Supporting Information

Ultra-high rate capability of nanoporous carbon network@V_2O_5 sub-micron bricks composite as a novel cathode material for asymmetric supercapacitors

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Outlines

1. Calculation of theoretical specific capacitance of pseudocapacitive nano-size V_2O_5

For pseudocapacitive nano-size V_2O_5 (extrinsic pseudocapacitive materials) [1], under ideal conditions (the extent of fractional coverage of surface or inner structure is 100%), its theoretical capacitance is calculated based on the following equation [1]:

$$C = \frac{nF}{mE} \tag{1}$$

where n is the mean number of the electrons transferred in the redox reaction, F is the Faraday constant, m is the molar mass of the metal oxide and E is the operating voltage window. Therefore, when V^{5+} is reduced to V^{4+} and $E = 1$ V, the theoretical capacitance is calculated as: (2×96485.3383/1.0/182) F g^{-1} ≈ 1060 F g^{-1}.

2. Pore characteristic parameters of NCN, V_2O_5 SMBs and NCN@V_2O_5 SMBs

Table S1. Pore characteristic parameters of NCN, V_2O_5 SMBs and NCN@V_2O_5 SMBs.

Materials	BET surface area (m^2 g^{-1})	Pore volume (cm^3 g^{-1})
NCN	459	1.0
V_2O_5 SMBs	1.58	0.013
NCN@V_2O_5 SMBs	19.5	0.089

3. Areal capacitance and rate capability comparisons of NCN@V_2O_5 SMBs

Table S2. Areal capacitance and rate capability comparisons of NCN@V_2O_5 SMBs with some recently reported V_2O_5-based electrodes.

Electrodes	Maximum areal capacitance/mF cm^{-2}	Rate capability (capacitance retention ratio)	Ref.[a]
Mo-doped V_2O_5 thin film	**175.0** (1.0 mA cm^{-2})	**31.1%** 1.0 to 2.0 mA cm^{-2} (**2 times**)	38
V_2O_5 nanorods/stainless steel	**337.6** (0.25 mA cm^{-2})	**62.5%** 0.25 to 2.0 mA cm^{-2} (**8 times**)	39
V_2O_5-reduced graphene oxide	**382.0** (0.11 mA cm^{-2})	**16.2%** 0.11 to 1.1 mA cm^{-2} (**10 times**)	40
Carbon-coated flowery V_2O_5	**417.0 (**0.5 mA cm^{-2}**)**	**30.3%** 0.5 to 5.0 mA cm^{-2} (**10 times**)	41
3D N-doped carbon nanofibers/V_2O_5 aerogels	**476.1 (**0.4 mA cm^{-2}**)**	**33.7%** 0.4 to 8.0 mA cm^{-2} (**20 times**)	42
V_2O_5-polyaniline	**664.5** (0.5 mA cm^{-2})	**63.8%** 0.5 to 5.0 mA cm^{-2} (**10 times**)	43
NCN@V_2O_5 SMBs	**786.4** (0.2 mA cm^{-2}) **744.5** (0.5 mA cm^{-2}) **708.0** (1.0 mA cm^{-2}) **674.6** (2.0 mA cm^{-2}) **645.5** (5.0 mA cm^{-2}) **485.2** (50.0 mA cm^{-2})	**85.8%** 0.2 to 2.0 mA cm^{-2} (**10 times**) **82.1%** 0.2 to 5.0 mA cm^{-2} (**25 times**) **61.7%** 0.2 to 50.0 mA cm^{-2} (**250 times**)	**This work**

[a]Please find these references in the main body of the paper.

4. GCD curve of NCN@V_2O_5 SMBs electrode at 50 mA cm^{-2}

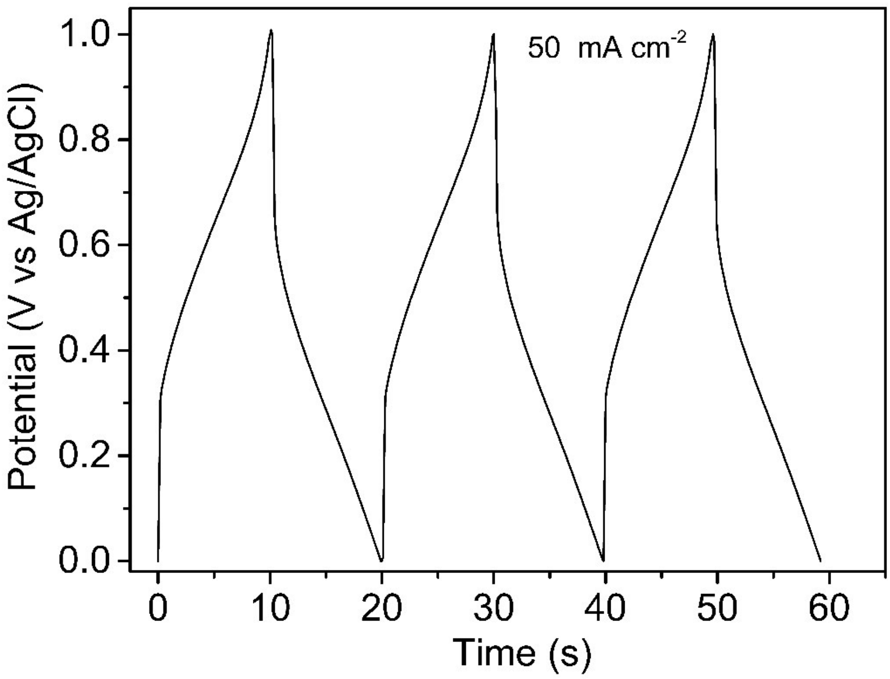

Figure S1. GCD curve of the NCN@V_2O_5 SMBs electrode at 50 mA cm^{-2}.

5. Electrochemical properties of CA V_2O_5 and NCN@CA V_2O_5

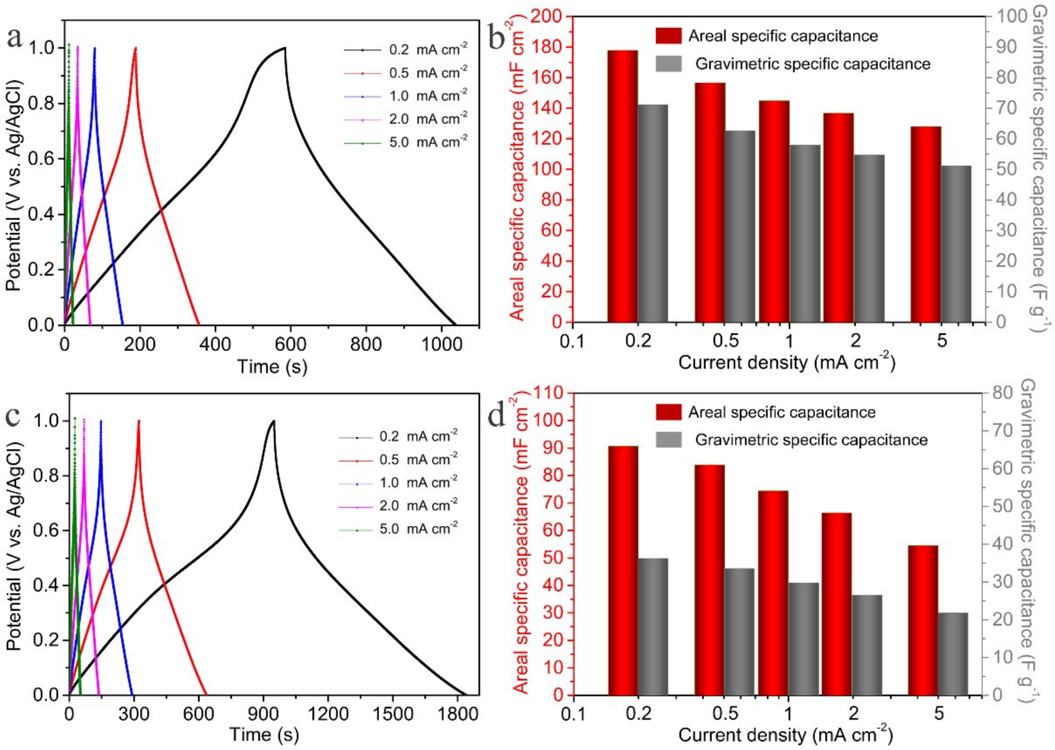

Figure S2. Electrochemical properties of the commercially available V_2O_5 (coded as CA V_2O_5) and its mixture with NCN (coded as NCN@CA V_2O_5) tested in a positive potential range in a three-electrode system. (a-b) GCD curves of CA V_2O_5 at current densities of 0.2–5 mA cm^{-2} and its rate performance; (c-d) GCD curves of NCN@CA V_2O_5 at current densities of 0.2–5 mA cm^{-2} and its rate performance.

References

[1] Augustyn, V., Simon, P., & Dunn, B. (2014). Pseudocapacitive oxide materials for high-rate electrochemical energy storage. *Energy & Environmental Science*, *7*(5), 1597-1614.