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

Electronic Supplementary Information

Mono-faceted WO_{3-x} nanorods *in-situ* hybridized in carbon nanosheets for ultra-fast/stable sodium-ion storage

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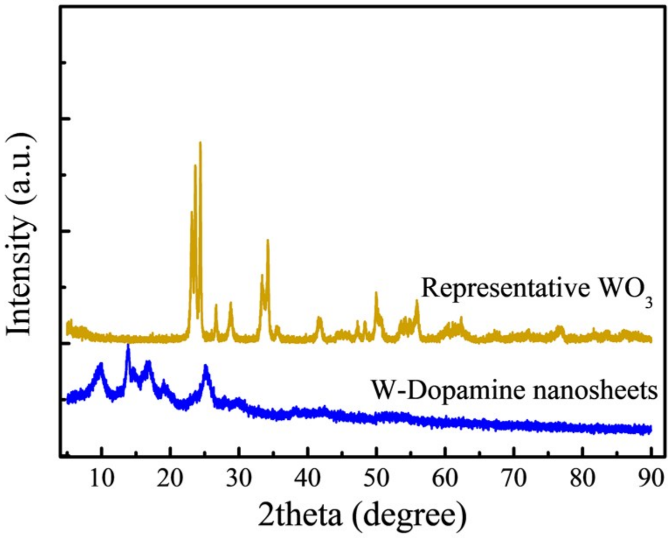

Figure S1 XRD patterns of the W-dopamine nanosheets and representative WO_3.

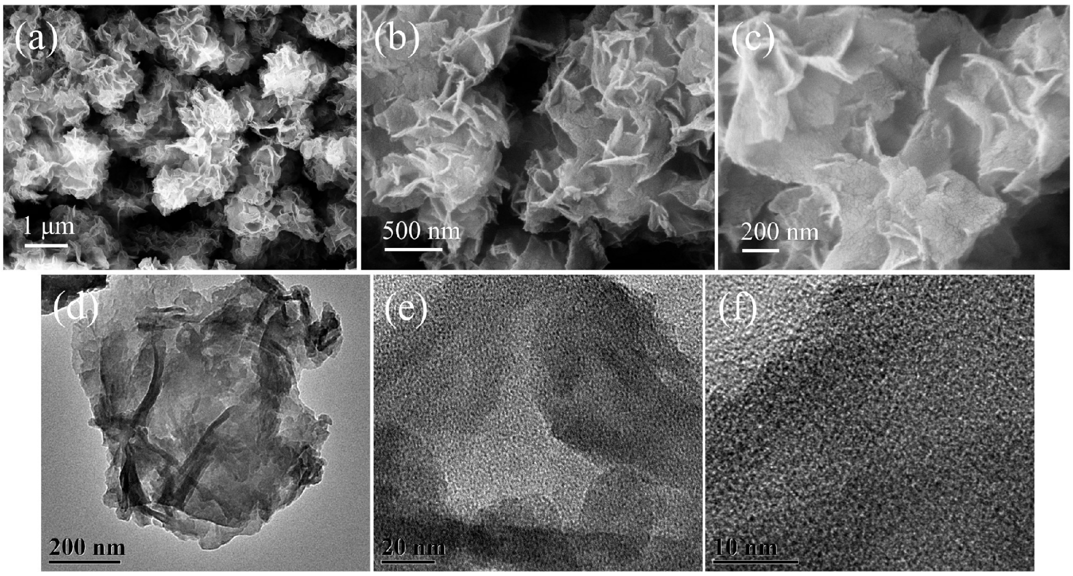

Figure S2 (a-c) SEM and (d-f) TEM images of the W-dopamine nanosheets at different magnifications.

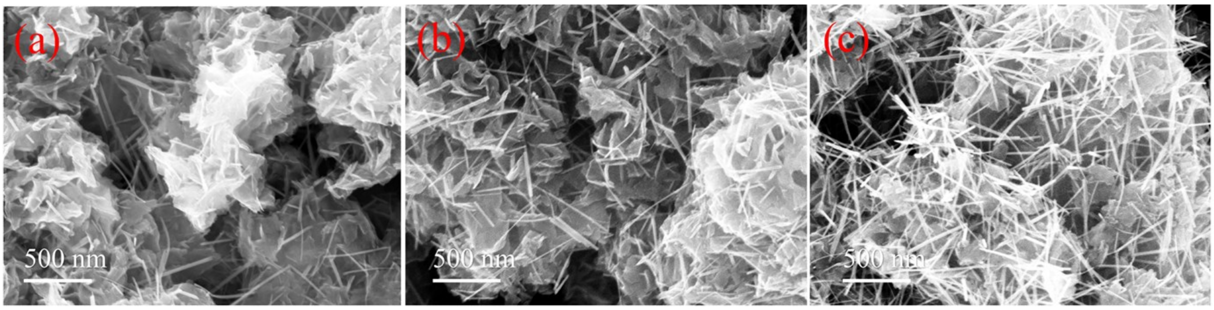

Figure S3 SEM images of the WO_{3-x} NRs/N-CNSs at the different annealing temperatures: (a) 500, (b) 600 and (c) 700 ℃.

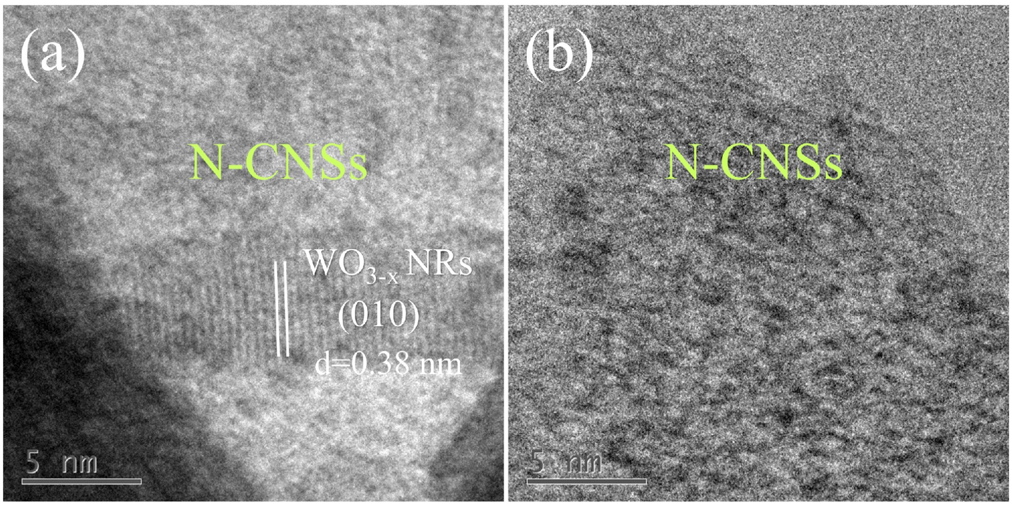

Figure S4 (a) TEM image of the WO_{3-x} NRs/N-CNSs and (b) the corresponding TEM image in pure carbon sites.

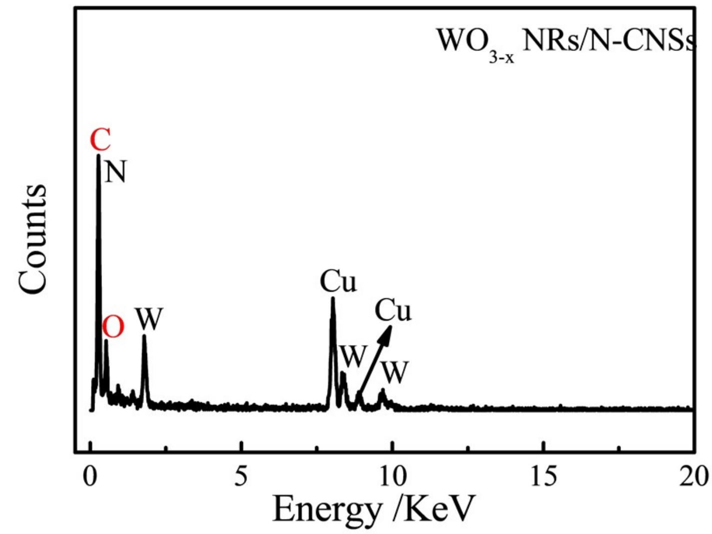

Figure S5 EDX spectrum of the WO_{3-x} NRs/N-CNSs.

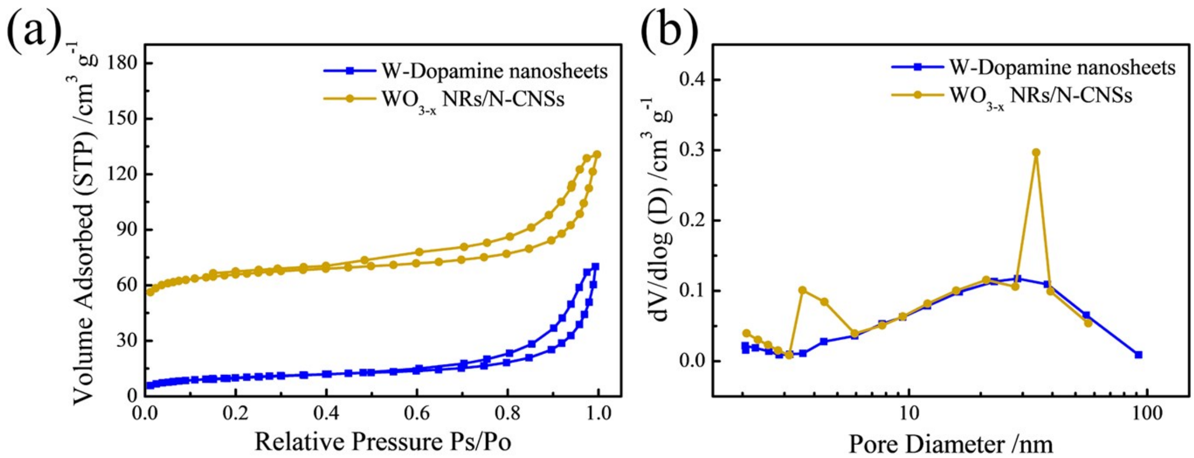

Figure S6 (a) N_2 absorption-desorption isotherms and (b) Pore-size distribution curves of the W-dopamine nanosheets and WO_{3-x} NRs/N-CNSs.

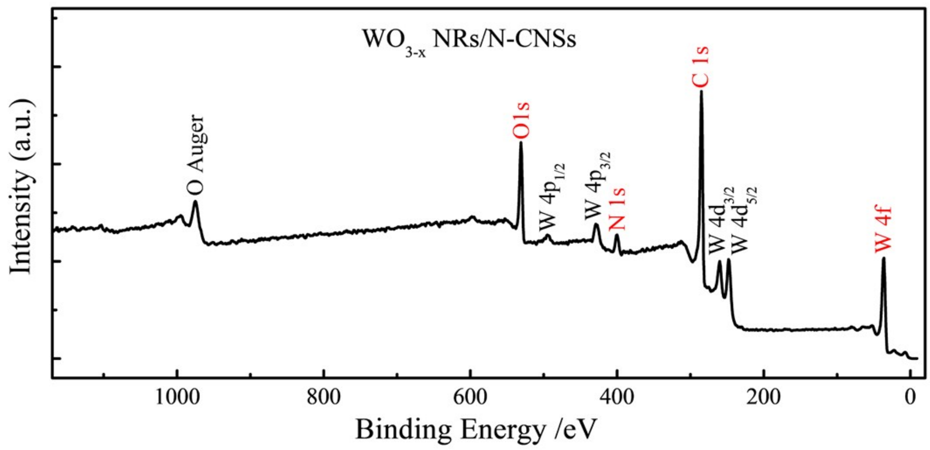

Figure S7 XPS survey spectrum of the WO_{3-x} NRs/N-CNSs.

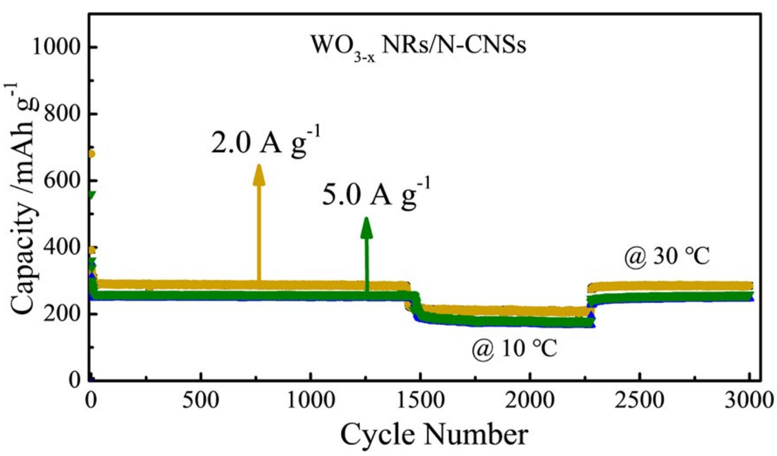

Figure S8 High- (at 10 ℃) and low- (at 30 ℃) temperature cyclic stabilities of the WO_{3-x} NRs/N-CNSs at 2.0 and 5.0 A g^{-1}.

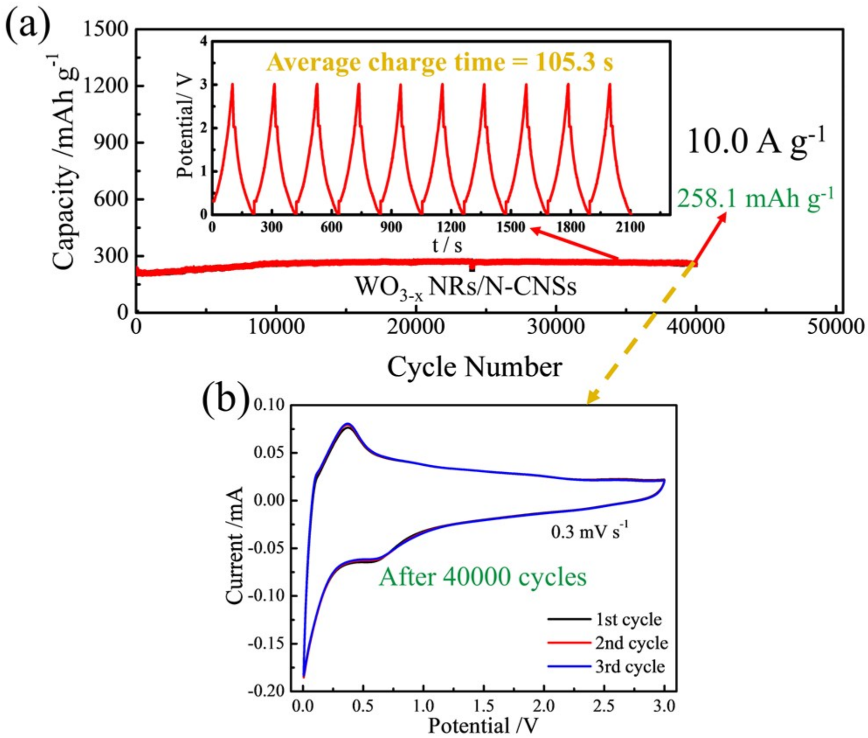

Figure S9 (a) Ultralong cycling stability of the WO_{3-x} NRs/N-CNSs at the high current rate of 10.0 A g^{-1}, and (b) CVs at 0.3 mV s^{-1} after the 40000 cycles.

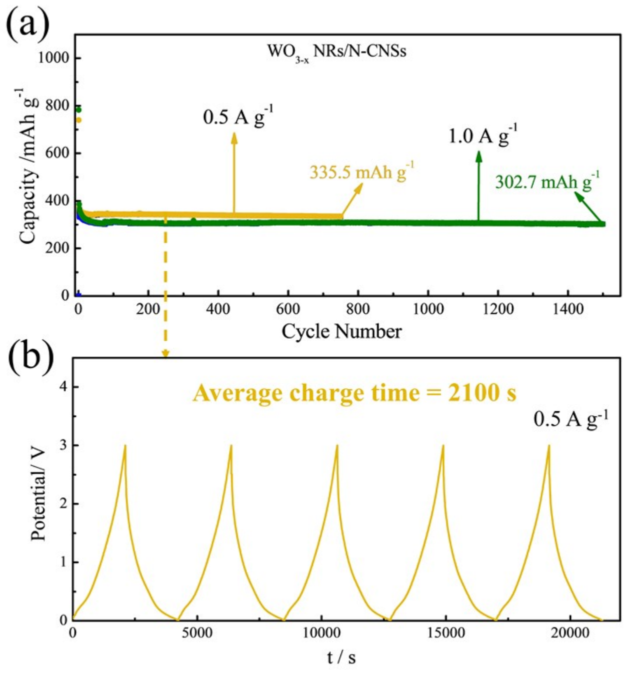

Figure S10 (a) Cycling stabilities of the WO_{3-x} NRs/N-CNSs at the low current rates of 0.5 and 1.0 A g^{-1}, with (b) stable discharge/charge curves (at 0.5 A g^{-1}).

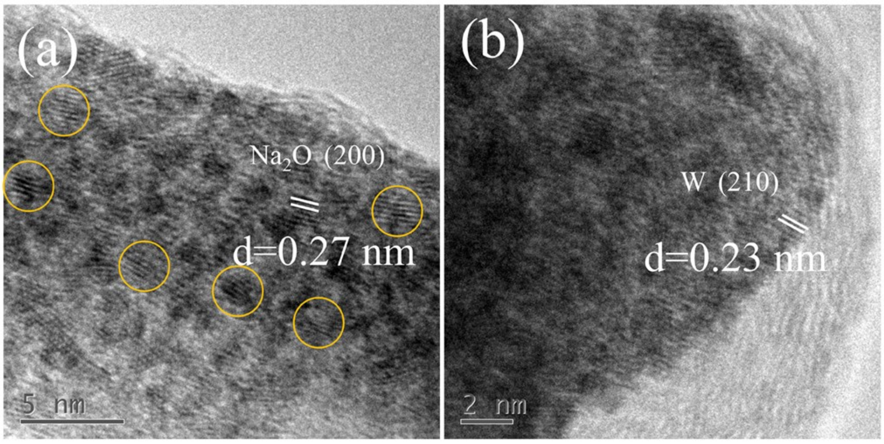

Figure S11 (a-b) *Ex-situ* HR-TEM images of the WO_{3-x} NRs/N-CNSs after 50000 cycles at 30.0 A g^{-1} (at the charge state of 1.2 V).

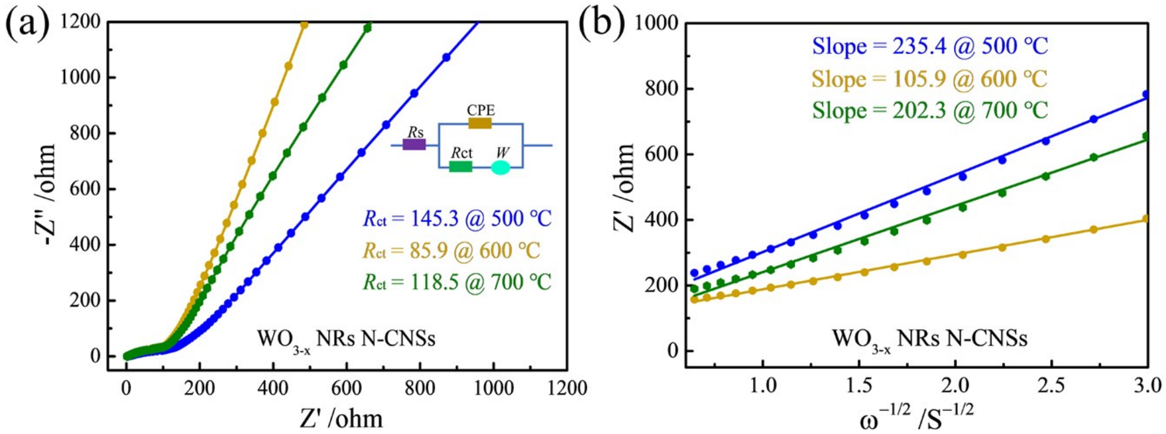

Figure S12 (a) Nyquist plots of the WO_{3-x} NRs/N-CNSs (at 500, 600 and 700 ℃) with an equivalent circuit model (inset), and (b) the fitting lines between Z′ and $\omega^{-1/2}$ after 100 cycles at 30.0 A g^{-1}.

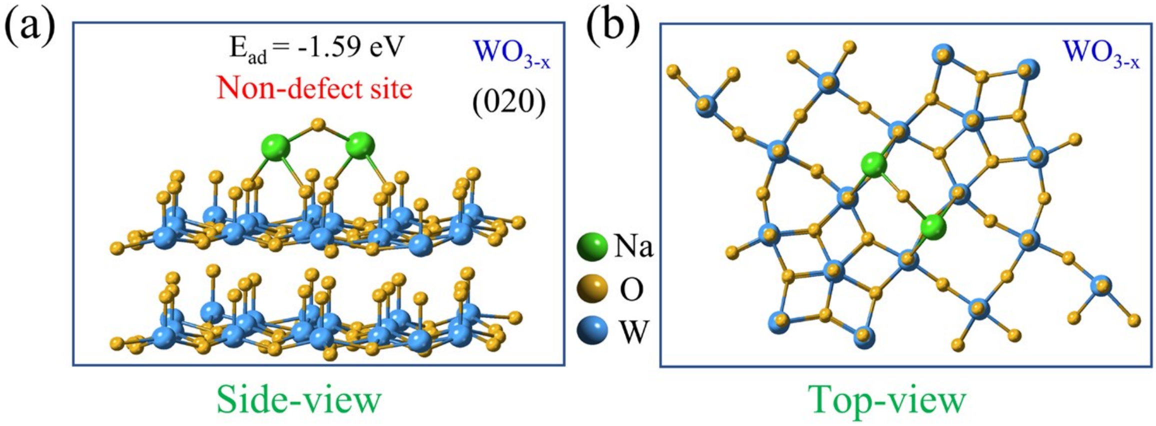

Figure S13 Geometrically stable configuration of Na_2O adsorbed on nonstoichiometric WO_{3-x} (010 or 020) surface (non-defect site): (a) Side- and (b) Top- view.

Equations S1:[1]

$$D_{Na^+} = \frac{4}{\pi}\left(\frac{V_M}{AFZ_i}\right)^2\left[\frac{I_0\left(\frac{dE}{d\delta}\right)}{\left(\frac{dE}{d\sqrt{t}}\right)}\right]^2, t \ll \frac{L^2}{D_{Na^+}}$$

(S1)

where D_{Na^+} is the ion diffusion coefficients, V_M is the molar volume, A is the contact area of electrode, F is the Faraday constant, Z_i is the valence of substance, I_0 is the applied constant current, E is the electrode voltage, δ is the stoichiometric ratio, t is the time during constant current pulse and L is the thickness of the electrode.

Equations S2 and S3: [2, 3]

$$Z' = R_s + R_{ct} + \sigma\omega^{-\frac{1}{2}} \tag{S2}$$

$$D_{Na^+} = \frac{R^2T^2}{2A^2n^2F^4C^2\sigma^2}$$

(S3)

where R_{ct} is the charge-transfer resistance, ω is the angular frequency, D_{Na^+} is the ion diffusion coefficients, the R is the gas constant, T is the absolute temperature, A is the contact area of electrode, n is the transferred charge, F is the Faraday constant, C is the concentration of Na^+ and σ is the Warburg impedance.

References:

1 C. J. Wen, B. A. Boukamp, R. A. Huggins and W. Weppner, *J. Electrochem. Soc.*, 1979, **126**, 2258.

2 N. Takami, *J. Electrochem. Soc.*, 1995, **142**, 371.

3 C. Ho, *J. Electrochem. Soc.*, 1980, **127**, 343.