Supporting Information

Hard Carbon Derived from Physalis alkekengi L. husk as a Stable Anode for Sodium-Ion Batteries

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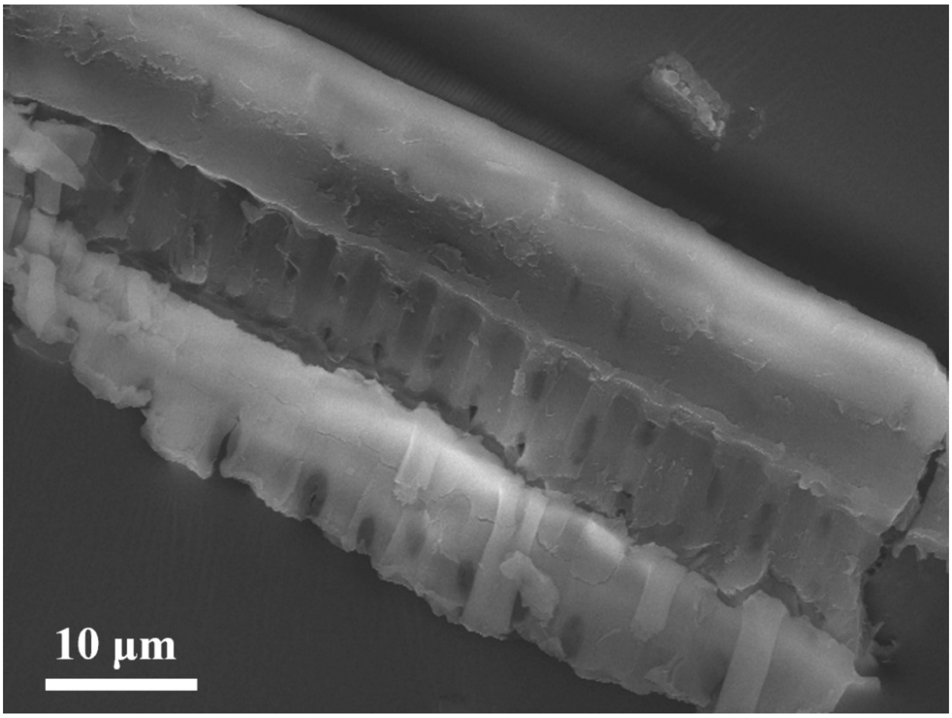

Figure S1 The SEM image of the PLH.

Table S1. Structural properties of S-Xs.

Sample	*d*-spacing (Å)	R	I_D/I_G (%)	Surface area ($m^2\ g^{-1}$)	Pore volume ($cm^3\ g^{-1}$)
S-1000	3.62	2.41	2.38	18.81	0.024
S-1200	3.63	2.58	2.20	20.17	0.038
S-1400	3.58	2.64	1.70	9.92	0.031

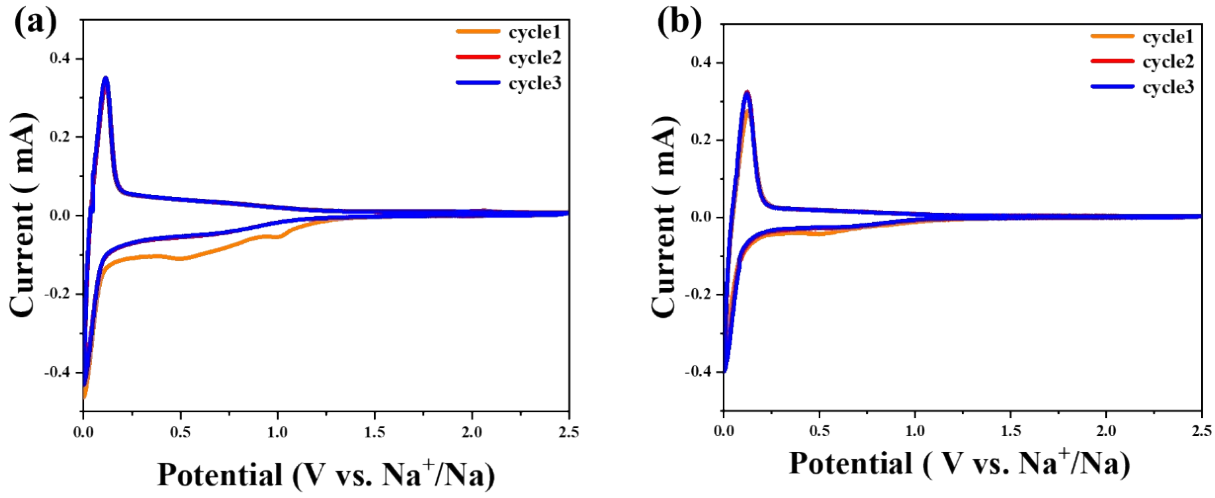

Figure S2 CV curves of (a) S-1000 and (b) S-1400.

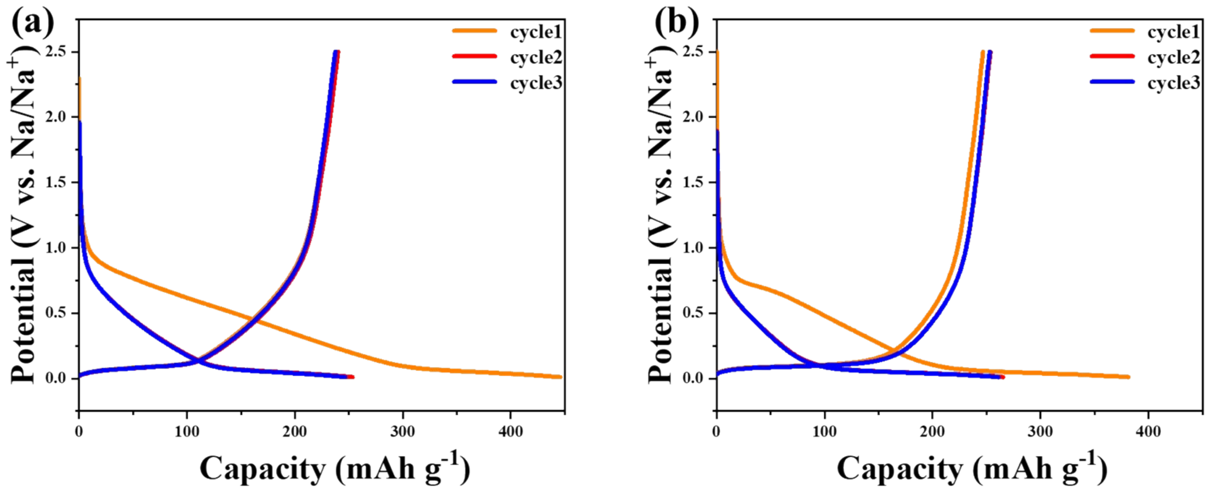

Figure S3 Galvanostatic charge/discharge profiles of (a) S-1000 and (b) S-1400.

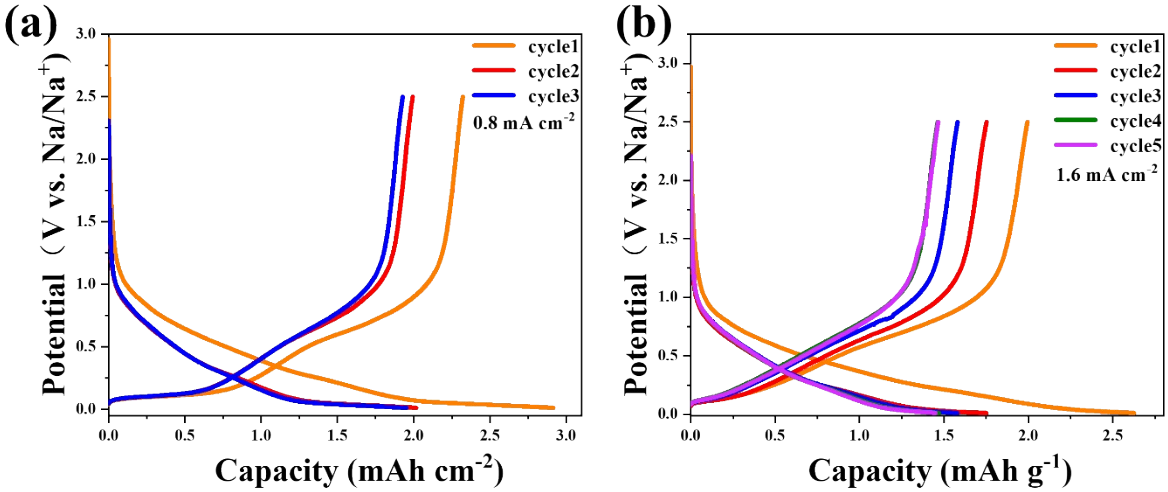

Figure. S4 Electrochemical performance of high mass loading S-1200 (~8 mg cm^{-2}): the charge-discharge profiles at a current density of (a) 0.8 mA cm^{-2} and (b) 1.6 mA cm^{-2}.

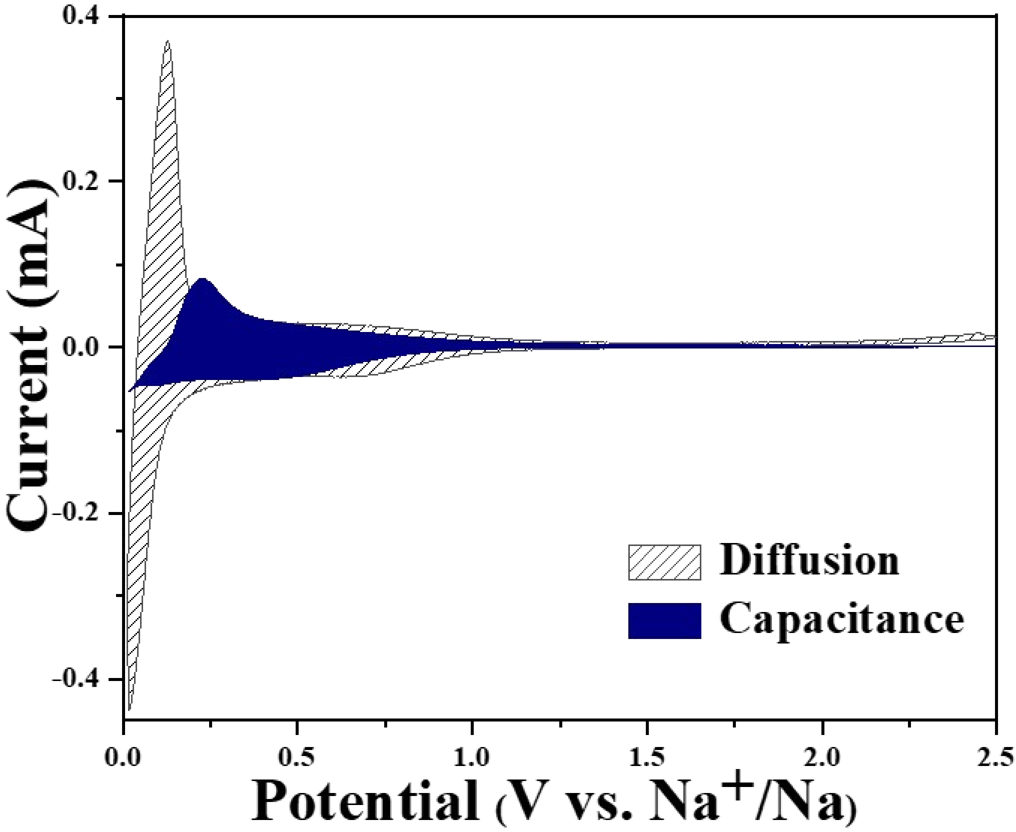

Figure S5 Sketch view of the capacitive contribution ratio at the scan rate of 0.1 mV s^{-1}.

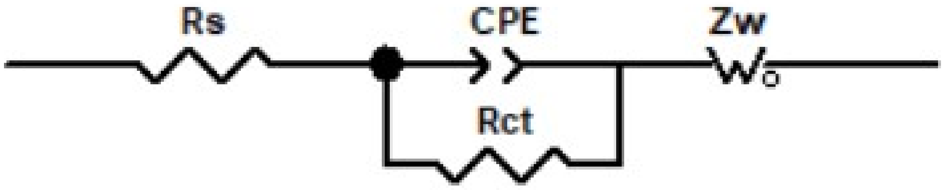

Figure S6 Equivalent circuit used for fitting the impedance data. Rs and Rct refer to electrolyte resistance and charge transfer resistance, respectively. CPE represents double-layer capacitance. Warburg impedance (Z_w) corresponds to ion diffusion in the host material.

Table S2 Fitting results of resistances in the equivalent circuit.

Sample	Rct (Ω)	Rs (Ω)
S-1000	29.93	9.28
S-1200	22.86	5.25
S-1400	26.37	9.58

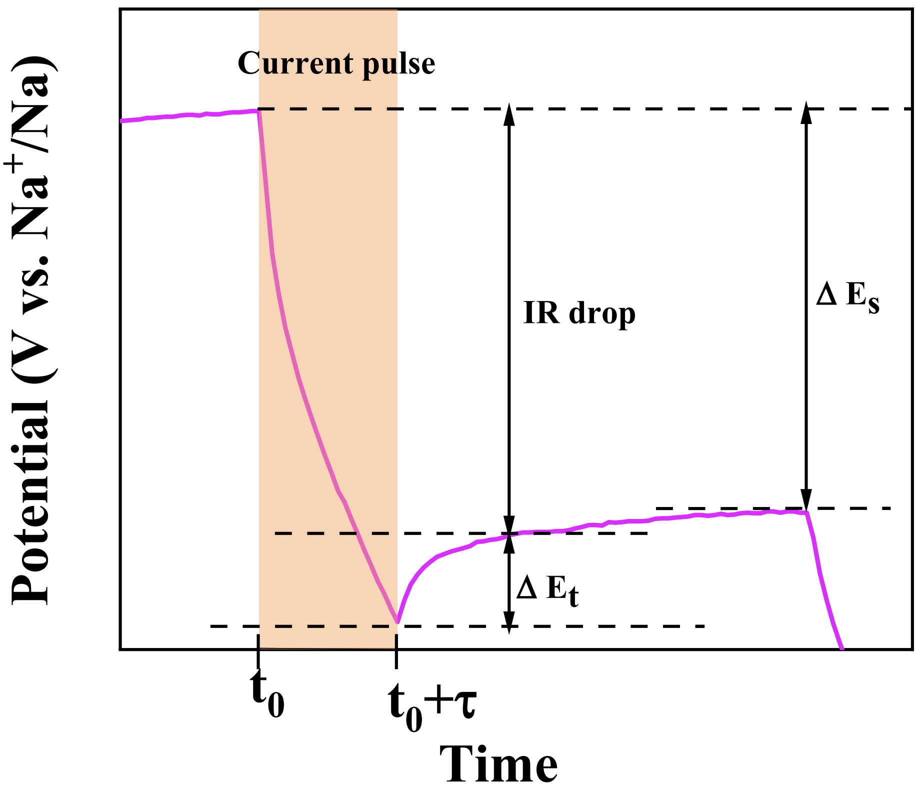

Figure S7 Schematic of the calculation of Na^+ diffusion coefficient using the GITT technique. According to Fick's second law, the value of diffusion coefficient D_2 was calculated by the following equation.

$$D_2 = \frac{4}{\pi\tau}\left(\frac{m_b \cdot V_m}{M_B \cdot S}\right)^2\left(\frac{\Delta E_s}{\Delta E_\tau}\right)^2$$

Where τ is the current pulse time (s), m_b is the active material mass (g), V_m and M_B are the molar volume ($cm^3\ mol^{-1}$) and molar mass ($g\ mol^{-1}$) of carbon respectively, S is the electrode contact surface area (cm^2), E_s is the GITT single-step steady-state voltage change, and E_τ is the single-step current pulse voltage change.

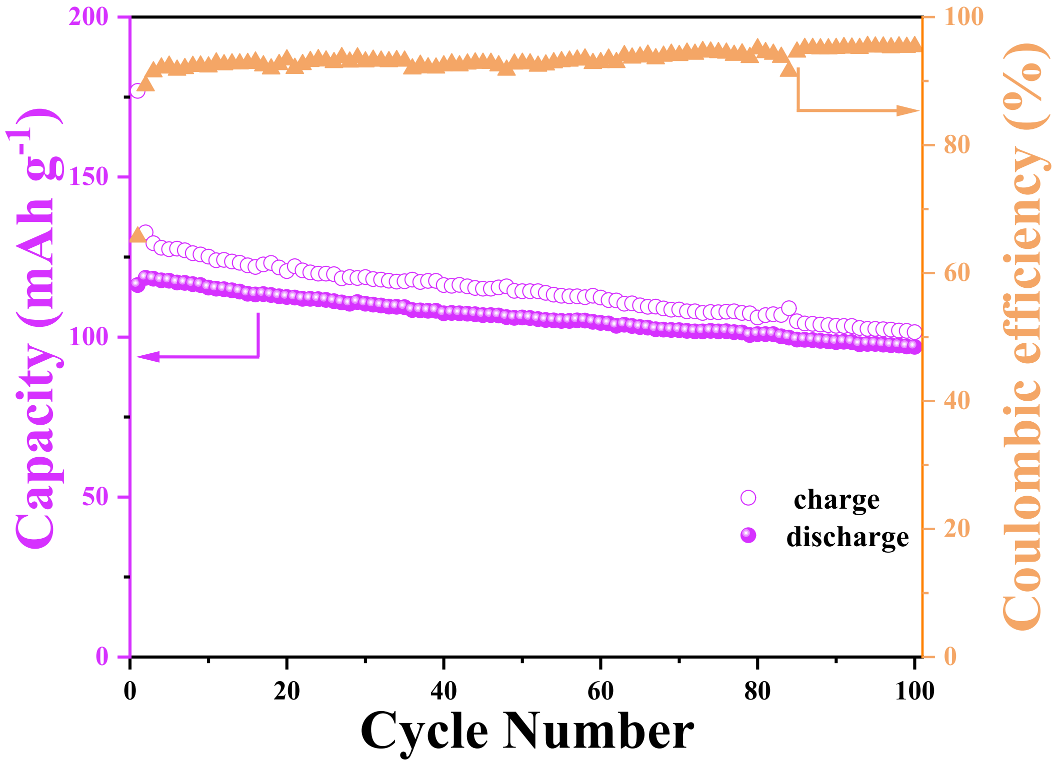

Figure S8 Cycling performance of $Na_3V_2(PO_4)_3$.

Table S3 Electrochemical performance comparison of SIB full cells reported in literatures.

Materials	Cycling performance	Rate capability	Reference
$Na_3V_2(PO_4)_3$/ hard carbon	60 mAh g^{-1}@0.059 A g^{-1}/1000 cycles		*Nano Energy*, 2016, **28**, 216.
$Na_3V_2(PO_4)_2F_3$@C/hard carbon	88 mAh g^{-1}@0.002 A g^{-1}/300 cycles 71 mAh g^{-1}@0.02 A g^{-1}/600 cycles	114.1, 107.8, 105.6, 102, 97.9, 90.6 mAh g^{-1}@0.001, 0.002, 0.004, 0.01, 0.02, 0.04 A g^{-1}	*Chem. Eng. J.*, 2020, **413**, 127565.
$Na_3V_2(PO_4)_3$/ P-HC-2	111 mAh g^{-1}@0.1 A g^{-1}/100 cycles	123, 92, 68, 54, 47 mAh g^{-1}@0.1, 0.2, 0.5 1, 1.5A g^{-1}	*Small*, 2023, DOI: 10.1002/smll.202309809
$Na_3V_2O_2(PO_4)_2F$/ Hard Carbon	112.8 mAh g^{-1}@0.06 A g^{-1}/70 cycles	121, 109, 99 mAh g^{-1}@0.06, 0.24, 0.36 A g^{-1}	*ACS Appl. Mater. Interfaces*, 2018, **10**, 16581.
$Na_{2-\delta}$MnHCF /hard carbon	140 mAh g^{-1}@0.1 A g^{-1}/30 cycles	96 mAh g^{-1}@0.28 A g^{-1}	*J. Am. Chem. Soc*, 2015, **137**, 2658.
$NaCrO_2$ nanowires/hard carbon	103 mAh g^{-1}@0.2 A g^{-1}/55 cycles	88.2, 82.6 mAh g^{-1}@2, 3 A g^{-1}	*ACS Appl. Mater. Interfaces*, 2019, **11**, 4037.
$Na_3V_2(PO_4)_3$/ S-1200	161.99 mAh g^{-1}@0.1 A g^{-1}/100 cycles	221.41, 179.90, 141.74 mAh g^{-1}@0.1, 0.2, 0.3 A g^{-1}	This work

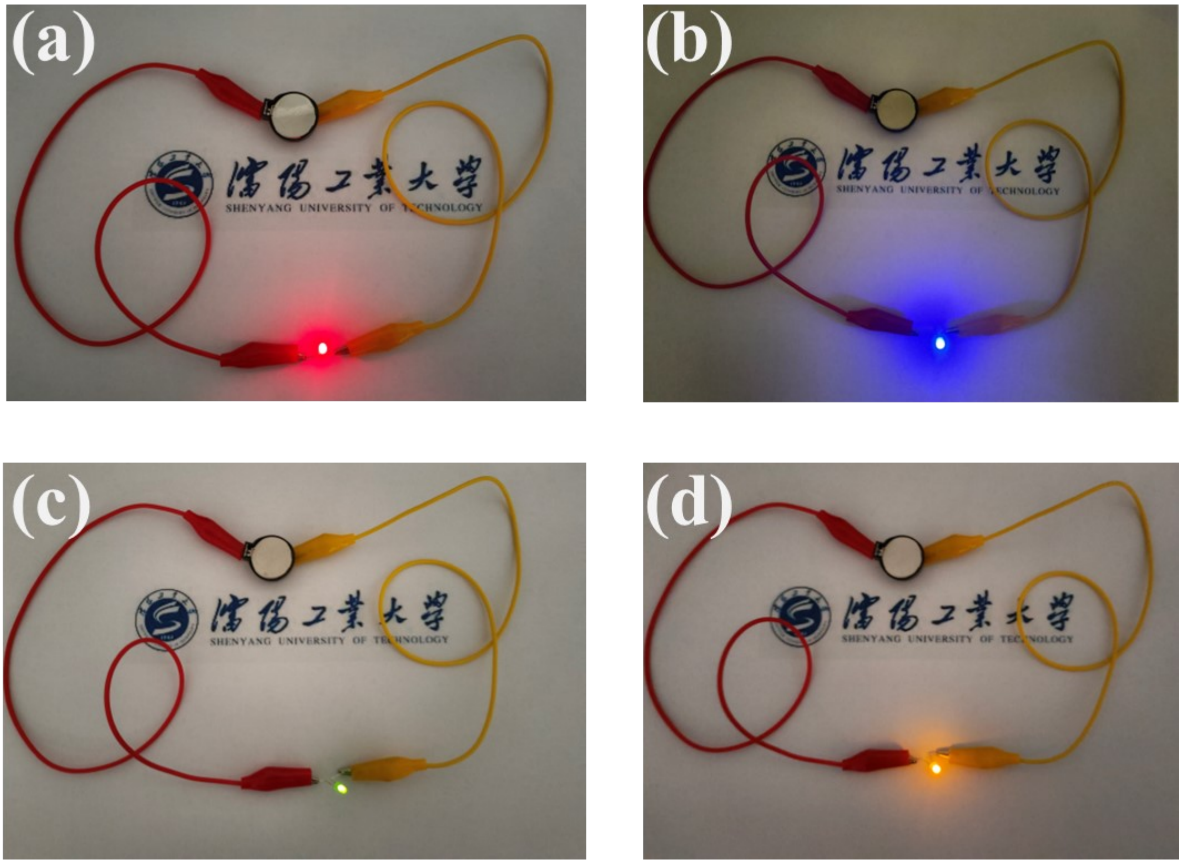

Figure S9 The full cell illuminates different LEDs with different working potentials for red (1.8−2.4 V), blue (2.8−3.4 V), green (1.8−2.4 V), and yellow (1.8−2.4 V).

video S1.mp4

Video S1 The full cell lightens a white LED. Herein, only two-minute video is shown; it actually could work more than fifteen minutes without obvious changes).

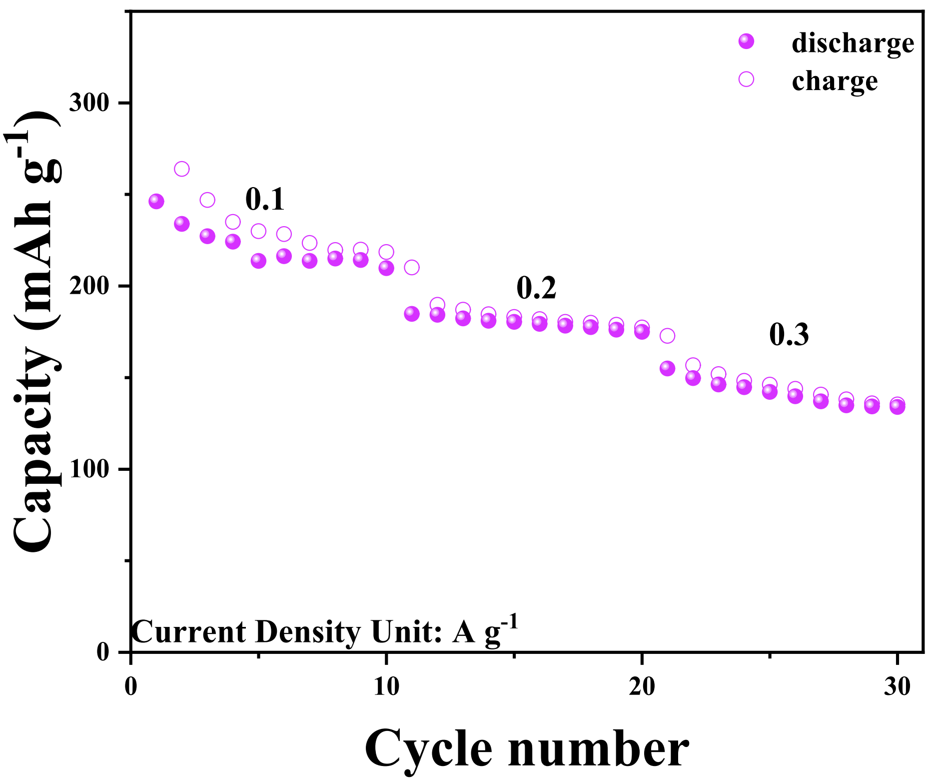

Figure S10 Rate performance of the SIB full cell.