Supplementary material

3.3 nm-sized TiO_2/carbon hybrid spheres endowed with pseudocapacitance-dominated superhigh-rate Li-ion and Na-ion storages

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Supporting Notes

1. Calculation of electrical conductivity: 10 measurements of the electrical resistivity ρ (Ω cm) of 3.3-TO/C have been conducted, and the values are depicted in the following table. The electrical conductivity σ (S cm^{-1}) is calculated based on the following equation,

$$\sigma = 1/\rho.$$

The reported σ is an average of 8 values except the largest and the lowest ones. The standard division is given.

1^{st}	2^{nd}	3^{rd}	4^{th}	5^{th}	6^{th}	7^{th}	8^{th}	9^{th}	10^{th}
72.01	85.98	75.05	79.26	69.25	78.22	71.67	73.51	70.06	78.52

2. Determination of intersection potential of the domain I and the domain II:

The mathematically smoothed C_d data in a potential range of 0.01 to 0.12 V (*vs* Li/Li^+) have been linearly fitted as fitting line 1 (Figure a in the following image), *i.e.*,

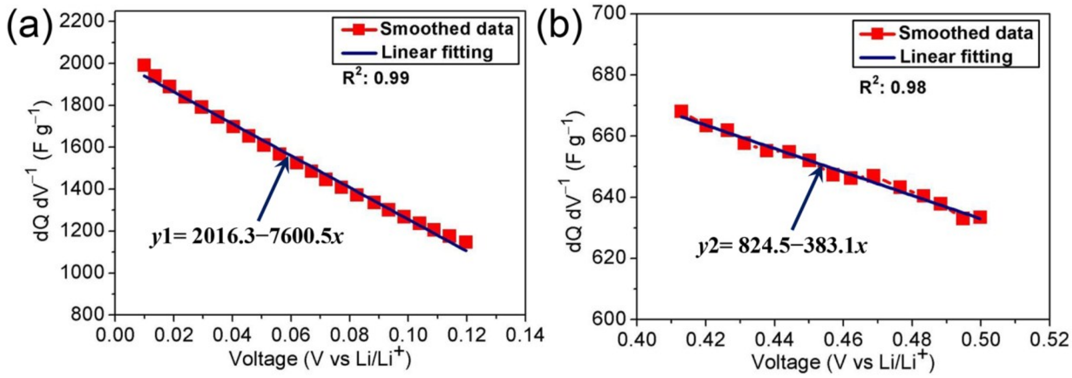
$$y1 = 2016.3 - 7600.5x. \qquad (1)$$

The coefficient of determination R^2 is 0.99. Fitting line 2 is derived from the smoothed C_d data in a potential range of 0.41 to 0.50 V (Figure b), *i.e.*,

$$y2 = 824.5 - 383.1x. \qquad (2)$$

The coefficient of determination R^2 is 0.98. The intersection potential thus can be determined by the solution of Equations (1) and (2), *i.e.*,

$$x = 0.17 \text{ V}.$$



3. Calculation of average voltage V_a: The calculation is based on the voltage profiles of 3.3-TO/C at 2 C (Figure 4e). The energy E is a product of electric charge Q and voltage V, *i.e.*,

$$E = QV. \tag{3}$$

Thus for a given voltage profile, E is an integration of V in a full scale of Q, *i.e.*,

$$E = \int_0^Q V dQ = \int_0^C 3.6 V dC\,. \tag{4}$$

The average voltage V_a is defined as

$$V_a = \frac{E}{Q} = \frac{\int_0^C 3.6 V dC}{3.6C} = \frac{\int_0^C V dC}{C}\,. \tag{5}$$

Supporting Figures

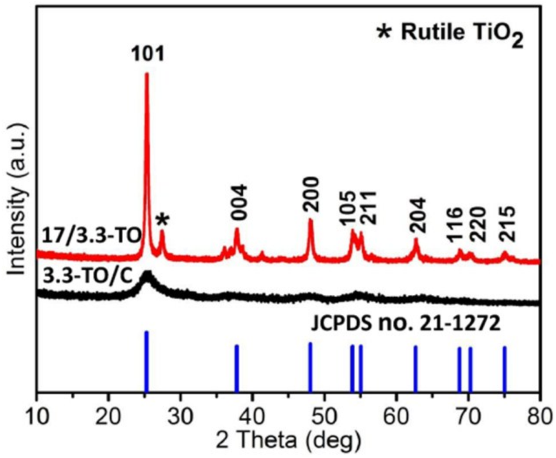


Fig. S1. XRD patterns of 3.3-TO/C and 17/5.3-TO.

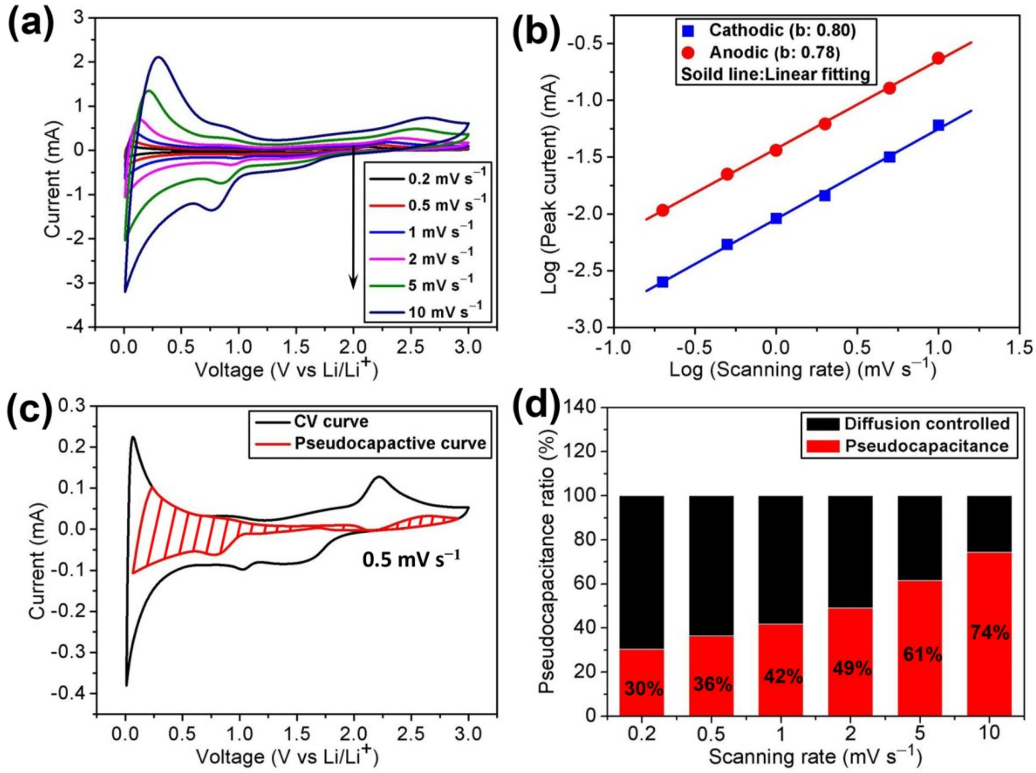


Fig. S2. Pseudocapacitive performance of 17/5.3-TO for Li-ion storage. (a) CV curves at various scanning rates. (b) Plots and linear fittings of logarithmic peak current as a function of logarithmic scanning rate of the anodic and the cathodic CV peaks. (c) CV profile and pseudocapacitance contribution represented by the red slashed area at 0.5 mV s^{-1}. (d) Variation of the pseudocapacitance contribution with an increase of the CV scanning rate.

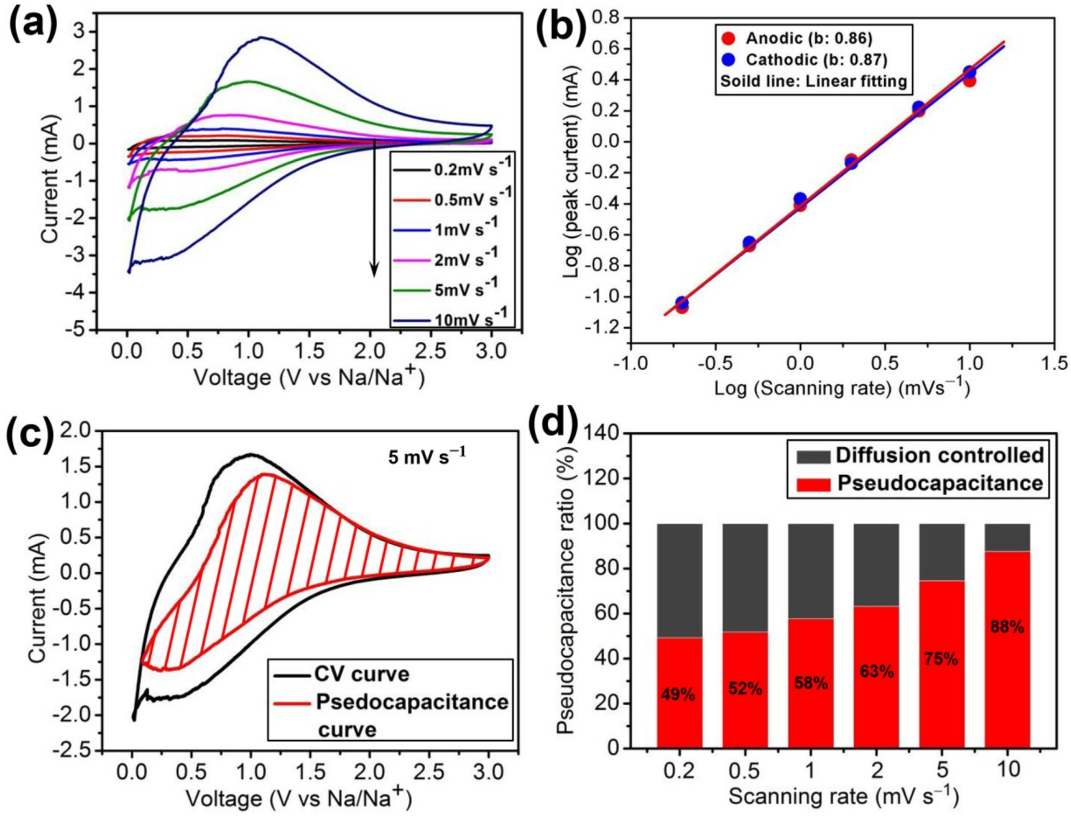


Fig. S3. Pseudocapacitive performance of 3.3-TO/C for Na-ion storage. (a) CV curves at various scanning rates. (b) Plots and linear fittings of logarithmic peak current as a function of logarithmic scanning rate of the anodic and the cathodic CV peaks. (c) CV profile and pseudocapacitance contribution represented by the red slashed area at 5 mV s^{-1}. (d) Variation of the pseudocapacitance contribution with an increase of the CV scanning rate.

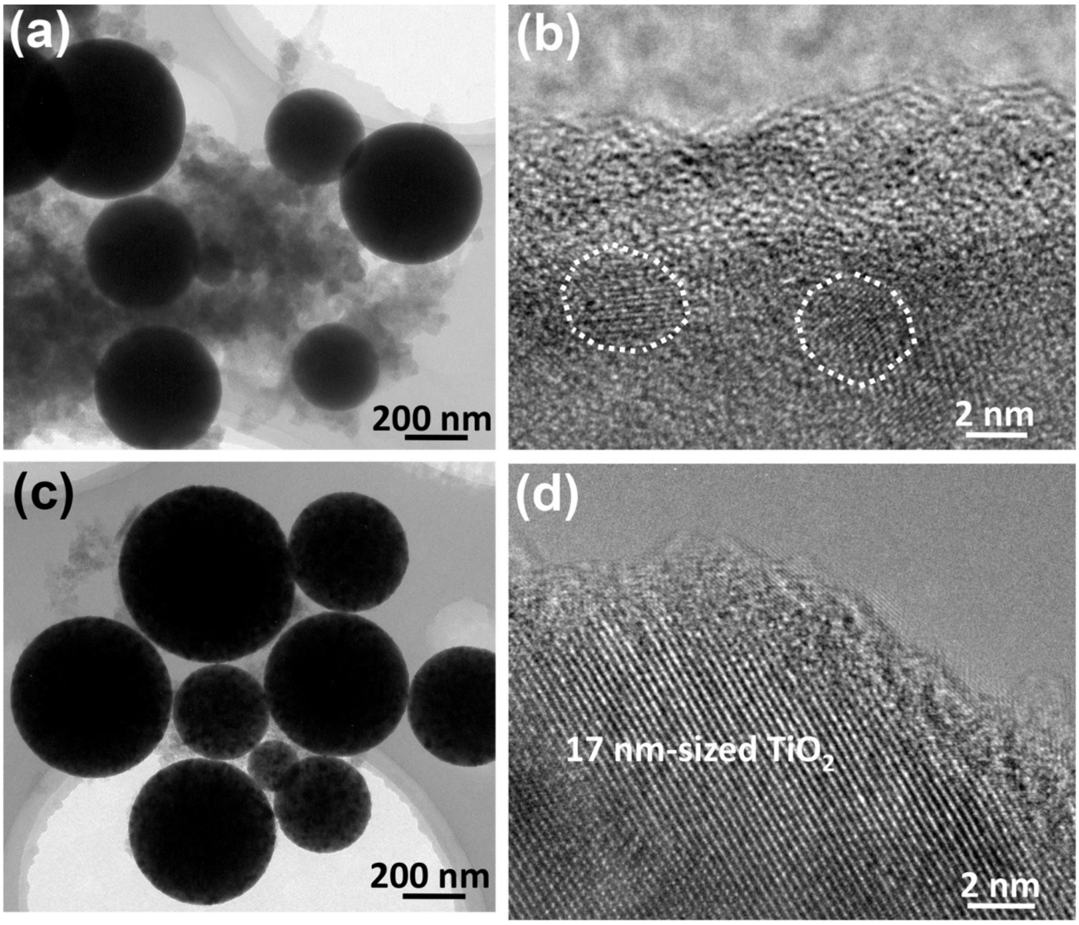


Fig. S4. Microstructures of 3.3-TO/C and 17/5.3-TO after 600 discharge/charge cycles of Li-ion stroage. (a) TEM and (b) HREM of 3.3-TO/C. (c) TEM and (d) HREM images of 17/5.3-TO.

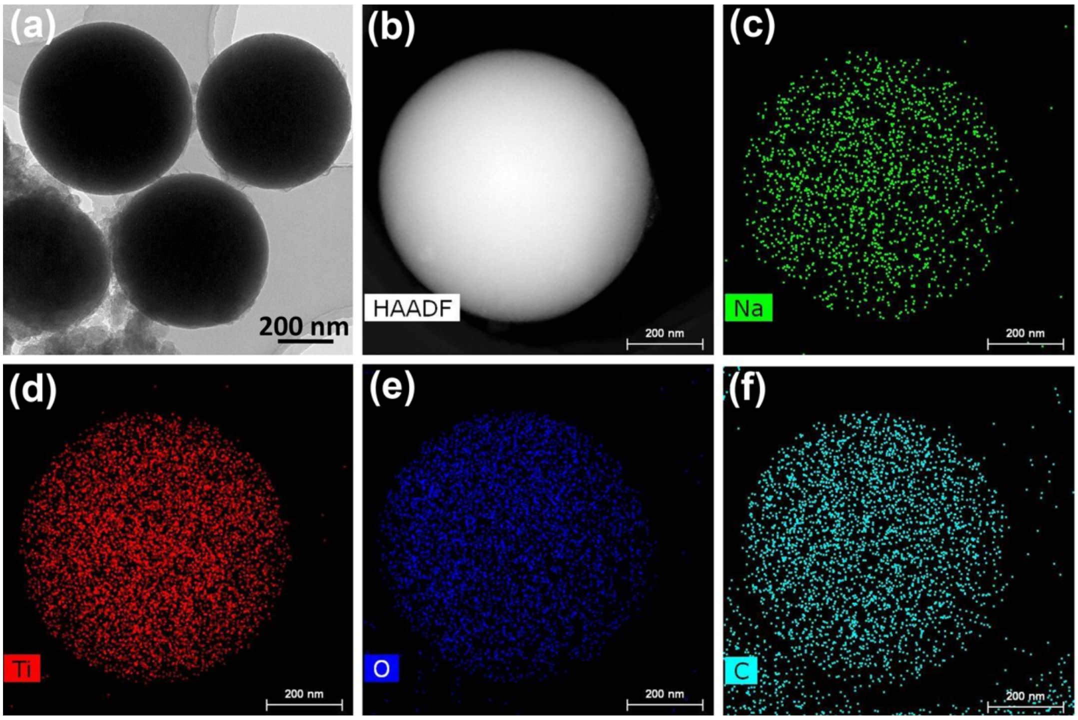


Fig. S5. Microstructure and element distributions of 3.3-TO/C after 500 discharge/charge cycles for Na-ion stroage. (a) TEM and (b) HAADF image of 3.3-TO/C. Element mappings of (c) sodium, (d) titanium, (e) oxygen and (f) carbon.