Supporting information

A Templated Carbon as Anode Material for Room-temperature Sodium-Ion Batteries

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Table S1: Literature overview: Sodium capacities for different carbon materials and measurement conditions (as far as reported).

Type of carbon	Temp. / °C	Capacity / mAh g^{-1}	C-Rate*	ΔV	Reference
Carbon black	86	NaC_{15} (approx. 148, only one discharge)	50 µA cm^{-2}	0,03 - ? (approx 3V)	M Doeff, J. Electrochem. Soc., 140, 12, (1993)
Ground petroleum coke	21	NaC_{24} (approx. 93, only one discharge)	50 µA cm^{-2}	0,03 - ? (approx. 3 V)	M Doeff, J. Electrochem. Soc., 140, 12, (1993)
Pyrolyzed glucose	30	280-300 (Na plating)	C/80 35µA cm^{-2}	<0.0 - 2.0	J. R. Dahn, J. Electrochem. Soc., 147, 1271, (2000)
Saccharose coke	60	114 (Na plating)	33 µA cm^{-2}	<0.0 - 2.0	J. R. Dahn, J. Electrochem. Soc., 148, A803, (2001)
Carbon fibers	(RT)	83	7 µA mg(C)$^{-1}$	? - 2.0	D. Billaud, Electrochimica Acta, 45, 3, (1999)
Pyrolyzed cellulose	60	279	7 µA mg(C)$^{-1}$	0.002 - 2.5	D. Billaud, Electrochim. Acta, 47, 20, (2002)
Carbon Black	(RT)	121	C/75	not reported	R. Alcantara, Electrochem. Commun., 3,639, (2001)
Petroleum Cokes	(RT)	15-100 (~1.5 cycles)	C/75	? - 1.5	R. Alcantara, J. Electrochem. Soc., 149, 2, (2005)
Carbon microspheres	(RT)	285	40 µA cm^{-2}	not reported	R. Alcantara, Electrochem. Solid St., 8, 4, (2005)
Templated Carbon	RT	130 (~NaC_{17})	C/5 74.4 µA mg(C)$^{-1}$ ~160 µA cm^{-2}	0.01 - 1.6	This work
Templated Carbon	RT	110 (~NaC_{20})	1C 372 µA mg(C)$^{-1}$ ~800 µA cm^{-2}	0.01 - 1.6	This work

***The current at which the galvanostatic insertion/deinsertion experiments are conducted can be expressed in different ways. The C-rate expresses, at which rate a cell is charged or discharged relative to its theoretical capacity. A rate of 1C means that the cell is discharged or charged within 1 hour. The theoretical capacity of NaC_6 is 372 mAh g^{-1}, i.e. in case the mass of carbon (active mass) is 1 g, the applied current at 1C is 372 mA. At 2C, the current is 744 mA, at C/5 74.4 mA, at C/75 4.96 mA and so on. A reasonable current for practical application would be C/5, i.e. full charge within 5 hours. C-rate and the current per gram of active mass can be directly converted. Sometimes, the current is also given with respect to the electrode area. As the thickness of the electrode can vary, here, a direct conversion is not possible unless the loading (gram of active mass per electrode area) is known.

The properties of the electrodes used in this work are as follows:
Electrode area: 1,131 cm^2
Thickness: ~ 40 µm on a 10 µm Cu foil, i.e. ~50 µm in total
Loading of active mass: Typically around 2.3 mg(C) cm^{-2}

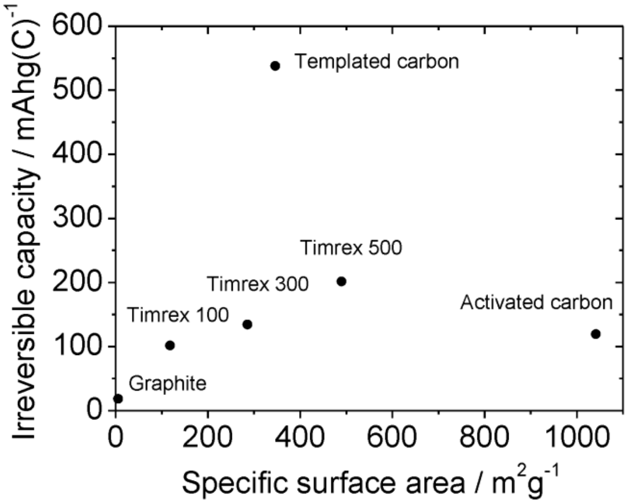

Figure S1. Irreversible capacities after the first cycle for the different carbon materials as a function of the specific BET surface area. A linear behavior is only found for carbon materials from the same series, indicating that also other factors such as pore structure and impurities must be important parameters.

Experimental details

Commercial carbon materials (Timrex 100, 300 and 500) and synthetic graphite (SFG-44) were obtained from Timcal Ltd., activated charcoal from Fluka. Silica templates were synthesized via the Nakanishi process as earlier described.[31] The templated carbon was prepared via the nanocasting route by infiltrating the silica monoliths with a solution of ~10wt% mesophase-pitch (Mitsubishi Gas Chemical Company) in THF in an opened glass vessel. After drying at room temperature, the samples were carbonized at 700 °C under N_2 atmosphere. Silica was etched by a solution of $NH_4HF_{2,}$(aq).The final samples were rinsed several times with demin. water and ethanol and finally dried at 60 °C.

Carbon electrodes (40 µm) on copper foil (10 µm, Schlenk Metallfolien GmbH & Co KG) were prepared via doctor blading and contained 10wt% PVDF binder (Solef 1013). N-Methyl-2-pyrrolidon (Sigma Aldrich, 99.5 %) was used to prepare the slurry from the carbon powders. Electrochemical characterization was performed in a 3-electrode Swagelok type cell with a glass-fibre (Whatman) separator. A 1M solution of $NaPF_6$ in a 30/70 wt% mixture of EC/DMC (all 99+ %, Sigma Aldrich) was used as electrolyte. Cells were cycled at room temperature vs. metallic Na between 0.01 V – 1.6 V using a Maccor 4300 system. The C-Rate was calculated as in Ref. [4b], i.e. assuming a NaC_6 stoichiometry to calculate the theoretical capacity, i.e. q_{th} = 372 mAh $g(C)^{-1}$. A C-rate of C/5 corresponds to a current of 74.4 mA $g(C)^{-1}$ ($j \approx 0{,}16$ mA cm^{-2}), i.e. nominal formation of NaC_6 within 5 hours (see supp. info.). Specific capacities are given per gram carbon (g(C)). *Note*: Electrolytes based on organic solvents and sodium-containing conducting salts are chemically reactive and can limit the long term stability of the cells. We found that the glass separators are not completely inactive and had slightly reacted with the electrolyte during the time of cycling. Thus reference measurements (graphite in the present case) are necessary in order to test whether there is any effect on the capacity determination.

N_2 physisorption experiments were conducted at 77 K using a Quantachrome Autosorb-6. SEM images were recorded with a LEO Gemini 982 from Zeiss.

[31] T. Hara, H. Kobayashi, T. Ikegami, K. Nakanishi, N. Tanaka, *Anal.Chem.* **2006**, *78*, 7632