Supporting Information

Carbon Nanotube Transistors as Gas Sensors: Response Differentiation Using Polymer Gate Dielectrics

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Table S1: List of polymer dielectrics. DMF stands for dimethylformamide. PVP-pMSSQ stands for poly(vinylphenol) poly(methylsilsesquioxane) blend. CNN-FET data for nylons in bold fonts are presented in Figure S5. Dielectric parameters have not been measured but were obtained from supplier datasheets or from the literature. Reported values for nylons can vary by 10-20%.

Name	**Supplier/ Brand**	**Dielectric constant/Loss**	**Method**
PA6	**Scientific Polymer, Inc.**	**3.6/0.2**	**m-cresol, spin coating**
PA66	**Scientific Polymer, Inc.**	**3.2/0.2**	**m-cresol, spin coating**
PA66	Sigma Aldrich 181129	3.2	m-cresol, spin coating
PA69	**Scientific Polymer, Inc.**	**3.2/0.02**	**m-cresol, spin coating**
PA610	**Scientific Polymer, Inc.**	**4.7/0.09**	**m-cresol, spin coating**
PA610	Dupont Zytel LC3030	3.9	m-cresol, spin coating
PA610	Dupont Zytel LC3090	3.9	m-cresol, spin coating
PA612	**Scientific Polymer, Inc.**	**3.6/0.02**	**m-cresol, spin coating**
PA612	RTP200 white	3.6	m-cresol, spin coating
PA612	RTP200 blue	3.6	m-cresol, spin coating
PA612	Dupont Zytel 151L	3.6	m-cresol, spin coating
PA1010	Dupont Zytel LC1600	3.6	m-cresol, spin coating
PA11	**Scientific Polymer, Inc.**	**3.9/0.2**	**m-cresol, spin coating**
PA11	Arkema Rilsamid	3.9	m-cresol, spin coating
PA12	Scientific Polymer, Inc.	3.9	m-cresol, spin coating
PA12	Arkema Kynar	3.9	m-cresol, spin coating
PA12	Evonik Vestamid X7377	3.8	m-cresol, spin coating
PA12	**Evonik Vestamid L1670**	**3.8/0.05**	**m-cresol, spin coating**
PA6T	**Dupont Zytel HTNE8200**	**3.7/0.012**	**m-cresol, spin coating**
PA6(3)T	**Scientific Polymer, Inc.**	**4.6/0.025**	**m-cresol or DMF, spin coating**
MXD6	**Mitubishi**	**3.9/0.01**	**m-cresol, spin coating**
PA9T	**Kuraray GC72010**	**3.8/0.01**	**m-cresol, spin coating**
PA10T	**Evonik CX7323**	**3.6/0.01**	**m-cresol, spin coating**
PA10T	Evonik HTM3000	3.6	m-cresol, spin coating
Cellulose Acetate	Sigma Aldrich	5.6/0.03	DMF, spin coating
Cell. Nitrate (Collodion)	Sigma Aldrich	6.4	DMF, spin coating
Cyanoethyl Cell. (CR-S)	Shin-Etsu Chemical Co	13	DMF, spin coating
Poly-4vinylpyridine	Scientific Polymer, Inc.	3.2	DMF, spin coating
Poly-(4vinylpyridine-co-styrene 10%)	Scientific Polymer, Inc.	3.1	DMF, spin coating
PVDF	Solvay Solef 9009	7.5	DMF, spin coating
Parylene C	Specialty Coating Systems (Kisco)	3.1/0.02	Vapor condensation
Parylene HT	Specialty Coating Systems (Kisco)	2.2/0.0002	Vapor condensation
Teflon AF	Dupont	1.9	Spin coating
Merck Lisicon D139-FC43	Merck, D139-FC43-045	2	Spin coating
PVP-pMSSQ	Xerox Xdi-dcs	3	Spin coating

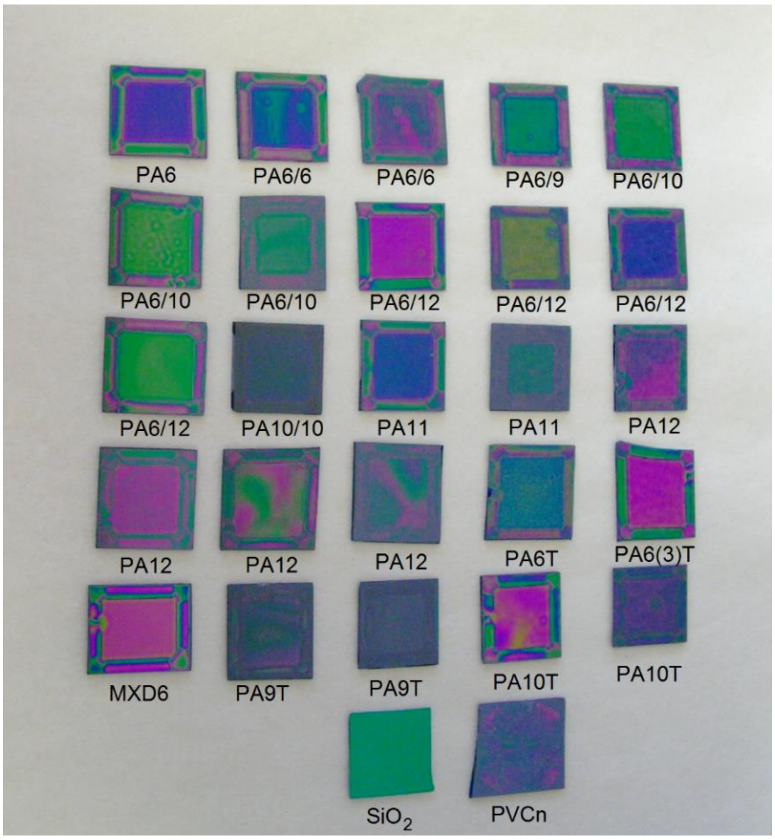

Figure S1: Optical image of a set of nylon polymers spin-coated on Si/SiO_2 substrate.

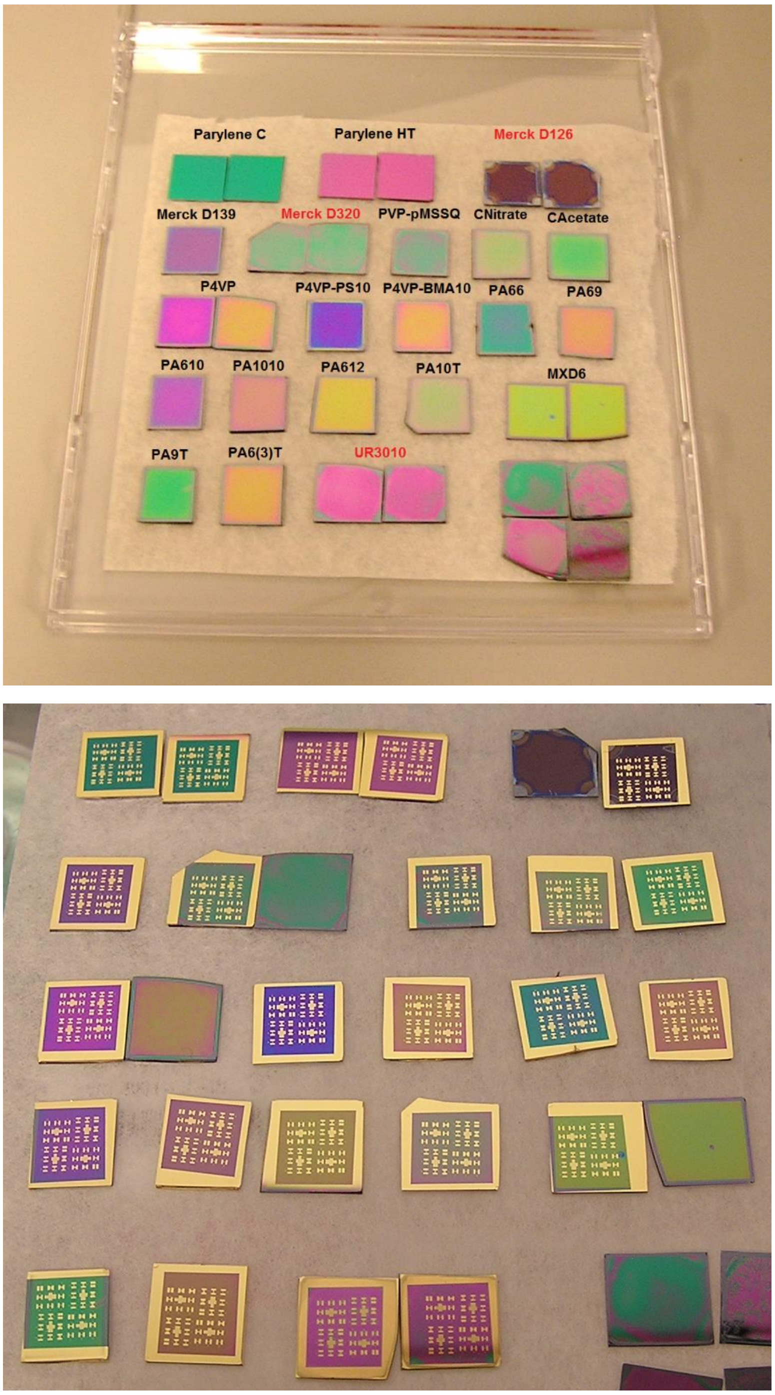

Figure S2: Optical image of a set of polymer spin coated on Si/SiO_2 substrate. Polymers marked in red were degraded during nanotube deposition by soaking in toluene and did not produce working transistors.

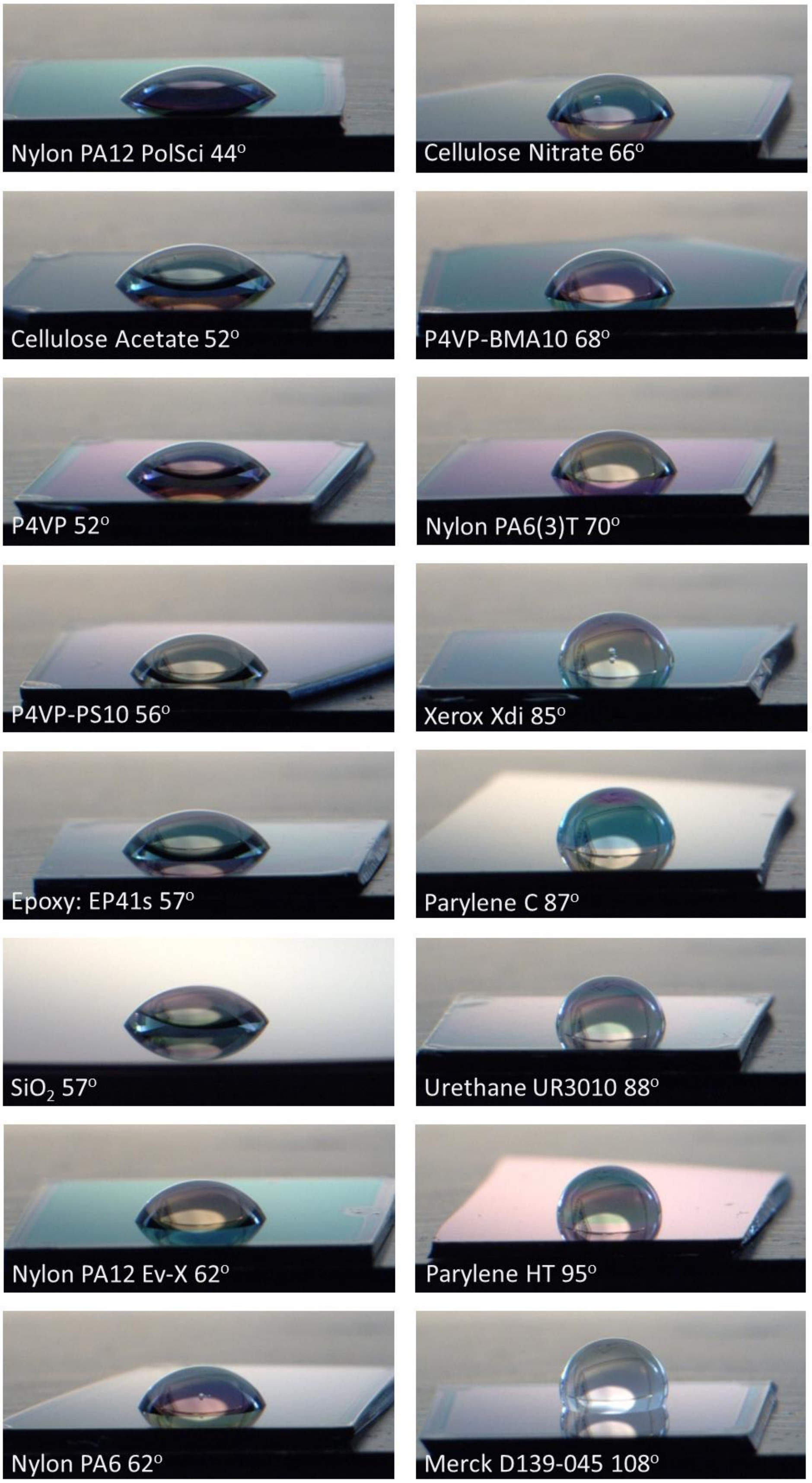

Figure S3: Water contact angle for a representative set of polymeric materials.

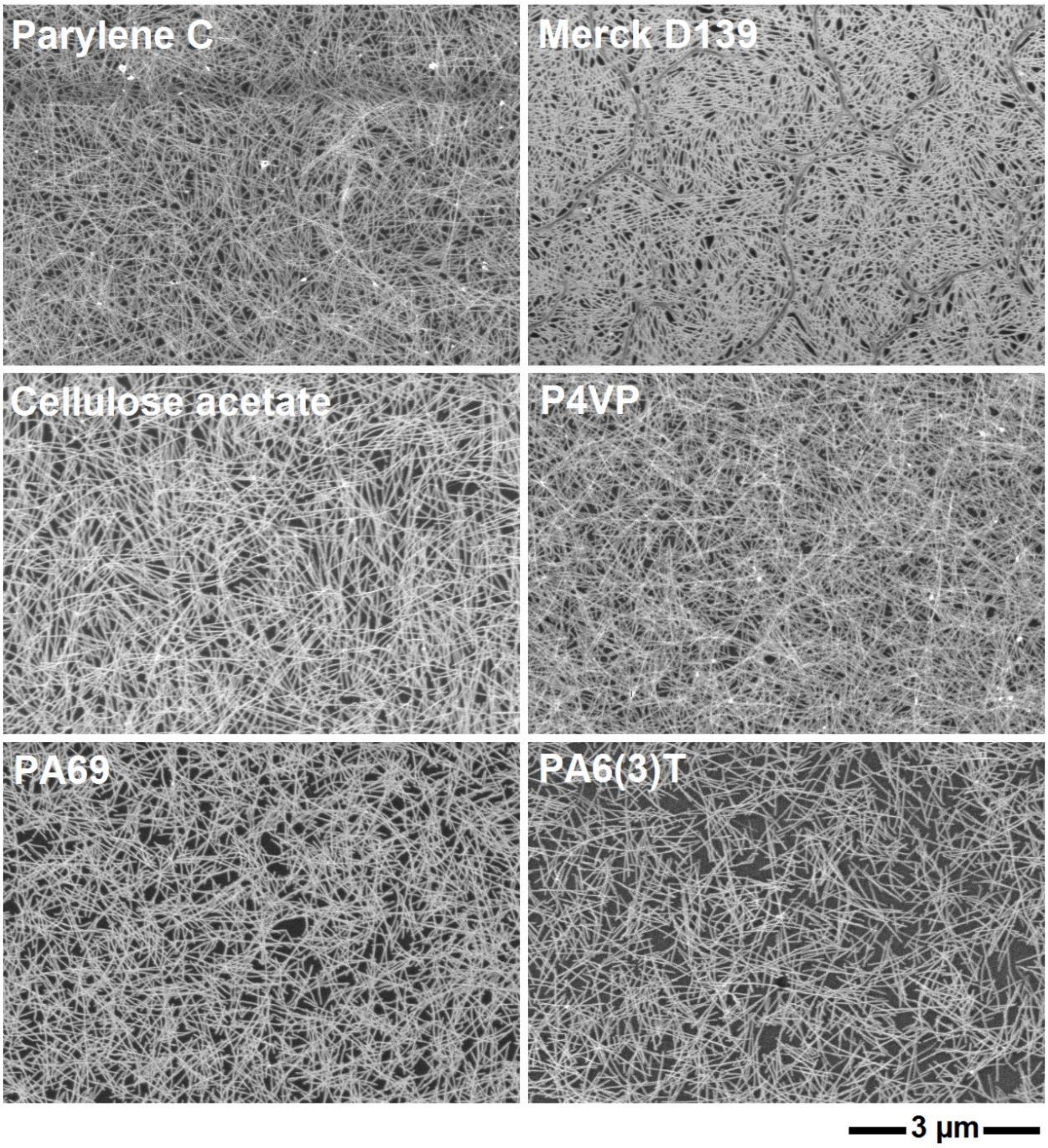

Figure S4: Scanning electron micrographs of single-walled carbon nanotubes on six polymer surfaces. Images were acquired using Hitachi S4700 at 0.5 kV, 15 µA and 5.6 mm working distance in all cases.

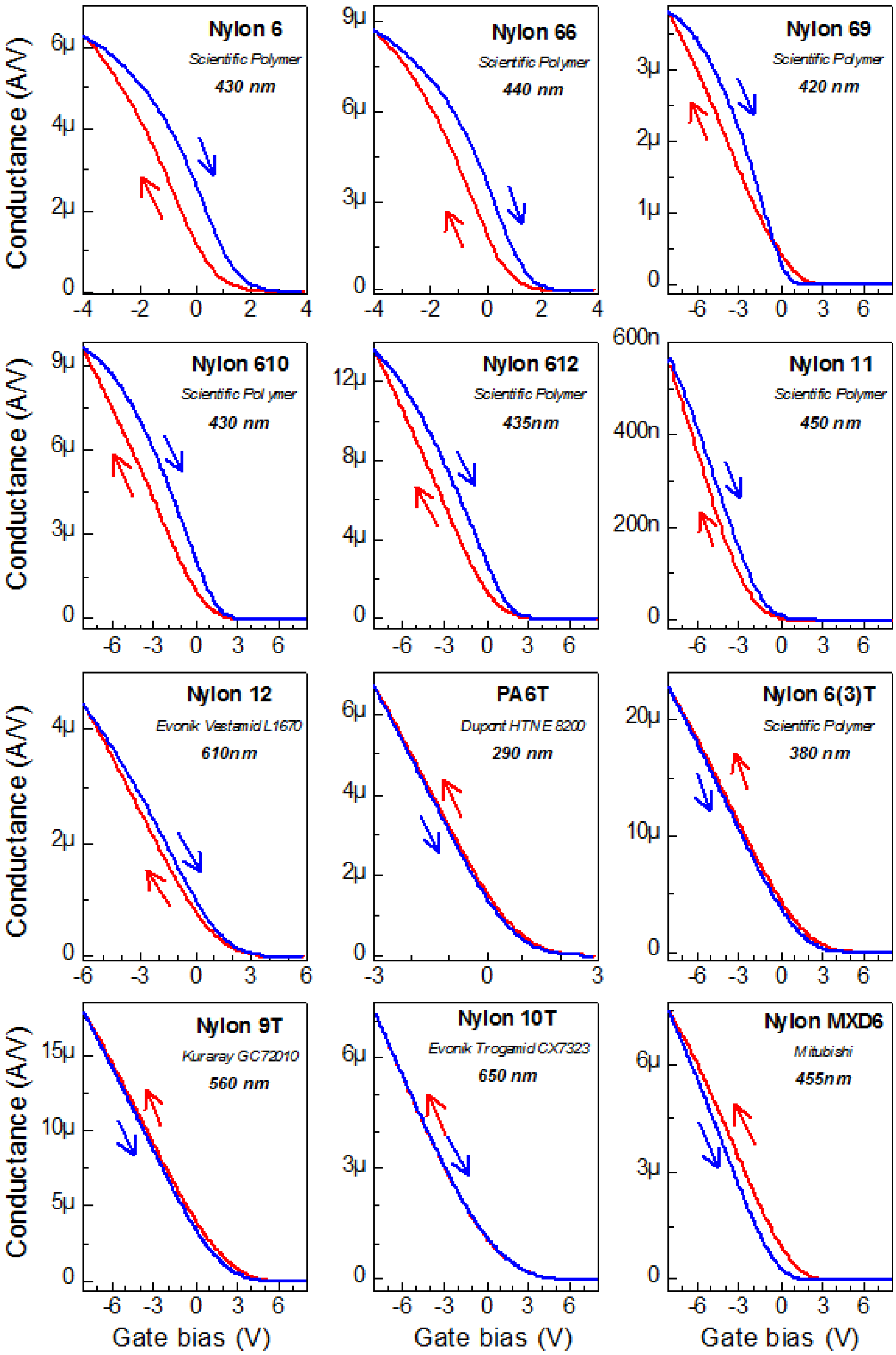

Figure S5: Transfer characteristics for CNN-FETs using nylons as polymer gate dielectrics.

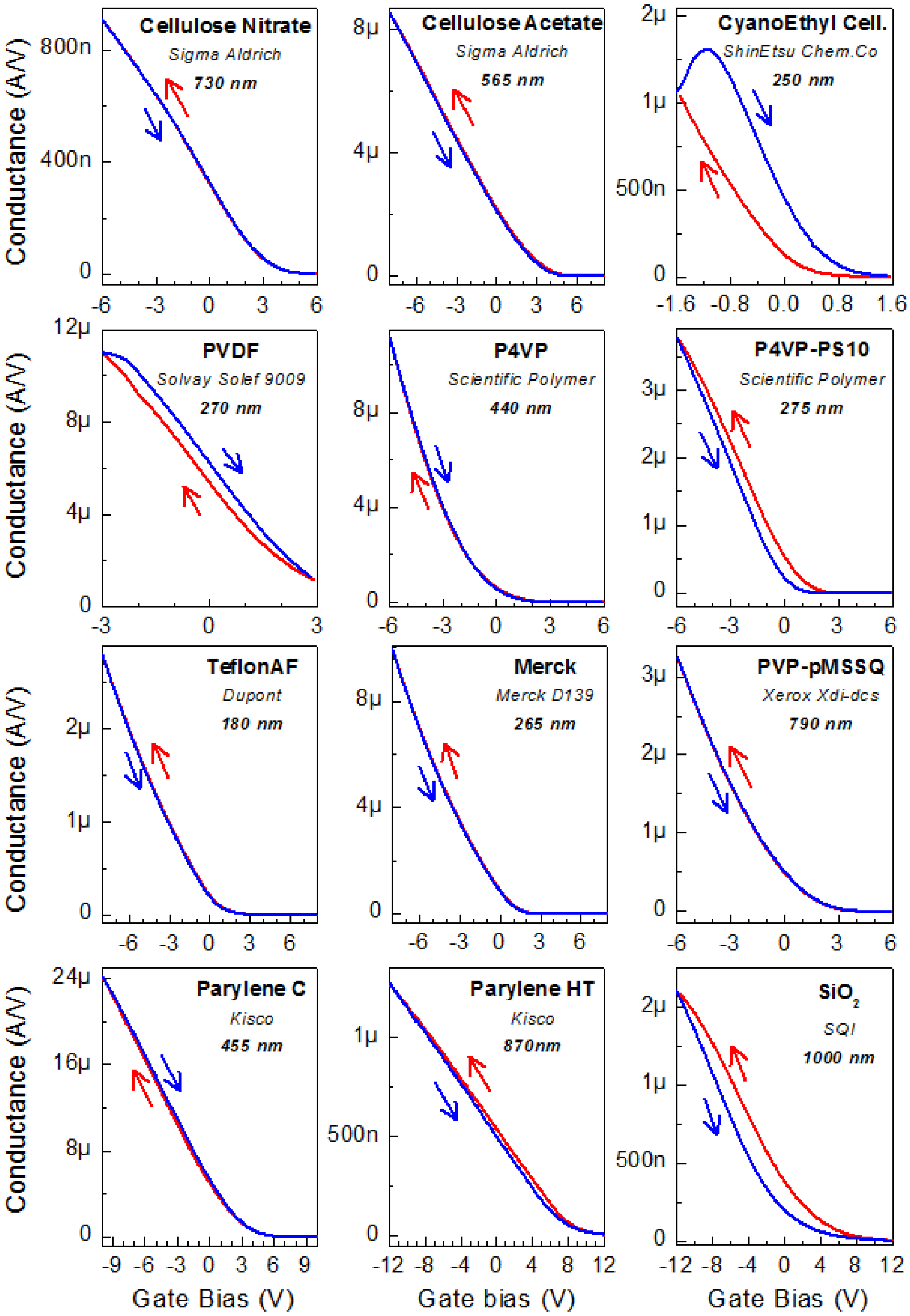

Figure S6: Transfer characteristics for CNN-FETs using various polymers as gate dielectrics.

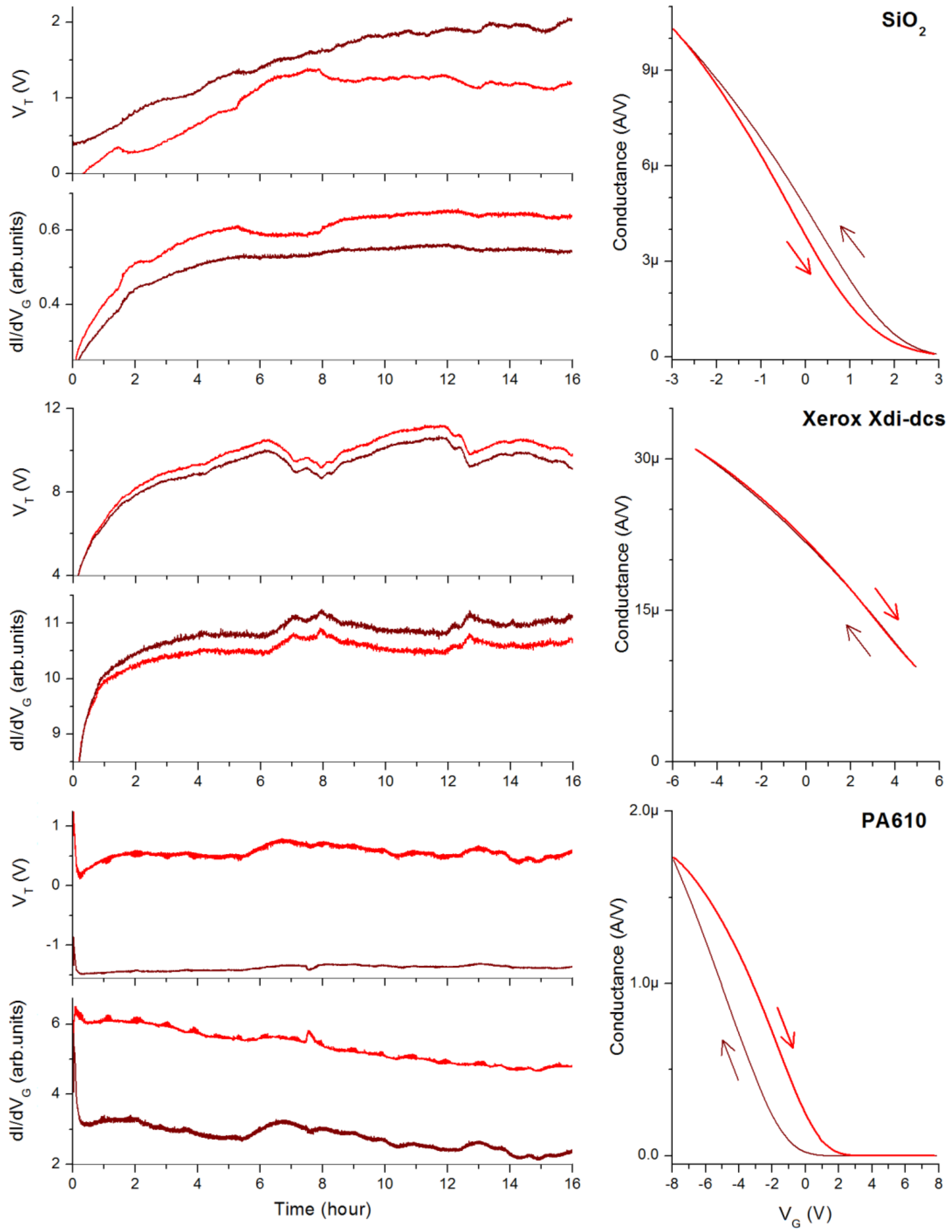

Figure S7: Time evolution of transistor threshold voltage (V_T) and transconductance (dI/dV_G) for three gate dielectric materials in ambient air.

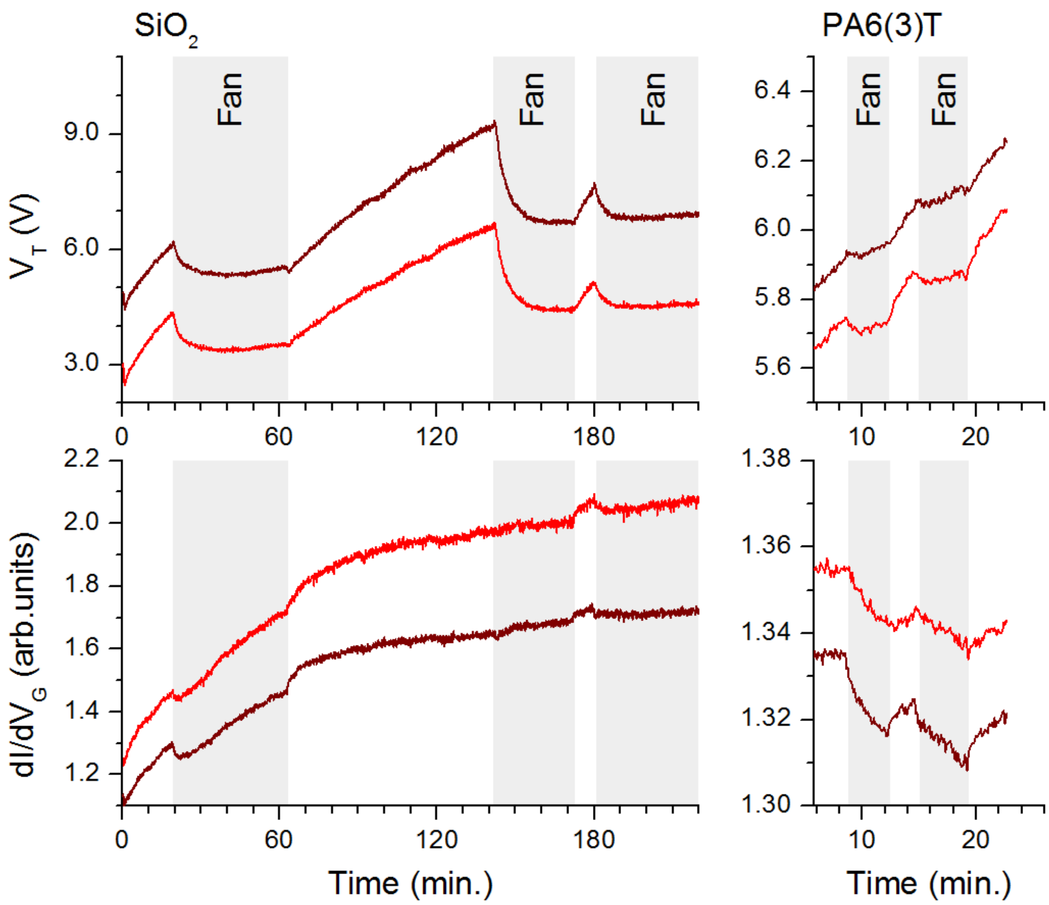

Figure S8: Effect of deionizing fan on the time evolution of transistor threshold voltage (V_T) and transconductance (dI/dV_G) for two gate dielectric materials in air ambient.

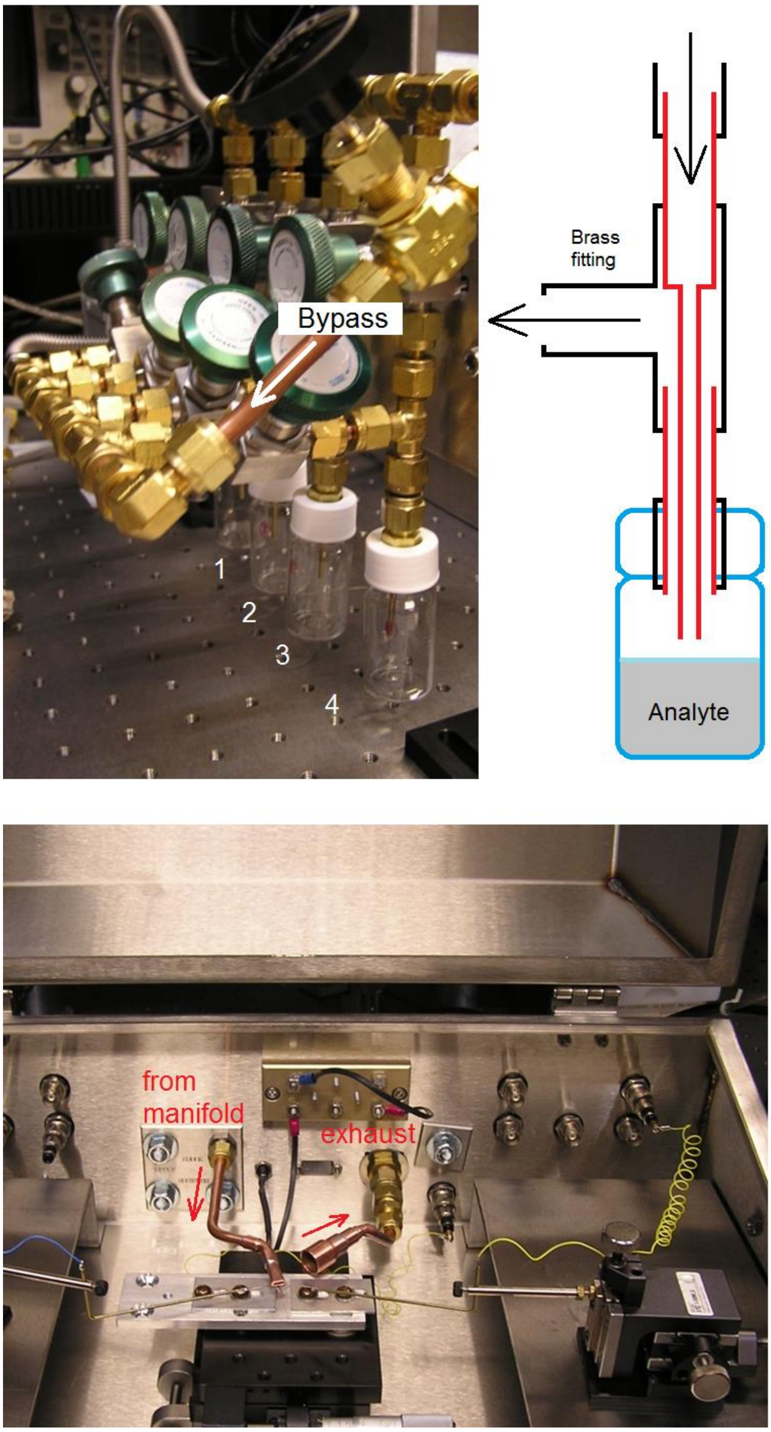

Figure S9: Experimental setup for exposure to volatile compounds. Top left is a picture of the manifold with four bubblers in parallel with a bypass line. Top right is an illustration of the tubing configuration for the incoming and outgoing flow. Bottom is a picture of the probe station with incoming and exhaust copper tubing.

Table S2: Calculated analyte concentration from measured mass loss.

Analyte	Molecular mass (g/mol)	Ambient vapor pressure (mmHg)	Mass loss / Duration	Volume concentration (mg/L)	Mass ppm	Mole ppm
H_2O_2	34	2	62/213’	0.6	480	430
n-Octane	114	11	145mg/71’	4.1	3400	900
NaOCl	74	15	28mg/107’	0.05	42	17
Vinegar (5%wt)	60	16	46mg/114’	.04	30	15
H_2O	18	17	65mg/189’	0.7	580	950
Toluene	92	25	333mg/105’	6.3	5200	1700
Isopropanol	60	33	202mg/71’	6.6	5500	2750
Heptane	100	40	313mg/70’	8.9	7400	2200
Methanol	32	95	400mg/75’	11	9200	8600
Tetrahydrofuran	72	132	246mg/36’	14	11500	4750
Acetone	58	184	452mg/32’	28	23000	12000
Tripropylamine	143	0.02 (1.5)	333mg/105’	.008	7	1.4
diIsobutylamine	129	0.02 (7)	333mg/105’	.007	6	1.4
Isobutylamine	73	0.02 (138)	333mg/105’	.004	3	1.4
Triethylamine	101	0.02 (57)	333mg/105’	.006	5	1.4

In order to calculate the analyte concentration, one bubbler in Figure S9 was operated at 500 sccm for a duration sufficient to obtain a loss of liquid measurable on a balance. The second column in Table S2 reports the measured values from which ppm concentrations are calculated.

Using the measured mass loss and duration, the volume concentration of analyte is given by:

$$\frac{\Delta M}{\Delta t * 0.5\ ^{\mathrm{L}}/_{\mathrm{min}}}$$

The mass ppm ratio is given by dividing the volume concentration by 1.2 g/L, the density of air. A mole ppm ratio is obtained by converting mass numbers into moles (~30g/mol for air). Concentrations in ppm mole fraction are quoted in the text.

For amine solutions diluted with toluene, ppm values for toluene were used and scaled using the partial pressure (0.02 mmHg) of the amine with respect to toluene (25 mmHg).

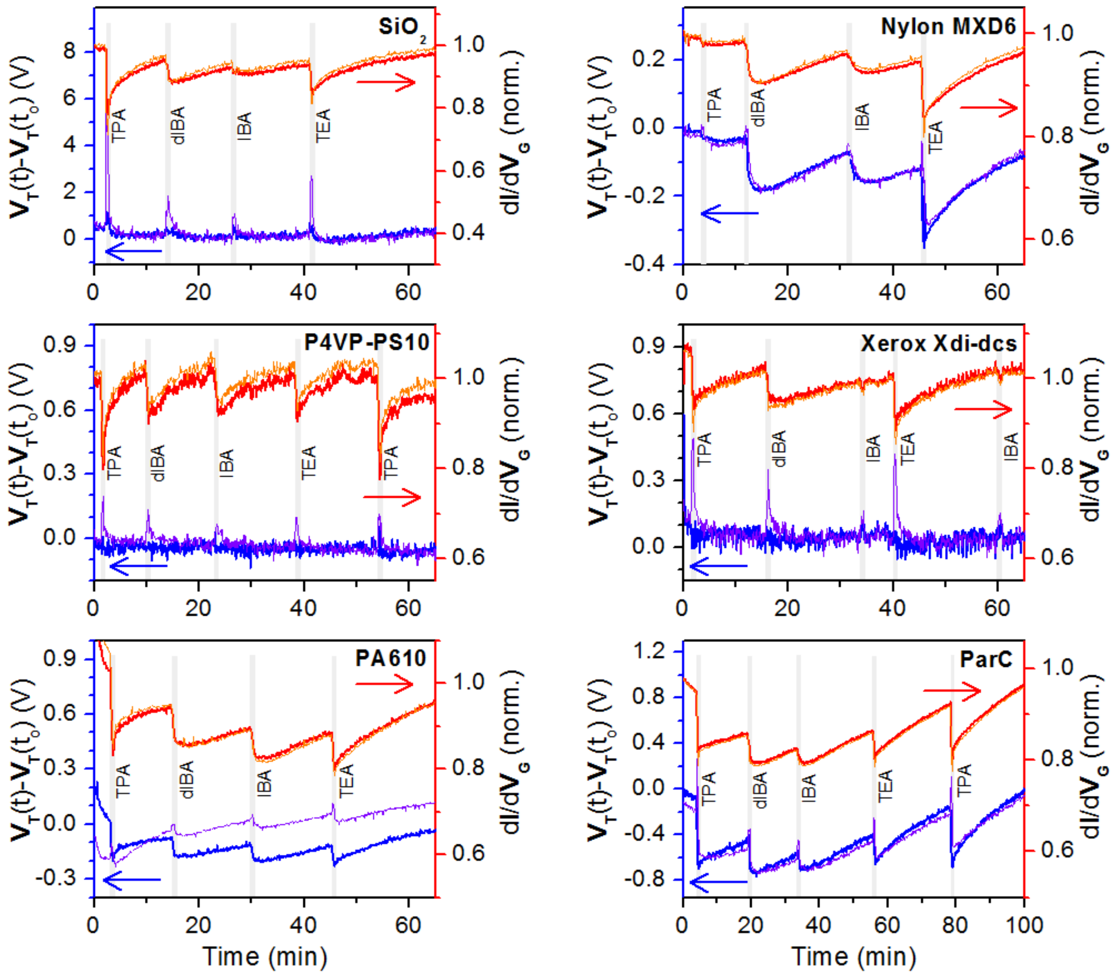

Figure S10: Evolution of threshold voltage (V_T) and transconductance (dI/dV_G) for six transistors with different gate dielectrics upon exposure to four volatile amines in a toluene solution: tripropylamine (TPA), diisobutylamine (dIBA), isobutylamine (IBA) and trimethylamine (TEA). The molar concentration in air is 1.4 ppm for the four amines.