Electronic Supplementary Information

Tuning pseudocapacitive and battery-like lithium intercalation in vanadium dioxide/carbon onion hybrids for asymmetric supercapacitor anodes

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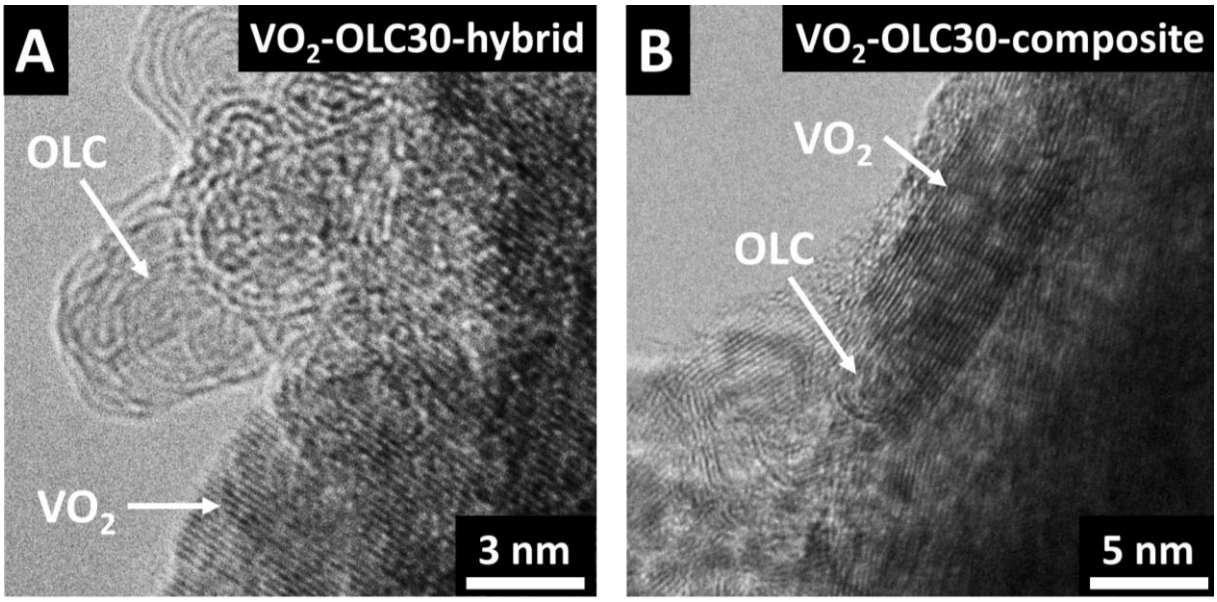

Figure S1: Transmission electron micrographs of (A) VO_2-OLC30-hybrid and (B) VO_2-OLC30-composite samples.

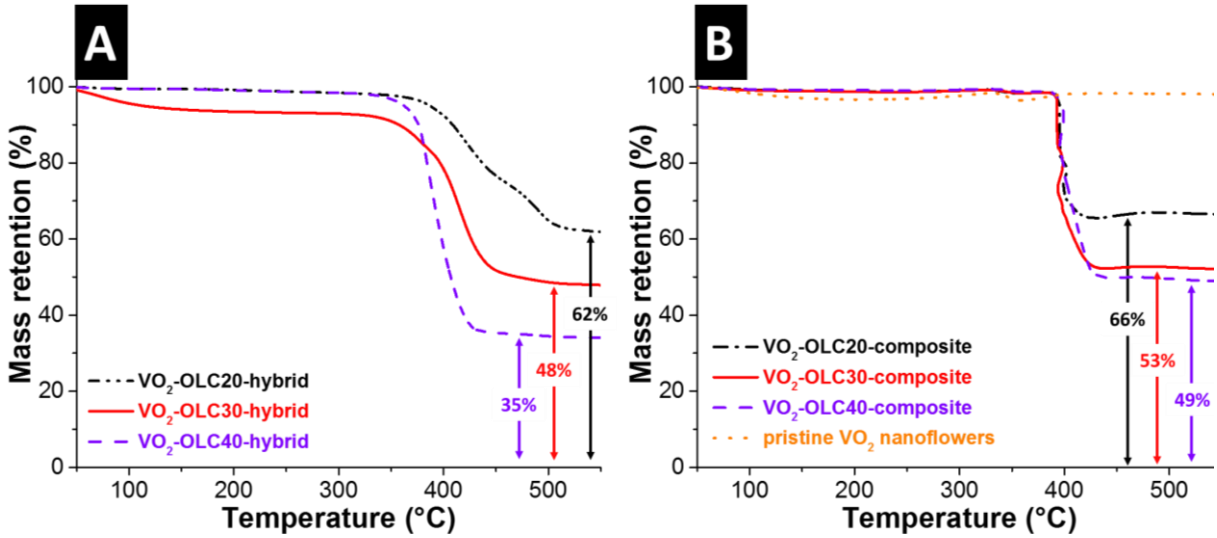

Figure S2: Thermogravimetric analysis of (A) VO_2-OLC-hybrid samples and (B) VO_2-OLC-composite samples and pristine VO_2 nanoflowers, carried out in synthetic air (flow rate of 20 mL·min^{-1}) up to a temperature of 550 °C at a heating rate of 5 °C·min^{-1}.

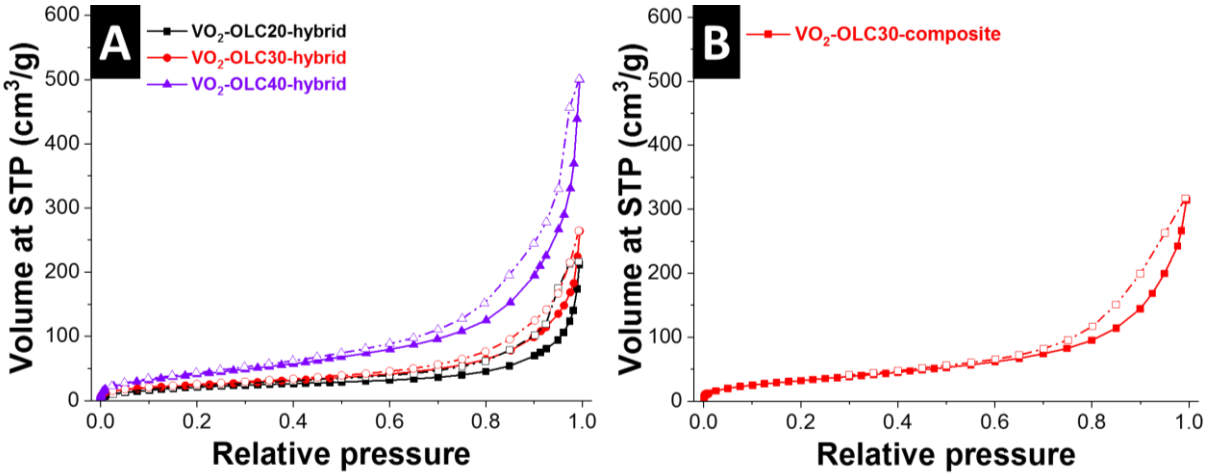

Figure S3: Nitrogen sorption isotherms at standard temperature and pressure of (A) VO_2-OLC-hybrid samples and (B) VO_2-OLC30-composite sample. The dashed lines correspond to the desorption branch.

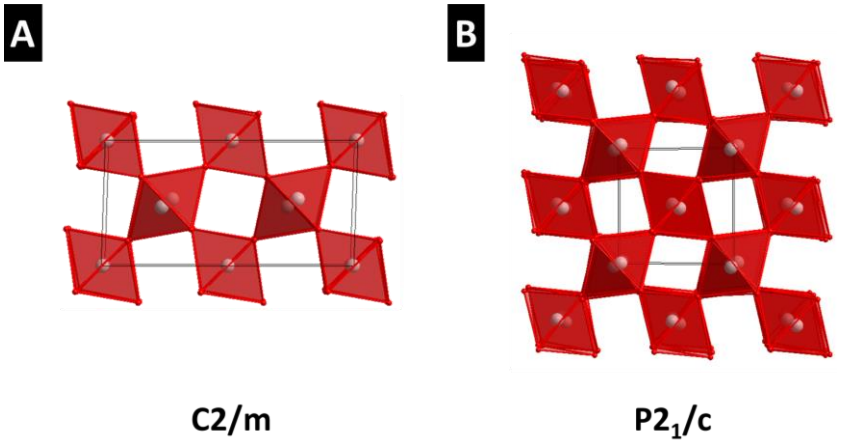

Figure S4: Crystal structures of the monoclinic VO_2 structure in (A) C2/m and (B) $P2_1/c$ space group. The vanadium atoms are represented by white spheres, oxygen atoms by red spheres. The distances between the shared oxygen atoms at the corners of the octahedra show a fixed distance of 3.3 Å for C2/m and a varying distance between 2.9 Å and 6.4 Å for $P2_1/c$.

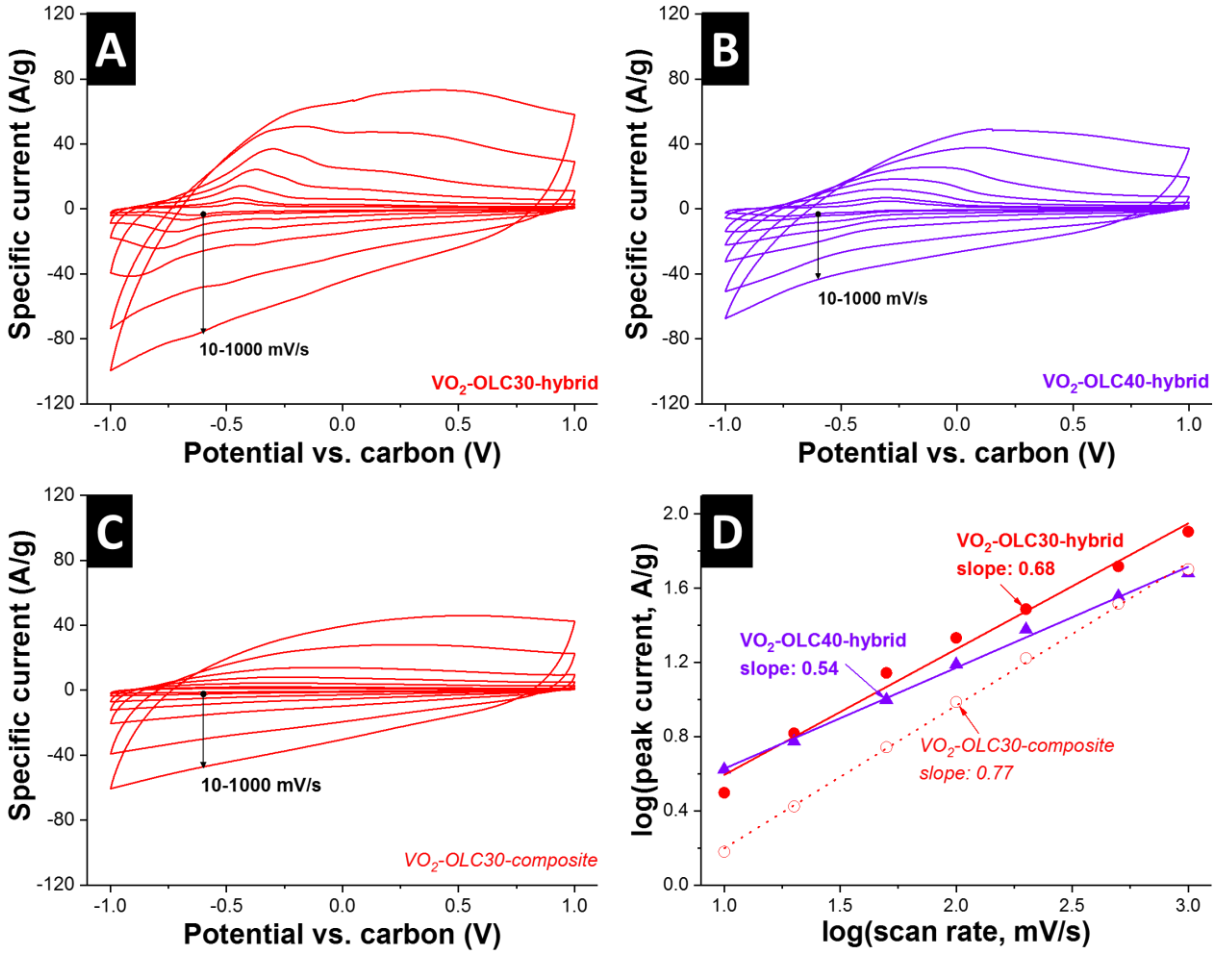

Figure S5: CVs of (A) VO_2-OLC30-hybrid, (B) VO_2-OLC40-hybrid, and (C) VO_2-OLC30-composite samples measured in half-cells and varying scanning speeds of 10-1000 $mV \cdot s^{-1}$. (D) Kinetic analysis via logarithmic plotting of the peak current at -0.7 V vs. carbon against the scan rate and linear regression applied to the data points.

Table S1: Electrode conductivity of VO_2-OLC30-hybrid and VO_2-OLC30-composite electrodes by 4-point probe as an average of six measurements.

Material	Electrode conductivity ($S \cdot cm^{-1}$)
VO_2-OLC30-hybrid	0.30 ± 0.03
VO_2-OLC30-composite	0.16 ± 0.05

Table S2: Specific surface area (BET) and pore volume (at P/P_0=0.95) of VO_2-OLC samples and as synthesized vanadium oxide nanoflowers and carbon onions.

Material	SSA (BET) ($m^2 \cdot g^{-1}$)	Pore volume ($cm^3 \cdot g^{-1}$)
VO_2-OLC20-hybrid	81	0.15
VO_2-OLC30-hybrid	89	0.21
VO_2-OLC40-hybrid	160	0.41
VO_2-OLC30-composite	118	0.31
VO_2 *as synthesized*	38	0.04
OLCs *as synthesized*	352	0.93

Table S3: Analysis of D- and G-bands of the samples VO_2-OLC30-hybrid and VO_2-OLC30-composite, calculated by peak deconvolution.

Material	FWHM D (cm^{-1})	FWHM G (cm^{-1})	I_D/I_G	Pos. D-band (cm^{-1})	Pos. G-band (cm^{-1})
VO_2-OLC30-hybrid	69	48	2.7	1347	1590
VO_2-OLC30-composite	58	40	2.3	1347	1587