Supporting Information

S1. CNT Alignment Apparatus

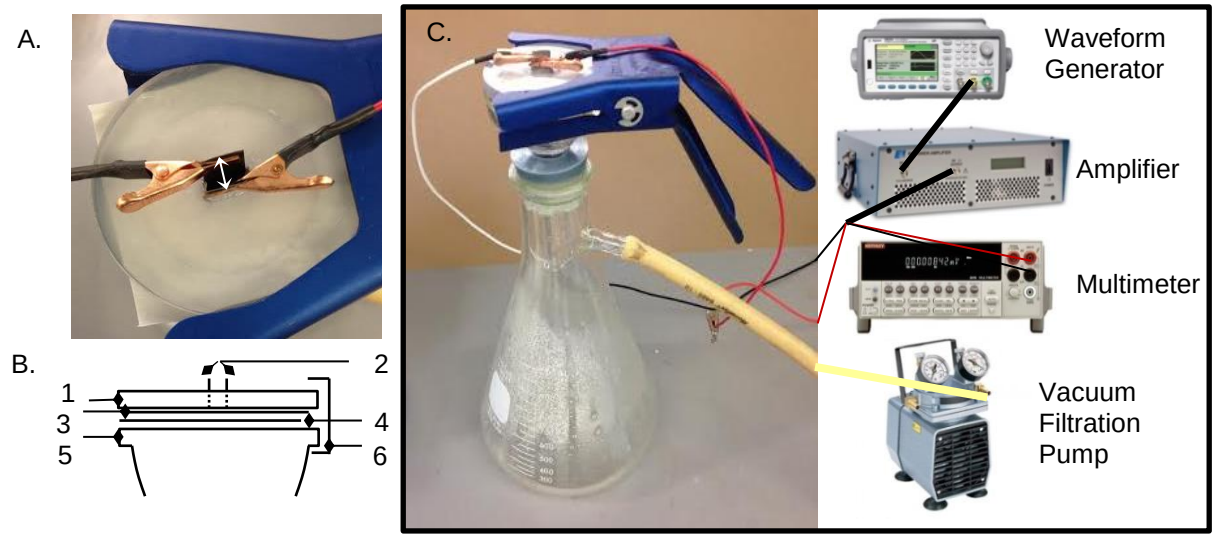


Figure S. 1. Filtration and alignment apparatus. A. A custom-made stencil was used to deposit the MWCNT onto the microfiltration membranes (top view). The white arrow indicates the direction of the electric field within the device. **B.** The stencil consisted of (1) an acrylic disk with rectangular hole cut into center, 5 mm x 10 mm, (2) titanium electrodes, 5 mm spacing, (3) parafilm, to prevent leakage, (4) microfiltration membrane, (5) filtration flask with fritted glass support, and (6) filter flask clamp, (side view). **C.** Schematic of complete experimental apparatus. (Remillard *et al.* 2016)

S2. Oxygen Analysis

Oxygen content was determined using X-Ray Photoelectron Spectroscopy (XPS); measurements were made with a Thermo Scientific K-Alpha XPS, ESCA. Suspended MWCNT samples were vacuum filtered onto PVDF membrane coupons. Samples were then mounted to an aluminum stage using conductive carbon or copper tape and two types of scans were performed: survey scans looking for elemental signatures between -10 and 1350 eV and an elemental scans for the C1s signature (279-298 eV) (spot size = 400 μm, flood gun = on, auto height ±1000 μm, step = 50 μm, dwell time = 0.5 sec, energy step size 1.00 eV). The automated *Enhanced Survey ID* feature of *Avantage* (Thermo Fisher Scientific) was used to analyze the XPS survey spectrums. Measurements were taken in three locations of each sample and the average oxygen content was reported. Total oxygen content was measured at each processing step, i.e. before oxidation, after oxidation, after sonication, etc.

Oxygen functional groups were identified from the C1s curve using the automated *Peak Fit* feature of *Avantage* (Thermo Fisher Scientific), and matching the peaks to the binding energies listed in Table S. 1.

Table S. 1 Select C1s binding energies.

Bond/Group	Binding Energy (eV)
C-C	284.0-286.0
C-C (sp2)	284.3-284.6
C-C (sp3)	285.0-286.0
C-O	286.1-290.0
O=C-OH (carboxyl)	288.0-289.4
-C-O (epoxy)	286.1-287.1
-C-OH (hydroxyl)	286.4-286.7
-C-O-C- (ether)	286.1-288.0
-C=O (aldehyde/ketone)	287.1-288.1

Source: Flood and Barron (2013) *XPS of Carbon Nanomaterials*. Rice University. http://cnx.org/content/col11576/1.1/

To determine the oxygen attributed to each functional group, the fraction of oxygen accounting for each functional group was multiplied by the total oxygen content of the sample. For example:

$$T_{C-OH} = \frac{f_{C-OH}}{f_{C-OH} + f_{C=O,\ C-O-C} + 2 * f_{O=C-OH}} \times T_O$$

Where T_{C-OH} is the total oxygen present as C-OH, f_{C-OH} is the fraction of the C1s peak produced by C-OH, $f_{C=O}$ is the fraction of the C1s peak produced by C=O or C-O-C, $f_{O=C-OH}$ is the fraction of the C1s peak produced by O=C-OH and T_O is the total oxygen content in the sample. A weighting factor of two is used in the case of the carboxyl group since there are two oxygen atoms in each functional group.

Examples of XPS survey and C1s spectra are provided for CNT3 oxidized with various treatments (Figure S. 2) and CNT1-Ox3, CNT2-Ox3, CNT4-Ox0 and CNT4-Ox3 (Figure S. 3). Additionally, tabulated XPS data including functional group analysis is provided for pre-sonication (Table S. 2) and probe-sonicated samples (Table S. 3).

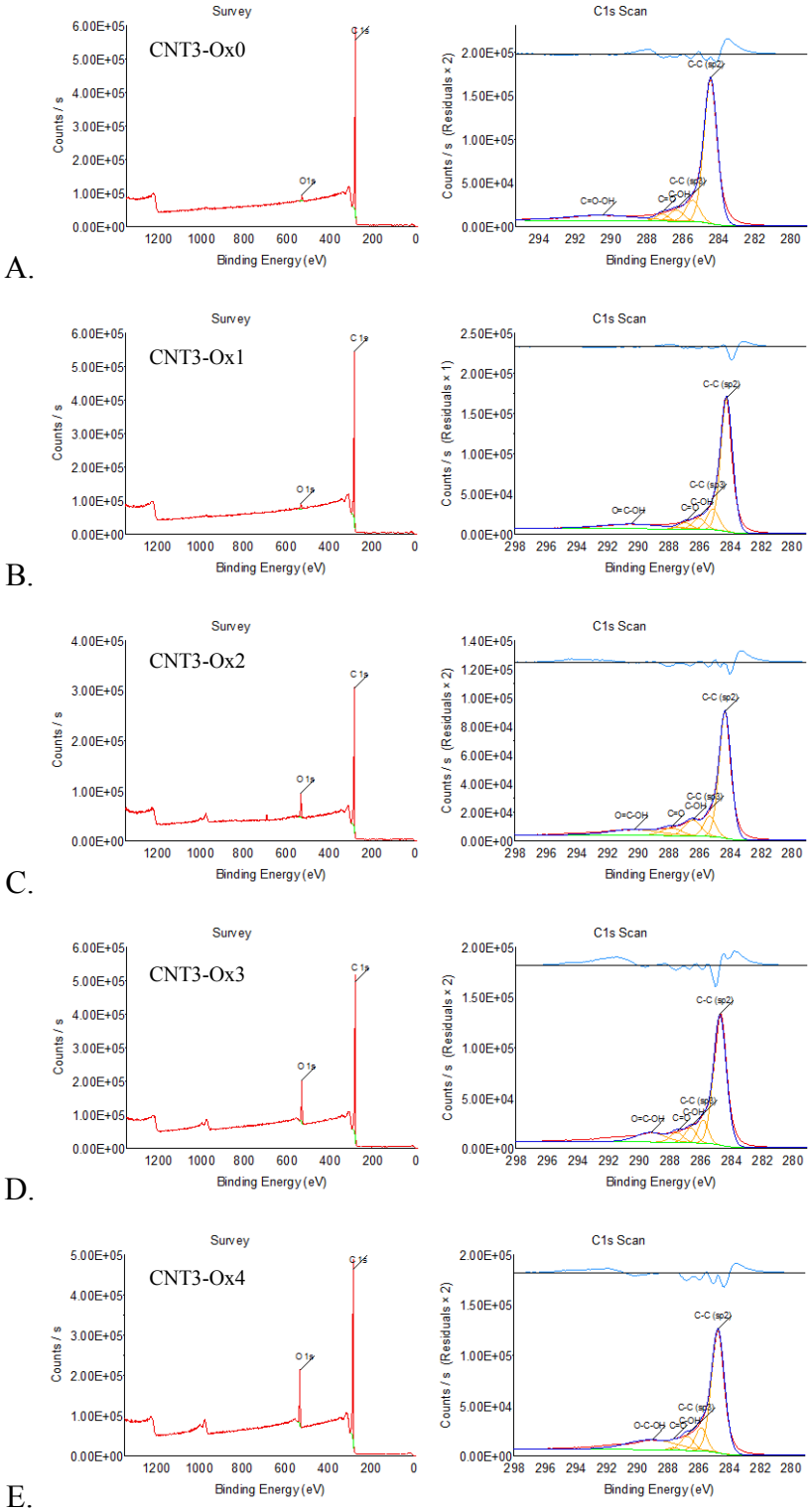


Figure S. 2. XPS spectra A. pristine CNT3, and CNT oxidized with **B.** Ox1 (52.5% HNO_3) **C.** Ox2 (O_3) **D.** Ox3 (H_2SO_4:HNO_3) **E.** Ox4 (O_3+H_2SO_4:HNO_3).

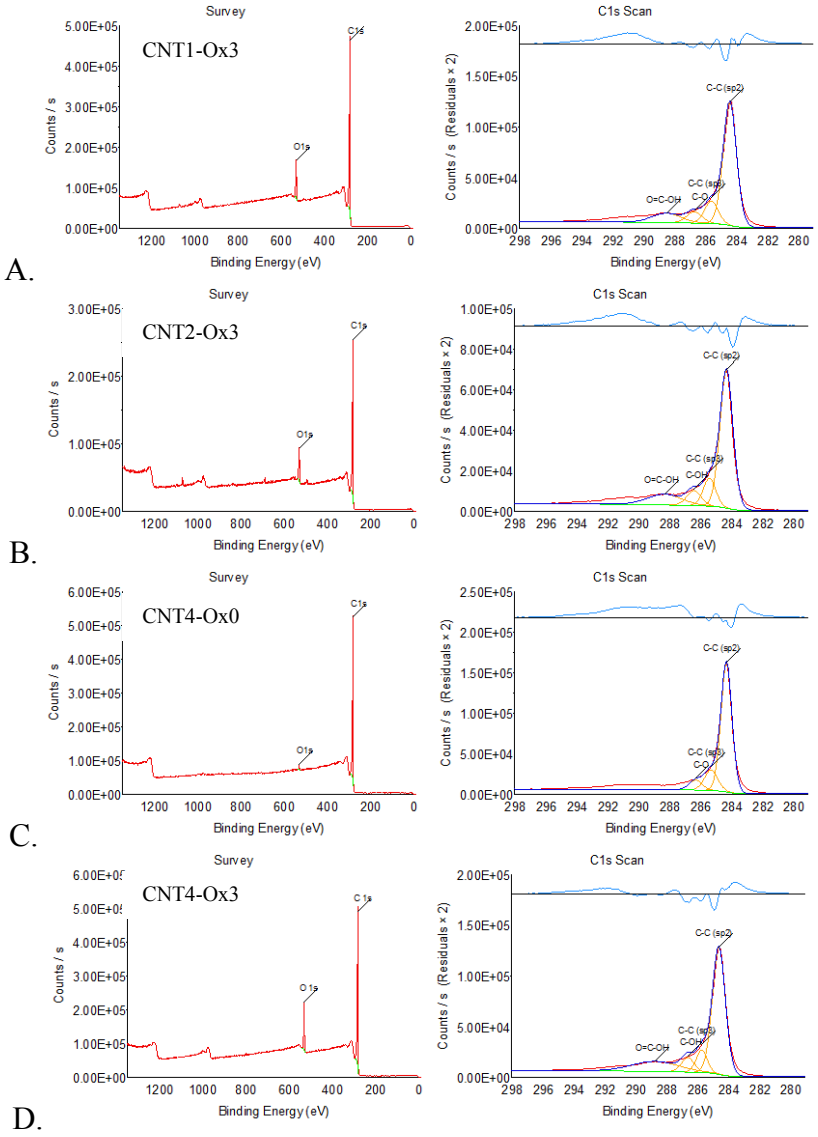


Figure S. 3. XPS spectra. A.CNT1-Ox3 **B.** CNT2-Ox3 **C.** CNT4-Ox0 **D.** CNT4-Ox3.

Table S. 2. Summary of XPS Peak Fit Data for oxidized CNT, pre-sonication.

Oxidation	Total Oxygen (at%)	C1s Data (%)					Oxygen by Functional Group		
		C-C (sp_2)	C-C (sp_3)	C-OH/C-O	C=O	O=C-OH	C-OH	C=O	O=C-OH
CNT3-Ox0-P	1.16	63.94	11.68	6.11	4.15	14.11	0.18	0.13	0.85
CNT3-Ox0-P	1.56	72.89	11.34	8.07	7.69	0.00	0.80	0.76	0.00
CNT3-Ox0-P	1.07	66.78	7.03	5.94	5.50	14.75	0.16	0.14	0.77
CNT3-Ox1-P	3.52	75.14	12.09	8.40	4.37	0.00	2.32	1.20	0.00
CNT3-Ox1-P	3.37	72.70	11.15	7.94	4.57	3.64	1.35	0.78	1.24
CNT3-Ox1-P	3.53	73.94	11.80	8.33	5.92	0.00	2.06	1.47	0.00
CNT3-Ox2-P	7.27	61.37	9.77	10.75	6.36	11.75	1.92	1.14	4.21
CNT3-Ox2-P	7.24	68.67	12.61	11.94	0.00	6.79	3.39	0.00	3.85
CNT3-Ox2-P	6.80	61.45	10.61	11.03	0.00	16.90	1.67	0.00	5.13
CNT3-Ox3-P	10.98	67.21	9.38	6.83	5.20	11.38	2.16	1.64	7.18
CNT3-Ox3-P	11.93	62.70	9.42	6.44	5.31	16.13	1.75	1.44	8.74
CNT3-Ox3-P	11.21	67.78	9.01	8.92	6.83	7.46	3.26	2.50	5.45
CNT3-Ox4-P	12.79	62.44	10.19	7.1	0.88	19.39	1.94	0.24	10.61
CNT3-Ox4-P	12.61	62.56	9.03	8.01	0.00	20.40	2.07	0.00	10.54
CNT3-Ox4-P	12.46	62.27	10.00	7.30	0.00	20.43	1.89	0.00	10.57
CNT1-Ox3-P	14.63	68.35	12.82	7.41	0.00	11.42	3.58	0.00	11.05
CNT1-Ox3-P	13.72	62.33	11.34	6.63	0.00	19.70	1.98	0.00	11.74
CNT1-Ox3-P	13.84	61.75	10.80	6.66	0.00	20.78	1.91	0.00	11.93
CNT2-Ox3-P	10.04	65.78	12.77	7.88	0.00	13.57	2.26	0.00	7.78
CNT2-Ox3-P	9.95	64.36	9.85	6.23	0.42	19.14	1.38	0.09	8.48
CNT2-Ox3-P	9.60	64.11	10.83	7.10	0.00	17.96	1.58	0.00	8.02
CNT4-Ox3-P	12.05	64.32	9.69	7.29	0.00	18.71	1.96	0.00	10.09
CNT4-Ox3-P	11.95	63.53	9.24	7.2	0.54	19.5	1.84	0.14	9.97
CNT4-Ox3-P	11.78	63.41	11.16	8.74	0.00	16.69	2.44	0.00	9.34

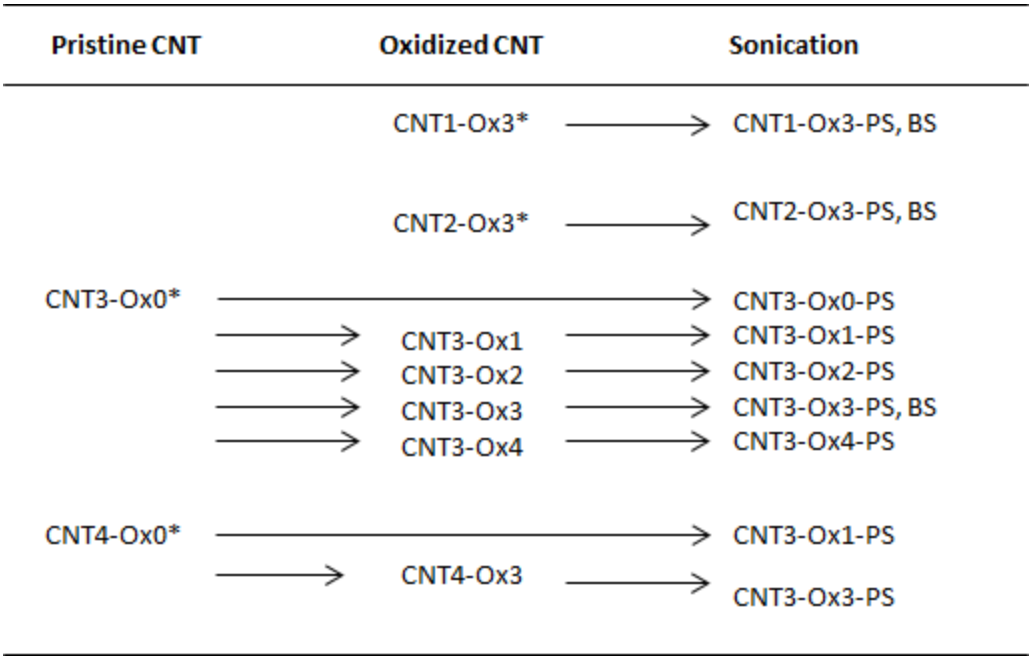
Table S. 3. Summary of XPS Peak Fit Data for oxidized CNT, after probe sonication.

Oxidation	Total Oxygen (at%)	C1s Data (%)					Oxygen by Functional Group		
		C-C (sp_2)	C-C (sp_3)	C-OH/C-O	C=O	O=C-OH	C-OH	C=O	O=C-OH
CNT3-Ox0-PS	1.72	66.43	10.18	5.60	3.68	14.11	0.26	0.17	1.29
CNT3-Ox0-PS	2.57	70.36	9.26	5.48	4.95	9.95	0.46	0.42	1.69
CNT3-Ox0-PS	3.14	69.09	9.23	5.69	6.25	9.75	0.57	0.62	1.95
CNT3-Ox1-PS	1.87	66.73	10.55	9.45	0.80	12.47	0.50	0.04	1.33
CNT3-Ox1-PS	1.63	68.95	13.55	4.27	0.00	13.22	0.23	0.00	1.40
CNT3-Ox1-PS	1.93	67.35	12.23	6.03	3.60	10.79	0.37	0.22	1.33
CNT3-Ox2-PS	2.39	69.28	7.64	6.56	4.14	12.38	0.44	0.28	1.67
CNT3-Ox2-PS	2.12	69.67	8.26	6.05	4.60	11.41	0.38	0.29	1.45
CNT3-Ox2-PS	1.95	66.47	11.70	6.68	4.55	10.60	0.40	0.27	1.27
CNT3-Ox3-PS	9.81	68.09	10.24	7.02	5.25	9.40	2.22	1.66	5.94
CNT3-Ox3-PS	9.32	69.68	10.97	7.14	6.17	6.04	2.62	2.26	4.43
CNT3-Ox3-PS	9.27	67.18	11.92	7.57	6.31	7.02	2.51	2.10	4.66
CNT3-Ox4-PS	10.56	67.15	14.43	7.24	0.00	11.18	2.58	0.00	7.98
CNT3-Ox4-PS	11.04	68.45	11.76	9.42	0.00	10.37	3.45	0.00	7.59
CNT3-Ox4-PS	11.47	69.91	10.80	9.25	0.00	10.04	3.62	0.00	7.85
CNT1-Ox3-PS	12.13	64.12	12.31	7.24	0.00	16.33	2.20	0.00	9.93
CNT1-Ox3-PS	11.57	64.72	9.47	7.52	0.00	18.29	1.97	0.00	9.60
CNT1-Ox3-PS	11.37	66.57	9.91	6.31	0.00	17.21	1.76	0.00	9.61
CNT2-Ox3-PS	10.89	71.20	12.98	0.00	8.41	7.41	0.00	3.94	6.95
CNT2-Ox3-PS	10.19	68.90	12.78	5.97	8.04	4.31	2.69	3.62	3.88
CNT2-Ox3-PS	10.51	67.46	10.80	8.23	8.26	5.26	3.20	3.21	4.09
CNT4-Ox3-PS	11.81	63.39	12.55	16.47	0.00	7.60	6.14	0.00	5.67
CNT4-Ox3-PS	11.29	65.28	15.68	9.88	0.00	9.16	3.96	0.00	7.33
CNT4-Ox3-PS	12.44	55.28	14.16	17.39	0.00	13.18	4.94	0.00	7.50

S3. Regression Analysis for Length and Diameter during CNT Processing

Changes in length and diameter throughout CNT processing were characterized using regression analysis. Each CNT batch went through three stages: pre-oxidation (Stage 1), post-oxidation but pre-sonication (Stage 2), and post-sonication (Stage 3) as shown in Scheme S.1.

Scheme S. 1. CNT processing.



*CNT acquired from manufacturer, PS= probe sonicated, BS = bath sonicated

The goal of this analysis is to determine how length and diameter were affected throughout solution processing. However, all three stages of this process were only observed for CNT3 and CNT4, while only Stages 2 and 3 were observed for CNT1 and CNT2. Furthermore, Ox3 and Ox4 were used for CNT3, but only Ox3 was used for the other CNT types. Finally, only probe sonication was used for CNT4, while both probe and bath were used for the other CNT batches. As a result, a unique set of experiments was performed for each of the four CNT types. Thus, only some CNT batches can be used to estimate particular effects: The effect of oxidation can only be estimated from the CNT3 and CNT4 samples; the effect of different oxidations can only

be estimated from CNT3 samples; and the interaction between oxidation and sonication can only be estimated from the probe-sonicated CNT3 samples. Because of these differences in what can and cannot be estimated across samples, a separate regression analysis was performed for each CNT batch.

Length and diameter measurements were consistently right-skewed, and the measurements appeared fairly normally-distributed when a log-transformation was applied. Thus, a linear regression after a log-transformation appeared appropriate for determining the mean effect that each processing stage had on the length and diameter of CNT. Furthermore, the overall dispersion of length and diameter measurements could have changed during each processing stage, so this was taken into account in the regression. This results in the following distributional assumption for log lengths and diameters:

Stage 1: $\log(y_{b1}) \sim N(\mu_{b1}, \sigma_{b1}^2)$

Stage 2: $\log\big(y_{b2}(o)\big) \sim N(\mu_{b2}(o), \sigma_{b2}^2)$, where $\mu_{b2}(o) = \mu_{b1} + \tau_{b2}(o)$

Stage 3: $\log(y_{b3}(o,s)) \sim N(\mu_{b3}(o,s), \sigma_{b3}^2)$, where $\mu_{b3}(o,s) = \mu_{b2}(o) + \tau_{b3}(o,s)$

In the above, the normal distribution with mean μ and variance σ^2 is denoted by $N(\mu, \sigma^2)$, the CNT batch (1, 2, 3, or 4) is denoted by b; the oxidation type during Stage 2 (Ox3 or Ox4) is denoted by o, and the sonication type during Stage 3 (probe or bath) is denoted by s. The main parameters of interest are $\tau_{b2}(o)$ and $\tau_{b3}(o,s)$, which denote the effect that Stages 2 and 3 have on the mean length or diameter, respectively. Thus, the above model allows for the effect at Stage 2 to vary by oxidation type and the effect at Stage 3 to vary by oxidation and sonication type; furthermore, these effects can vary across batches. Finally, the above model takes into account that the variance of length and diameter measurements may differ across batches and

stages, which will allow for more precise estimation of $\tau_{b2}(o)$ and $\tau_{b3}(o,s)$, the parameters of interest.

Weighted least-squares regression was performed to fit the above model, where the weights were set equal to the inverse of the estimated variance at each stage, because this has been shown to maximize the precision of mean estimates.

It should be noted that the only model where the normal linear model assumptions probably did not hold was the diameter analysis for CNT4; the log-diameters were distinctly bimodal, and so it is not appropriate to model the log-diameters as normally distributed. The smoothed histograms of the log-diameter for CNT4 are plotted in Figure S. 5. Although the assumptions for normal linear regression did not hold, the regression analysis nonetheless captured a notable trend: the log-diameter for the CNT4 appeared to increase throughout the processing stages, with the left-hand mode appearing to shift more than the right-hand mode.

The tables below show the length analysis results for each CNT batch. The reference group for each analysis is Stage2 – oxidation – so that the Stage1-versus-Stage2 and Stage2-versus-Stage3 comparisons can be identified. For CNT3, a separate regression was performed for Ox3 and Ox4.

For example, the coefficient for Stage3 represents the change between Stage2 and Stage3; the negative of the coefficient for Stage1 represents the change between Stage1 and Stage2.

Table S. 4. Length Analysis for CNT1

Variable	Coefficient	Standard Error	p-value
Intercept	-0.0870	0.0455	0.0565
Stage3	0.1773	0.0690	0.0104
Stage3*Probe	-0.0146	0.0632	0.8175

Table S. 5. Length Analysis for CNT2

Variable	Coefficient	Standard Error	p-value
Intercept	0.1698	0.0602	0.0050
Stage3	0.1707	0.0822	0.0385
Stage3*Probe	0.0418	0.0792	0.5976

Table S. 6. Length Analysis for CNT3-Ox3

Variable	Coefficient	Standard Error	p-value
Intercept	0.5591	0.0480	$< 2*10^{-16}$
Stage1	3.3986	0.0857	$< 2*10^{-16}$
Stage3	0.4866	0.0651	$2.83*10^{-13}$
Stage3*Probe	-0.5259	0.0617	$< 2*10^{-16}$

Table S. 7. Length Analysis for CNT3-Ox4

Variable	Coefficient	Standard Error	p-value
Intercept	1.0544	0.0426	$< 2*10^{-16}$
Stage1	2.9034	0.0772	$< 2*10^{-16}$
Stage3	-0.6835	0.0601	$< 2*10^{-16}$

Table S. 8. Length Analysis for CNT4

Variable	Coefficient	Standard Error	p-value
Intercept	3.2337	0.0598	$< 2*10^{-16}$
Stage1	0.2053	0.0903	0.0234
Stage3	-1.4520	0.0717	$< 2*10^{-16}$

The tables below show the diameter analysis results for each CNT batch. The reference group for each analysis is Stage2 – oxidation – so that the Stage1-versus-Stage2 and Stage2-versus-Stage3 comparisons can be identified. For CNT3, a separate regression was performed for each oxidation type.

For example, the coefficient for Stage3 represents the change between Stage2 and Stage3; the negative of the coefficient for Stage1 represents the change between Stage1 and Stage2.

Table S. 9. Diameter Analysis for CNT1

Variable	Coefficient	Standard Error	p-value
Intercept	2.399	0.0181	$< 2*10^{-16}$
Stage3	0.1041	0.0275	0.0002
Stage3*Probe	-0.0379	0.0254	0.1355

Table S. 10. Diameter Analysis for CNT2

Variable	Coefficient	Standard Error	p-value
Intercept	2.6610	0.0198	$< 2*10^{-16}$
Stage3	-0.1278	0.0278	$5.17*10^{-6}$
Stage3*Probe	0.0154	0.0279	0.581

Table S. 11. Diameter Analysis for CNT3-Ox1

Coefficient	Estimate	Standard Error	p-value
Intercept	2.9462	0.0218	$< 2*10^{-16}$
Stage1	-0.1693	0.0310	0.5850
Stage3	-0.0150	0.0310	0.6280

Table S. 12. Diameter Analysis for CNT3-Ox2

Coefficient	Estimate	Standard Error	p-value
Intercept	2.8898	0.0237	$< 2*10^{-16}$
Stage1	0.0395	0.0336	0.2400
Stage3	0.0333	0.0338	0.3250

Table S. 13. Diameter Analysis for CNT3-Ox3

Coefficient	Estimate	Standard Error	p-value
Intercept	2.8897	0.0214	$< 2*10^{-16}$
Stage1	0.0396	0.0301	0.1890
Stage3	0.1563	0.0302	$2.78*10^{-7}$
Stage3*Probe	-0.0048	0.0302	0.8740

Table S. 14. Diameter Analysis for CNT3-Ox4

Coefficient	Estimate	Standard Error	p-value
Intercept	2.8673	0.0233	$< 2*10^{-16}$
Stage1	0.0619	0.0327	0.0585
Stage3	0.1283	0.0329	0.0001

Table S. 15. Diameter Analysis for CNT3 (Stage 2, Different Oxidations)

Coefficient	Estimate	Standard Error	p-value
Intercept	2.9462	0.0236	$< 2*10^{-16}$
Ox2	-0.0564	0.0336	0.0929
Ox3	-0.0565	0.0338	0.0952
Ox4	-0.0789	0.0338	0.0197

Table S. 16. Diameter Analysis for CNT4

Variable	Coefficient	Standard Error	p-value
Intercept	4.5664	0.0503	$< 2*10^{-16}$
Stage1	-0.3341	0.0859	0.0001
Stage3	0.1752	0.0715	0.0144

S3. Length and Diameter Distributions

Table S. 17. Manufacture specifications for CNT length and diameter.

CNT Symbol	CNT Name	Manufacturer	Length (μm)	Diameter (nm)
CNT 1	D15L1-5 MWCNT	Nanolab	1-5	15 ± 5
CNT2	D30L5-20 MWCNT	Nanolab	5-20	30 ± 5
CNT3	C-grade MWCNT	NanoTech Labs	100	5-30
CNT4	M-Grade MWCNT	NanoTech Labs	NR	70-80

Note: NR = not reported

CNT length and diameter were measured from SEM images using ImageJ ((National Institute of Health). Aliquots of the CNT suspension were applied directly to the SEM stub and dried overnight before imaging. Diameter measurements for CNT1-3 were obtained at 200 kx magnification, CNT4 measurements at 50 kx due to their much larger size. Length measurements were obtained using a wider range of magnifications: 1-20 kx. N >250 for diameter, N >135 for length. Example images are presented below:

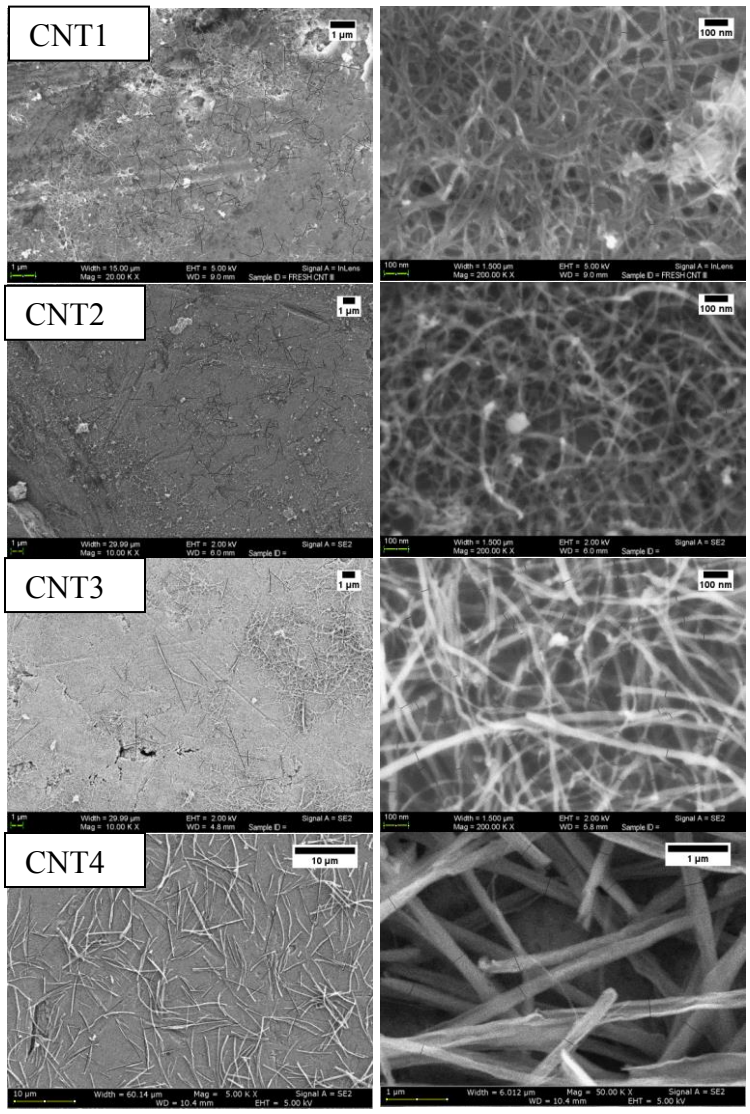


Figure S. 4. Example SEM images used to obtain length and diameter data.

Smoothed histograms of the length and diameter distributions are presented below.

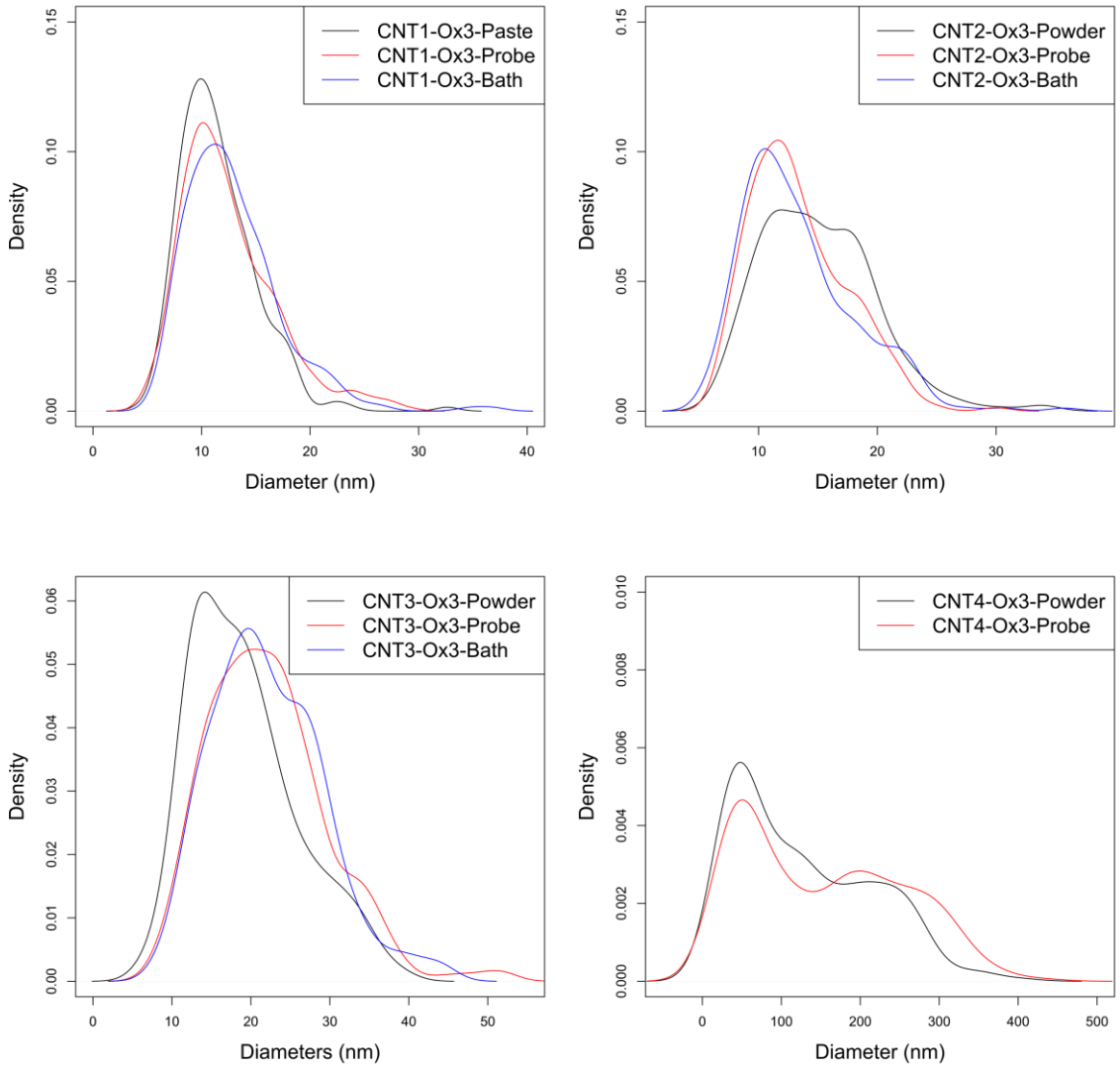


Figure S. 5. Diameter distributions for CNT1-4-Ox3. Post oxidation (black), after probe sonication (red), and after bath sonication (blue).

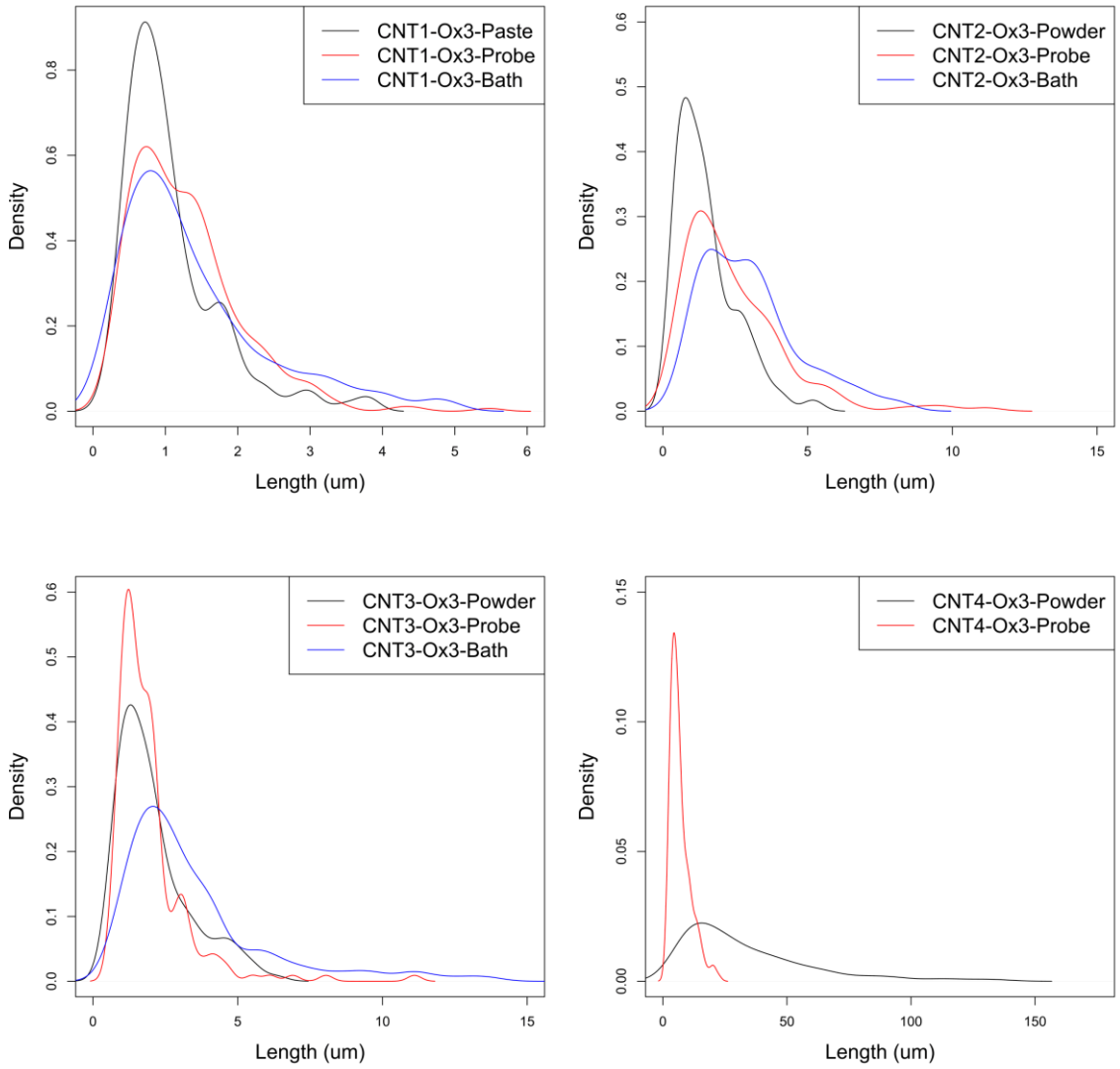


Figure S. 6. Length distributions for CNT1-4-Ox3. Post oxidation (black), after probe sonication (red), and after bath sonication (blue).

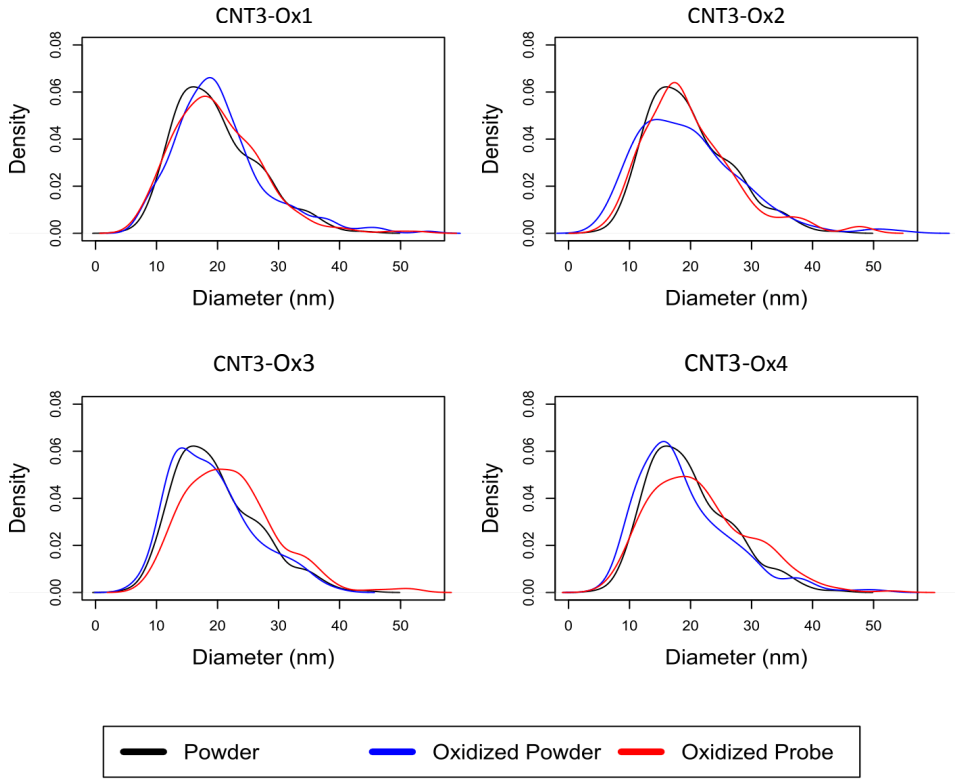
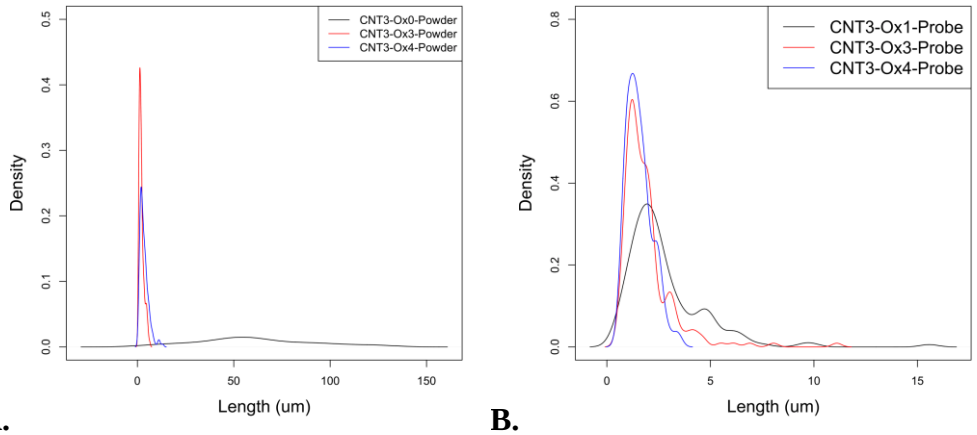


Figure S. 7. Diameter distributions for CNT-3. Values prior to oxidation (black), after oxidation but before sonication (blue), and after the oxidized CNT were dispersed via probe sonication (red).



A. **B.**

Figure S. 8. Diameter and length distributions for CNT3 oxidized with various treatments. **A.** Post-oxidation, and **B.** After dispersion via probe sonication.

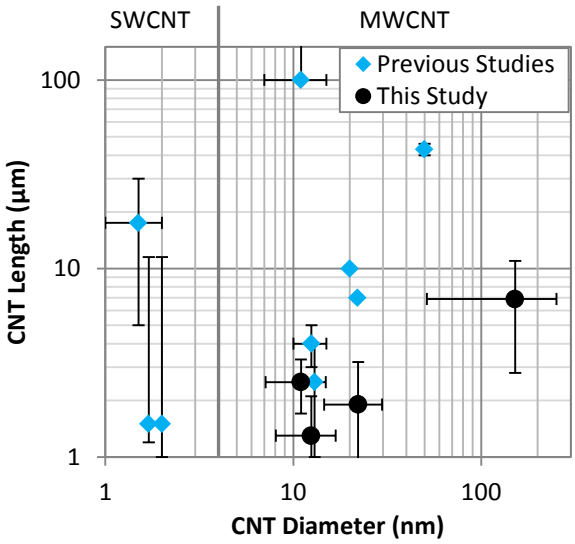


Figure S. 9**. CNT size comparison to previous studies.** CNT lengths and diameters reported in prior studies (blue) compared to the length and diameter of the samples tested (black). The values obtained from the literature included averages, ranges, medians; consequently, the representation here is approximate. For this study, the data depicts the average length and diameter after oxidation and sonication. Error bars represent one standard deviation. (N>135 for length, N>250 for diameter).

S4. Force Calculation Parameters

Table S. 18. Parameters used to calculate torque and coulombic forces.

	Solvent			Oxidation				Probe Sonicated				Bath Sonicated		
Parameter	DIW	EtOH	IPA	52.5% HNO3	O3	H2SO4HNO3	O3+	D15L1-5	D30L5-20	C-grade	M-grade	D15L1-5	D30L5-20	C-grade
l (μm)	2.00	3.30	3.70	2.70	55.70	2.00	1.60	1.30	2.40	2.00	7.00	1.40	3.00	3.60
d (μm)	0.022	0.021	0.023	0.02	0.02	0.022	0.022	0.012	0.013	0.022	0.155	0.012	0.013	0.022
Ω (m^3)	7.60E-22	1.14E-21	1.54E-21	8.48E-22	1.75E-20	7.60E-22	6.08E-22	1.47E-22	3.19E-22	7.60E-22	1.32E-19	1.58E-22	3.98E-22	1.37E-21
a	90.9	157	161	135	2785	90.9	72.7	108	185	90.9	45.2	117	231	164
L_x	5.09E-04	1.92E-04	1.84E-04	2.52E-04	9.83E-07	5.09E-04	7.52E-04	3.73E-04	1.44E-04	5.09E-04	1.72E-03	3.27E-04	9.64E-05	1.79E-04
ε_p (F m^{-1})	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05	1.00E+05
ε_m (F m^{-1})	7.06E-10	1.98E-10	1.62E-10	7.06E-10	7.06E-10	7.06E-10	7.06E-10	7.06E-10	7.06E-10	7.06E-10	7.06E-10	7.06E-10	7.06E-10	7.06E-10
σ_p (S m^{-1})	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
σ_m (S m^{-1})	5.00E-06	1.40E-07	6.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06
ω (Hz)	3.00E+05	3.00E+05	3.00E+05	3.00E+05	3.00E+05	3.00E+05	3.00E+05	3.00E+05	3.00E+05	3.00E+05	3.00E+05	3.00E+05	3.00E+05	3.00E+05
Re[K_f]	1966	5198	5421	3963	1017190	1966	1329	2680	6940	1966	582	3057	10372	5589
E (V m^{-1})	22000	22000	22000	22000	22000	22000	22000	22000	22000	22000	22000	22000	22000	22000
T_{EF} (Nm)	1.28E-19	1.43E-19	1.63E-19	2.87E-19	1.52E-15	1.28E-19	6.90E-20	3.37E-20	1.89E-19	1.28E-19	6.56E-18	4.13E-20	3.53E-19	6.53E-19
$F_{CNT-CNT}$ (N)	3.17E-10	2.71E-10	3.10E-10	4.21E-10	2.11E+37	3.17E-10	6.94E-11	2.51E-11	5.17E-10	1.33E-11	3.29E-08	3.75E-10	5.17E-10	1.90E-09

Notes: l = CNT length; d= CNT diameter; Ω = volume = $l\pi\left(\frac{d}{2}\right)^2$;a = aspect ratio = $\frac{l}{d}$;

L_x = dimensionless polarization factor = $\frac{\ln(2a)-1}{a^2}$; ε_p = permittivity of CNT; ε_p = permittivity of medium; σ_p = conductivity of CNT; σ_p = conductivity of medium; ω = AC electric field frequency; Re[K_f] = real portion of Klaussius-Mossotti factor; E = electric field; T_{EF} = torque induced by electric field; $F_{CNT-CNT}$ = coulombic forces between particles spaced 10 nm apart

The permittivity and conductivity values for CNT were taken from Oliva-Avilés *et al.* 2016. To test the sensitivity of these parameters, calculations were repeated with permittivity values ranging from 10^0-10^{12} F m^{-1} and conductivities from 10^{-2}-10^{12} S m^{-1} with no change in response. Typical values for conductivity of CNT: 10^3-10^5 S/cm, (Ma 2010)

S5. Effect of Solvent on CNT Alignment Morphology

In addition to CNT morphology and chemistry, solvent properties and dispersion method will affect the degree and stability of the suspension and, in turn, the CNT alignment process. A wide range of solvents have been successfully used for electric field alignment: DI water (DI),[5,10,12,26] ethanol (EtOH),[1,2,27] isopropyl alcohol (IPA),[4,23] and dimethylformamide (DMF)[3] in addition to polymer-solvent mixtures. Nevertheless, few studies have compared the specific solvent effect on electric-field-based CNT alignment,[12] and there is evidence that solvent selection processing alone can yield mesoscale alignment: e.g. Du *et al.* observed regional alignment for drop cast thin films of oxygen functionalized CNT in DI and DMF, but not IPA.[28]

15 mg of C-grade MWCNT were dispersed in 15 mL of DI, IPA, or EtOH via probe sonication (15 min, 20 kHz, 13.3 kW L^{-1}; Branson S450). To prevent evaporation, samples were sonicated in an ice bath. Final CNT concentrations were approximately 0.1 mg mL^{-1}. The authors considered dimethyl sulfoxide (DMSO) and dimethylformamide (DMF) as well. DMSO and DMF are used as polymer solvents for phase inversion membrane synthesis; however, they are incompatible with PVDF and/or the acrylic stencil. Properties of the solvents considered are listed in Table S. 19.

Table S. 19. Chemical Properties of Solvents.

Property	Distilled Water	Ethanol	Isopropyl Alcohol
[1]Boiling Point (°C)	100.0	78.5	82.4
[1]Density (g mL^{-1})	0.998	0.789	0.785
[2]Viscosity (cP) (25°C)	0.89	1.08	2.0
[2]Conductivity (S cm^{-1})	5.0E-8	1.4 E-9	6.0E-8
[2]Dielectric Constant	79.7	22.4	18.3
[3]Permittivity (pF m^{-1})	705	198	162

Notes: All values are for 20°C unless otherwise stated. (1) Myeres, B. J. Common Organic Solvents: Table of Properties. ACS. https://www.organicdivision.org/orig/organic_solvents.html updated: March 20, 2016. (2) Smallwood, IM. 1996. *Handbook of Organic Solvents and Properties*. (3) Permittivity was calculated by multiplying the dielectric constant by permittivity in a vacuum; ε_0 = 8.8541878176 pF/m

The degree of dispersion and alignment behavior for pristine CNT3 was strongly affected by the solvent selected; the effects of DI, EtOH, and IPA are displayed in Figure S. 10. In DI, the CNT aggregated to form clusters (<d> = 370 μm) less than five minutes after sonication, and within one hour, the CNT aggregates were partitioning out of solution (some CNT clusters settled while others floated to the surface). The suspension was used within 30 minutes after sonication. Alignment was abrupt; in less than one second, CNT bundles (<d> = 140 ± 40 μm) bridged the electrodes. Over time, the CNT bundles migrated perpendicular to the electric field forming slightly thicker bundles (<d>= 160 ± 50 μm). Infrared thermometer measurements indicated temperatures rose from 28°C to 65°C, possibly due to resistive heating of the CNT, and the solution was filtered after 20 seconds due to boiling and sparking. During filtration, the majority of the CNT in suspension remained adhered to the electrode. Only a modest number of electrode-bridging CNT bundles were successfully filtered onto the underlying PVDF membrane and only 11% of the membrane was coated.

In EtOH, the CNT appeared more dispersed with smaller aggregates (<d>=230 μm). Upon exposure to the electric field, the CNT once again formed aligned bundles (<d>= 100 ± 60 μm), bridging the two electrodes. However, EtOH boiling and vaporization created turbulence, causing the CNT bundles to break-up and repeatedly re-assemble. During vacuum filtration, the turbulence diminished and the CNT bundles became more stable. Additionally, like the DI sample, the majority of the CNT collected near the electrodes with CNT coating 66% of the membrane area.

In IPA, the CNT dispersed readily, creating a black ink of smaller suspended aggregates (<d> = 200 μm). During alignment, thin CNT spindles (<d> = 40 ± 10 μm) bridged the two electrodes, and the solvent boiled. Large CNT aggregates accumulated near the electrodes and remained

during filtration. The final coating had numerous thin spindles (~5-7 bundles per mm) bridging the electrodes with dense CNT accumulations near the electrodes; CNT coated 57% of the membrane surface.

In all three cases, photographs (0 x) and microscope images (10 x) show aligned bundles of CNT; however, under higher magnification (50 kx) the CNT formed random networks. SEM images also revealed structural damage to the membrane when using IPA, shown in Figure S. 11.

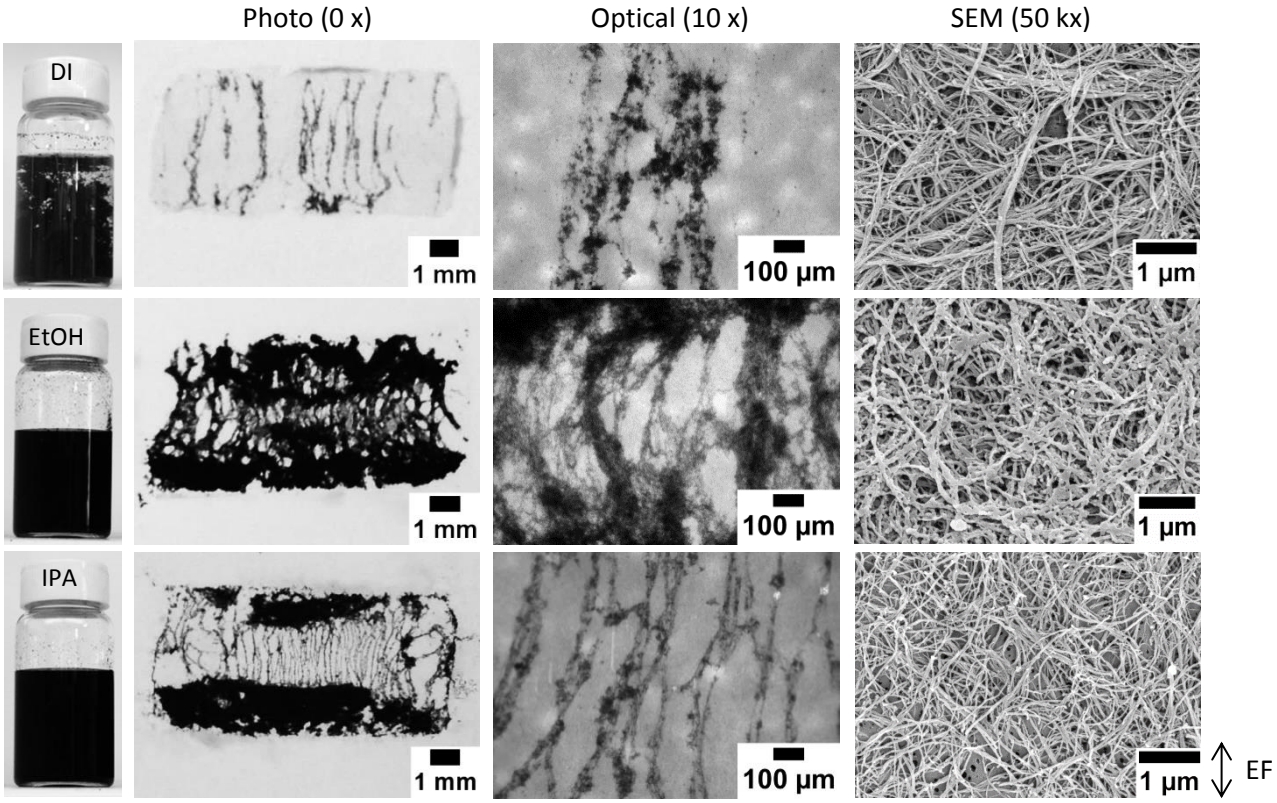
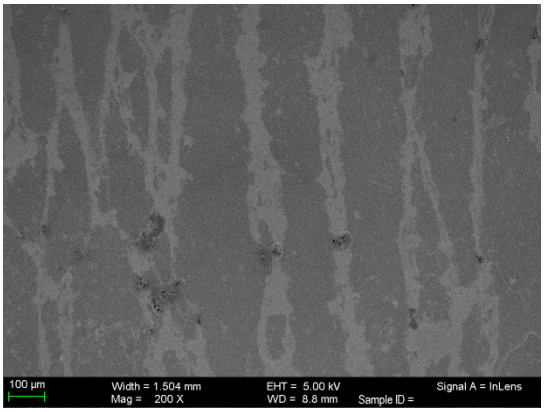


Figure S. 10. Solvent effects on electric field CNT alignment. Alignment of CNT3-Ox0 dispersed in DI, EtOH, and IPA. All samples were prepared using an electric field of 22 V_{rms} mm^{-1}, 300 kHz, and 300 mmHg vacuum pressure at a concentration of 0.1 mg mL^{-1}. EF indicates the electric field direction.

Membrane Damage

A. 

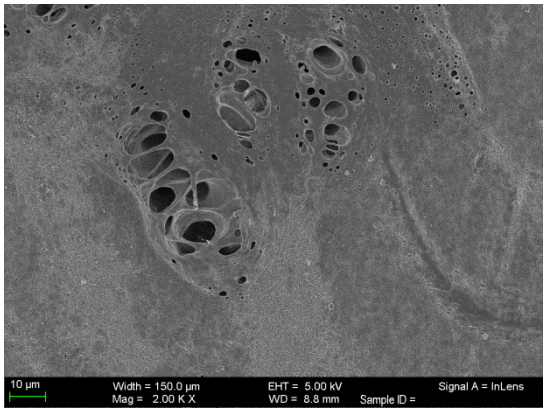
B. 

Figure S. 11. Membrane Damage. PVDF membrane surface after electric field alignment of CNT3-Ox0 suspended in IPA.

S6. Effect of Solution Stability on CNT Properties and Alignment

The effect of solution stability and re-dispersion on CNT alignment was tested over a three month period using highly oxidized CNT (C-grade MWCNT treated with H_2SO_4:HNO_3 and O_3+ H_2SO_4:HNO_3, D15L1-5, and D30L5-20). The oxidized CNT were initially dispersed at a concentration of 0.1 mg mL^{-1} by probe sonication (15 min, 20 kHz, 13.3 kW L^{-1}; Branson S450) in an ice bath. An aliquot of the CNT suspension was aligned in an electric field and deposited onto PVDF membrane coupons as described previously. CNT length, diameter, oxygen content, and electrical anisotropy were recorded. After the initial data points were collected (t=0), the suspensions were separated into two vials. Half of the sample was monitored with no additional processing over the three month period (-NS), and the other half was bath sonicated (15 min, 130W, 40 kHz; Branson 2510) prior to each monthly alignment (-BS).

The effect of time-dependent aggregation on aligned morphology varied considerably by CNT properties and sonication treatment. For coatings prepared with CNT1-Ox3, there was little difference in morphology between bath sonicated and non-sonicated samples. However, in both cases, CNT aggregate formation over two months yielded CNT coatings with a mottled appearance at 10 x magnification. At higher magnification (50 kx), CNT were regionally aligned and appeared unaffected by time. Experiments using the CNT1-Ox3 samples ended after two months due to limited CNT supply. Like the CNT1-Ox3, the CNT2-Ox3-NS coatings appeared mottled at 10 x magnification over the course of three months and the electric field aligned CNT in patches. However, in this case, bundled structures began to form at the end of the three month trial period. Bath sonication of the CNT2-Ox3 resulted in more uniform coatings for the first two months, but did not enhance nano-scale alignment. After three months, the CNT2-Ox3-BS samples filtered quickly, producing a sparsely coated elliptical region with an ‘X’ shaped CNT

formation at the center. Meanwhile, the CNT3-Ox3-NS produced the most consistent morphology, with clearly aligned features observed each month. Conversely, its sonicated counterpart became more resistant to electric field alignment over time with a less uniform coating. Particle aggregation was observed in both samples, and at the end of three months, the particle size was ~1-3 μm for the non-sonicated sample and <1 μm for the sonicated sample based on image analysis. Finally, compared to CNT3-Ox3, CNT3-Ox4 tended to aggregate more quickly. For the non-sonicated sample, bundles of aligned CNT were observed at 10x magnification after two months. Sonication only appears to partially disrupt the CNT bundles. Images of all trials are available in the Supporting Information, S5.

A regression analysis was performed to determine time and sonication effects on the CNT length and diameter. The most notable trend in CNT characteristics over time was that lengths tended to decrease, regardless of whether or not samples were sonicated. Average log-length reductions were typically <0.3 μm per month and the decrease in length was more pronounced for CNT with smaller diameters (CNT1 = 0.26 μm per month, CNT2 = 0.31 μm per month, CNT3-Ox3 = 0.04 μm per month, CNT3-Ox4 = 0.09 μm per month). The length difference in bath-sonicated and non-sonicated samples after several months was unclear. There was a slight trend for bath-sonicated samples to be longer than non-sonicated samples on average, but this difference varied with time and CNT type and there was no observable trend. For non-sonicated samples, the change in length may be a reflection of aggregation over time resulting in settling of larger CNT and/or entanglement making longer CNT more difficult to measure. Along with aggregation and entanglement, the fracturing of CNT likely contributed to the change in length observed in bath sonicated samples. Second, the non-sonicated CNT diameters tended to return to the pre-sonication width after one month with especially pronounced results for CNT3. When

samples were re-suspended via bath sonication, CNT diameters increased slightly (>5%) or remained unchanged. However, similar to CNT length, the difference between bath-sonicated and non-sonicated samples varied over time and CNT type. The increased diameter may be an indicator of sidewall damage and may explain the decreased alignment and less desirable coverage for the bath sonicated samples. More detailed results and raw data for this regression analysis are included in the Supporting Information, S6 and S7. In all samples, there was no statistically significant change in oxygen content, <2 at% and within instrument error, for non-sonicated and bath sonicated samples. The changes in CNT material properties, alongside aggregation, likely contributed to the decrease in log-ratio of resistance observed over the course of three months.

Additional regression analysis was conducted to determine how time influenced alignment measured via log-ratio of resistance. The log-ratio of resistance for suspensions over time is reported in Figure S. 12. Alignment decreased with time and bath sonicated samples tended to decrease to a greater extent than their non-sonicated counterparts even when controlling for mean length and diameter. The only case where alignment may appear to improve over time is the CNT3-Ox3 non-sonicated sample. Furthermore, CNT diameter, length and oxygen content were not significant factors in the decreased alignment. This suggests that unmeasured properties (i.e., aggregation, sidewall damage, etc.) likely influence the outcome.

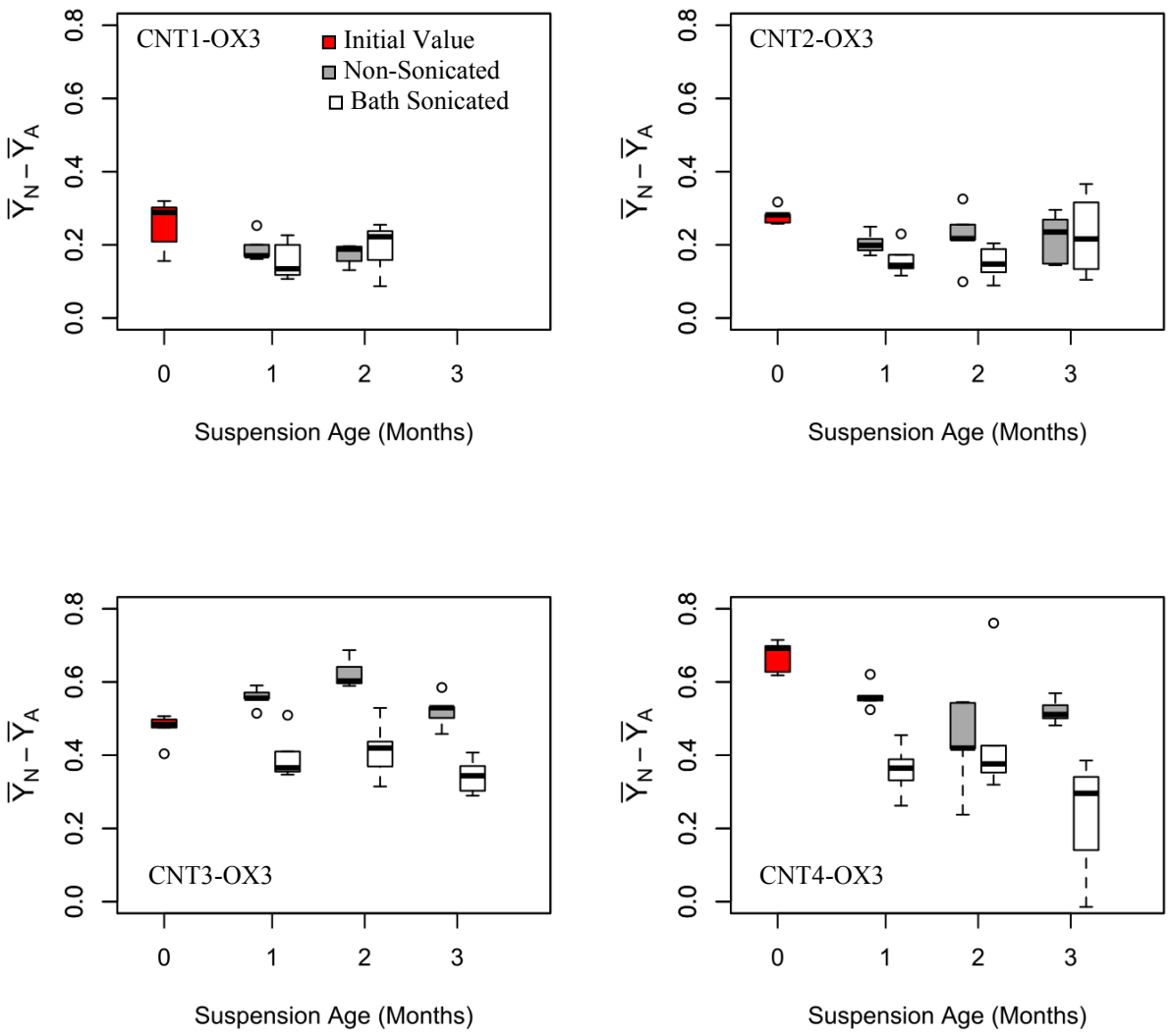


Figure S. 12. Log-ratio of resistance ($\bar{Y}_N$-$\bar{Y}_A$) for CNT1-Ox3, CNT2-Ox3, CNT3-Ox3, and CNT3-Ox4 suspensions tested over three months. Initial measurements are shown in red, non-sonicated samples in grey, and bath sonicated samples in white. Circles depict outliers in the data, while the whisker plot divides the data set into quartiles with the median presented as a solid horizontal line.

S6. Solution Stability

All trials were conducted using a 0.1 mg mL^{-1} CNT suspension, an electric field of 22 V_{rms} mm^{-1}, frequency of 300 kHz, and vacuum pressure of 300 mmHg. CNT were exposed to the electric field for 5 min prior to filtration. Below, T = age of CNT suspension in months, NS = non-sonicated, BS = bath sonicated, and EF depicts the direction of the electric field.

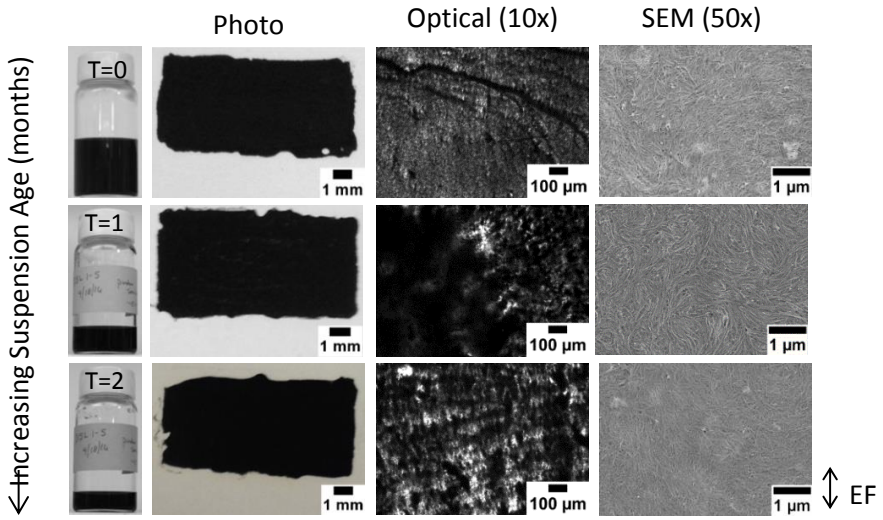


Figure S. 13. CNT1-Ox3-NS.

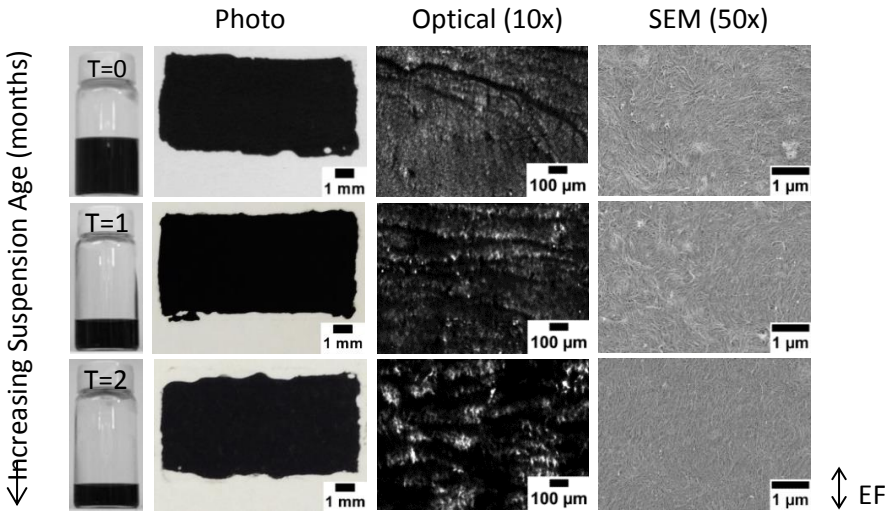


Figure S. 14. CNT1-Ox3-BS.

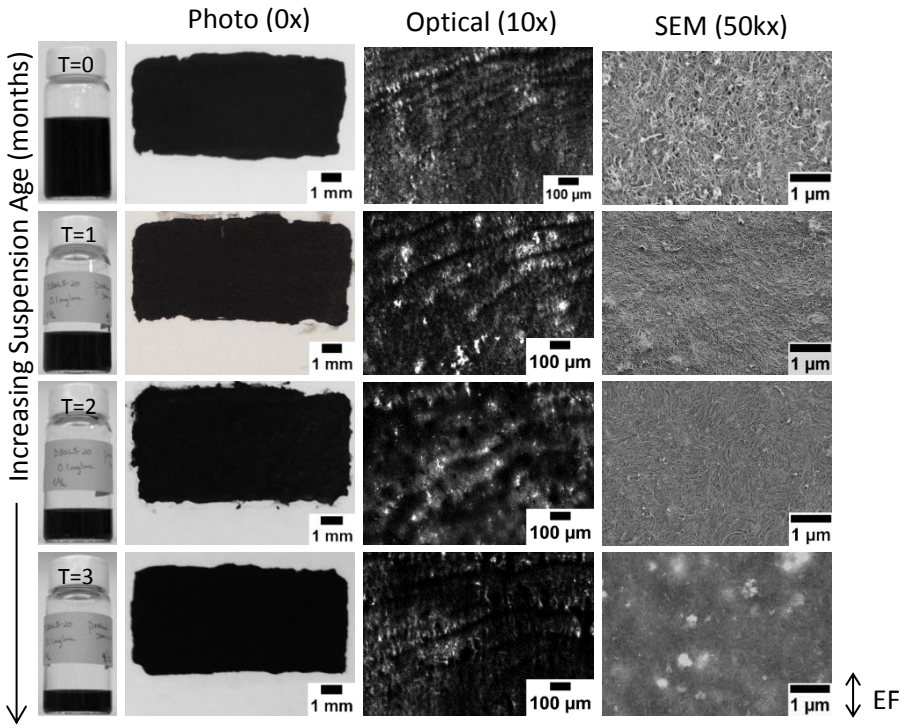


Figure S. 15. CNT2-Ox3-NS.

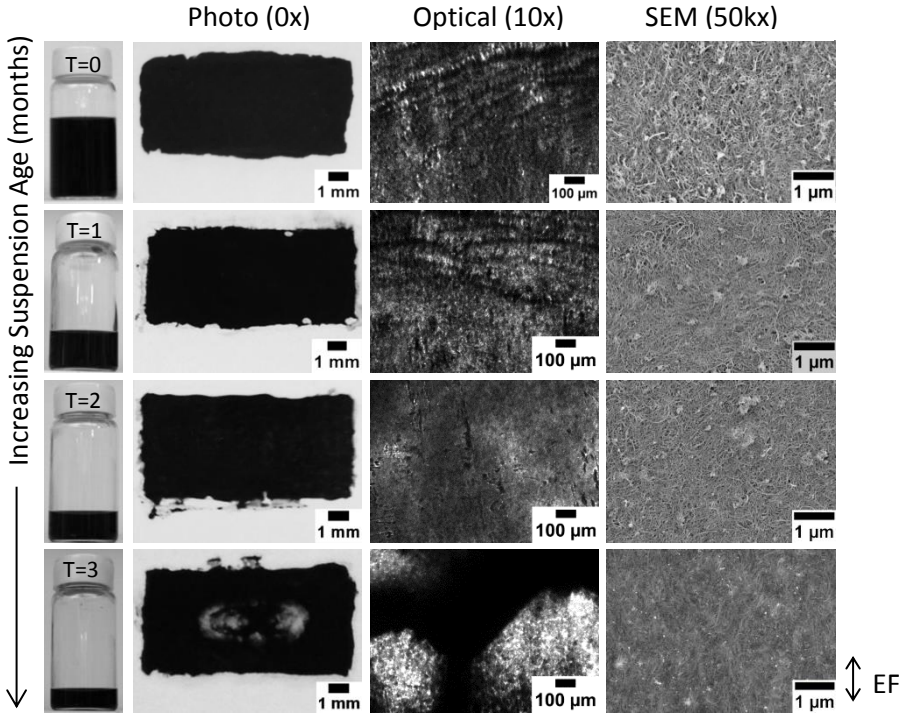


Figure S. 16. CNT2-Ox3-BS.

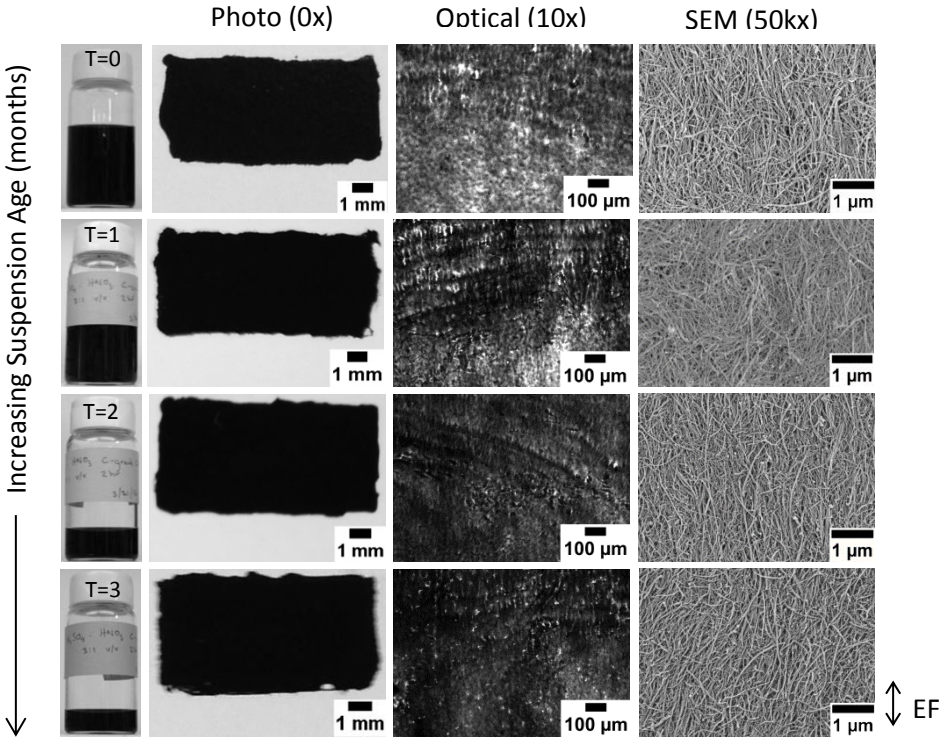


Figure S. 17. CNT3-Ox3-NS.

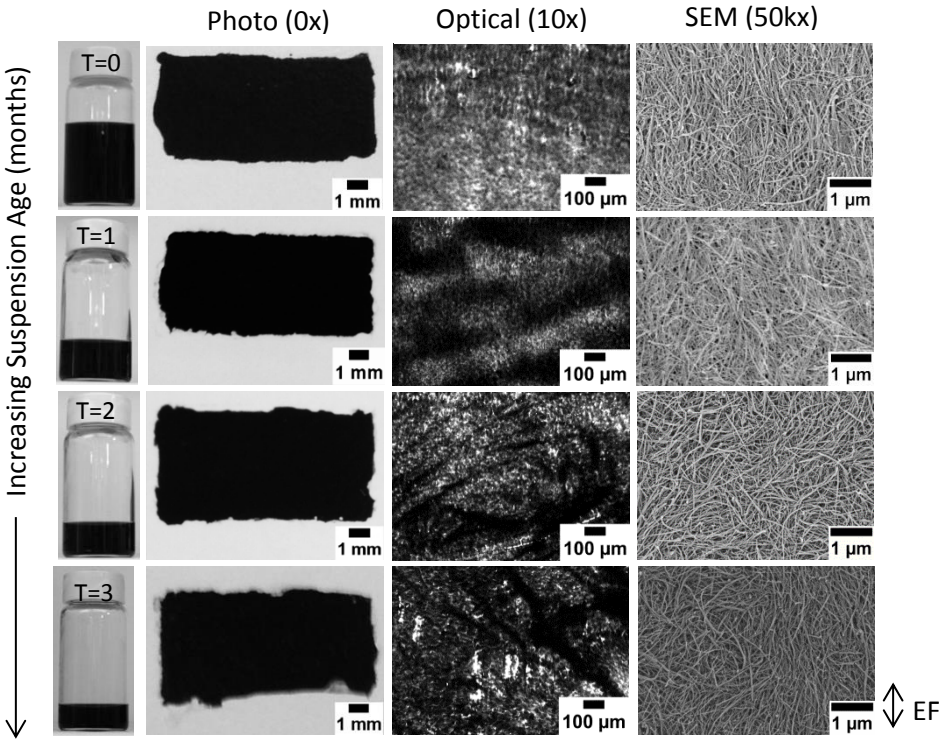


Figure S. 18. CNT3-Ox3-BS.

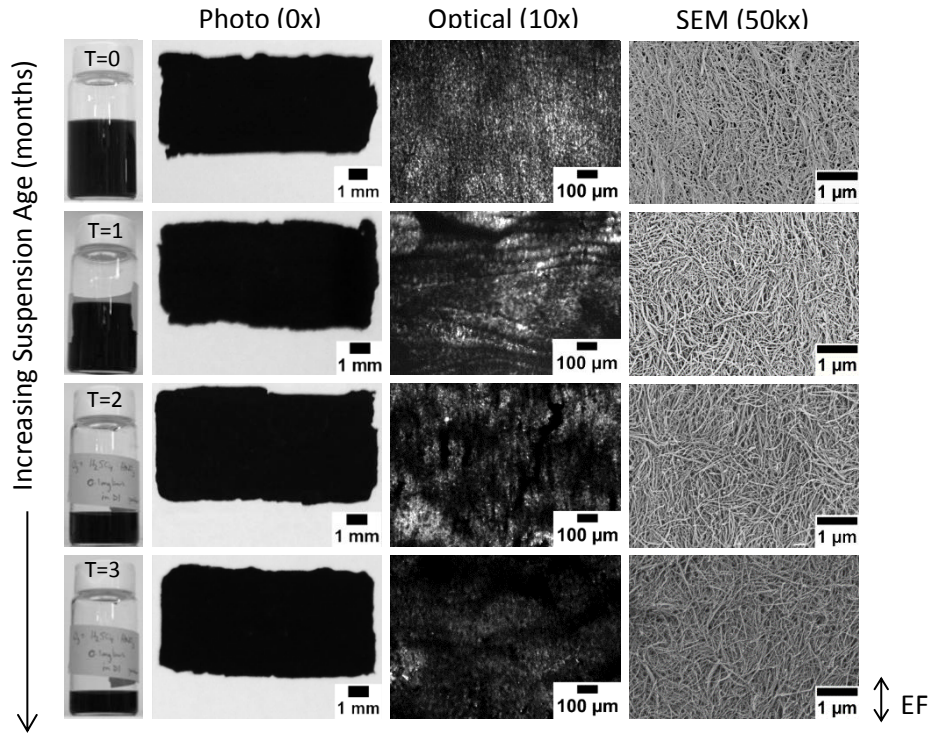


Figure S. 19. CNT3-Ox4-NS.

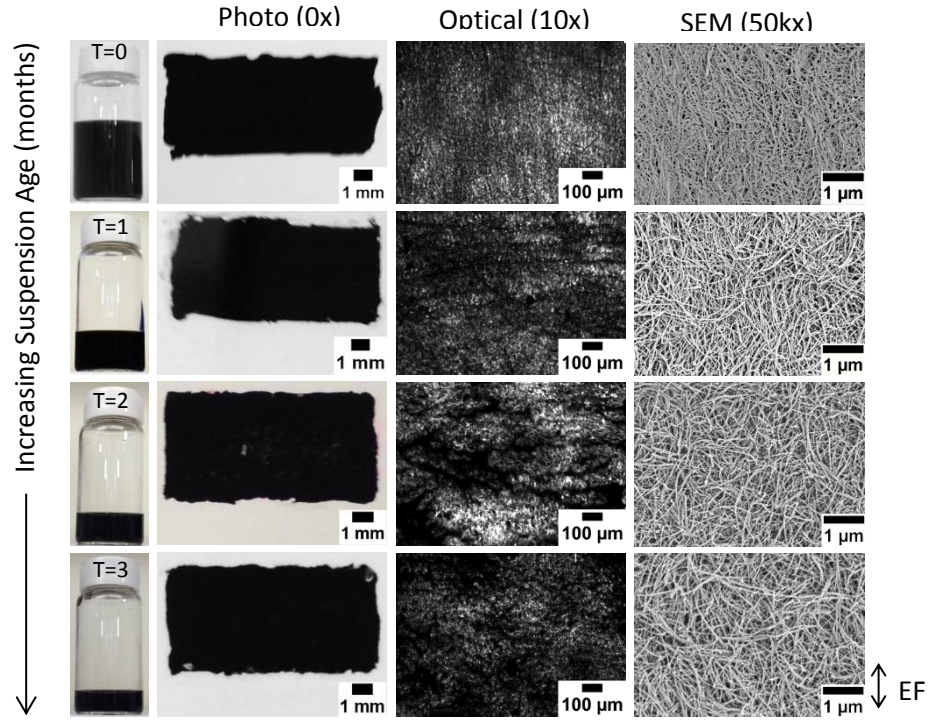


Figure S. 20. CNT3-Ox4-BS.

Raw Resistance Data

Table S. 20. CNT Coating Electrical Resistance, CNT 1-Ox3.

	Date	V_{rms}	Aligned Resistance (kΩ mm^{-1})					Non-Aligned Resistance (kΩ mm^{-1})					<A>	<NA>
CNT1-Ox3-M0BS														
1	3/12/16	104.2	0.166	0.156	0.133	0.140	0.156	0.193	0.229	0.182	0.174	0.186	0.150	0.193
2	3/12/16	106.3	0.133	0.136	0.132	0.133	0.139	0.180	0.193	0.169	0.163	0.186	0.135	0.178
3	3/12/16	106.1	0.132	0.131	0.121	0.131	0.135	0.161	0.203	0.160	0.161	0.173	0.130	0.172
4	3/12/16	106.2	0.136	0.138	0.134	0.142	0.125	0.188	0.187	0.162	0.157	0.158	0.135	0.170
5	3/12/16	106.3	0.131	0.135	0.129	0.129	0.140	0.180	0.169	0.159	0.159	0.160	0.133	0.165
CNT1-Ox3-M0PS														
2	4/18/16	106.8	0.142	0.138	0.146	0.142	0.143	0.188	0.218	0.188	0.176	0.193	0.142	0.192
3	4/18/16	106.8	0.181	0.153	0.165	0.178	0.155	0.195	0.194	0.188	0.193	0.200	0.166	0.194
5	4/18/16	106.6	0.140	0.138	0.143	0.134	0.151	0.172	0.229	0.176	0.173	0.197	0.141	0.189
6	4/18/16	106.3	0.143	0.133	0.143	0.150	0.149	0.180	0.202	0.164	0.172	0.168	0.144	0.177
7	4/18/16	106.8	0.148	0.146	0.146	0.141	0.151	0.189	0.228	0.192	0.198	0.202	0.146	0.202
CNT1-Ox3-M1NS														
2	5/21/16	106.9	0.176	0.182	0.185	0.179	0.194	0.234	0.260	0.208	0.207	0.208	0.183	0.223
3	5/21/16	107.5	0.158	0.163	0.161	0.165	0.154	0.181	0.215	0.183	0.176	0.183	0.160	0.187
5	5/21/16	107.0	0.163	0.207	0.170	0.161	0.194	0.190	0.265	0.202	0.185	0.184	0.179	0.205
6	5/21/16	106.7	0.162	0.149	0.155	0.154	0.149	0.186	0.216	0.176	0.180	0.180	0.154	0.188
7	5/21/16	104.4	0.140	0.162	0.151	0.159	0.167	0.194	0.186	0.189	0.183	0.186	0.156	0.188
CNT1-Ox3-M1BS														
2	5/21/16	106.5	0.245	0.288	0.235	0.236	0.255	0.246	0.333	0.235	0.283	0.283	0.252	0.276
3	5/21/16	106.6	0.225	0.218	0.233	0.226	0.227	0.246	0.400	0.241	0.270	0.278	0.226	0.287
5	5/21/16	104.5	0.191	0.182	0.175	0.184	0.183	0.217	0.280	0.219	0.209	0.241	0.183	0.233
6	5/21/16	106.6	0.195	0.179	0.174	0.169	0.191	0.209	0.244	0.194	0.204	0.214	0.181	0.213
7	5/21/16	106.6	0.225	0.211	0.207	0.182	0.208	0.250	0.290	0.263	0.268	0.260	0.206	0.266
CNT1-Ox3-M2NS														
1	6/18/16	108.2	0.208	0.260	0.210	0.226	0.250	0.241	0.283	0.258	0.270	0.303	0.231	0.271
2	6/18/16	107.2	0.206	0.163	0.156	0.168	0.162	0.198	0.243	0.215	0.210	0.233	0.171	0.220
3	6/18/16	104.8	0.174	0.177	0.176	0.163	0.174	0.207	0.242	0.223	0.191	0.195	0.173	0.212
4	6/18/16	106.7	0.169	0.179	0.154	0.172	0.167	0.209	0.218	0.193	0.181	0.195	0.168	0.199
5	6/18/16	106.6	0.175	0.174	0.159	0.162	0.169	0.202	0.211	0.198	0.181	0.203	0.168	0.199
CNT1-Ox3-M2BS														
1	6/18/16	106.7	0.240	0.265	0.230	0.218	0.258	0.268	0.363	0.303	0.265	0.288	0.242	0.297
2	6/18/16	106.5	0.214	0.246	0.222	0.218	0.233	0.295	0.388	0.238	0.247	0.273	0.226	0.288
3	6/18/16	106.4	0.208	0.293	0.186	0.200	0.214	0.212	0.295	0.216	0.255	0.239	0.220	0.243
4	6/18/16	106.4	0.196	0.208	0.198	0.213	0.228	0.260	0.278	0.226	0.215	0.219	0.209	0.240
5	6/18/16	106.4	0.240	0.241	0.255	0.290	0.275	0.278	0.315	0.263	0.295	0.313	0.260	0.293

Table S. 21. CNT Coating Electrical Resistance CNT2-Ox3.

	Date	V_{rms}	Aligned Resistance (kΩ mm^{-1})					Non-Aligned Resistance (kΩ mm^{-1})					<A>	<NA>
CNT2-Ox3-M0BS														
1	3/14/16	110.0	0.149	0.154	0.130	0.136	0.138	0.186	0.204	0.126	0.119	0.203	0.141	0.167
2	3/14/16	107.4	0.168	0.128	0.153	0.144	0.135	0.182	0.209	0.189	0.160	0.187	0.145	0.185
3	3/14/16	106.9	0.146	0.142	0.167	0.156	0.134	0.203	0.169	0.166	0.131	0.164	0.149	0.166
4	3/14/16	106.6	0.130	0.158	0.141	0.138	0.158	0.187	0.234	0.164	0.166	0.180	0.145	0.186
5	3/14/16	106.8	0.143	0.145	0.126	0.119	0.129	0.198	0.163	0.140	0.106	0.150	0.132	0.151
CNT2-Ox3-M0PS														
1	4/12/16	109.4	0.165	0.180	0.172	0.166	0.178	0.207	0.283	0.222	0.214	0.222	0.172	0.229
2	4/12/16	107.8	0.160	0.169	0.158	0.169	0.183	0.203	0.280	0.218	0.218	0.200	0.168	0.224
3	4/12/16	107.2	0.151	0.165	0.149	0.152	0.155	0.186	0.208	0.191	0.205	0.210	0.154	0.200
4	4/12/16	107.1	0.144	0.162	0.157	0.159	0.161	0.197	0.225	0.191	0.204	0.200	0.156	0.203
5	4/12/16	106.8	0.145	0.166	0.144	0.138	0.161	0.187	0.233	0.213	0.198	0.204	0.151	0.207
CNT2-Ox3-M1NS														
1	5/12/16	110.5	0.208	0.216	0.163	0.169	0.179	0.265	0.265	0.202	0.212	0.218	0.187	0.232
2	5/12/16	106.6	0.173	0.193	0.189	0.183	0.201	0.195	0.303	0.197	0.240	0.243	0.188	0.236
3	5/12/16	105.3	0.156	0.290	0.198	0.204	0.232	0.255	0.350	0.238	0.260	0.275	0.216	0.276
4	5/12/16	106.9	0.216	0.190	0.231	0.209	0.213	0.230	0.533	0.265	0.265	0.250	0.212	0.308
5	5/12/16	106.7	0.212	0.280	0.221	0.233	0.242	0.260	0.313	0.243	0.239	0.258	0.238	0.262
CNT2-Ox3-M1BS														
1	5/12/16	106.5	0.241	0.207	0.238	0.221	0.229	0.280	0.303	0.255	0.270	0.285	0.227	0.279
2	5/12/16	104.4	0.180	0.206	0.193	0.186	0.283	0.204	0.360	0.215	0.207	0.240	0.209	0.245
3	5/12/16	104.3	0.205	0.295	0.237	0.250	0.270	0.258	0.365	0.246	0.275	0.285	0.251	0.286
4	5/12/16	104.2	0.290	0.445	0.300	0.295	0.295	0.328	0.540	0.275	0.330	0.328	0.325	0.360
5	5/12/16	106.4	0.234	0.232	0.209	0.216	0.250	0.270	0.420	0.258	0.239	0.225	0.228	0.282
CNT2-Ox3-M2NS														
1	6/12/16	112.7	0.165	0.179	0.206	0.176	0.179	0.192	0.280	0.175	0.198	0.258	0.181	0.221
2	6/12/16	106.2	0.192	0.194	0.197	0.199	0.212	0.246	0.231	0.237	0.244	0.253	0.198	0.242
3	6/12/16	105.1	0.166	0.179	0.201	0.198	0.194	0.210	0.229	0.224	0.209	0.240	0.188	0.222
4	6/12/16	104.5	0.179	0.201	0.160	0.148	0.174	0.193	0.258	0.213	0.218	0.224	0.172	0.221
5	6/12/16	104.4	0.177	0.174	0.195	0.199	0.172	0.293	0.218	0.201	0.205	0.230	0.183	0.229
CNT2-Ox3-M2BS														
1	6/12/16	104.4	0.138	0.148	0.150	0.149	0.172	0.172	0.194	0.163	0.162	0.175	0.151	0.173
2	6/12/16	104.3	0.154	0.156	0.165	0.162	0.176	0.189	0.189	0.189	0.176	0.170	0.163	0.182
3	6/12/16	104.3	0.157	0.154	0.145	0.155	0.174	0.179	0.203	0.198	0.168	0.185	0.157	0.186
4	6/12/16	106.3	0.150	0.146	0.151	0.142	0.169	0.177	0.179	0.175	0.162	0.181	0.151	0.175
5	6/12/16	106.4	0.199	0.207	0.204	0.211	0.220	0.268	0.278	0.245	0.246	0.275	0.208	0.262
CNT2-Ox3-M3NS														
1	7/12/16	107.9	0.200	0.202	0.177	0.175	0.186	0.221	0.249	0.227	0.243	0.250	0.188	0.238
2	7/12/16	107.2	0.161	0.164	0.152	0.135	0.172	0.182	0.188	0.161	0.171	0.203	0.157	0.181
3	7/12/16	107.0	0.147	0.135	0.146	0.137	0.145	0.163	0.239	0.187	0.187	0.186	0.142	0.192
4	7/12/16	106.8	0.141	0.158	0.165	0.149	0.166	0.166	0.186	0.177	0.181	0.194	0.156	0.181
5	7/12/16	106.9	0.167	0.179	0.177	0.175	0.166	0.211	0.230	0.221	0.228	0.241	0.173	0.226
CNT2-Ox3-M3BS														
1	7/12/16	106.7	0.190	0.206	0.200	0.176	0.195	0.255	0.177	0.258	0.550	0.260	0.193	0.300
2	7/12/16	106.6	0.385	0.215	0.213	0.194	0.205	0.233	0.300	0.207	0.420	0.340	0.242	0.300
3	7/12/16	106.7	0.208	0.228	0.244	0.253	0.290	0.241	0.330	0.231	0.263	0.298	0.245	0.272
4	7/12/16	106.6	0.221	0.184	0.222	0.192	0.173	0.203	0.253	0.293	0.423	0.228	0.198	0.280
5	7/12/16	106.6	0.183	0.173	0.202	0.232	0.213	0.220	0.228	0.216	0.320	0.177	0.201	0.232

Table S. 22. CNT Coating Electrical Resistance, CNT 3-Ox3.

	Date	V_{rms}	Aligned Resistance (kΩ mm^{-1})					Non-Aligned Resistance (kΩ mm^{-1})					<A>	<NA>
CNT3-Ox3-M0BS														
1	4/18/16	107.0	0.808	0.990	0.895	0.890	0.943	1.598	1.543	1.625	1.755	1.658	0.905	1.636
2	4/18/16	107.2	0.490	0.455	0.488	0.468	0.500	0.795	1.008	0.845	0.915	0.825	0.480	0.878
3	4/18/16	107.0	0.563	0.420	0.498	0.605	0.455	0.733	0.970	0.718	0.728	0.935	0.508	0.817
4	4/18/16	106.9	0.503	0.545	0.425	0.495	0.495	0.908	0.868	0.898	0.800	0.815	0.493	0.858
5	4/18/16	106.6	0.378	0.883	0.645	0.473	0.815	0.880	0.780	1.223	1.128	1.028	0.639	1.008
CNT3-Ox3-M0PS														
1	3/21/16	105.2	0.305	0.828	0.265	0.285	0.408	0.988	0.640	0.458	0.443	0.458	0.418	0.597
2	3/21/16	107.0	0.189	0.204	0.198	0.190	0.189	0.285	0.358	0.318	0.320	0.333	0.194	0.323
3	3/21/16	106.8	0.181	0.189	0.219	0.184	0.199	0.340	0.340	0.320	0.300	0.298	0.194	0.320
4	3/21/16	106.6	0.198	0.218	0.192	0.198	0.212	0.313	0.345	0.330	0.338	0.313	0.204	0.328
5	3/21/16	106.7	0.174	0.241	0.198	0.199	0.227	0.360	0.323	0.333	0.320	0.340	0.208	0.335
CNT3-Ox3-M1NS														
1	4/21/16	107.1	0.233	0.264	0.223	0.214	0.226	0.415	0.595	0.413	0.458	0.290	0.232	0.434
2	4/21/16	106.7	0.222	0.203	0.209	0.182	0.183	0.370	0.483	0.368	0.378	0.390	0.200	0.398
3	4/21/16	106.5	0.245	0.212	0.231	0.207	0.223	0.398	0.415	0.413	0.395	0.408	0.224	0.406
4	4/21/16	106.4	0.235	0.185	0.201	0.187	0.206	0.350	0.408	0.385	0.393	0.385	0.203	0.384
5	4/21/16	106.3	0.315	0.300	0.265	0.242	0.270	0.433	0.638	0.480	0.495	0.475	0.278	0.504
CNT3-Ox3-M1BS														
1	4/21/16	106.4	0.197	0.212	0.196	0.186	0.187	0.328	0.330	0.323	0.343	0.338	0.196	0.332
2	4/21/16	104.2	0.230	0.214	0.220	0.212	0.191	0.308	0.385	0.333	0.320	0.308	0.213	0.331
3	4/21/16	106.3	0.278	0.197	0.210	0.206	0.218	0.280	0.420	0.378	0.303	0.313	0.222	0.339
4	4/21/16	106.1	0.335	0.285	0.219	0.250	0.231	0.380	0.453	0.330	0.328	0.313	0.264	0.361
5	4/21/16	106.1	0.250	0.242	0.244	0.232	0.258	0.345	0.415	0.333	0.350	0.335	0.245	0.356
CNT3-Ox3-M2NS														
1	5/21/16	106.3	0.213	0.211	0.206	0.198	0.199	0.360	0.360	0.335	0.380	0.385	0.205	0.364
2	5/21/16	106.3	0.200	0.223	0.211	0.204	0.206	0.330	0.393	0.350	0.368	0.380	0.209	0.364
3	5/21/16	104.4	0.209	0.227	0.195	0.186	0.206	0.328	0.403	0.345	0.338	0.370	0.205	0.357
4	5/21/16	106.6	0.202	0.238	0.205	0.202	0.225	0.353	0.430	0.350	0.395	0.410	0.214	0.388
5	5/21/16	104.6	0.225	0.230	0.258	0.242	0.221	0.358	0.370	0.395	0.410	0.435	0.235	0.394
CNT3-Ox3-M2BS														
1	5/21/16	106.6	0.238	0.250	0.246	0.203	0.238	0.295	0.398	0.318	0.320	0.335	0.235	0.333
2	5/21/16	106.6	0.184	0.195	0.186	0.198	0.213	0.290	0.313	0.270	0.290	0.308	0.195	0.294
3	5/21/16	106.6	0.186	0.240	0.215	0.210	0.217	0.340	0.365	0.360	0.335	0.370	0.213	0.354
4	5/21/16	106.6	0.206	0.216	0.220	0.189	0.199	0.298	0.290	0.285	0.288	0.308	0.206	0.294
5	5/21/16	106.5	0.194	0.211	0.206	0.189	0.184	0.247	0.338	0.260	0.283	0.298	0.197	0.285
CNT3-Ox3-M3NS														
1	6/21/16	107.0	0.189	0.190	0.184	0.181	0.201	0.305	0.370	0.315	0.343	0.365	0.189	0.340
3	6/21/16	107.2	0.216	0.217	0.199	0.197	0.223	0.278	0.380	0.375	0.380	0.385	0.210	0.360
4	6/21/16	106.9	0.192	0.164	0.216	0.196	0.176	0.333	0.293	0.318	0.300	0.313	0.189	0.311
5	6/21/16	106.7	0.213	0.214	0.204	0.203	0.201	0.293	0.413	0.315	0.355	0.400	0.207	0.355
6	6/21/16	106.9	0.200	0.207	0.206	0.201	0.232	0.303	0.330	0.313	0.340	0.370	0.209	0.331
CNT3-Ox3-M3BS														
1	6/21/16	106.5	0.275	0.308	0.298	0.245	0.249	0.320	0.493	0.333	0.358	0.458	0.275	0.392
2	6/21/16	104.6	0.242	0.310	0.278	0.270	0.273	0.403	0.468	0.393	0.400	0.398	0.274	0.412
3	6/21/16	104.6	0.246	0.275	0.236	0.232	0.248	0.350	0.315	0.330	0.330	0.348	0.247	0.335
4	6/21/16	104.5	0.250	0.290	0.263	0.248	0.278	0.325	0.370	0.343	0.375	0.360	0.266	0.355
5	6/21/16	106.5	0.388	0.510	0.435	0.423	0.458	0.690	0.640	0.638	0.588	0.640	0.443	0.639

Table S. 23. CNT Coating Electrical Resistance, CNT 3-Ox4.

	Date	V_{rms}	Aligned Resistance (kΩ mm^{-1})					Non-Aligned Resistance (kΩ mm^{-1})					<A>	<NA>
CNT3-Ox4-M0PS														
3	3/29/16	107.6	0.340	0.290	0.237	0.234	0.233	0.488	0.445	0.585	0.485	0.455	0.267	0.492
2	3/29/16	107.1	0.239	0.345	0.240	0.220	0.270	0.475	0.508	0.460	0.475	0.515	0.263	0.487
1	3/29/16	106.7	0.227	0.255	0.219	0.198	0.240	0.458	0.493	0.443	0.450	0.475	0.228	0.464
5	3/29/16	106.6	0.197	0.197	0.196	0.207	0.207	0.415	0.388	0.403	0.395	0.415	0.201	0.403
4	3/29/16	106.6	0.227	0.185	0.209	0.202	0.198	0.360	0.483	0.370	0.395	0.440	0.204	0.410
CNT3-Ox4-M1NS														
1	4/29/16	108.3	0.340	0.375	0.350	0.315	0.360	0.435	0.575	0.480	0.543	0.633	0.348	0.533
2	4/29/16	107.1	0.343	0.285	0.355	0.313	0.325	0.535	0.590	0.500	0.605	0.563	0.324	0.559
3	4/29/16	106.8	0.295	0.390	0.353	0.338	0.398	0.510	0.580	0.520	0.538	0.533	0.355	0.536
4	4/29/16	106.6	0.433	0.348	0.395	0.425	0.345	0.508	0.473	0.495	0.445	0.540	0.389	0.492
5	4/29/16	106.5	0.265	0.358	0.318	0.295	0.305	0.625	0.545	0.498	0.508	0.475	0.308	0.530
CNT3-Ox4-M1BS														
1	4/29/16	106.5	0.423	0.380	0.355	0.320	0.330	0.488	0.553	0.548	0.555	0.483	0.362	0.525
2	4/29/16	106.4	0.385	0.388	0.363	0.383	0.360	0.478	0.528	0.515	0.563	0.595	0.376	0.536
3	4/29/16	106.5	0.423	0.418	0.343	0.320	0.430	0.545	0.568	0.473	0.520	0.540	0.387	0.529
4	4/29/16	106.4	0.338	0.373	0.325	0.330	0.370	0.508	0.555	0.523	0.505	0.565	0.347	0.531
5	4/29/16	106.4	0.853	1.555	0.895	1.105	1.900	2.145	2.643	2.300	2.955	2.903	1.262	2.589
CNT3-Ox4-M2NS														
1	5/29/16	106.4	0.333	0.345	0.305	0.288	0.305	0.533	0.523	0.523	0.563	0.585	0.315	0.545
2	5/29/16	105.1	0.218	0.229	0.219	0.209	0.210	0.378	0.388	0.393	0.420	0.445	0.217	0.405
3	5/29/16	104.7	0.238	0.295	0.245	0.235	0.250	0.430	0.440	0.430	0.448	0.448	0.252	0.439
4	5/29/16	104.7	0.207	0.298	0.237	0.270	0.280	0.408	0.403	0.420	0.468	0.470	0.258	0.434
5	5/29/16	104.8	0.198	0.283	0.222	0.243	0.243	0.400	0.433	0.405	0.410	0.425	0.238	0.415
CNT3-Ox4-M2BS														
1	5/29/16	104.6	0.280	0.285	0.273	0.280	0.288	0.448	0.390	0.418	0.425	0.350	0.281	0.406
2	5/29/16	104.7	0.209	0.290	0.230	0.242	0.260	0.363	0.375	0.348	0.360	0.360	0.246	0.361
3	5/29/16	104.7	0.237	0.239	0.222	0.205	0.216	0.350	0.355	0.353	0.360	0.340	0.223	0.352
4	5/29/16	104.7	0.229	0.224	0.231	0.234	0.248	0.320	0.375	0.313	0.315	0.303	0.233	0.325
5	5/29/16	104.7	0.320	0.263	0.320	0.283	0.295	0.410	0.430	0.383	0.340	0.363	0.296	0.385
CNT3-Ox4-M3NS														
1	6/29/16	105.5	0.335	0.390	0.325	0.315	0.345	0.560	0.558	0.545	0.560	0.593	0.342	0.563
2	6/29/16	106.7	0.370	0.247	0.255	0.250	0.258	0.408	0.458	0.490	0.448	0.408	0.276	0.442
3	6/29/16	106.5	0.278	0.280	0.260	0.233	0.246	0.438	0.425	0.450	0.445	0.455	0.259	0.443
4	6/29/16	106.3	0.270	0.280	0.263	0.246	0.260	0.438	0.410	0.443	0.448	0.460	0.264	0.440
5	6/29/16	106.3	0.335	0.270	0.320	0.318	0.300	0.510	0.555	0.540	0.550	0.565	0.309	0.544
CNT3-Ox4-M3BS														
1	6/29/16	106.1	1.825	0.615	0.620	0.575	0.638	0.755	0.825	0.748	0.700	0.728	0.855	0.751
2	6/29/16	106.2	0.698	0.453	0.390	0.378	0.373	0.673	0.725	0.645	0.615	0.615	0.458	0.655
3	6/29/16	106.4	0.425	0.425	0.415	0.420	0.415	0.515	0.553	0.585	0.613	0.563	0.420	0.566
4	6/29/16	106.2	0.293	0.475	0.543	--	--	0.598	0.585	0.625	--	--	0.437	0.603
5	6/29/16	104.0	0.510	0.458	0.445	--	--	0.593	0.870	0.648	--	--	0.471	0.703

Regression Analysis

Length

A regression analysis was used to determine changes in CNT length and diameter over the course of three months. Three CNT types were examined over time: CNT1, CNT2, and CNT3. Furthermore, for each month, CNT either went through bath sonication or no sonication. Thus, the goal of the regression analysis was to determine both time and sonication effects on the length and diameter. Figure S. 21 is a plot showing the mean length measurements over time for CNT1, CNT2, CNT3-Ox3, and CNT3-Ox4.

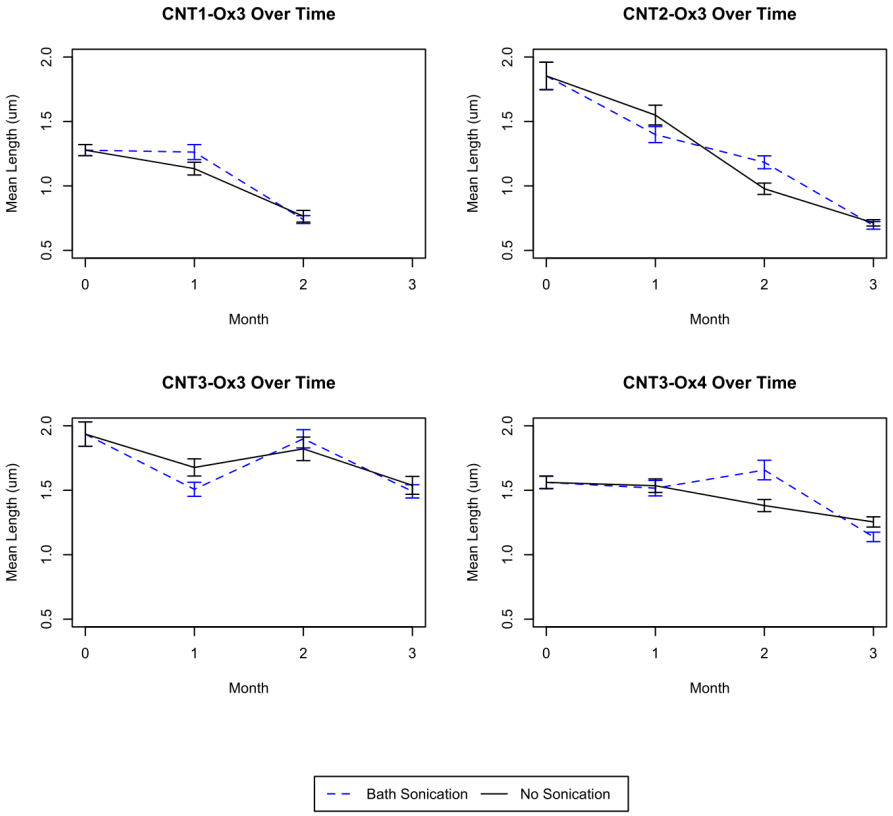


Figure S. 21. Mean length measurements over time for CNT1, CNT2, CNT3-Ox3, and CNT3-Ox4. (N >135). Error bars represent standard deviation.

This analysis is similar to the analysis described in S1: a distributional assumption on the lengths and diameters was made, and then a linear regression analysis was performed to determine the time and sonication effects on the length and diameter. Specifically, the following distributional assumption was made for each month and sonication type:

$$\log y_{MS} \sim N(\mu_{MS}, \sigma^2_{MS})$$

where M is the Month (ranging from 0 to 3) and S is the sonication type. Only probe sonication was used for Month 0, and bath or non-sonication was used for Months 1 to 3. Thus, the mean log-length and log-diameter for each sonication type during each month was modeled, and variance of the length and diameter measurements was accounted for, similar to the CNT processing analysis. By accounting for the variation among length and diameter measurements, more precise estimates of the mean time and sonication effects could be obtained.

First, a regression accounting only for Month was performed in order to determine if there was an average trend across months. Then, Sonication within each month was also accounted for in the regression analysis in order to determine if there were different Sonication effects across Months.

Time Regression Analysis for CNT1 Lengths

First, a regression accounting only for Month was performed. There was not a significant difference in mean log-length between Month 1 and 2 (p-value = 0.4035); however, the mean log-length measurements for Month 3 were significantly shorter (by 0.4679 μm, p-value $<2*10^{-16}$) than Month 2. When Month was coded numerically into this regression, there was a significant trend (p-value $< 2*10^{-16}$) for log-lengths to decrease by 0.2663 μm per month, but this trend was drawn by the Month 3 measurements.

Then, a regression accounting for both Month and Sonication was performed; the point estimates, standard errors, and corresponding p-values for this regression are reported below.

Table S. 24. Time Regression Analysis for CNT1 Lengths.

Variable	Coefficient	Standard Error	p-value
Intercept	0.0757	0.0338	0.0253
Month 2	0.0257	0.0526	0.6253
Month 3	-0.4870	0.0488	$< 2*10^{-16}$
Month2:NoSonication	-0.1176	0.0555	0.0343
Month3:NoSonication	-0.0510	0.0600	0.3958

The interpretation of the above analysis is the following. Within Month 2, non-sonicated measurements were significantly shorter than the corresponding bath-sonicated measurements. However, there was not a significant difference between bath sonication and no sonication within Month 3. Thus, there was an overall trend for mean log-lengths to become shorter over time, with non-sonication having a stronger negative effect on the mean log-lengths than bath sonication, on average.

Time Regression Analysis for CNT2 Lengths

First, a regression accounting only for Month was performed. It was found that Month 2 measurements were significantly shorter (by 0.1470 μm, p-value = 0.0273) than Month 1 measurements. Furthermore, Month 3 measurements were significantly shorter (by 0.2987 μm, p-value = $4.71*10^{-12}$) than Month 2 measurements, and Month 4 measurements were significantly shorter (by 0.3886 μm, p-value < $2*10^{-16}$) than Month 3 measurements, on average. When month was coded numerically into the regression, it was estimated that log-lengths significantly (p-value < $2*10^{-16}$) decreased by 0.3130 μm per month.

Then, a regression accounting for both month and sonication was performed; the point estimates, standard errors, and corresponding p-values for this regression are reported below.

Table S. 25. Time Regression Analysis for CNT2 Lengths.

Variable	Coefficient	Standard Error	p-value
Intercept	0.3823	0.0582	$7.87*10^{-11}$
Month 2	-0.1891	0.0728	0.0095
Month 3	-0.3514	0.0702	$6.44*10^{-7}$
Month 4	-0.8536	0.0684	$<2*10^{-16}$
Month2:NoSonication	0.0870	0.0629	0.1669
Month3:NoSonication	-0.2020	0.0574	0.0004
Month4:NoSonication	0.0374	0.0500	0.4555

The interpretation of the above analysis is the following. There was only a significant difference between bath sonication and no sonication for the Month 3 measurements, where the mean log-length for no sonication was significantly less than that of bath sonication. Otherwise, there was not a significant difference between bath sonication and non-sonication within months. Thus, there was a clear trend that log-lengths tended to get shorter across months, but there does not appear to be a significant difference between bath sonication and non-sonication within months.

Time Regression Analysis for CNT3-Ox3 Lengths

First, a regression accounting only for Month was performed. It was found that Month 2 measurements were significantly shorter (by 0.1652 μm, p-value = 0.0002) than Month 1 measurements. However, Month 3 measurements were significantly longer (by 0.1553 μm, p-value = $2.21*10^{-5}$) than Month 2 measurements, but Month 4 measurements were significantly shorter (by 0.2113 μm, p-value = $2.05*10^{-8}$) than Month 3 measurements, on average. When Month was coded numerically into the regression, the overall linear trend was that mean log-lengths significantly (p-value = 0.0013) decreased by 0.0442 μm per month, suggesting that the Month 3 measurements were anomalous from the overall linear trend.

Then, a regression accounting for both month and sonication was performed; the point estimates, standard errors, and corresponding p-values for this regression are reported below.

Table S. 26. Time Regression Analysis for CNT3-Ox3 Lengths.

Variable	Coefficient	Standard Error	p-value
Intercept	0.5198	0.0364	$<2*10^{-16}$
Month 2	-0.2045	0.0504	$5.13*10^{-5}$
Month 3	0.0216	0.0489	0.6590
Month 4	-0.2171	0.0497	$1.46*10^{-5}$
Month2:NoSonication	0.0827	0.0506	0.1020
Month3:NoSonication	-0.0887	0.0549	0.1060
Month4:NoSonication	-0.0107	0.0546	0.8450

The interpretation of the above analysis is the following. There was a somewhat significant difference between bath sonication and no sonication for Months 2 and 3, but with opposite differences between Months 2 and 3. Furthermore, there was no difference between bath sonication and non-sonication within Month 4. Thus, there appears to be an overall trend for log-lengths to get shorter on average, but there does not appear to be a clear sonication effect within months.

Time Regression Analysis for CNT3-Ox4 Lengths

First, a regression accounting only for Month was performed. It was found that there was not a significant difference (p-value = 0.3690) between Month 1 and Month 2 log-lengths on average, nor was there a significant difference between Months 2 and 3 (p-value = 0.385). However, Month 4 log-lengths were significantly shorter (by 0.2064 μm, p-value = $1.01*10^{-9}$) than Month 3 log-lengths, on average. When Month was coded numerically into the regression, the overall linear trend was that mean log-lengths significantly (p-value = $3.15*10^{-14}$) decreased by 0.0913 μm per month, but this trend is mostly drawn by Month 4 measurements.

Then, a regression accounting for both month and sonication was performed; the point estimates, standard errors, and corresponding p-values for this regression are reported below.

Variable	Coefficient	Standard Error	p-value
Intercept	0.3709	0.0308	$<2*10^{-16}$
Month 2	-0.0522	0.0468	0.2650
Month 3	0.0275	0.0491	0.5752
Month 4	-0.3293	0.0457	$1.06*10^{-12}$
Month2:NoSonication	0.0312	0.0475	0.5135
Month3:NoSonication	-0.1537	0.0493	0.0019
Month4:NoSonication	0.1086	0.0460	0.0185

The interpretation of the above analysis is the following. There was a significant difference between bath sonication and no sonication for Months 3 and 4, but with opposite effects for Months 3 and 4. Thus, similar to the results for CNT3-Ox3, there appears to be an overall trend for log-lengths to become shorter over time, on average; however, the bath-sonicated samples during Month 3 notably deviated from this trend.

Diameter Over Time

Now we will report the same analysis for the CNT diameters. Below is a plot showing the mean diameter measurements over time for CNT1, CNT2, CNT3-Ox3, and CNT3-Ox4.

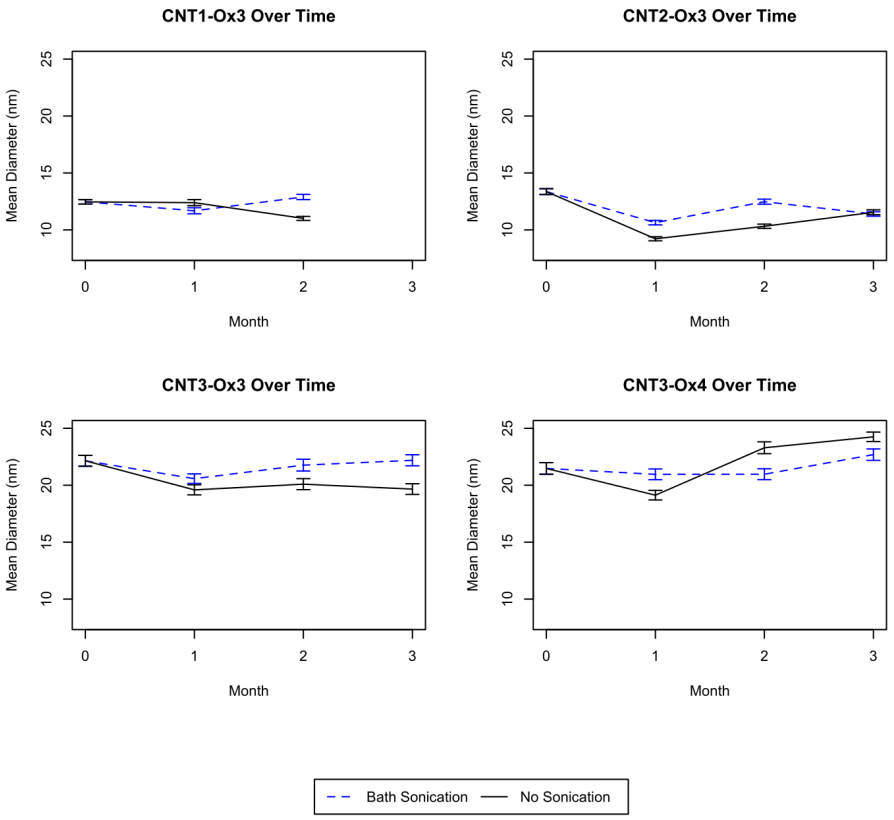


Figure S. 22. Mean Diameter over Time. Error bars represent standard deviation. (N > 250)

Time Regression Analysis for CNT1 Diameters

First, a regression accounting only for Month was performed. It was found that there was not a significant difference in mean log-diameter between Months 1 and 2 (p-value = 0.1380), nor was there a significant difference in mean log-diameter between Months 2 and 3 (p-value = 0.8750).

Then, a regression accounting for both Month and Sonication was performed; the point estimates, standard errors, and corresponding p-values for this regression are reported below.

Table S. 27. Time Regression Analysis for CNT1 Diameters.

Variable	Coefficient	Standard Error	p-value
Intercept	2.4656	0.0149	$<2*10^{-16}$
Month 2	-0.0652	0.0258	0.0115
Month 3	0.0531	0.0227	0.0196
Month2:NoSonication	0.0646	0.0290	0.0262
Month3:NoSonication	-0.1539	0.0236	$9.54*10^{-11}$

The interpretation of the above analysis is the following. Within Month 2, non-sonicated measurements were significantly wider than the corresponding bath-sonicated measurements. However, within Month 3, non-sonicated measurements were significantly thinner than the corresponding bath-sonicated measurements. Thus, for the CNT1 diameters, there does not appear to be a definite time or sonication effect.

Time Regression Analysis for CNT2 Diameters

First, a regression accounting only for Month was performed. It was found that Month 2 log-diameters were significantly smaller (by 0.2947 nm, p-value $< 2*10^{-16}$) than Month 1 log-diameters, on average. However, Month 3 log-diameters were significantly larger (by 0.1347 nm, p-value = $4.12*10^{-14}$) than Month 2 log-diameters, on average, and there was not a significant (p-value = 0.6360) difference between Month 3 and Month 4.

Then, a regression accounting for both Month and Sonication was performed; the point estimates, standard errors, and corresponding p-values for this regression are reported below.

Table S. 28. Time Regression Analysis for CNT2 Diameters.

Variable	Coefficient	Standard Error	p-value
Intercept	2.5487	0.0186	$<2*10^{-16}$
Month 2	-0.2253	0.0253	$<2*10^{-16}$
Month 3	-0.0630	0.0252	0.0125
Month 4	-0.1505	0.0246	$1.17*10^{-9}$
Month2:NoSonication	-0.1450	0.0248	$6.23*10^{-9}$
Month3:NoSonication	-0.1932	0.0240	$1.36*10^{-15}$
Month4:NoSonication	-0.0029	0.0244	0.9050

The interpretation of the above analysis is the following. Within Months 2 and 3, the mean log-diameter was significantly larger for bath-sonicated samples compared to the corresponding non-sonicated samples; however, within Month 4, there did not appear to be a significant difference between bath-sonicated and non-sonicated samples in the mean log-diameter.

Time Regression Analysis for CNT3-Ox3 Diameters

First, a regression accounting only for Month was performed. It was found that log-diameters for Month 2 were significantly smaller (by 0.0936 nm, p-value = 0.0004) than log-diameters for Month 1, on average. However, there was not a significant difference (p-value = 0.2787) between Months 2 and 3; furthermore, there did not appear to be a significant difference (p-value = 0.6160) between Months 3 and 4.

Then, a regression accounting for both Month and Sonication was performed; the point estimates, standard errors, and corresponding p-values for this regression are reported below.

Table S. 29. Time Regression Analysis for CNT3 Diameters.

Variable	Coefficient	Standard Error	p-value
Intercept	3.0412	0.0214	$<2*10^{-16}$
Month 2	-0.0662	0.0291	0.0230
Month 3	-0.0281	0.0314	0.3715
Month 4	0.0013	0.0302	0.9668
Month2:NoSonication	-0.0642	0.0301	0.0331
Month3:NoSonication	-0.0839	0.0327	0.0104
Month4:NoSonication	-0.1329	0.0318	$3.11*10^{-5}$

The interpretation of the above analysis is the following. Within each month, bath-sonicated samples had a significantly larger mean log-diameter than their non-sonicated counterparts. Thus, log-diameters for bath-sonicated samples appeared smaller during Month 2 than Month 1, on average, but log-diameters for bath-sonicated samples appeared more similar to Month 1 measurements over time. On the other hand, log-diameters for non-sonicated samples tended to become smaller over time.

Time Regression Analysis for CNT3-Ox4 Diameters

First, a regression accounting only for Month was performed. It was found that log-diameters for Month 2 were somewhat significantly smaller (by 0.0542 nm, p-value = 0.0590) than log-diameters for Month 1, on average. However, Month 3 measurements were significantly larger (by 0.0940 nm, p-value = $1.42*10^{-5}$) than Month 2 measurements, and Month 4 measurements were significantly larger (by 0.0812 nm, p-value = $8.10*10^{-5}$) than Month 3 measurements. Then, a regression accounting for both month and sonication was performed; the point estimates, standard errors, and corresponding p-values for this regression are reported below.

Table S. 30. Time Regression Analysis for CNT3-Ox4 Diameters

Variable	Coefficient	Standard Error	p-value
Intercept	2.9956	0.0242	$<2*10^{-16}$
Month 2	-0.0092	0.0319	0.7738
Month 3	-0.0132	0.0324	0.6833
Month 4	0.0686	0.0322	0.0335
Month2:NoSonication	-0.0936	0.0301	0.0019
Month3:NoSonication	0.1065	0.0306	0.0005
Month4:NoSonication	0.0870	0.0275	0.0016

The interpretation of the above analysis is the following. There was not a significant difference in the mean log-diameter between Month 1 samples and bath-sonicated Month 2 samples; however, the mean log-diameter for non-sonicated Month 2 was significantly less than that of Month 1 and bath-sonicated Month 2 samples. Furthermore, within Month 3 and Month 4, the non-sonicated samples had significantly larger diameters than their bath-sonicated counterparts. Thus, there was an overall trend for log-diameters to first decrease after the first month and then increase afterwards, and this trend was driven by the non-sonicated samples.

Oxygen Content over Time

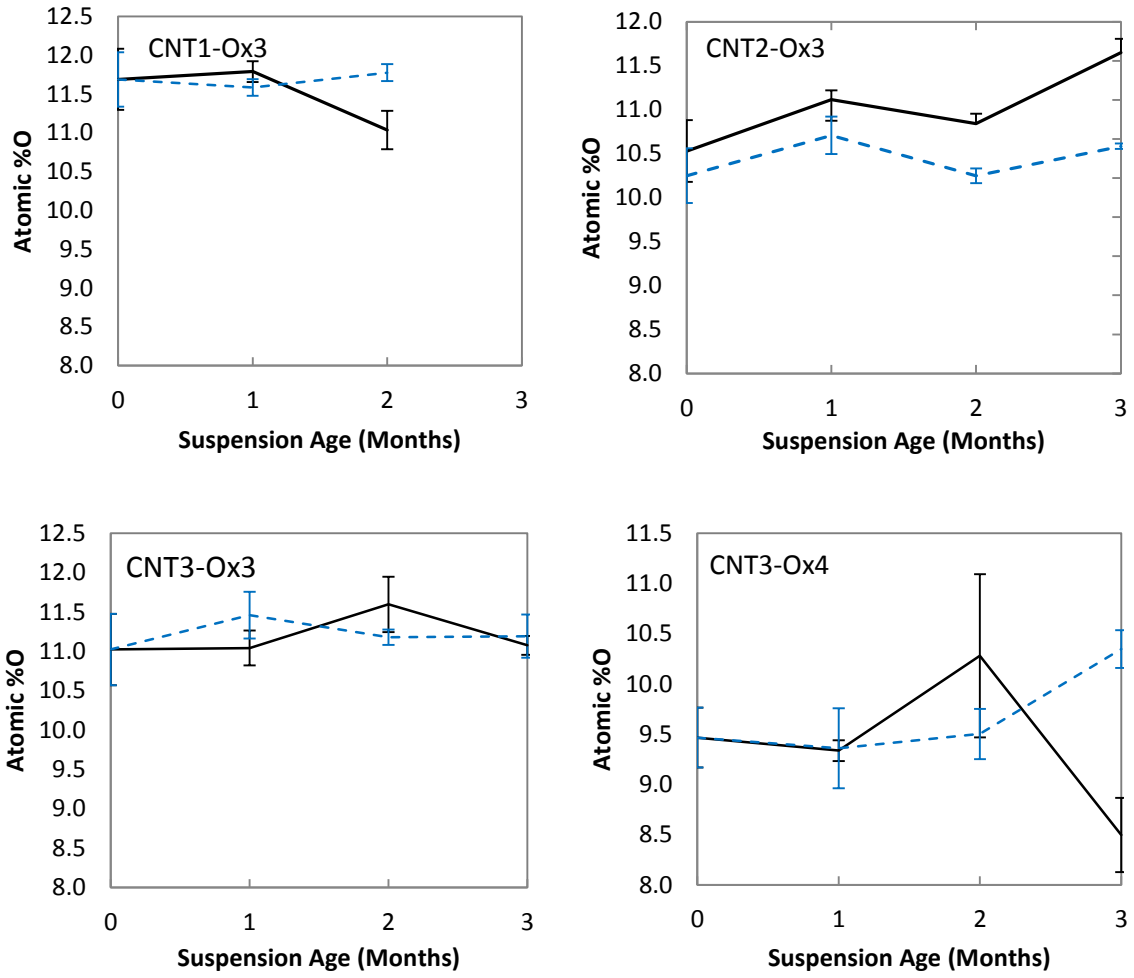


Figure S. 23. Effect of time on CNT oxygen content. Solid lines indicate non-sonicated samples while dashed lines depict bath-sonicated samples. Error bars depict standard deviation. (N=3)

Resistance in Aligned and Non-Aligned Directions Over Time

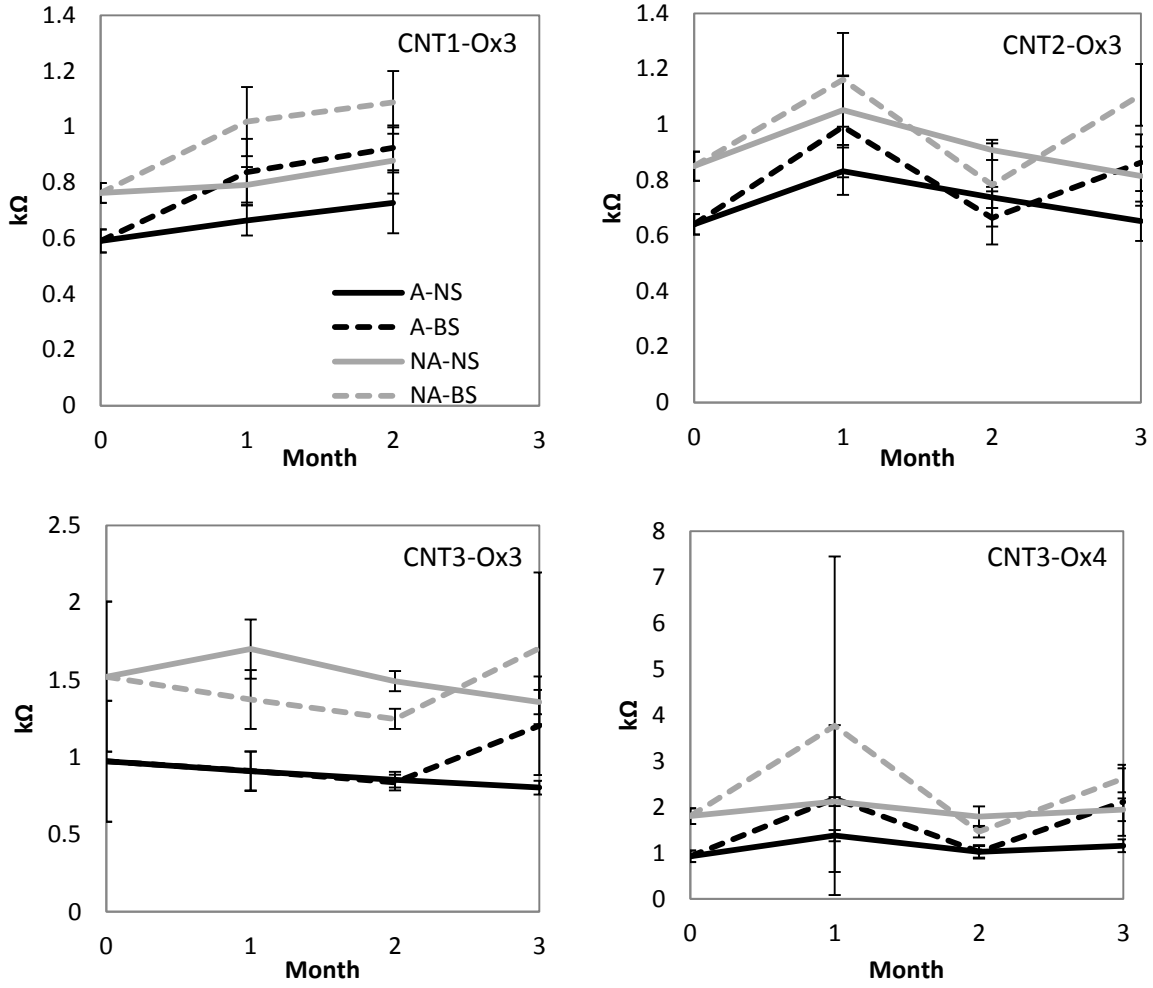


Figure S. 24. Effect of time on resistance of CNT coating in aligned (A) and non-aligned (NA) directions. Solid lines indicate non-sonicated (NS) samples while dashed lines depict bath-sonicated (BS) samples. Error bars depict standard deviation. (N=5)