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Supporting Information

Performance and Sustainability Tradeoffs of Oxidized Carbon Nanotubes as a Cathodic Material in Lithium-Oxygen Batteries

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Figures

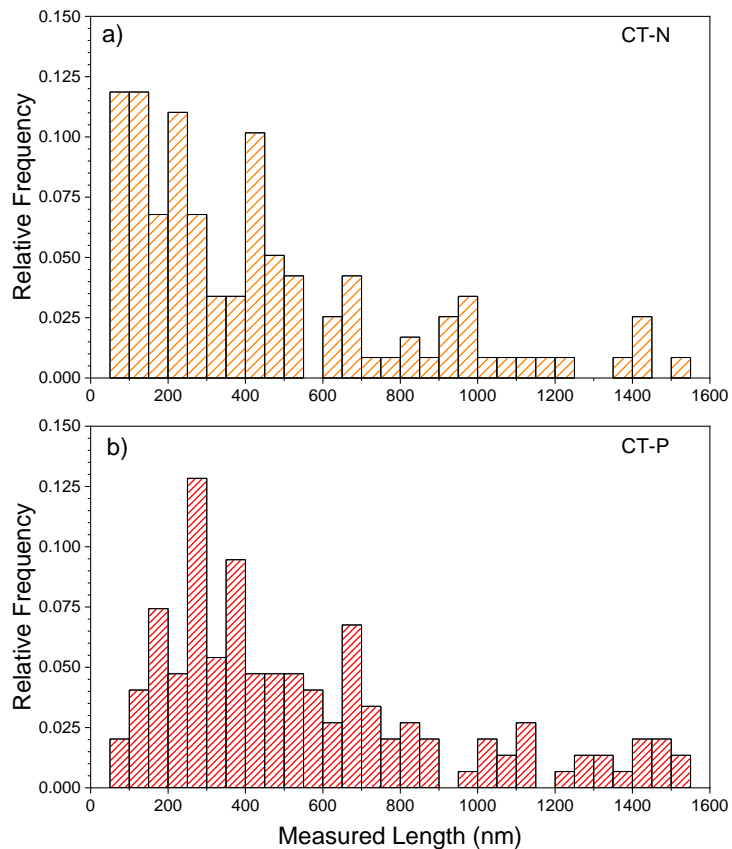


Figure S1: Length distribution of a) nitric acid-treated MWCNTs and b) pristine MWCNTs, as determined by scanning electron microscopy imaging.

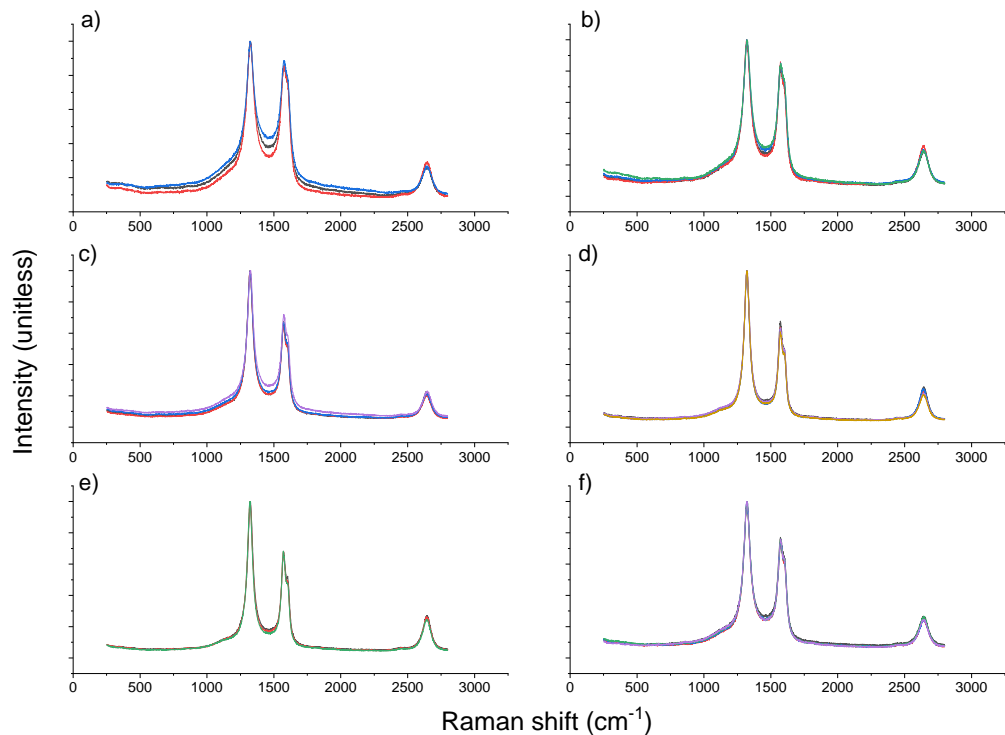


Figure S2: Raman spectra for all MWCNT samples used in this study: a) CT-P, b) CT-P-900, c) CT-N, d) CT-N-400, e) CT-N-600, f) CT-O. The G-band is at $\sim 1575 \text{ cm}^{-1}$ and the D-band is at $\sim 1325 \text{ cm}^{-1}$.

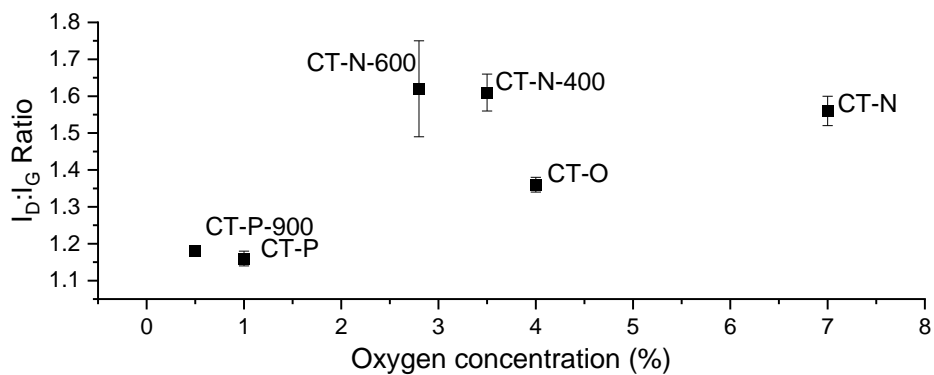


Figure S3: The relationship between disorder and surface chemistry, in the form of $I_D:I_G$ ratio vs. percent total surface oxygen for samples of different surface chemistry.

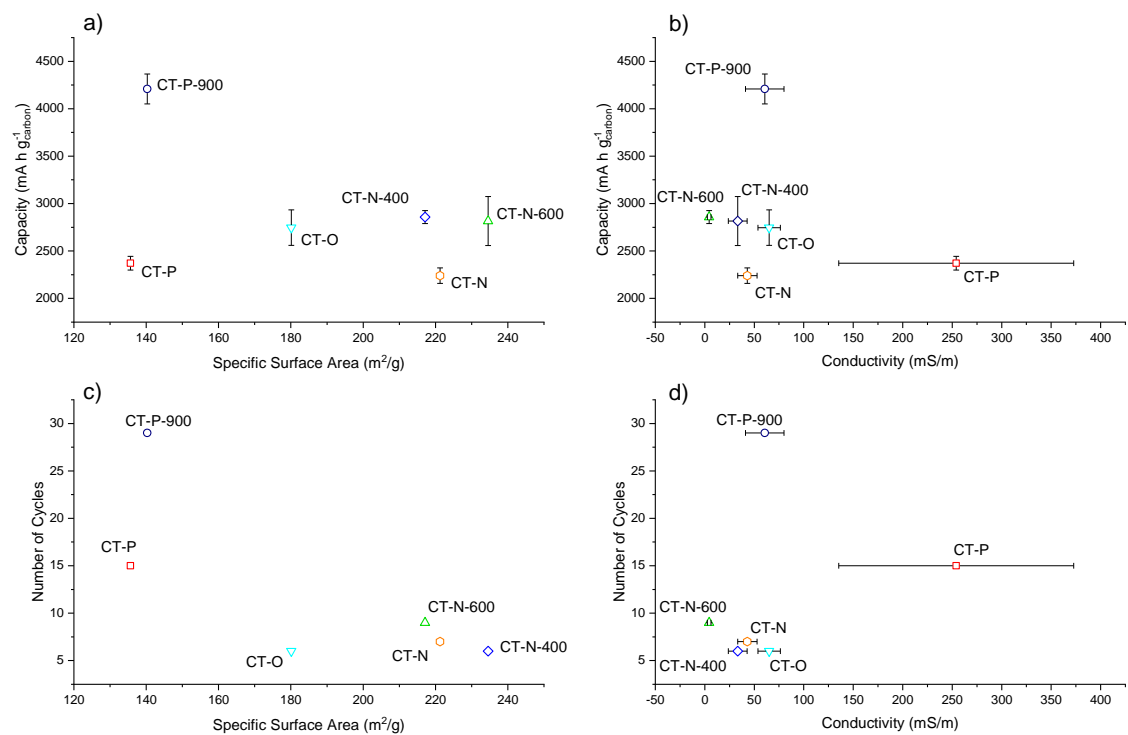


Figure S4: The relationship between capacity and a) specific surface area of MWCNT powder and b) conductivity of MWCNT:PVDF cathode, and the relationship between the number of completed cycles and c) specific surface area of MWCNT powder and d) conductivity of MWCNT:PVDF cathode.

Life Cycle Assessment Inventory:

Fluidized Bed Chemical Vapor Deposition (1 g MWCNT)

	Flow	Provider	Amount	Unit
Heating	argon, liquid	market for argon, liquid argon, liquid Cutoff, U – RoW	216.92	g
	electricity, low voltage	market group for electricity, low voltage electricity, low voltage Cutoff, U – US	0.18	kWh
Catalyst Deposition	aluminium oxide, metallurgical	market for aluminium oxide, metallurgical aluminium oxide, metallurgical Cutoff, U – RoW	153.85	g
	Aluminum isopropoxide	<i>Stoichiometrically estimated</i>	0.05	g
	argon, liquid	market for argon, liquid argon, liquid Cutoff, U – RoW	133.08	g
	oxygen, liquid	market for oxygen, liquid oxygen, liquid Cutoff, U – RoW	4.38	g
	Ferrocene	<i>Stoichiometrically estimated</i>	0.02	g
	electricity, low voltage	market group for electricity, low voltage electricity, low voltage Cutoff, U – US	0.04	kWh
	Annealing	argon, liquid	market for argon, liquid argon, liquid Cutoff, U – RoW	160.48
electricity, low voltage		market group for electricity, low voltage electricity, low voltage Cutoff, U – US	0.07	kWh
hydrogen, gaseous		market for hydrogen, gaseous hydrogen, gaseous Cutoff, U – GLO	2.82	g
water, deionised		market for water, deionised water, deionised Cutoff, U – RoW	0.06	g
MWCNT Growth		acetylene	market for acetylene acetylene Cutoff, U – RoW	1.55
	argon, liquid	market for argon, liquid argon, liquid Cutoff, U – RoW	158.08	g
	hydrogen, gaseous	market for hydrogen, gaseous hydrogen, gaseous Cutoff, U – GLO	2.82	g
	water, deionised	water production, deionised water, deionised Cutoff, U – RoW	0.06	g
	electricity, low voltage	market group for electricity, low voltage electricity, low voltage Cutoff, U – US	0.07	kWh
	Separation			
	Flow	Provider	Amount	Unit

argon, liquid	market for argon, liquid argon, liquid Cutoff, U – RoW	68.85	g
electricity, low voltage	market group for electricity, low voltage electricity, low voltage Cutoff, U – US	0.01	kWh

Hot Wall Chemical Vapor Deposition

Catalytic Particle Production (10 g)

Flow	Provider	Amount	Unit
electricity, low voltage	market group for electricity, low voltage electricity, low voltage Cutoff, U – US	0.9	kWh
iron (III) chloride, without water, in 40% solution state	market for iron (III) chloride, without water, in 40% solution state iron (III) chloride, without water, in 40% solution state Cutoff, U – GLO	54.12	g
nitrogen, liquid	market for nitrogen, liquid nitrogen, liquid Cutoff, U – RoW	126	g
water, deionised	market for water, deionised water, deionised Cutoff, U – RoW	100	g
zeolite, powder	market for zeolite, powder zeolite, powder Cutoff, U – GLO	10	g

MWCNT Growth (7.5 g)

Flow	Provider	Amount	Unit
acetylene	market for acetylene acetylene Cutoff, U – RoW	18.4	g
Catalytic Particles	<i>Calculated above</i>	0.22	g
electricity, low voltage	market group for electricity, low voltage electricity, low voltage Cutoff, U – US	2.3	kWh
nitrogen, liquid	market for nitrogen, liquid nitrogen, liquid Cutoff, U – RoW	160.8	g

Nitric Acid Treatment (8 g MWCNT)

Flow	Provider	Amount	Unit
electricity, low voltage	market group for electricity, low voltage electricity, low voltage Cutoff, U – US	560	Wh
nitric acid, without water, in 50% solution state	market for nitric acid, without water, in 50% solution state nitric acid, without water, in 50% solution state Cutoff, U – RoW	284	g

Ozonation (2 g MWCNT)

Flow	Provider	Amount	Unit
electricity, low voltage	market group for electricity, low voltage electricity, low voltage Cutoff, U – US	105	Wh
oxygen, liquid	market for oxygen, liquid oxygen, liquid Cutoff, U – RoW	10	g
water, deionised	water production, deionised water, deionised Cutoff, U – RoW	20	g

High Temperature Annealing (2 g MWCNT)

Flow	Provider	Amount	Unit
400°C			
electricity, low voltage	market group for electricity, low voltage electricity, low voltage Cutoff, U – US	0.186	kWh
helium	market for helium helium Cutoff, U – GLO	7.854	g
600°C			
electricity, low voltage	market group for electricity, low voltage electricity, low voltage Cutoff, U – US	0.2755	kWh
helium	market for helium helium Cutoff, U – GLO	9.996	g
900°C			
electricity, low voltage	market group for electricity, low voltage electricity, low voltage Cutoff, U – US	0.6422	kWh
helium	market for helium helium Cutoff, U – GLO	11.781	g