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Conjugated Wrapping Polymer Influences on Photoexcitation of Single-Walled Carbon Nanotube-based Thin Film Transistors

*Nicholas J. Dallaire[1], Brendan Mirka,[1] Joseph Manion[1], William J. Bodnaryk[2], Darryl Fong[2], Alex Adronov[2], Karin Hinzer,[3] Benoît H. Lessard[1,3]**

[1]Department of Chemical & Biological Engineering, University of Ottawa, 161 Louis Pasteur, Ottawa, ON, Canada K1N 6N5
[2]Department of Chemistry and Chemical Biology, McMaster University, 1280 Main Street W, Hamilton, Ontario, Canada L8S 4M1
[3]School of Electrical Engineering and Computer Science, University of Ottawa, 800 King Edward, Ottawa, ON, Canada K1N 6N5

*To whom correspondences should be addressed. E-mail:benoit.lessard@uottawa.ca

Supporting Information

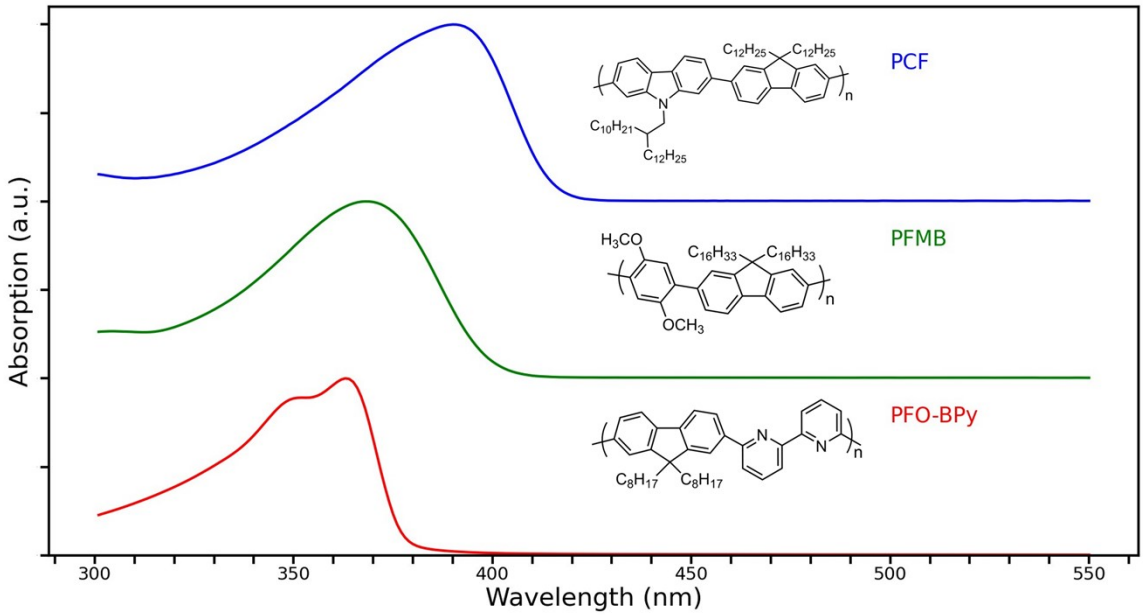

***Figure E1)**: Absorption Profile of each polymer. The polymer's structure is displayed over each corresponding absorption spectra.*

The peak absorptions are located at 390, 368 and 363 nm for the PCPF,

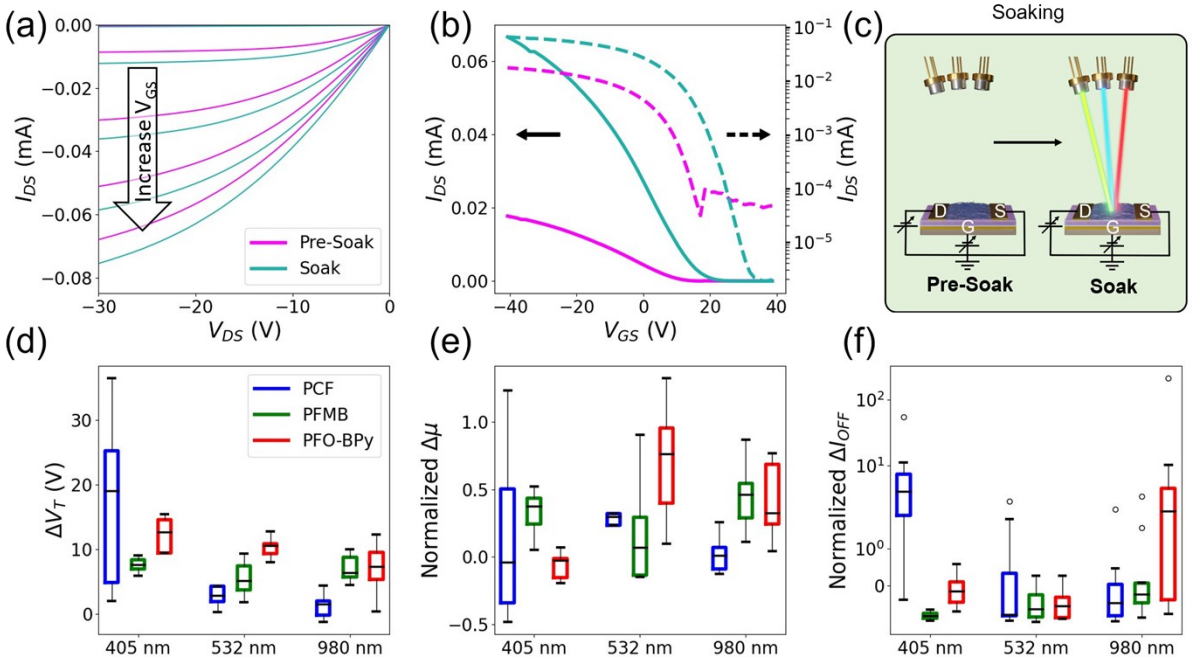

Figure E2): Difference in performance between Off Cycling and On Cycling at 4W/cm^2. Characteristic output curves with gate voltages (10, 0, -10, -20 and -30 V) (a). Characteristic transfer curves of a PFMB-SWNT device illuminated at 405 nm, linear curve (solid line) and logarithmic (dashed line) with V_{DS}= -3 V. (b). A procedural schematic of the Soaking process (c). Box plots of the average ΔV_T (d), average normalized $\Delta\mu$ (e) and the average normalized OFF current (f).

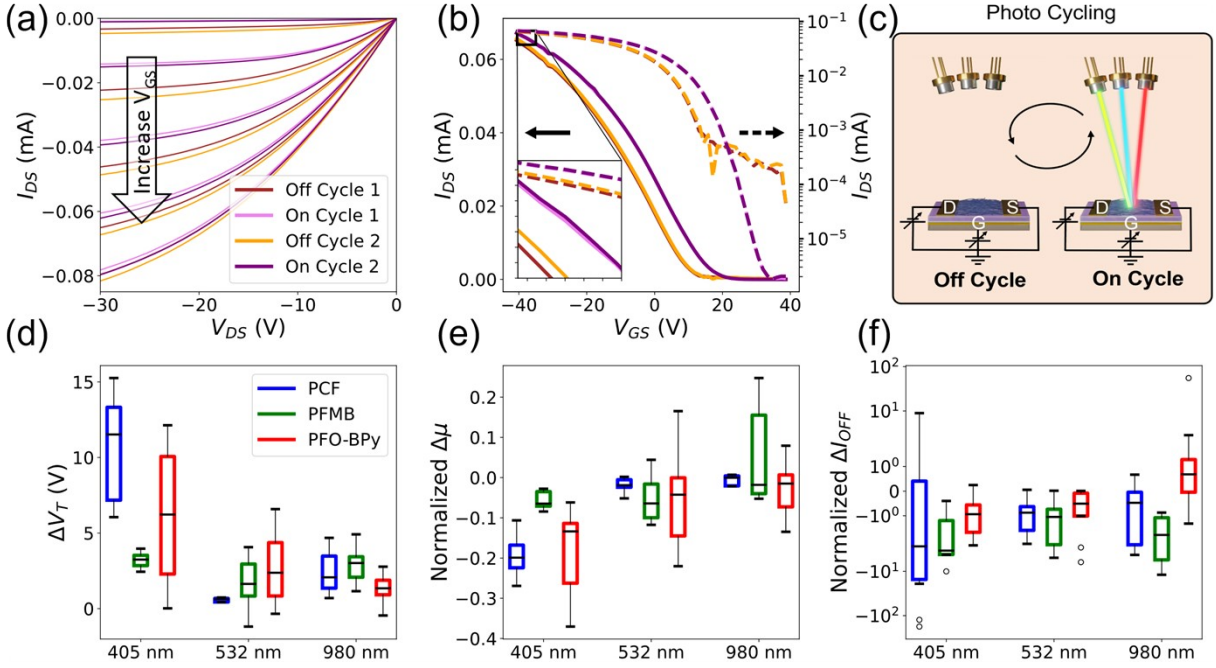

Figure E3): Difference in performance between Pre-Soak and Soak at 4W/cm^2. Characteristic output curves with gate voltages (10, 0, -10, -20 and -30 V) (a). Characteristic transfer curves of a PFMB-SWNT device illuminated at 405 nm, linear curve (solid line) and logarithmic (dashed line) with V_{DS} = -3 V. (b). A procedural schematic of the Soaking process (c). Box plots of the average ΔV_T (d), average normalized $\Delta\mu$ (e) and the average normalized OFF current (f).

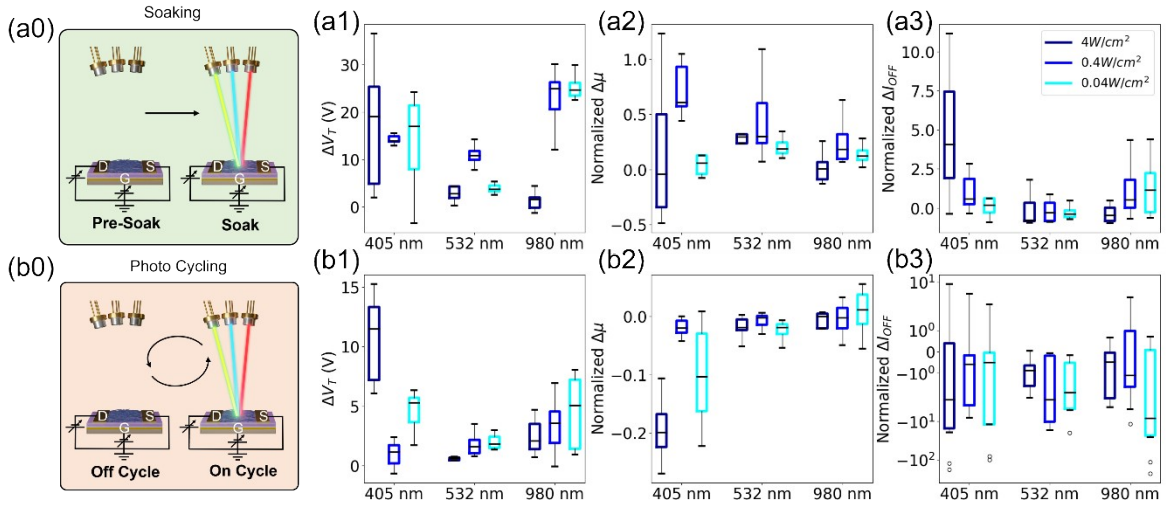

Figure E4): Difference in performance between Pre-Soak and during Soak (a) and the difference in performance between Off and On exposure cycling at different intensities (b). (0) The procedural schematics of both processes. (1) The average difference between the threshold voltage (2). The normalized difference for the mobility and (3) the average OFF current. All tests performed on SWNT OTFT using the PCF dispersion.

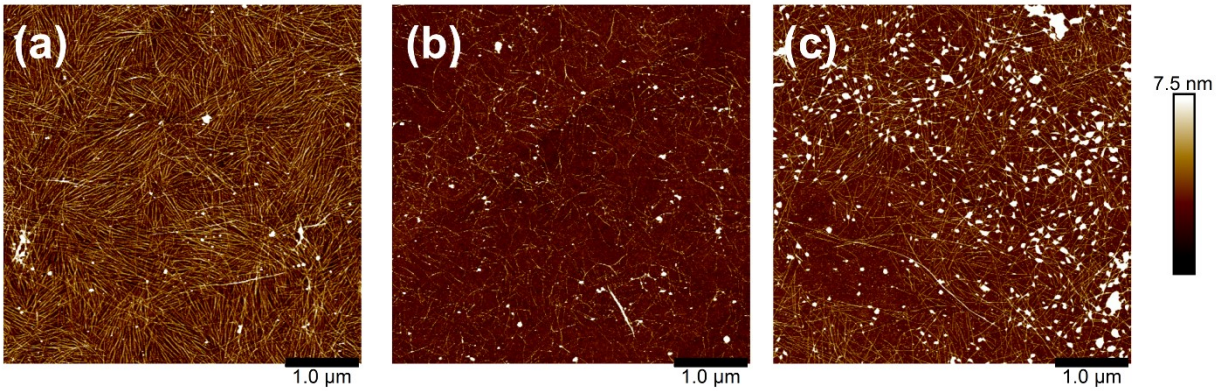

Figure E5): Atomic force microscopy images of the SWNT devices, PCF (a), PFMB (b) and PFO-BPy (c), on Si wafers. The scans were performed using a ScanAsyst Air tip in Bruker ScanAsyst mode using a Dimension Icon Atomic Force Microscope at a rate of 1 Hz with a resolution of 512 scans per line. The scan area is 5 x 5 µm with a maximum height of 7.5 nm.

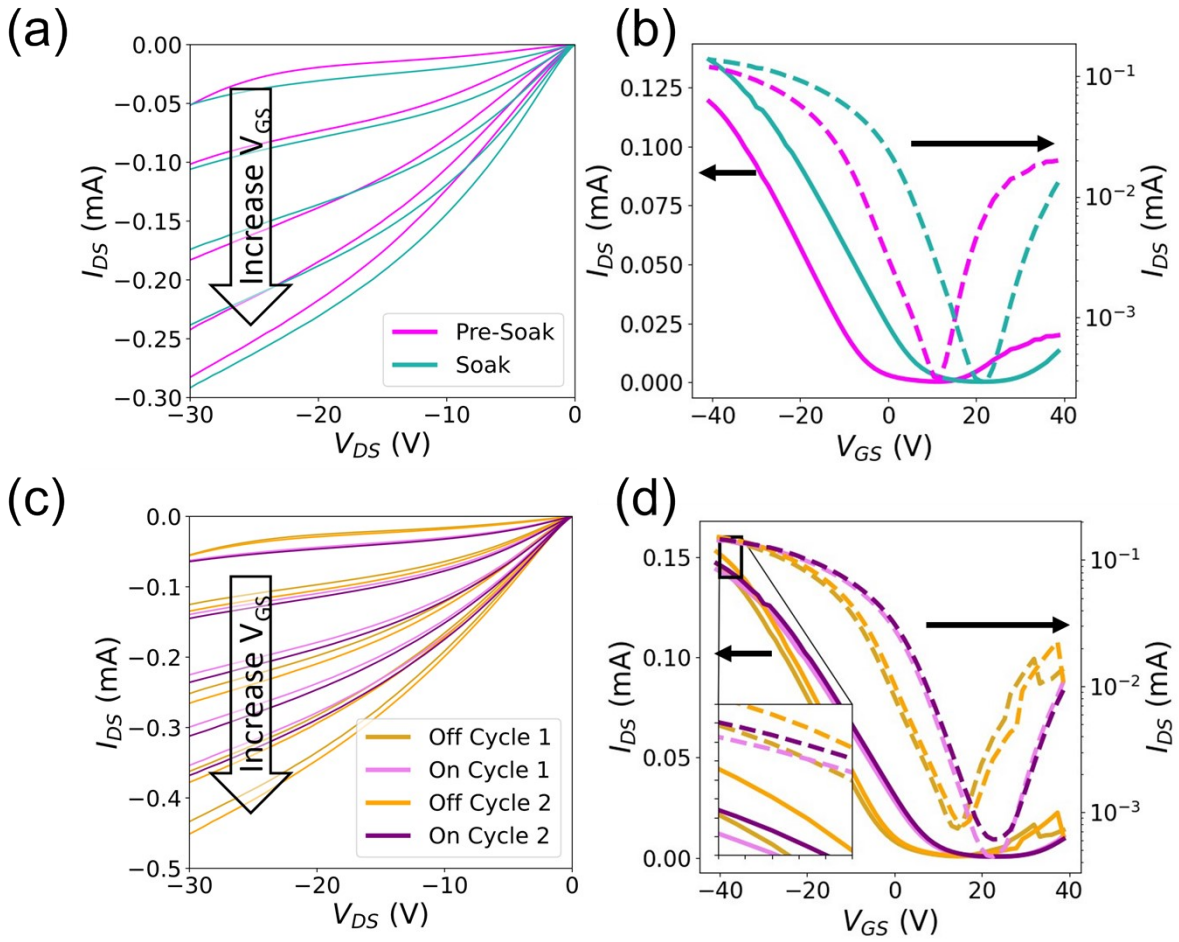

Figure E6): Characteristic output and transfer curves of a PFO-BPy+SWNT device with exposure at 405 nm and 4W/cm^2 (a) The output curves during the Soaking phase with gate voltages (10, 0, -10, -20 and -30 V) (b) . The transfer curves with during the Soaking phase V_{DS}=-3 V . (c) The output curves during the Cycling phase with gate voltages (10, 0, -10, -20 and -30 V). (d) The transfer curves with during the Cycling phase V_{DS}=-3 V .

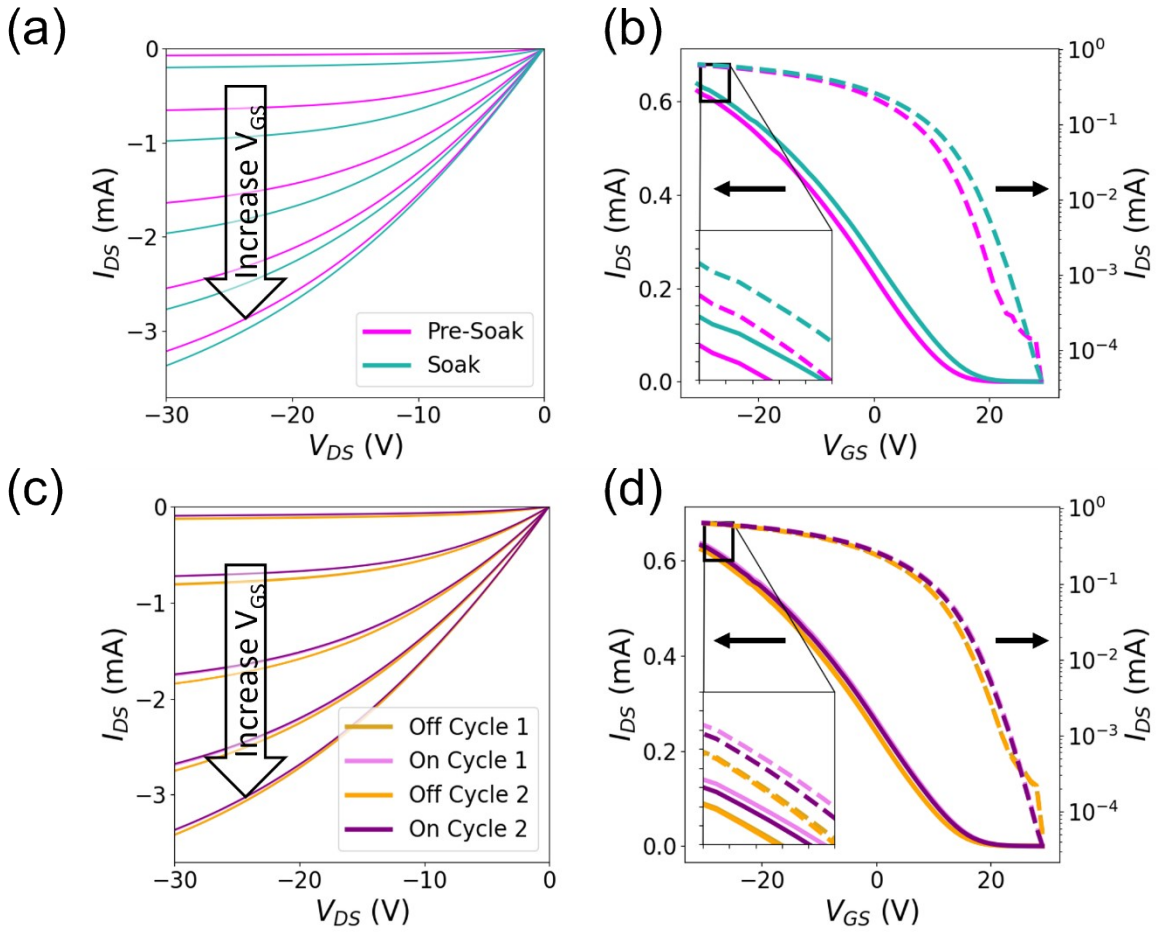

Figure E7): Characteristic output and transfer curves of a PCF+SWNT device with exposure at 980 nm and 4W/cm^2 (a) The output curves during the Soaking phase with gate voltages (10, 0, -10, -20 and -30 V) (b) . The transfer curves with during the Soaking phase V_{DS}=-3 V . (c) The output curves during the Cycling phase with gate voltages (10, 0, -10, -20 and -30 V). (d) The transfer curves with during the Cycling phase V_{DS}=-3 V .

Model Parameter Differences	Soaking	Photo Cycling
V_T (V)	7.9±0.9	3.6±0.6
δ	5±3 x 10^7 E+07	3±2 x 10^7
n	0.05±0.06	-0.09±0.07
l	0.02±0.04	0.01±0.02
λ	-0.13±0.06	0.07±0.03
V_{gcrit}	130±70	30±40
J_T	4±3	-2±1
V_{tun}	60±40	-30±30
V_0	4±3	-1±1
R_0	3000±3000	-300±200

R_{max}	0.06±0.09	0.05±0.05

Table E1) *Average differences of OVSED model parameters for all three SWNT based TFTs. V_T is the threshold voltage, δ a variable threshold constant, n is a gate coupling factor, l is a constant dependant on the density of trap states, λ is the ratio between the channel length and mean free path, V_{crit} is the critical voltage for carrier velocity saturation, J_T is the current density, V_0 is the turning point for the contact resistance, V_{tun} is the smoothing factor for the contact resistance, R_0 is the minimum contact resistance, R_{max} is the maximum contact resistance. All differences except for V_T were normalized using their respective pre-soaked values. Data extracted from 4-6 devices for each wavelength and polymer, totalling 46 devices, all were illuminated using an intensity of 4W/cm².*

Model parameter differences	Soaking phase 405nm			Soaking phase 532nm			Soaking phase 980nm		
	PCF	PFMB	PFO-BPy	PCF	PFMB	PFO-BPy	PCF	PFMB	PFO-BPy
$V_T(V)$	17 ± 7	5 ± 3	10 ± 3	5 ± 1	7 ± 2	8.9±0.9	5.9 ± 0.6	8 ± 3	8 ± 2
λ	0.1±0.2	-0.28±0.6	-0.06±0.04	-0.07±0.06	-0.13±0.04	-0.6±0.2	0.3 ± 0.1	0.2±0.1	-0.05±0.04

Table E2) *Average extracted OVSED model parameters for all three SWNT based TFTs during the Soaking phase. V_T is the threshold voltage, λ is the ratio between the channel length and mean free path. The λ parameter is normalized using the pre-soaked value. Data extracted from 4-6 devices for each wavelength and polymer, totalling 46 devices, all were illuminated using an intensity of 4W/cm².*

Model parameter differences	Photo Cycling phase 405nm			Photo Cycling phase 532nm			Photo Cycling phase 980nm		
	PCF	PFMB	PFO-BPy	PCF	PFMB	PFO-BPy	PCF	PFMB	PFO-BPy
$V_T(V)$	11 ± 3	4 ± 1	4 ± 2	2 ± 1	3.4±0.6	1.0±0.2	3.5±0.9	2.6±0.7	2.6±0.8
λ	-0.17±0.09	-0.03±0.02	0.03±0.02	0.02±0.06	0.00±0.03	-0.01±0.02	0.3±0.2	-0.03±0.06	-0.01±0.05

Table E3) *Average extracted OVSED model parameters for all three SWNT based TFTs during the Photo Cycling phase. V_T is the threshold voltage, λ is the ratio between the channel length and mean free path. The λ parameter is normalized using the pre-soaked value. Data extracted from 4-6 devices for each wavelength and polymer, totalling 46 devices, all were illuminated using an intensity of 4W/cm².*

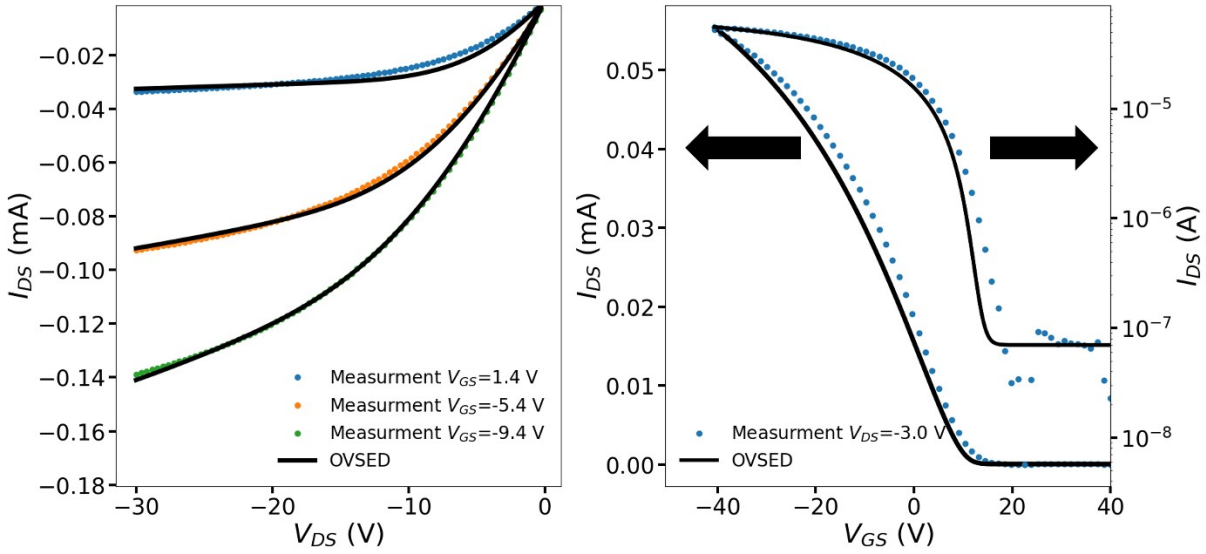

Figure E8) *Characteristic output and transfer curve for a PFMB+SWNT pre-Soak device with the OVSED model fitting.*

Model Parameters	PCF+SWNT	PFMB+SWNT	PFO-BPy+SWNT
V_T(V)	18.6±0.8	19±1	17±1
δ	0.021±0.009	0.016±0.006	0.0021±0.0009
n	138±9	100±10	68±2
l	2.4±0.1	2.1±0.1	2.3±0.2
λ	10±1 x 10^5	40±3 x 10^5	9±3 x 10^5
V_{gcrit}(V)	22±9 x 10^5	50±8 x 10^4	8±3 x 10^5
J_T (A/cm)	0.37±0.09	0.23±0.06	0.07±0.03
V_{tun} (V)	-13±3	-15±2	-8±2
V_0 (V)	-14±5	-39±3	-19±4
R_0 (kΩ)	1.1±0.3	2.8±0.6	2.0±0.5
R_{max} (kΩ)	12±3	60±10	30±10

Table E9) *Average extracted OVSED model parameters for all three SWNT based TFTs, all with Au/Mn contacts, pre-soak. V_T is the threshold voltage, δ a variable threshold constant, n is a gate coupling factor, l density of trap states constant, λ is the ratio between the gate length and mean free path, V_{crit} is the critical voltage for carrier velocity saturation, J_T is the current density, V_0 is the turning point for the contact resistance, V_{tun} is the smoothing factor for the contact resistance, R_0 is the minimum contact resistance, R_{max} is the maximum contact resistance. Data extracted from 15-16 devices for each polymer totalling 46 devices.*