Supporting Information

Electrochemical Synthesis of Titanium Nitride Nanoparticles onto Titanium Foil for Electrochemical Supercapacitors with Ultrafast Charge/Discharge

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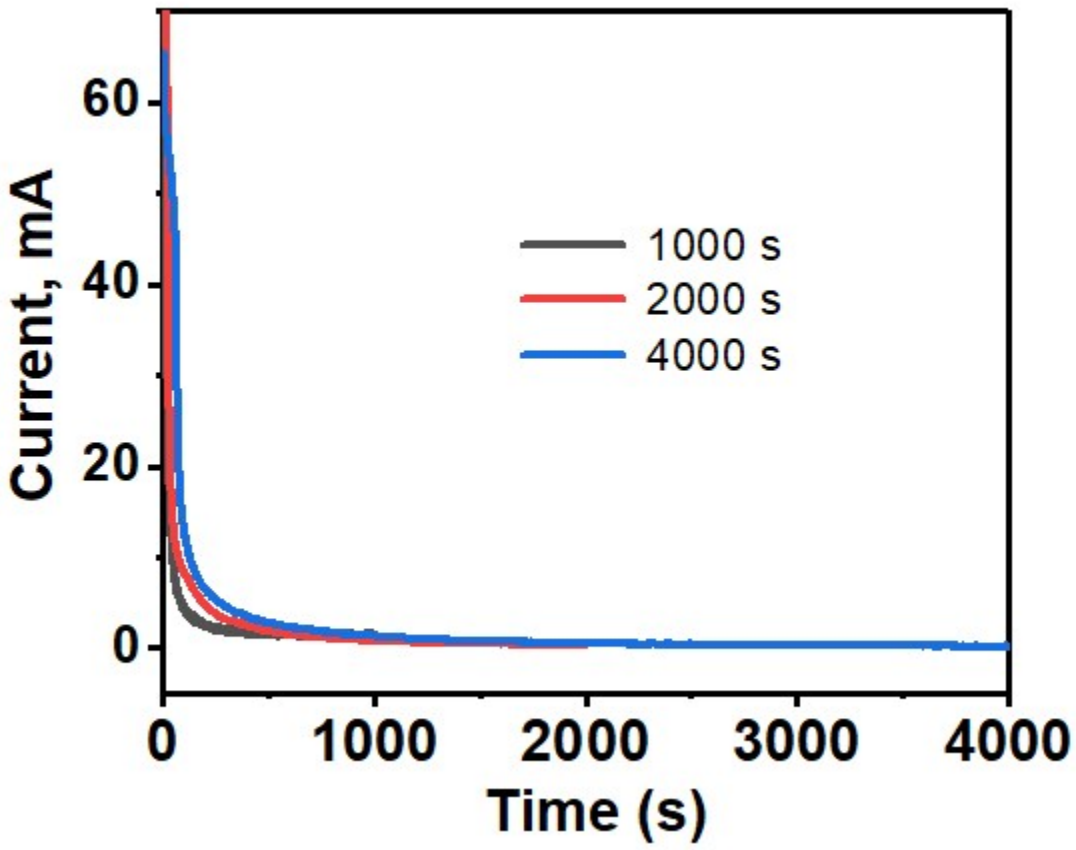

Fig. S1: Current (i)-time(t) plots for the synthesis of TiN nanoparticles onto Ti foil for 1000, 2000, and 4000s.

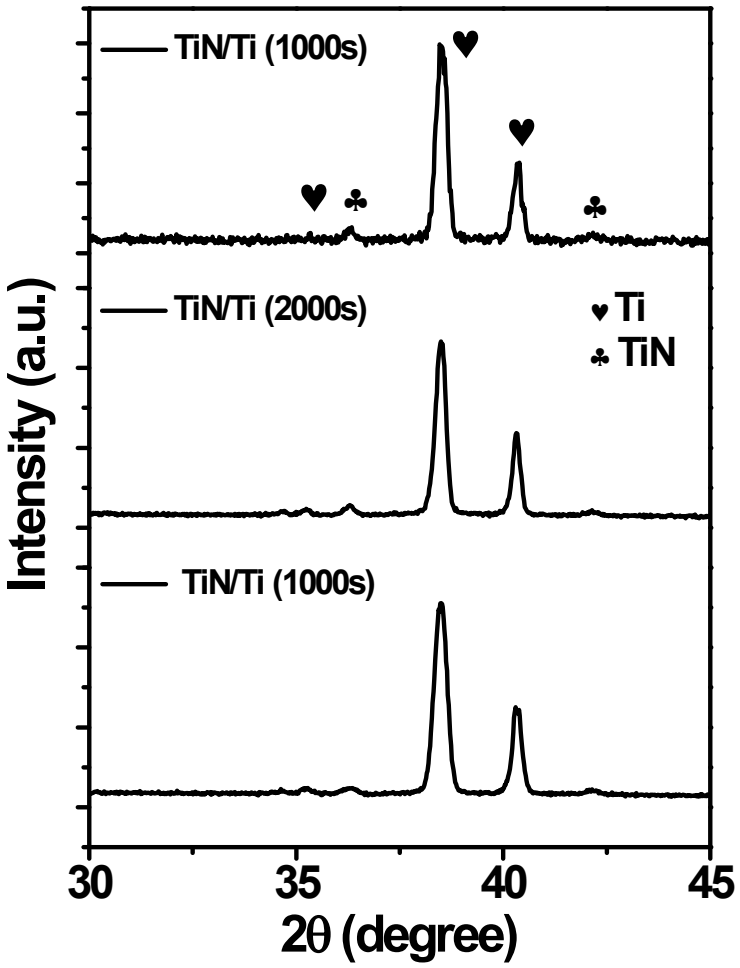

Fig S2. XRD patterns of TiN/Ti electrodes with the electrolysis time of 1000, 2000, and 4000 s for the synthesis of TiN.

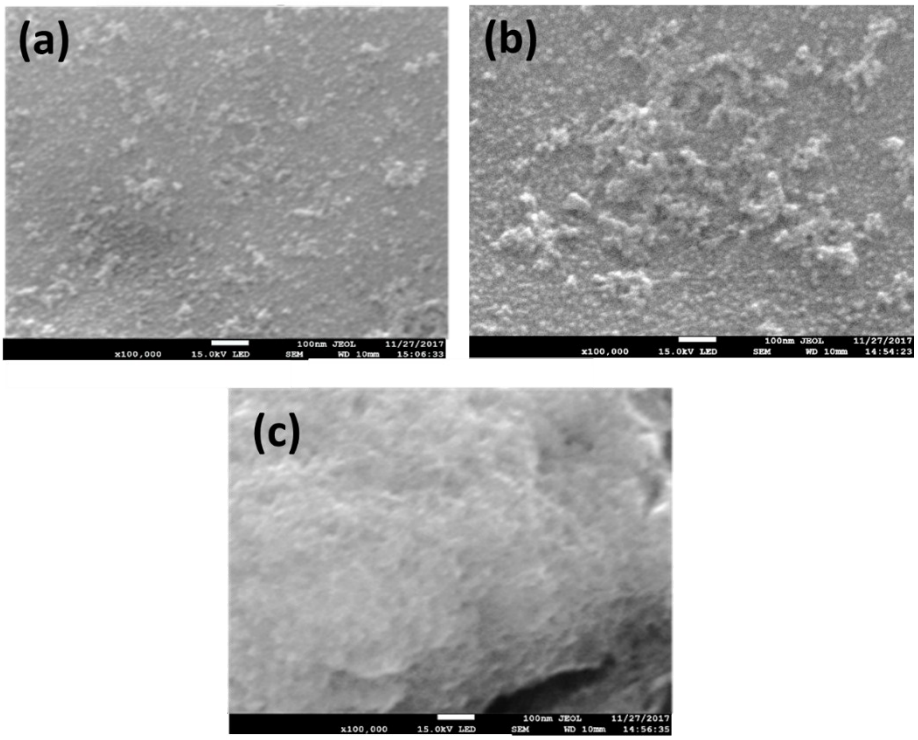

Fig S3. FE-SEM images of TiN/Ti electrodes with the electrolysis time of 1000, 2000, and 4000s for the synthesis of TiN.

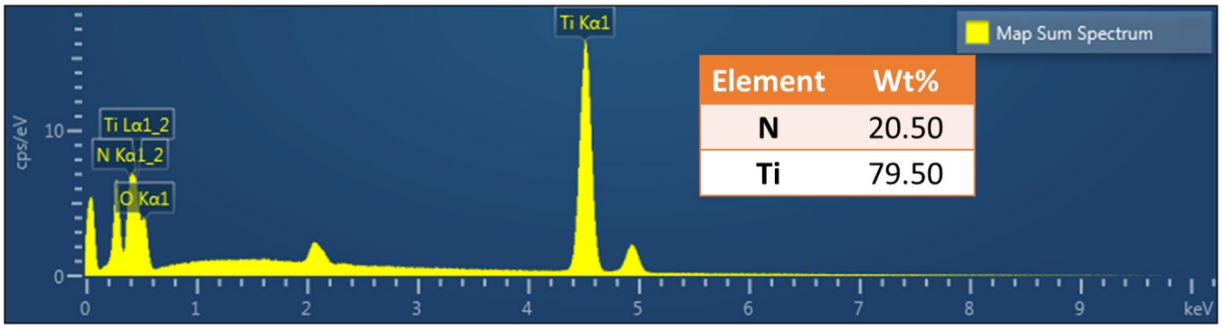

Fig. S4: EDS spectra of the TiN/Ti electrode (electrosynthesis time 3000s). Inset shows the elemental wt (%) of Ti and N in the TiN/Ti electrode.

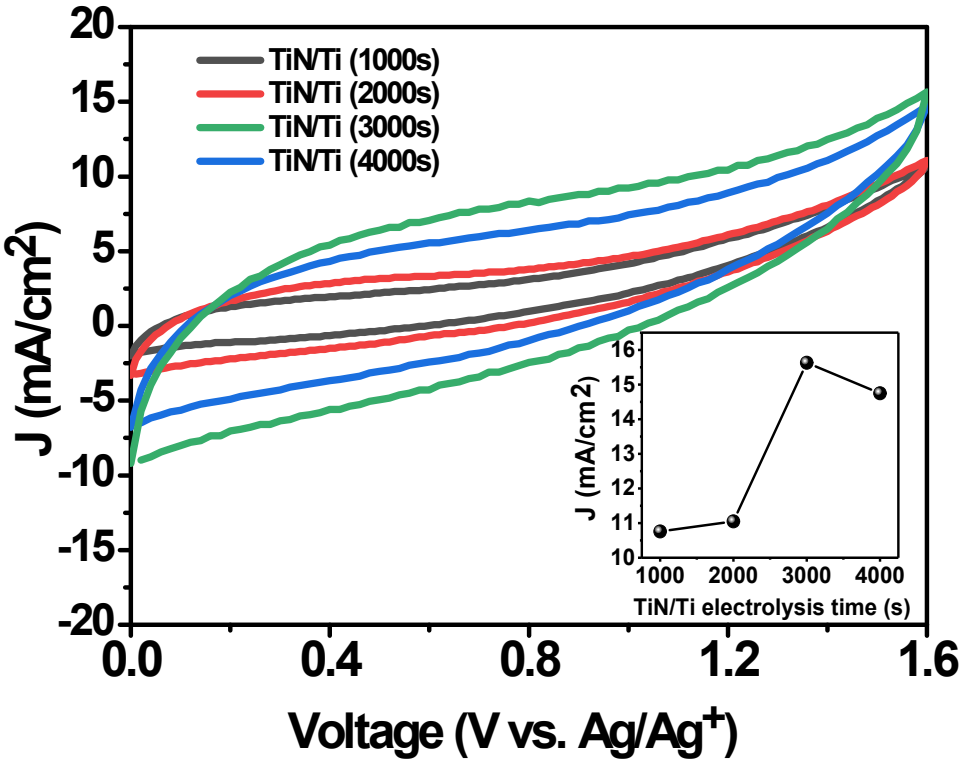

Fig. S5: CV of the TiN/Ti electrode in three electrode system with varying electrolysis time for the synthesis of TiN nanoparticles in $LiClO_4$ (1 M) electrolyte at a scan rate of 100 mV/s (Inset shows the plots of discharge current density vs. TiN/Ti electrodes with varying electrolysis time for the synthesis of TiN nanoparticles).

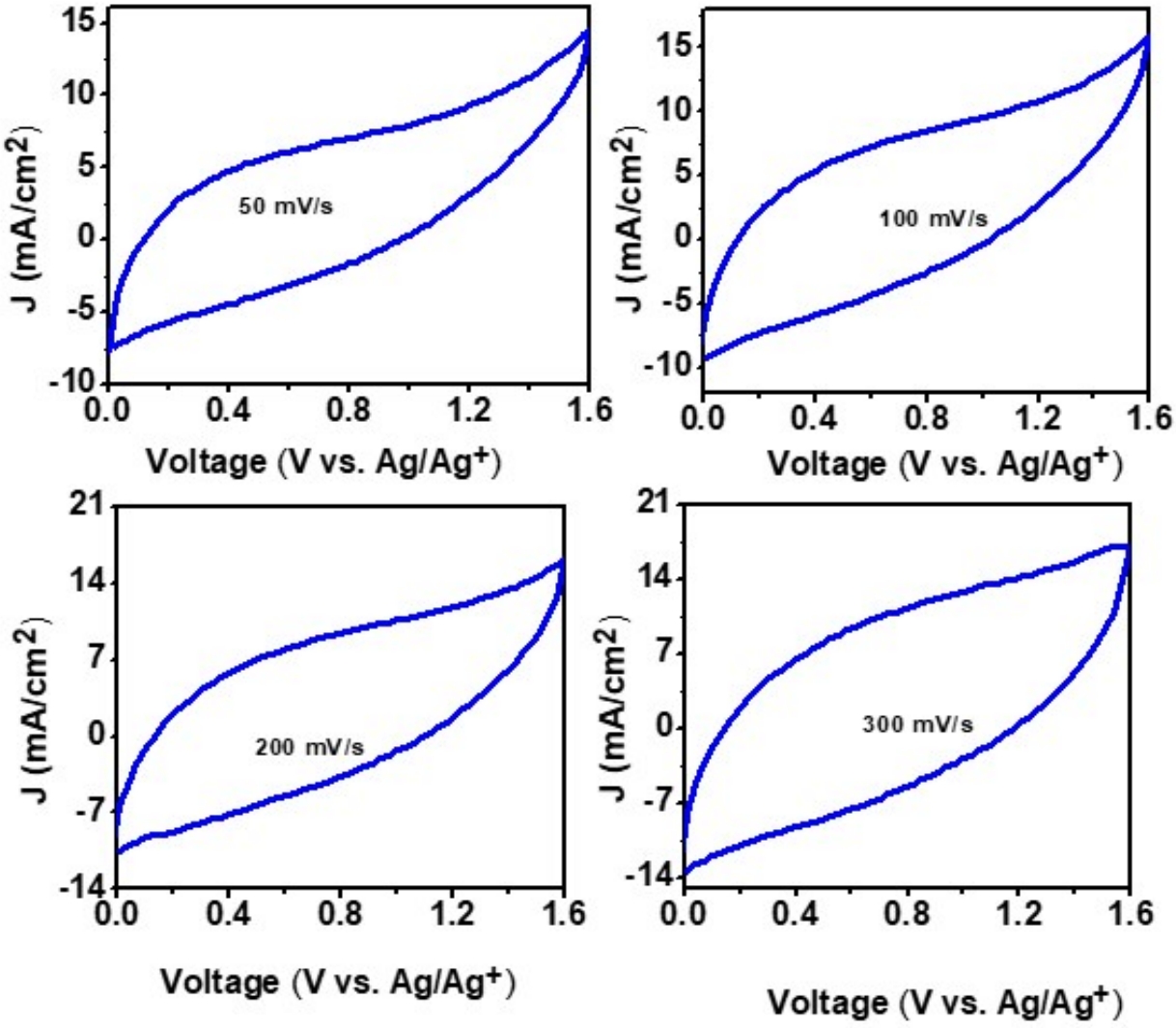

Fig. S6: CVs of the optimized TiN/Ti electrode in a three electrode system at a scan rate of 50, 100, 200, and 300 mV/s in an electrolyte solution of $LiClO_4$ (1M).

Calculation of specific capacitance (C_s):

From the CV plots, the C_s of the TiN/Ti electrode was calculated according to the following equation (S1).

$$C_s = \frac{\int_{V_1}^{V_2} i(V)dV}{2 \times \nu \times (V_2 - V_1) \times A} \quad \text{(S1)}$$

where, A, $\int_{V_2}^{V_1} i(V)dV$, V_2-V_1, and ν are the area of the electrode, total voltammetric charge, the width of the voltage, and scan rate, respectively.

From the CD plots, the C_s of the TiN/Ti electrode was calculated according to the following equation (S2).

$$C_s = \frac{I \times \Delta t}{A \times (V_2 - V_1)} \quad \text{(S2)}$$

where, I is the applied current and Δt is the discharge time.

Calculation of energy density (E_d) and power density (P_d):

The E_d and P_d of the TiN/Ti electrode was calculated according the following equations S3 and S4, respectively.

$$\text{Energy density } (E_D) = 0.5 \times C_s \times \Delta V^2 \quad \text{(S3)}$$

$$\text{Power density } (P_D) = E_D \times 3600 / \Delta t \quad \text{(S4)}$$

where, C_s is the areal capacitance, ΔV is the operating voltage window, and Δt is the discharge time obtained from the discharge plot after excluding IR drop.

Calculation of relaxation time constant (τ_o):

The τ_o of the TiN based SSC was calculated based on the following equation S5.

$$\tau_0 = \frac{1}{2\pi f_0} \quad \text{(S5)}$$

Here, f_0 is the frequency at angle -45°.

Table S1: Electrochemical performance comparison of reported titanium oxides/nitrides modified electrodes with the current TiN/Ti electrode in a three-electrode system.

Electode materials	Method	Applied current/Scan rate	Specific capacitance, C_s (mF/cm^2)	Ref.
K-doped TiO_2/Ti	CD	50 μA/cm^2	97.30	S1
2D TiNS/Ti	CD	50 μA/cm^2	4.7	S2
TiN/CNT/Si	CV	1V/s	18.3	S3
2D- TiO_2 platelet+1D-TiO_2 nanorod/Ti	CD	100 μA/cm^2	2.64	S4
2D porous TiO_2/Ti	CV	2 mV/s	81.75	S5
TiO_2 nanotube/Ti	CV	20 mV/s	0.26	S6
TiN nanotube/Ti	CV	20 mV/s	3.14	S6
TiN/Si	CD	1.0 mA/cm^2	27.3	S7
TiN nanoparticle /Ti	CV, CD	50 mV/s, 6.66 mA/cm^2	69, 53.66	**This work**

Note: TiNS = Titania/titanate nanosheets

References

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