Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information

Improved supercapacitive charge storage in electrospun niobium doped titania nanowires

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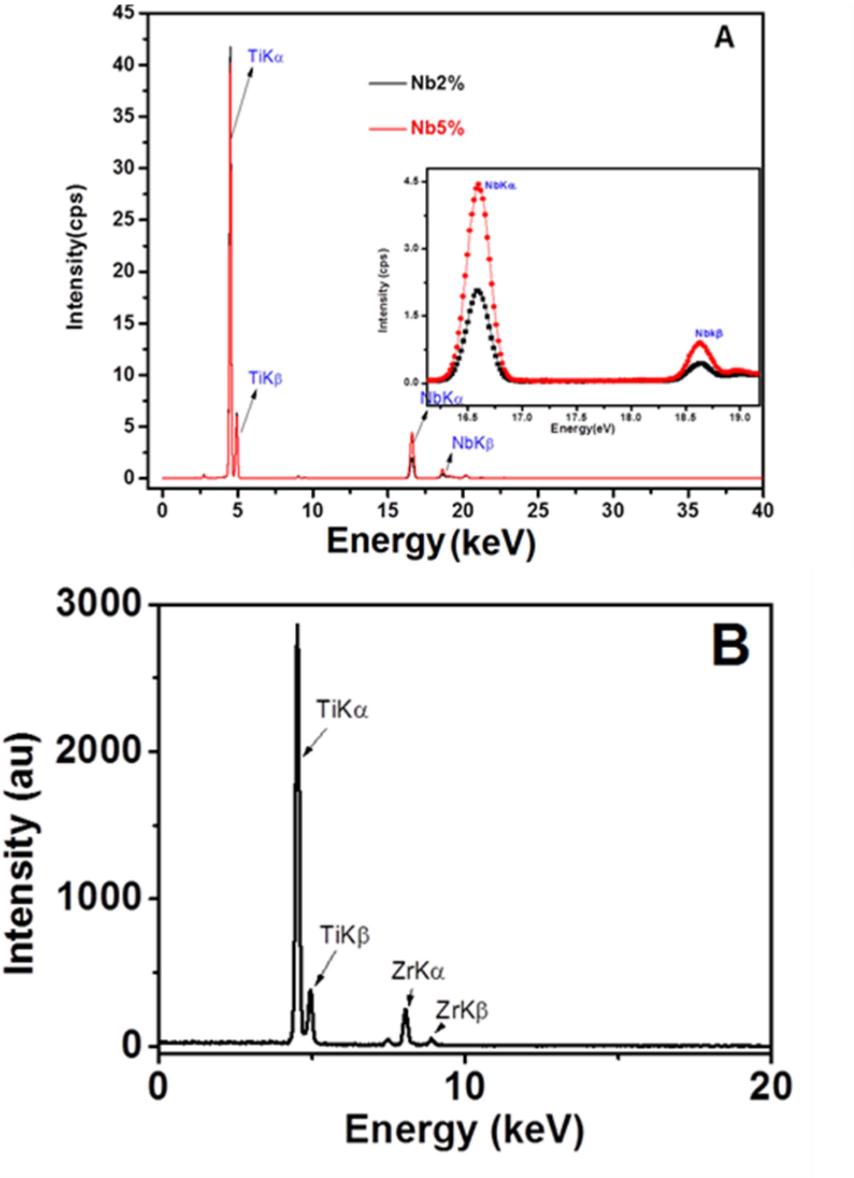
S1: CALCULATION OF THEORETICAL CAPACITANCE (C_S) OF TiO_2

Theoretical capacitance, $C_S = \frac{nF}{m\Delta V}$, where n is the number of electrons involved in the Faradic process, 'F' Faraday constant, 'm' molar mass of TiO_2 and ΔV is the difference between oxidation and reduction potential of Ti in TiO_2

$$C_S = \frac{nF}{m\Delta V} = \frac{1 \times 96485}{79.86 \times 1.76} = 686\,Fg^{-1}$$

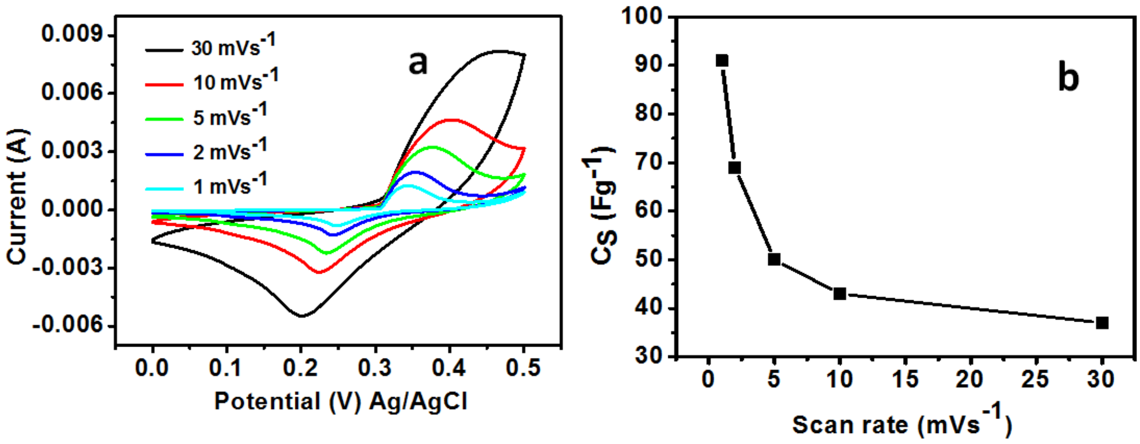
S2: X-RAY FLUORESCENCE SPECTRA OF (A) Nb AND (B) Zr DOPED TiO_2

Presence of Nb and Zr in the doped materials was confirmed by X-ray fluorescence measurements employing EDX-720 (Shimadzu). Figure S2(A) and S2(B) present the XRF spectra of Nb:TiO_2 and Zr:TiO_2, which clearly detect Nb and Zr in the respective samples.



S3. RESULTS OF THE ELECTROCHEMICAL ANALYSIS OF 5at.% Nb:TiO_2.

Figure S3(a) shows the variation of cyclic voltammograms as a function of scan rate; Figure S3(b) is the variation of specific capacitance determined from the cyclic voltammograms as a function of scan rate determined using the equation (2) described in the main article. Description of the behaviour of cyclic voltammograms as a function of scan rate is similar to the other materials considered in this study and are explained in the main article.



S4. CALCULATION OF DIFFUSION CONSTANT OF TiO_2 and Nb:TiO_2

$$i_p = 2.69\times10^5\times n^{3/2}\times D^{1/2}\times A\times C_0\times\sqrt{v}$$

Slope of TiO_2 = 0.0014

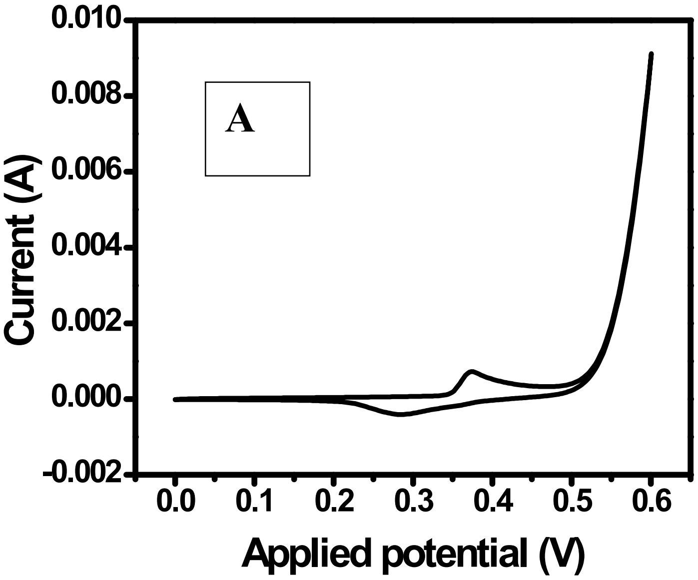
$$D=\left(\frac{0.0014}{2.69\times10^5\times1\times0.05296}\right)^2 = 9.78 \text{ x } 10^{-15}\ \text{cm}^2\text{/s}$$

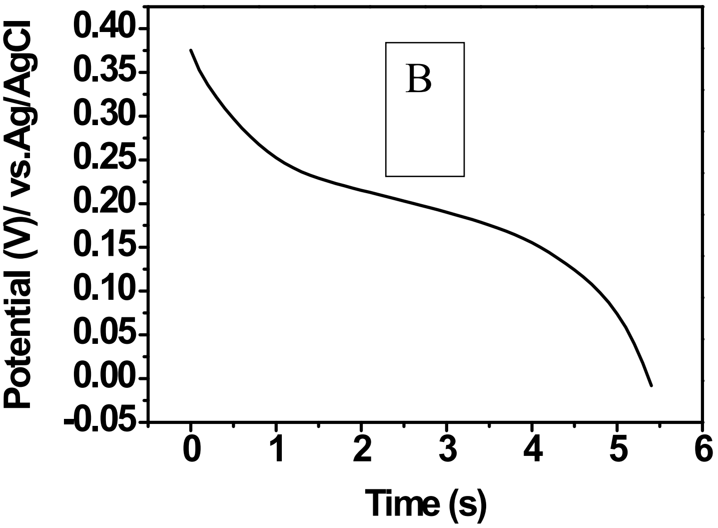
Slope of Nb:TiO_2 = 0.0047

$$D = \left(\frac{0.0047}{2.69 \times 10^5 \times 1 \times 0.05296}\right)^2 = 1.08 \text{ x } 10^{-13} \text{ cm}^2/\text{s}$$

S5. CYCLIC VOLTAMMOGRAMS OF THE NI FOAM SUBSTRATES

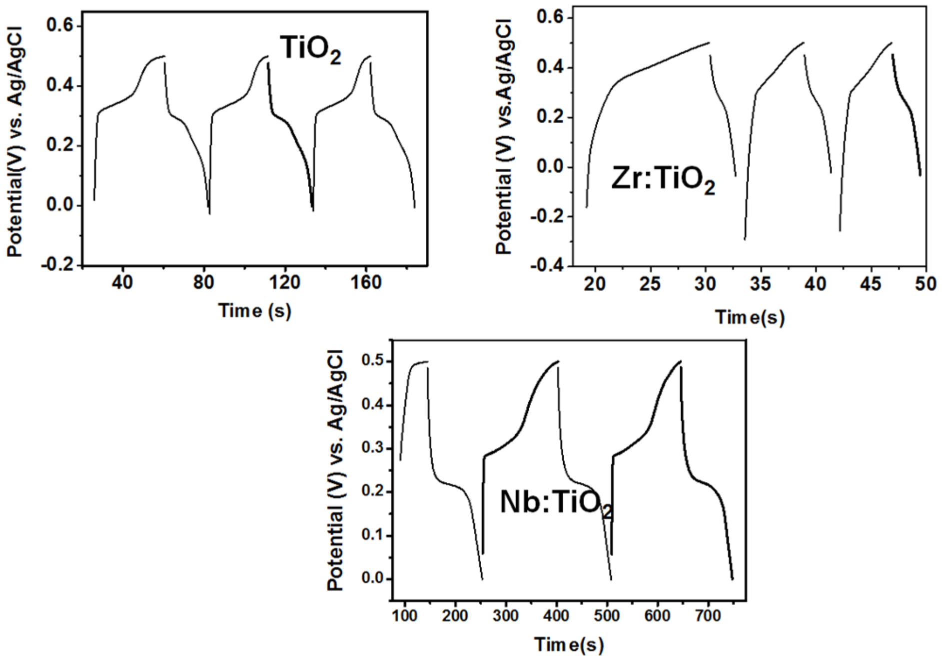
The area of the CV curve without using the nanowires was ~ 1.0 ×10^{-4} cm^2, which is only ~0.01 % of the total area in the presence of it (B) Discharge curve of the Ni foam substrate in 3 M KOH indicating that the discharge time is much lower (5 s) compared with that including the nanowires electrode. Area of the substrate was ~1 cm^2 similar to that of the nanowire electrode. A correction for calculation of specific capacitance based on the discharge time is applied in the present work.





S6. POTENTIAL DROP AND INTERNAL RESISTANCE BETWEEN CHARGE AND DISCHARGE CYCLES

Internal resistance of materials can be calculated from the potential drop between the charge and discharge currents in the charge discharge cycling curves. Figure S6 present the first three charge discharge cycling curves



For pristine TiO_2

Potential drop (V) = 23.07 mV; Discharge current (I) = 2.3 mA;

Internal resistance (R) = V/I = **10 Ω**

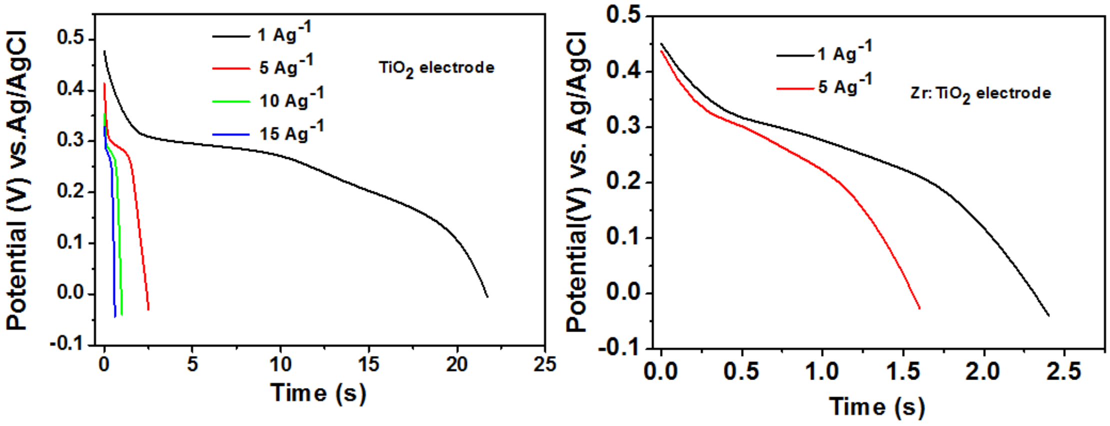
For $Nb:TiO_2$

V = 14.8 V; I = 2.4 V; R = V/I **= 6.1 Ω**

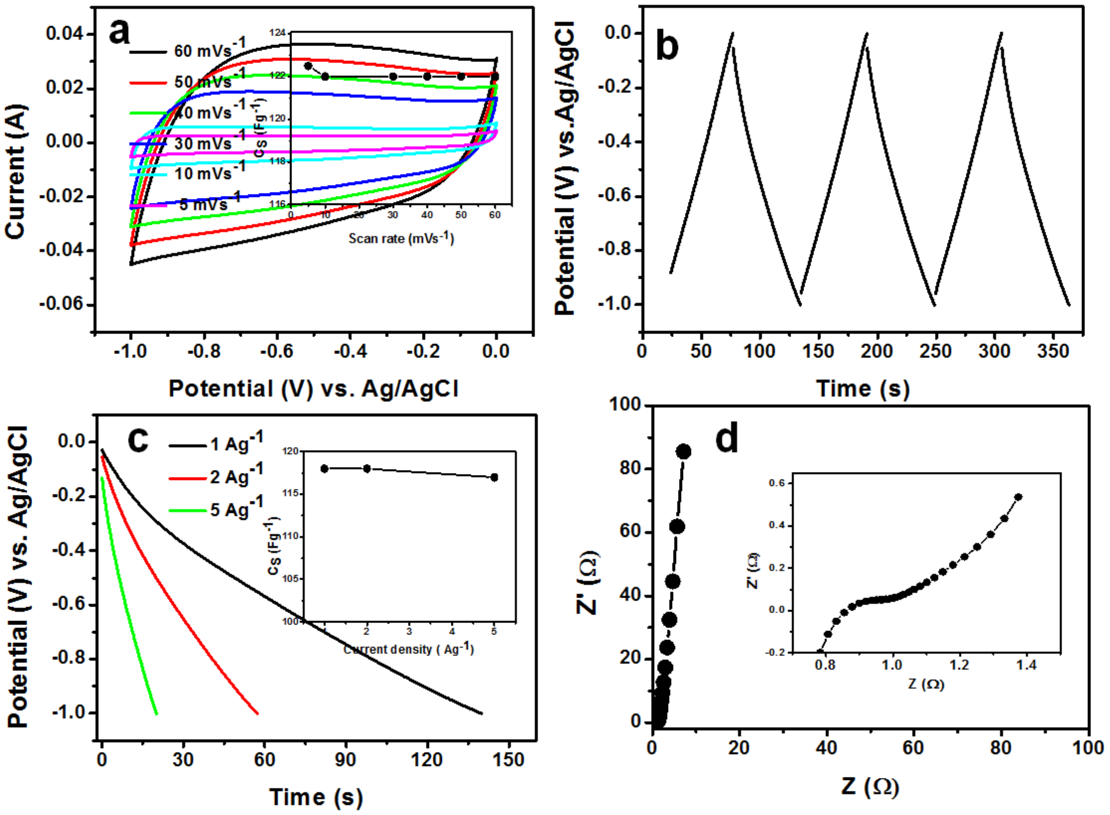
For $Zr:TiO_2$

V = 50.2 V; I = 2.3 V; R = V/I = 50.2/2.3 **= 21.8 Ω**

S7. DISCHARGE CURVES OF PRISTINE TiO_2 AND $Zr:TiO_2$ in 3 M KOH ELECTROLYTE

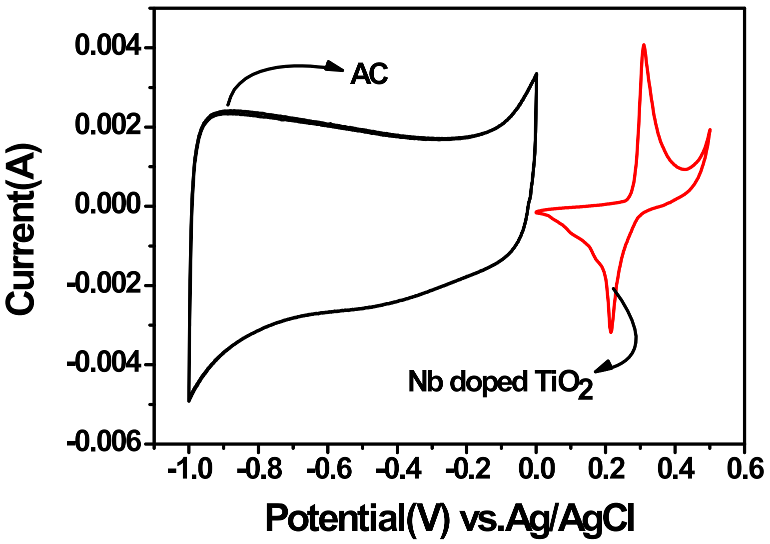


S8. ELECTROCHEMICAL CHARACTERIZATION OF ACTIVATED CARBON ELECTRODE IN 3 ELECTRODE CONFIGURATION IN 3 M KOH AQUEOUS ELECTROLYTE.



(a) CV curves of AC electrode in 3 M KOH aqueous electrolyte at varying scan rate; inset shows the variation of C_S with scan rate. (b) First three charge discharge curves of AC electrode (c) Discharge curves of AC electrode at various discharge current density; inset shows the variation of C_S with current density (d) Nyquist plot of AC electrode at open circuit potential.

S9. CV CURVES OF BOTH AC AND Nb:TiO$_2$ ELECTRODES IN 3 M KOH ELECTROLYTE



S10. CV CURVES OF AC//AC SYMMETRIC EDLC AT VARIOUS SCAN RATE IN THE POTENTIAL WINDOW 1.5 V IN 3 M KOH