# Vanadium nitride@N-doped carbon nanocomposites: Tuning of pore structure and particle size through salt templating and its influence on supercapacitance in ionic liquid media

Nina Fechler,*[a] Girum Ayalneh Tiruye,[b] Rebeca Marcilla,[b] and Markus Antonietti [a]

[a] Max Planck Institute of Colloids and Interfaces, Colloid Chemistry, Research Campus Golm, Am Mühlenberg 1, 14476 Potsdam (Germany)

[b] IMDEA Energy Institute, Avda. Ramón de la Sagra 3, 28935 Móstoles, Madrid (Spain)

Supporting Information
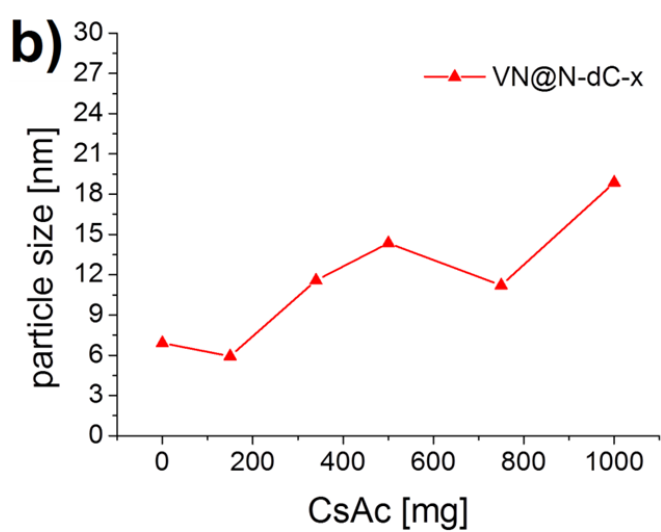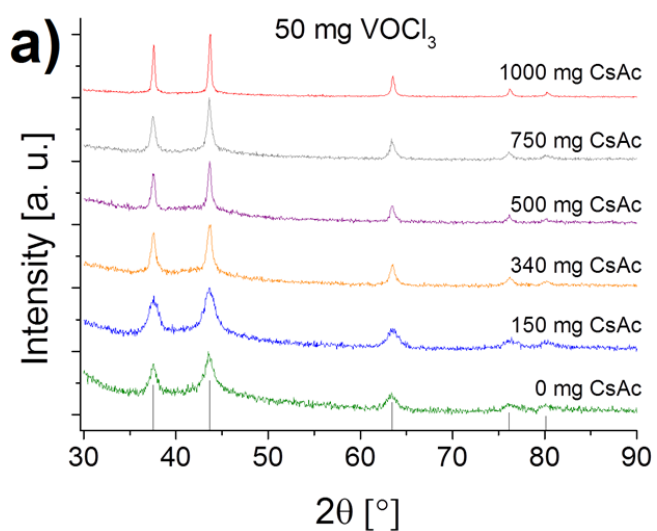
Figure SI-1 a) WAXS patterns of calcined, washed VN@N-dC-x-CsAc-VOCl$_3$ (Ref. pattern ICDD 00-035-0768) and **b)** calculated particle size using Scherrer equation at different CsAc concentrations.
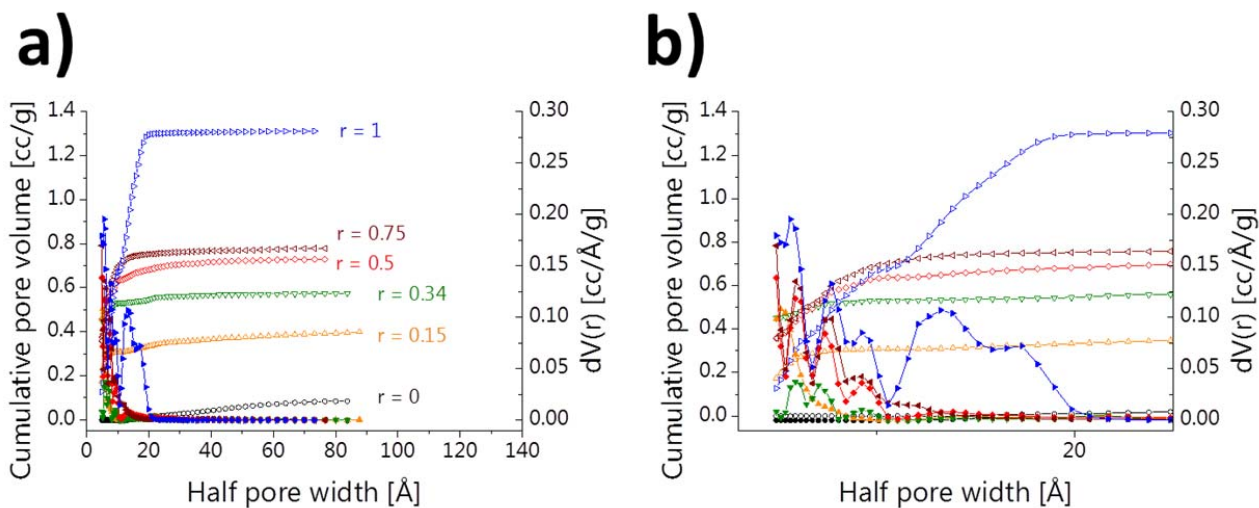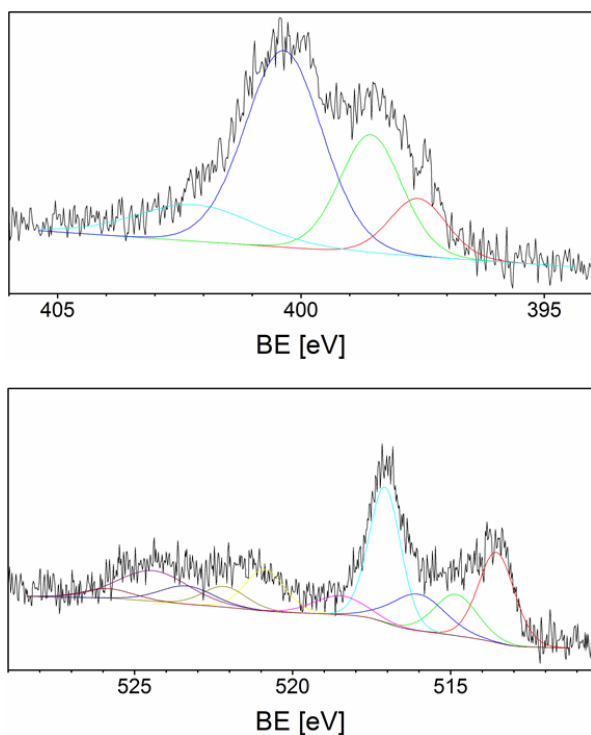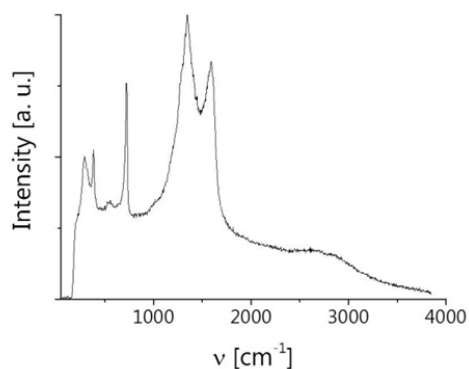
Figure SI-2 a) PSDs of VN@N-dC-x-CsAc-VOCl$_3$, **b)** magnification.

Table SI-1 Composition of the composites VN@N-dC-x-CsAc-VOCl$_3$.

| CsAc	Element [wt%]				
	Elemental analysis			ICP OES	XPS
[mg]	N	C	H	V	O
0	12.29	68.69	1.038	7.0	8.40
150	7.61	69.94	1.79	-	
340	7.60	68.55	1.58	5.6	10.64
500	5.95	65.39	2.78	-	
750	6.96	60.09	1.05	-	
1000	11.18	61.63	0.90	7.8	5.42

**Figure SI-3** XPS-spectra: N1s (**top**) and V2p (**bottom**) orbitals of VN@N-dC-340-CsAc-VOCl₃.

**Figure SI-4** Raman-spectrum of VN@N-dC-340-CsAc-VOCl3..

Raman spectroscopy revealed the presence of V_xO_y (Fig. SI-6),[SI-1] which can be attributed to a thin oxide layer on the vanadium nitride nanoparticles, since it is a surface sensitive measurement method and no vanadium oxide phase could be detected in the respective WAXS pattern. As speculated in our previous work,[23] an additional signal enhancement due to plasmon resonances on the surface of VN can be considered. Furthermore, the D- and G-bands are visible and are characteristic for slightly disordered and heteroatom-doped carbon[SI-2] with an intensity ratio of ID/IG > 1 suggesting the incorporation of nitrogen within the carbon matrix.
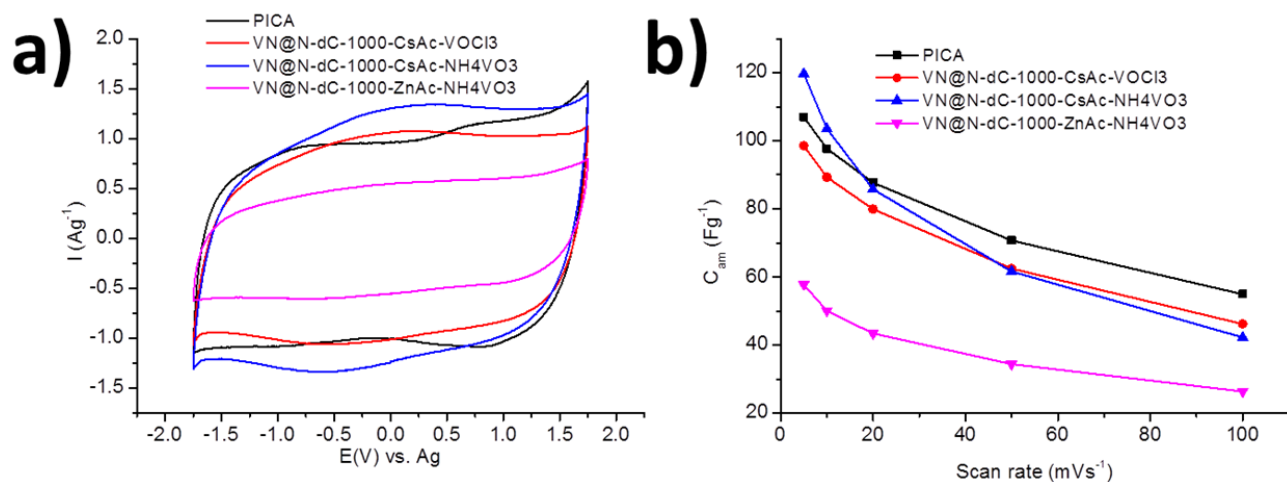
Figure SI-5 a) CVs of VN@N-dC-1000-CsAc-VOCl$_3$ (red), VN@N-dC-1000-CsAc-NH$_4$VO$_3$ (blue), VN@N-dC-1000-ZnAc-NH$_4$VO$_3$ (pink) and Pica (black) from -1.75 to 1.75 V at 10mV s^{-1} scan rate. **b)** Specific capacitances vs. the scan rate calculated from CVs performed from -1.75 to 1.75 V. Measurements were conducted at 60 °C in 3-electrode setup in PYR$_{14}$TFSI.
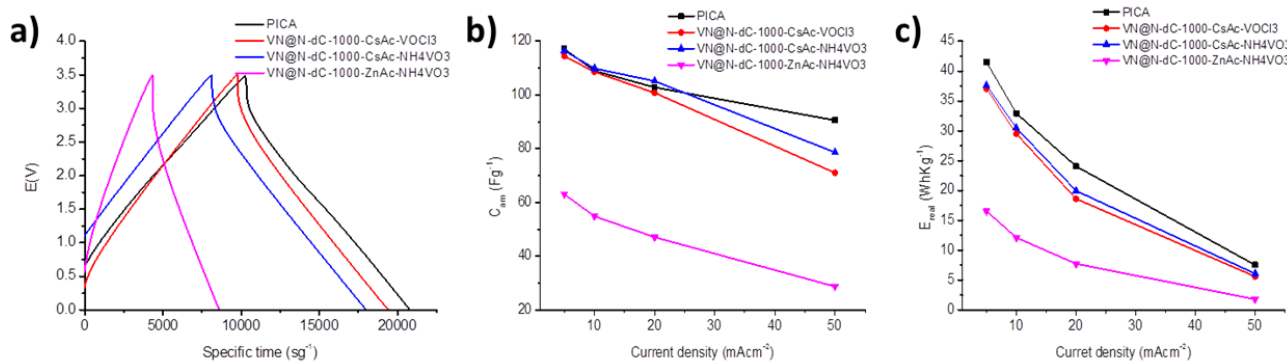
Figure SI-6 a) Galvanostatic charge-discharge profiles of VN@N-dC-1000-CsAc-VOCl$_3$ (red), VN@N-dC-1000-CsAc-NH$_4$VO$_3$ (blue), VN@N-dC-1000-ZnAc$_2$-NH$_4$VO$_3$ (pink) and Pica (black) carbon cycled from 0 V to 3.5 V at 10 mAcm^{-2}. Due to different weights of active material per supercapacitor, the discharge time has been referred to the total active mass. **b)** Specific capacitances (C$_{am}$) and **c)** specific real energy (E$_{real}$) vs. current density calculated from charge-discharge experiments. Measurements were conducted at 60 °C in 2-electrode setup in PYR$_{14}$TFSI.
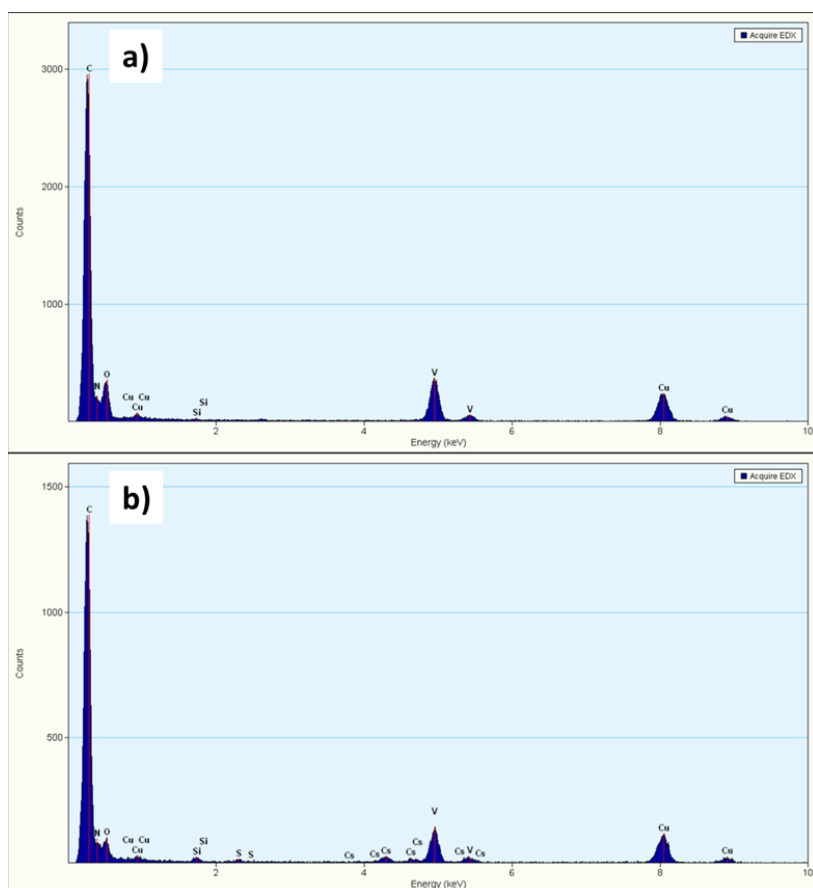
Figure SI-7 a) Energy-dispersive X-ray spectroscopy of VN@N-dC-0-CsAc-NH$_4$VO$_3$ and **b)** VN@N-dC-1000-CsAc-NH$_4$VO$_3$.
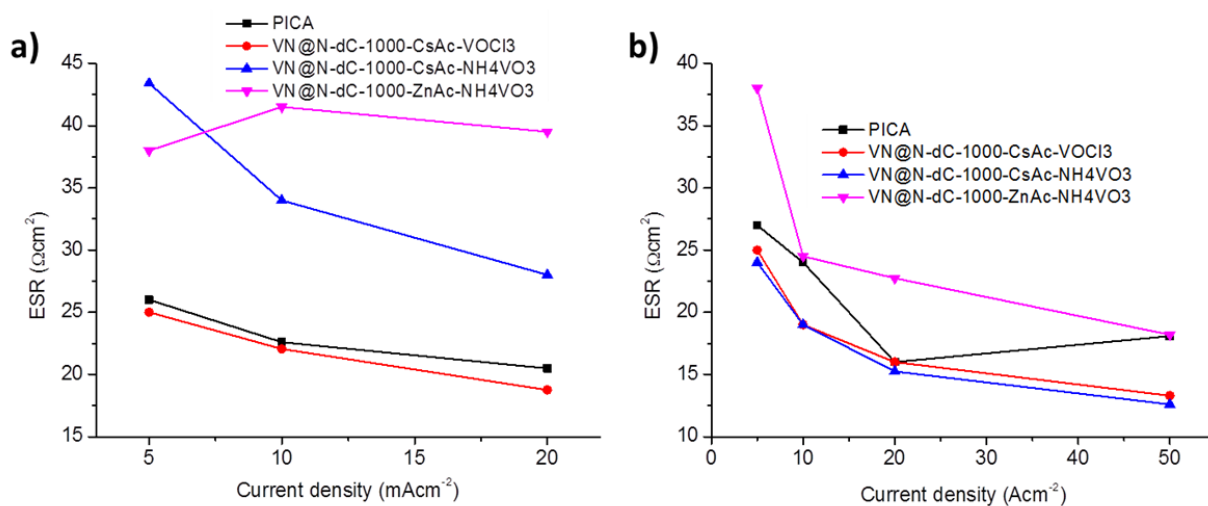
Figure SI-8 Equivalent series resistance (ESR) of the PICA (black) and composites obtained by CD experiments (from 0 V to 3.5 V at different current densities) in **a)** PYR$_{14}$FSI and **b)** PYR$_{14}$TFSI electrolytes.

[SI-1] C. M. Ghimbeu, E. Raymundo-Pinero, P. Fioux, F. Beguin, C. Vix-Guterl, *Journal of Materials Chemistry* **2011**, 21, 13268.

[SI-2] J. P. Paraknowitsch, A. Thomas, M. Antonietti, *Journal of Materials Chemistry* **2010**, 20, 6746.