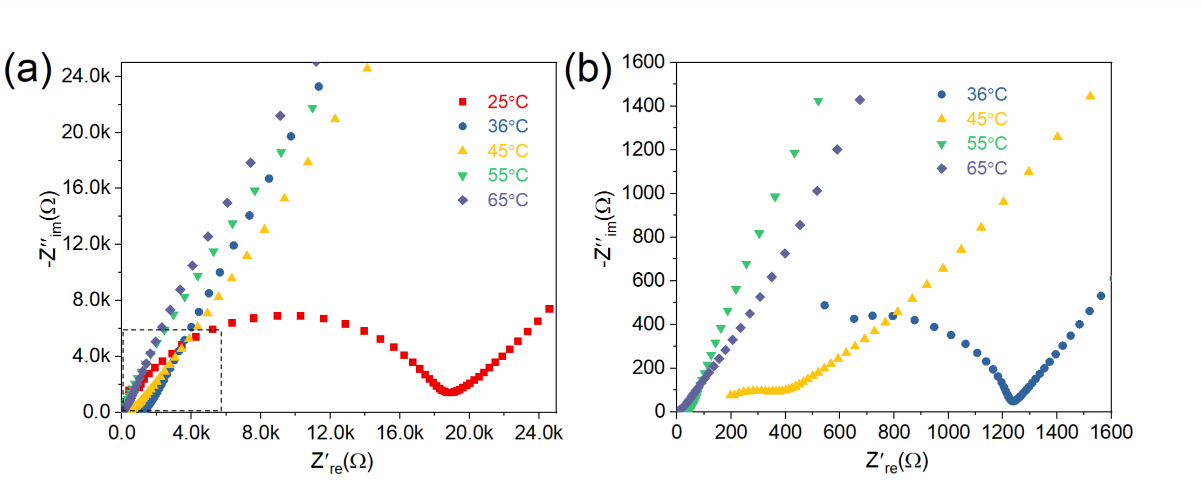

Figure S1. (a) Nyquist plots of Hy-NaBH4-20PEO from 25°C to 65°C. (b) magnification of the dash box in Figure S1(a).

At room temperature, the Nyquist plot consists of a semicircle and line tail consistent with that of the reported borohydride-based electrolytes.[1] R is the intercept of semicircle with the X axis. With temperatures increasing, the magnitude of the semicircle gradually decreases.

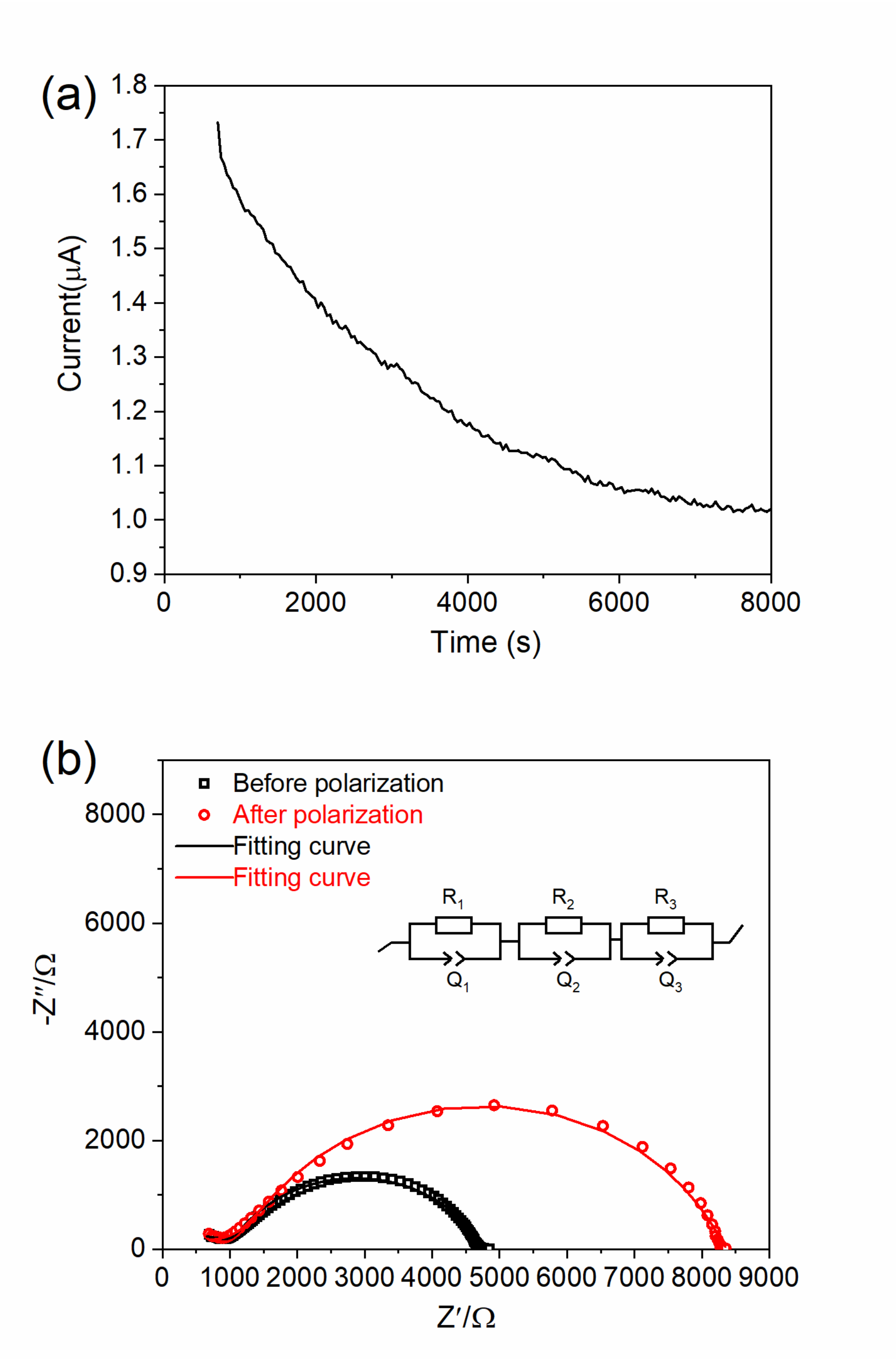

Figure S2. Current -time curves following DC polarization of Hy-NaBH4-20PEO with 10 mV polarization voltage at 45 °C. (b) The Nyquist plot of Hy-NaBH4-20PEO before and after DC polarization. The equivalent circuit was shown as insert.

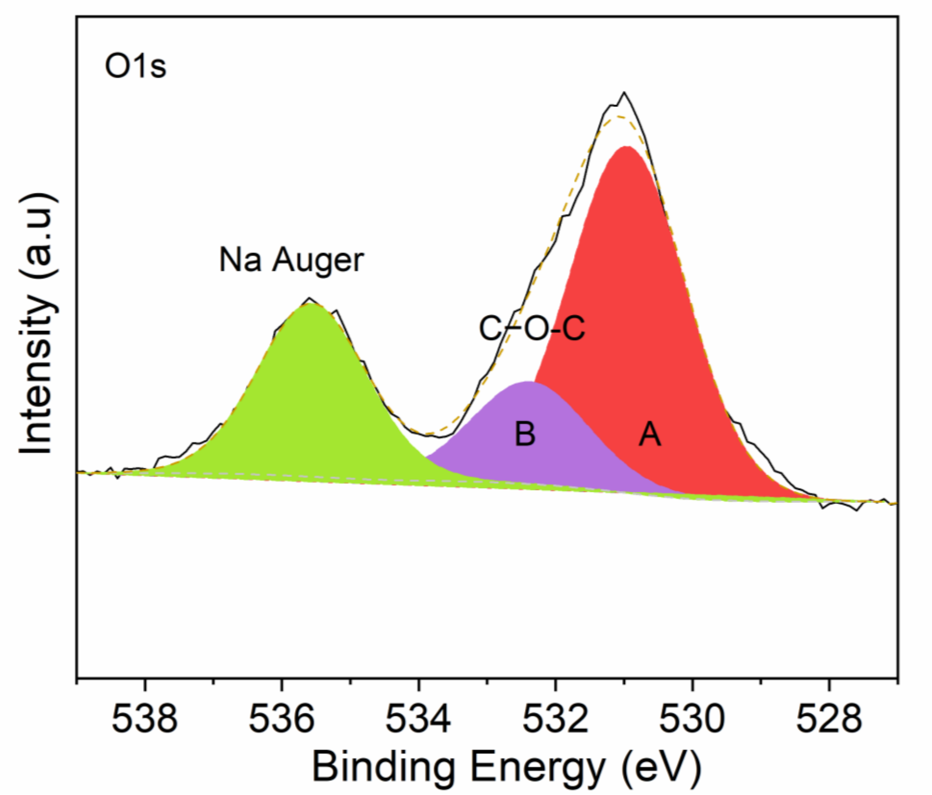

Figure S3. O1s XPS spectra of Hy-$NaBH_4$-20PEO.

The peak B located at 532.3 eV is assigned to the C-O-C from PEO.[2] The peak A may relate to the boron-oxide species,[3] which is consistent with 191.2 eV in B1s spectrum (Figure 3a).

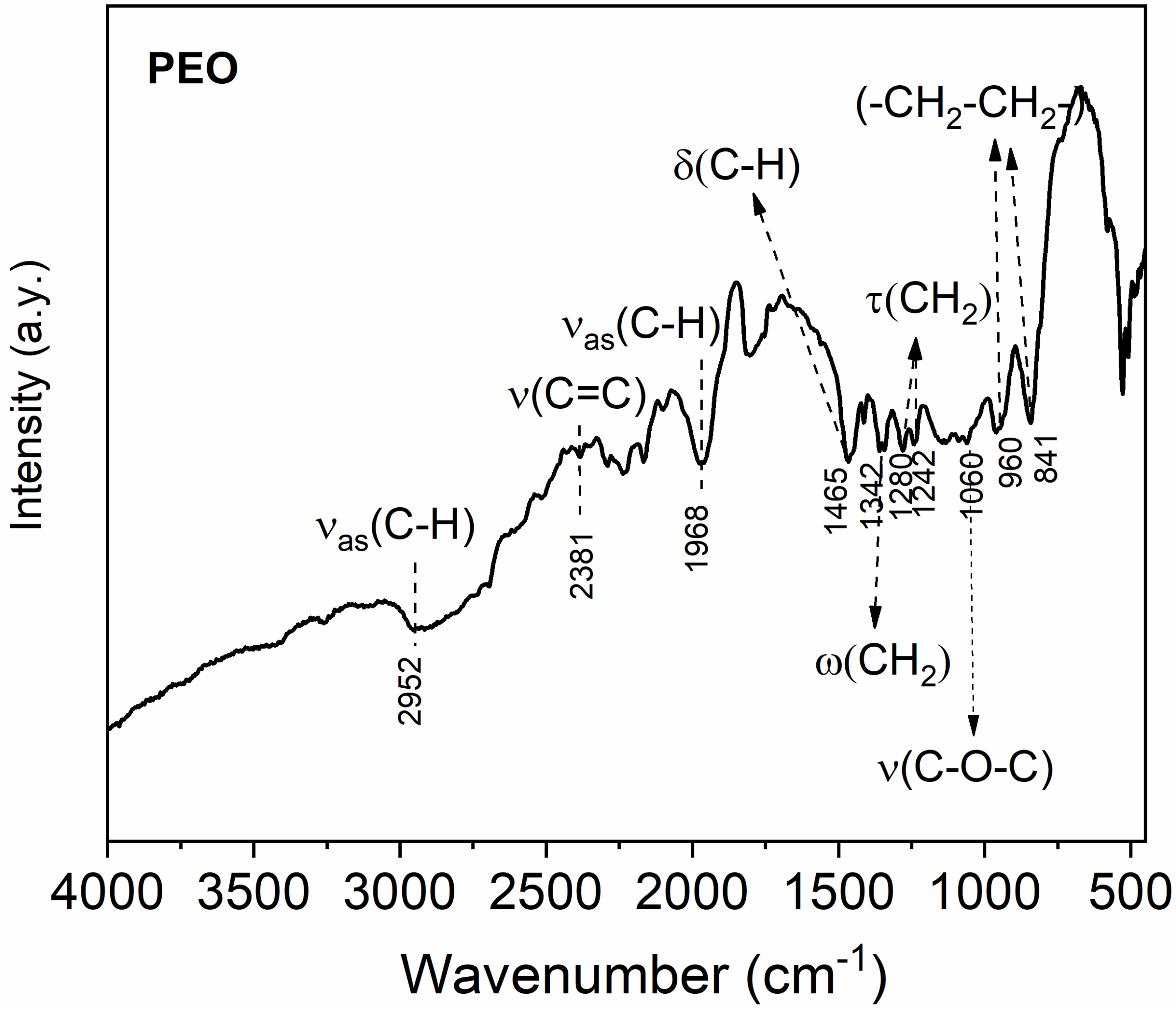

Figure S4. FTIR of PEO

Table S1 the lattice paraterm of $NaBH_4$ in Hy-$NaBH_4$-PEO calculated from XRD by Retvield analysis

Materials	Lattice parameter a (± 0.001 Å)
Unmodified $NaBH_4$	6.164
Hy- $NaBH_4$-5PEO	6.163
Hy- $NaBH_4$-10PEO	6.157
Hy- $NaBH_4$-20PEO	6.160
Hy- $NaBH_4$-30PEO	6.159

Table S2. The degreed of crystallinity (χ_c) of PEO in Hy-$NaBH_4$-PEO calculated by using melting enthalpy in DSC.

Materials	Degree of crystallinity (χ_c)
PEO	35.5%
Hy- $NaBH_4$-5PEO	10.7%
Hy- $NaBH_4$-10PEO	18.8%
Hy- $NaBH_4$-20PEO	20.8%
Hy- $NaBH_4$-30PEO	21.6%

Table S3. Na^+ transference number (t_{Na^+}) of Hy-$NaBH_4$-20PEO.

Materials	$I_{(t=0)}/\ \mu A$	$I_{(t=\infty)}/\mu A$	$R_{(t=0)}/\Omega$	$R_{(t=\infty)}/\Omega$	t_{Na+}
Hy-$NaBH_4$-20PEO	1.73	1.0	3630	6569	0.54

$$t_{Na^+} = \frac{I_\infty (\Delta V - I_0 R_0)}{I_0(\Delta V - I_\infty R_\infty)}$$

Table S4. Summarized of PEO composite sodium solid state electrolytes

Materials	Ionic conductivity ($S\ cm^{-1}$)	Transference number	Ref
PEO-$NaPF_6$	6.3×10^{-4} @ 80 °C	0.58	4
PEO–$NaClO_4$–$Na_3Zr_2Si_2PO_{12}$	7.8×10^{-4} @ 75 °C	NA	5
Na_3PS_4-PEO	9.5×10^{-4} @ 25 °C	NA	6
$Na_3Zr_2Si_2PO_{12}$–PEO_{12}–NaFSI	2.2×10^{-5} @ 25 °C	NA	7
PEO_{20}:NaTFSI	1.1×10^{-3} @ 80 °C	0.39	8
Hy-$NaBH_4$-20PEO	1.6×10^{-3} @ 45 °C	0.54	This work

References

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