Electronic Supplementary Material (ESI) for Energy & Environmental Science.

Supplementary Information

Hybrid solid electrolyte for flexible solid-state sodium battery

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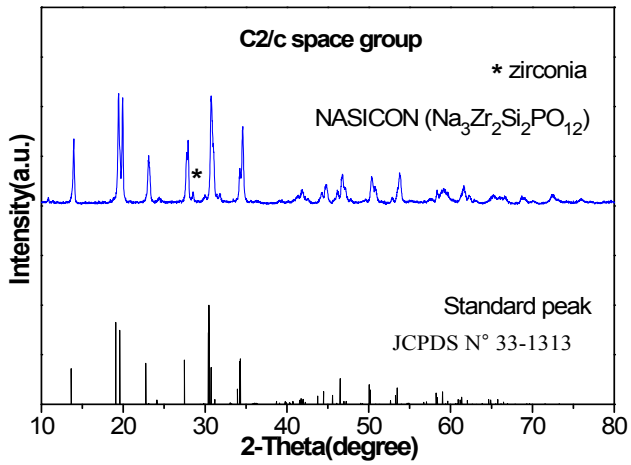

Fig. S1. XRD data for NASICON ($Na_3Zr_2Si_2PO_{12}$) ceramic powder.

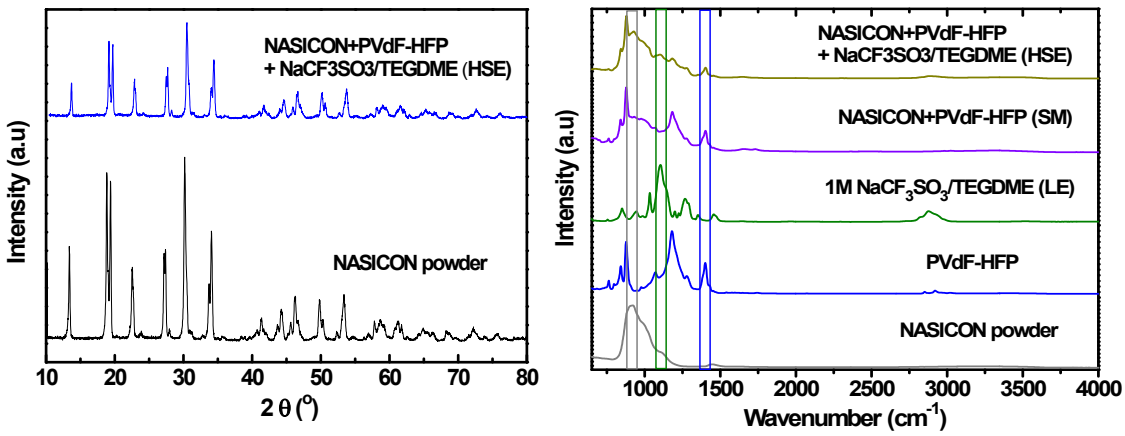

Fig. S2 XRD and FR-IR spectra of HSE, NASICON, PVdF-HFP and liquid electrolyte (1M $NaCF_3SO_3$ in TEGDME).

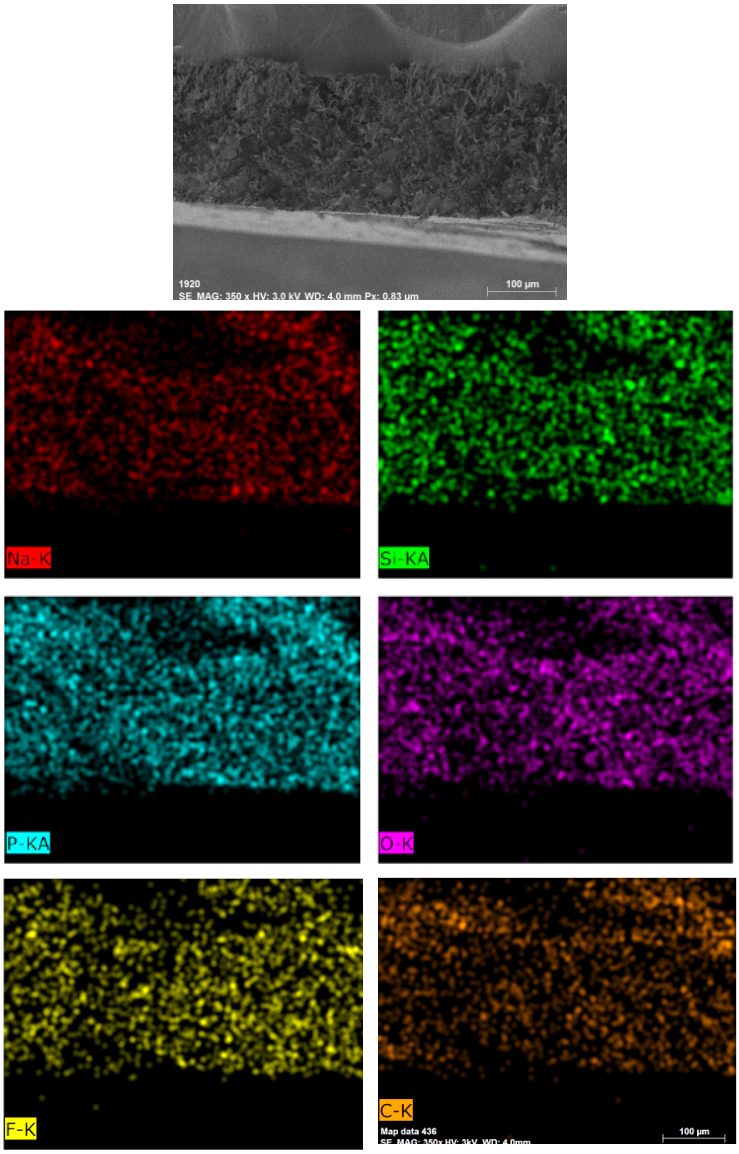

Fig. S3 EDX mappings of cross-sectional HSE with Na, Si, P, O, F, and C atoms.

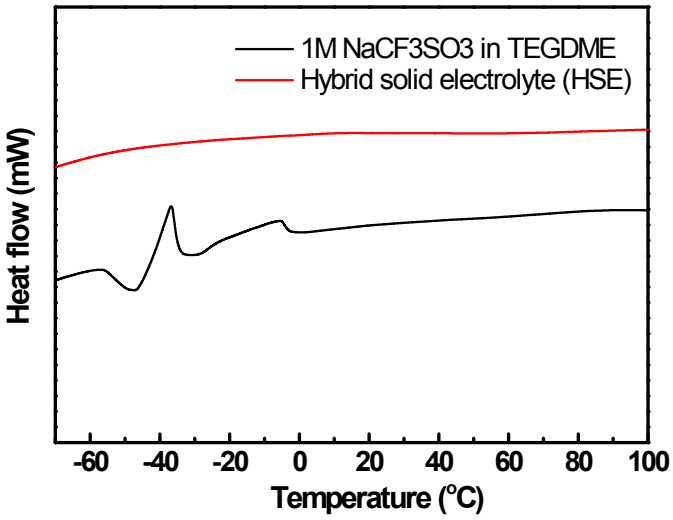

Fig. S4 DSC trace of liquid electrolyte and HSE. Scan rate: 10 °C min^{-1}.

1M NaCF3SO3 in TEGDME
Hybrid solid electrolyte (HSE)

Fig. S5 RT Raman spectra of liquid electrolyte and HSE showing symmetrical SO_3 bending mode for free CF_3SO_3 and CF_3SO_3 coordination to Na ions at 25 °C.

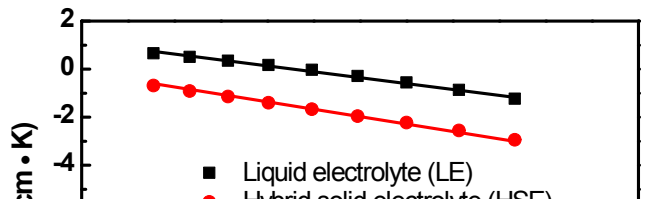

Fig. S6 Arrhenius plots of total conductivities of liquid electrolyte (1M $NaCF_3SO_3$ in TEGDME), solid film, and HSE.

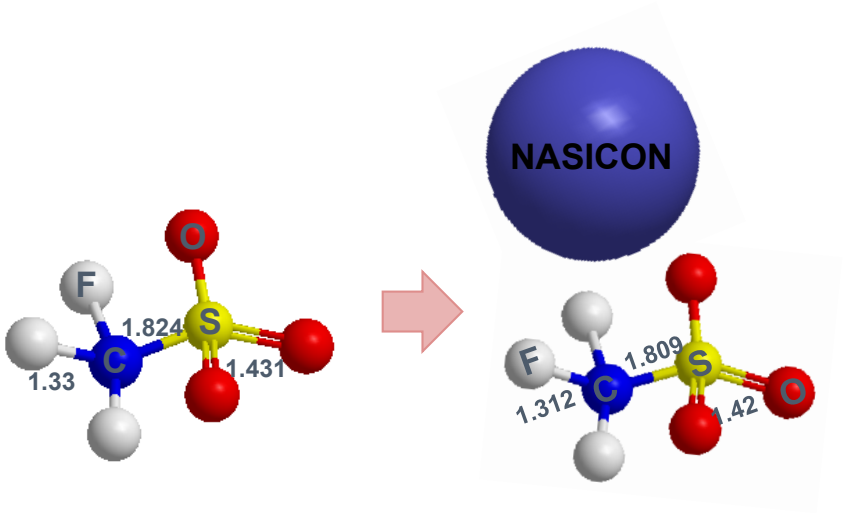

Fig. S7 Bond lengths (Å) of free CF_3SO_3 anions and CF_3SO_3 anions interacted with NASICON particle.

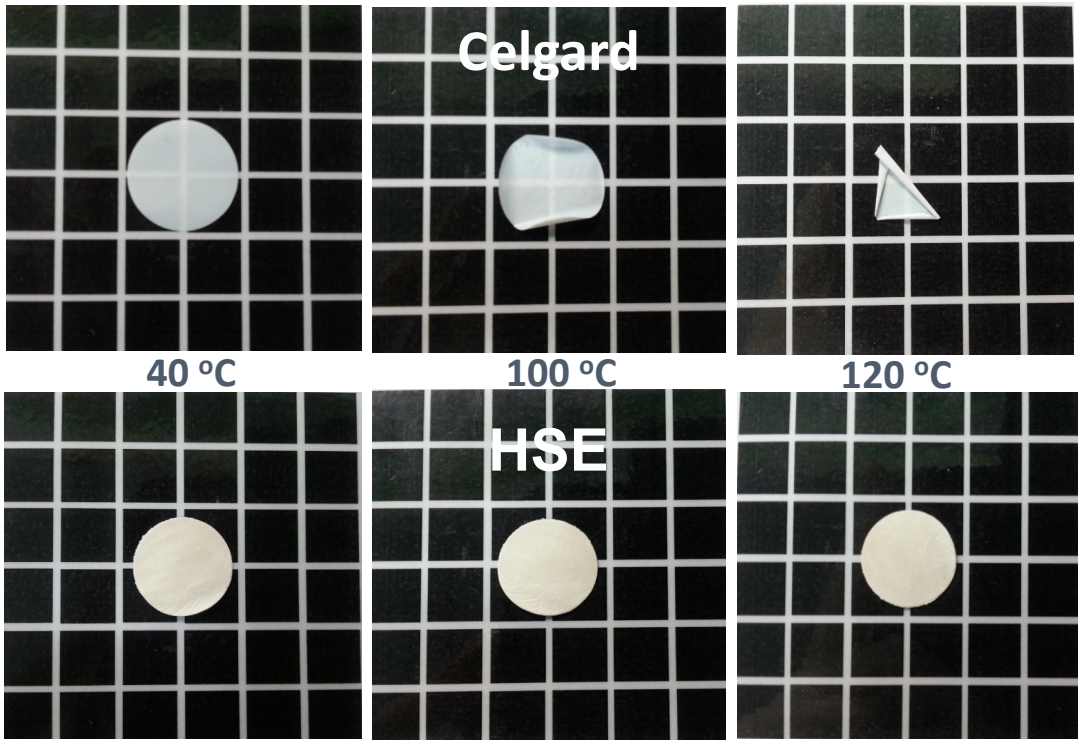

Fig. S8 Shrinkage of commercial membrane (Celgard) and HSE at various temperatures.

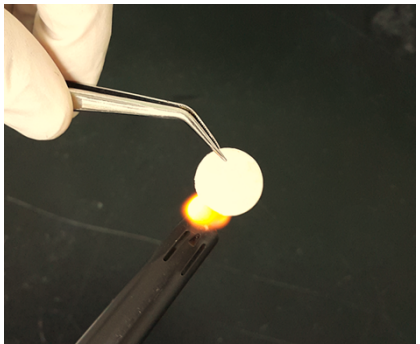

Fig. S9 The combustion test of HSE.

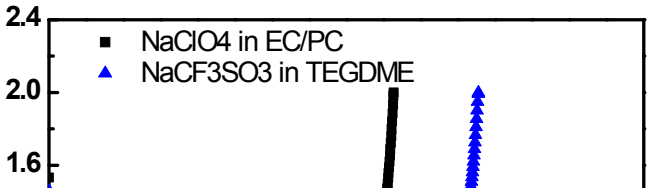

Fig. S10 Discharge and charge voltage curves of Na/hard carbon cell with two different electrolytes at room temperature (0.2 C-rate).

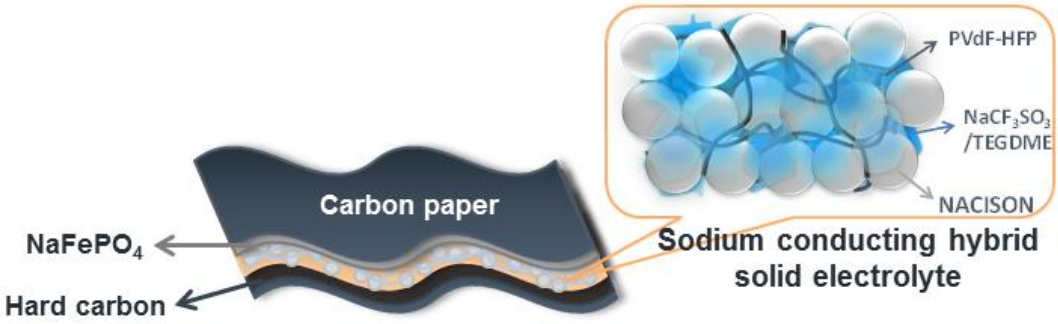

Fig. S11 Flexible solid-state Na battery scheme with Na-conducting HSE.

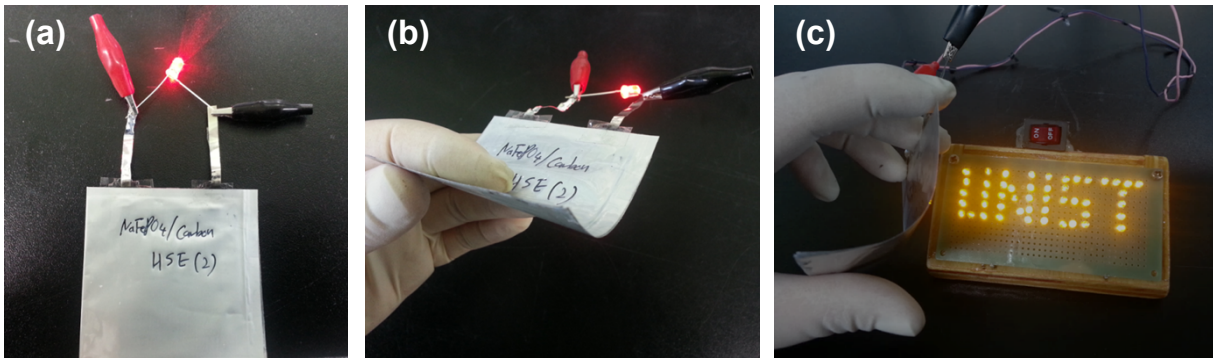

Fig. S12 Photographs showing electrical states (a: normal static condition, b: bending, c: following repeated bending) of red LED lamps connected to flexible solid-state Na batteries fabricated with HSE.

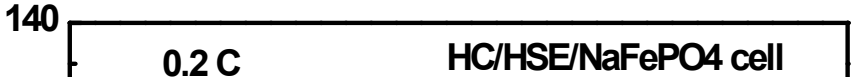

Fig. S13 Short-term cycling of flexible solid-state Na cell with Na-conducting and non-Na-conducting HSE at different C-rates (10 cycles at each C-rate, 25 °C, 1.5–4.0 V).