Electronic Supplementary Material (ESI) for Materials Chemistry Frontiers.

Supporting Information

Benzyl and Fluorinated Benzyl Side Chains for Perylene Diimide Non-Fullerene Acceptors

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1. Materials and Methods:

Materials: All reactants, reagents, and catalysts were purchased from Sigma-Aldrich. PTB7-Th was purchased from 1-Material. TTFQx-T1 **(**QX-1) was made by Yingping Zou's team as previously reported (J. Mater. Chem. A, 2018, **6**, 3074–3083). All solvents and materials purchased were used without further purification. Purification by flash column chromatography was performed using a Biotage® Isolera flash system.

Nuclear Magnetic Resonance (NMR): ^{1}H, ^{13}C{^{1}H}, and ^{19}F NMR spectra were recorded on a Bruker Avance-500 MHz spectrometer at 300 K. Chemical shifts are reported in parts per million (ppm). Multiplicities are reported as: singlet (s), doublet (d), doublet of doublets (dd), triplet (t), multiplet (m), quintet (quin), overlapping (ov), and broad (br).

High-resolution Mass Spectrometry (HRMS): High-resolution MALDI mass spectrometry measurements were performed courtesy of Jian Jun Li in the Chemical Instrumentation Facility at the University of Calgary. A Bruker Autoflex III Smartbeam MALDI-TOF (Na:YAG laser, 355nm), setting in positive reflective mode, was used to acquire spectra. Operation settings were all typical, e.g. laser offset 62-69; laser frequency 200Hz; and number of shots 300. The target used was Bruker MTP 384 ground steel plate target. Sample solution (~ 1 µg/mL in dichloromethane) was mixed with matrix trans-2-[3-(4-tert-Butylphenyl)-2-methyl-2-propenylidene]malononitrile (DCTB) solution (~ 5mg/mL in methanol). Pipetted 1µl solution above to target spot and dried in the fume hood.

Cyclic Voltammetry (CV): All electrochemical measurements were performed using a Model 1200B Series Handheld Potentiostat by CH Instruments Inc. equipped with Ag wire, Pt wire and glassy carbon electrode, as the pseudo reference, counter electrode and working electrode respectively. Glassy carbon electrodes were polished with alumina. The cyclic voltammetry experiments were performed in anhydrous dichloromethane solution with ~0.1 M tetrabutylammonium hexafluorophosphate ($TBAPF_6$) as the supporting electrolyte at scan rate 100 mV/s. All electrochemical solutions were purged with dry N_2 for 5 minutes to deoxygenate the system. Solution CV measurements were carried out with a small molecule concentration of ~0.5 mg/mL in dichloromethane. The ionization potentials (IP) and electron affinities (EA) were estimated by correlating the $E_{1/2}$ values of the first of oxidation and reduction (E_{ox}Fc/Fc+, E_{red}Fc/Fc+) referenced to a ferrocene internal standard to that of the ionization potential of ferrocene using a conversion value of 4.8 (see: Advanced Materials, 1995, 7 (6), 551-554, Advanced Materials, 2011, 23 (20), 2367-2371).

UV-Visible Spectroscopy (UV-Vis): All optical absorption measurements were recorded using Agilent Technologies Cary 60 UV-Vis spectrometer at room temperature. All solution UV-Vis experiments were run in $CHCl_3$ using 10 mm quartz cuvettes. Films were spin-cast into Corning glass micro slides from $CHCl_3$ solutions (10 mg/mL) at 1500 rpm or from C_6H_5Cl solutions (10mg/mL) at 1500 rpm. Prior to use, glass slides were cleaned with soap and water, acetone and isopropanol, and followed by UV/ozone treatment using a Novascan UV/ozone cleaning system.

CHN Analysis: Elemental analysis was performed by Jian Jun Li in the Chemical Instrumentation Facility at the University of Calgary. A Perkin Elmer 2400 Series II CHN Elemental Analyzer was used to obtain CHN data from a minimum of 3 mg of sample with particle sizes ranging between 0.2 and 0.5 mm in diameter. Results were obtained in duplicate.

OTFT Fabrication: Bottom-gate, bottom-contact (BGBC) OTFTs were made using prefabricated Si/SiO_2 substrates with gold/indium tin oxide (ITO) source-drain contacts (L = 2.5 µm - 20 µm, W=2000 µm) manufactured by Fraunhofer IPMS. Substrates were rinsed with acetone, dried with nitrogen, and then treated with oxygen plasma for 15 minutes. These substrates were modified with octyltrichlorosilane (OTS, Sigma, 97%) in 1% v/v solution for 1 hour at 70 ºC before rinsing and drying in vacuum at 70 ºC for 1 hour. Spin cast devices were made using solutions of **1**, **2** and **3** in $CHCl_3$ (10 mg/mL) filtered with a 0.2 µm PTFE filter and deposited dynamically onto OTS-modified substrates spinning at 3000 rpm for 60s, producing consistent blue to purple films. The substrates were dried at 50 °C for 20 minutes under vacuum. After initial testing, devices were annealed in a vacuum chamber at 180 °C for 10 minutes and cooled to room temperature before re-testing.

OTFT Testing: Prepared OTFTs were transferred in an evacuated capsule into an OTFT testing chamber designed by Element Instrumentation. Devices were not exposed to air before testing around 0.5 Pa. Output and transfer characteristics were obtained for each device with L = 2.5 µm. For transfer curves, data was collected at V_{DS} = 70 V. The gate voltage range tested was 0 to 60V in all cases except for unannealed devices using **2**, which had a higher threshold voltage and required a range of 0V to 80V to fully capture transfer characteristics. The electron saturation field-effect mobility (μ_e) and threshold voltage (V_T) were calculated using the following equation, using the capacitance density (C_i) calculated from the dielectric thickness (t, 230 nm):

$$I_{DS} = \frac{\mu_e C_i W}{2L}(V_{GS} - V_T)^2$$

$$C_i = \frac{k\varepsilon_0}{t}$$

where V_{GS} is the voltage applied between the gate and source, I_{DS} is the current measured between the source and drain, W and L are the channel width and length and k is the relative dielectric constant of SiO_2 (about 3.9).

OSC Fabrication/Testing: Devices were fabricated using ITO-coated glass substrates cleaned by sequentially ultra-sonicating detergent and de-ionized water, acetone, and isopropanol followed by exposure to UV/ozone for 30 minutes. ZnO was subsequently deposited as a sol-gel precursor solution in the air following the method of Sun et al.[1]. The room temperature solution was filtered and spin-cast at a speed of 4000 rpm and then annealed at 200 °C in air for 15 min. Active layer solutions of PTB7-Th and **PDI** material **1**, **2**, and **3** were prepared in the air with a total concentration of 10 mg/mL in CB. Solutions of PTB7-Th was stirred at 70 °C for 4-6 hrs. Active layer materials were combined in a 1:1 D/A weight ratio and cast at room temperature at a speed of 1500 rpm for 60 seconds. Active layer solutions of QX1(TTFQx-T1) and **PDI** material **1**, **2**, and **3** were prepared in the air with a total concentration of 10 mg/mL in 2Me-THF. Active layer materials were combined in a 4:6 D/A weight ratio and cast at room temperature at a speed of 1500 rpm for 60 seconds. All substrates upon casting active layers were kept in an N_2 atmosphere glovebox overnight before evaporating MoO_x and Ag. The evaporation of 10 nm of MoO_x followed by 100 nm of Ag was thermally deposited under vacuum ($3x10^{-6}$ Torr). The active areas of resulting devices were 0.09 cm^2. The current density-voltage (J-V) curves were measured by a Keithley 2420 source measure unit. The photocurrent was measured under AM 1.5 illumination at 100mW/cm^2 under a Solar Simulator (Newport 92251A-1000). The standard silicon solar cell (Newport 91150V) was used to calibrate light intensity. All tests carried out in air.

2. Synthetic Details:

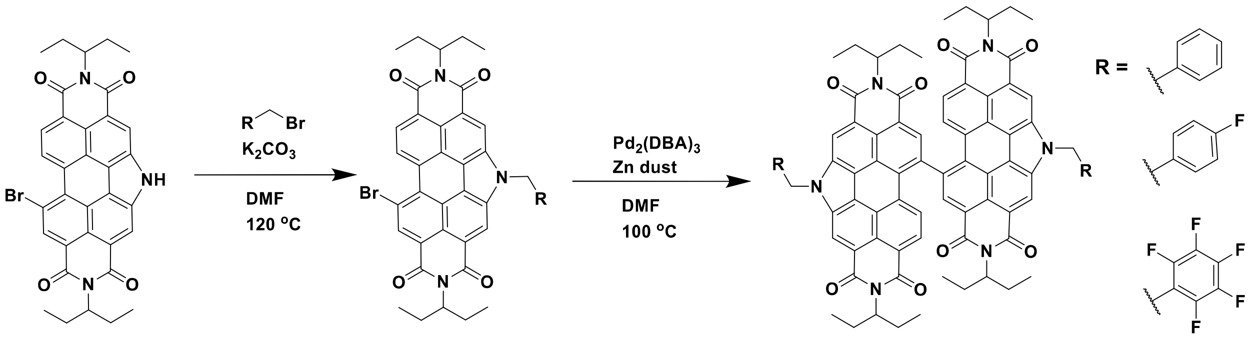
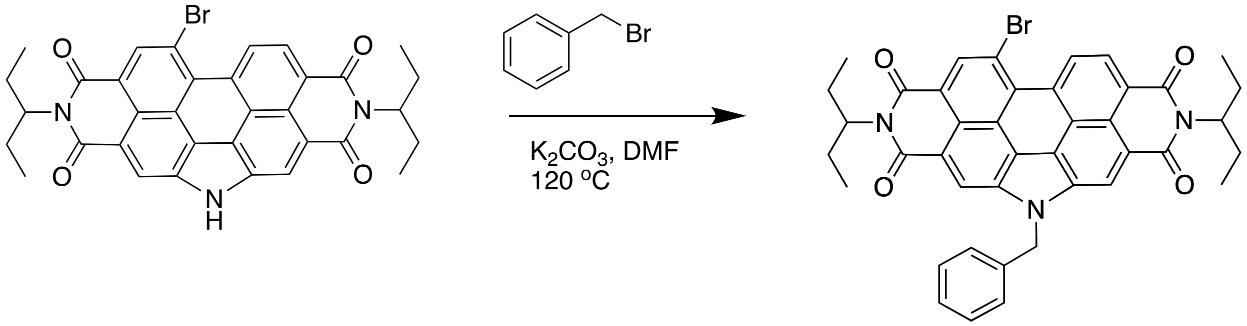


Figure S1. Synthesis of the target PDI materials.

Synthesis of Br-PDIN-benzyl:



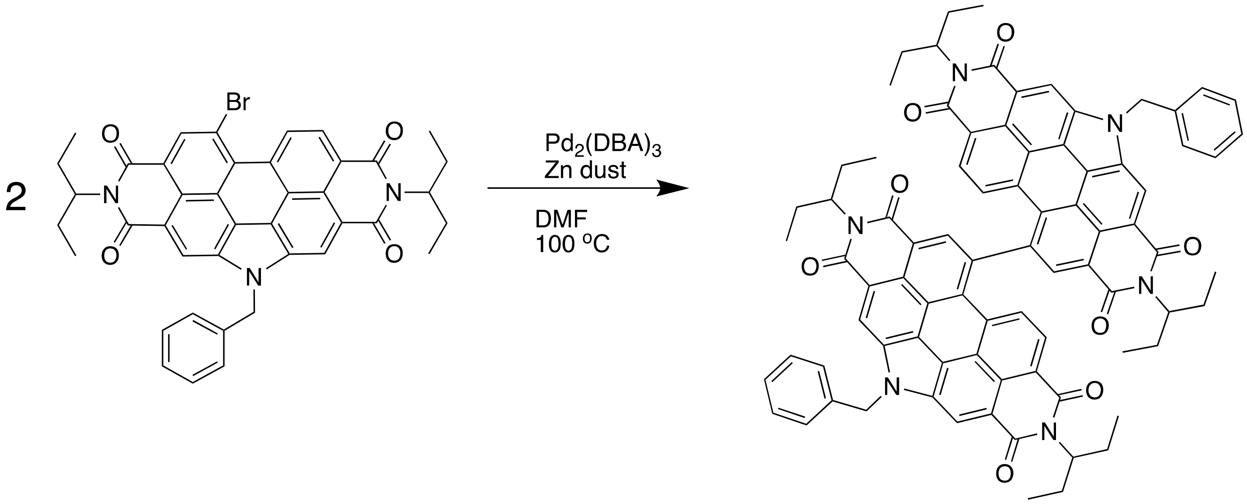
In a two-neck 250 mL round bottom flask were transferred Br-PDIN-H (1.3 g, 2.09 mmol) and K_2CO_3 (0.578 g, 4.18 mmol) along with a stir-bar. The flask was fitted with a reflux condenser, sealed, and then purged with nitrogen for 10 minutes. Approximately 60 mL of dry *N*,*N*-dimethylformamide were added via canula transfer. Benzyl-bromide (0.537 g, 3.14 mmol) was added to the flask via syringe and the reaction mixture was placed in a LabArmor® bead bath and heated at 120 °C for 35 minutes, at which time TLC analysis showed reaction completion. The reaction was taken up in 200 mL of methanol and 30 mL of water and left to stir for 1 hour. Crude solid was recovered *via* vacuum filtration, washing with methanol. The solid was recrystallized by dissolving in a minimal amount of dichloromethane and precipitating with methanol. **Yield:** 1.3011 g (87%)

^{1}H-NMR (500 MHz, chloroform-d) δ: 10.06-10.02 (d, 1H), 8.96 (s 1H), 8.93-8.90 (d, 2H), 8.80 (s, 1H), 7.35-7.30 (m, 3H), 7.29-7.26 (m, 2H), 6.05 (s, 2H), 5.24-5.14 (m, 2H), 2.41-2.29 (m, 5H), 2.09-1.98 (m, 5H), 1.03-0.968 (q, 14H)

^{13}C-NMR (125 MHz, chloroform-d) δ: 135.50, 134.17, 133.96, 128.78, 128.17, 127.08, 126.49, 123.73, 123.15, 122.79, 121.62, 120.99, 118.50, 118.06, 57.49, 57.35, 49.71, 24.63, 24.57, 10.98, 10.94

MALDI-TOF: m/z expected: 712.63 obtained: 712.1827

Synthesis of tPDI$_2$N-benzyl (1):



In a 20 mL pressure vial was transferred Br-PDIN-benzyl (500 mg, 0.702 mmol) and zinc dust (200 mg, 3.51 mmol). Tris(dibenzylideneacetone)dipalladium(0) (64 mg 10 mol%) was added under N_2 in the glovebox and the vial was sealed with a Teflon® cap. Out of the glovebox 15 mL of anhydrous *N*,*N*-dimethylformamide were added *via* syringe, The vial was placed in a LabArmor® bead bath heated at 100 °C for 25 minutes, after which the solution turned blue and TLC analysis showed reaction completion. The reaction mixture was extracted with dichloromethane and passed through a silica plug to remove the zinc and palladium catalyst. The solution was then concentrated and passed through a second silica plug to ensure total remove of zinc and palladium catalyst. The dichloromethane was removed *via* rotary evaporation and the crude solid was isolated *via* precipitation from methanol. The solid was purified by boiling in isopropanol for 1.5 hours. The isolated solid was then re-dissolved in dichloromethane and slurried with Celite 545 and aluminum oxide for 1 hour. The slurry was vacuum filtered, the solvent was removed, and the solid was isolated *via* vacuum filtration following precipitation from methanol. **Yield:** 263 mg (59%).

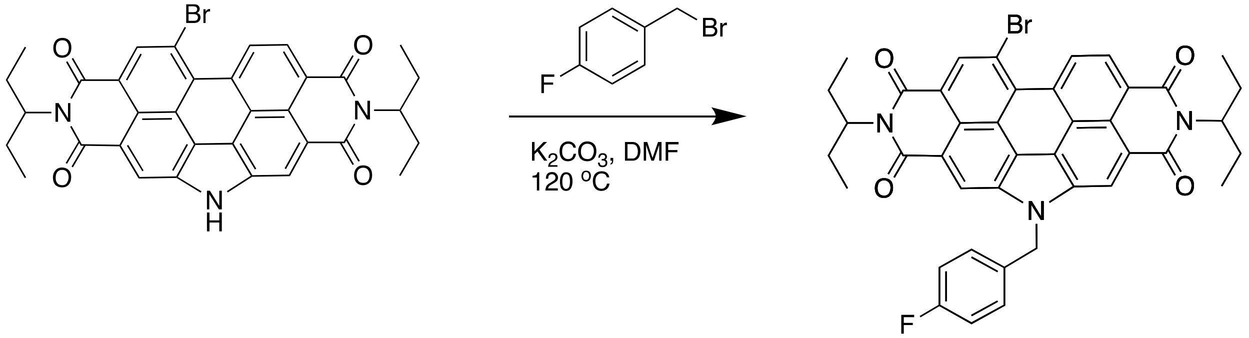
^{1}H-NMR (500 MHz, chloroform-d) δ: 9.21 (s, 1H), 9.04 (s, 1H), 8.87 (s, 1H), 8.00-7.96 (d, 1H), 7.72-7.70 (d, 1H), 7.48-7.37 (m, 6H), 6.20 (s, 2H), 5.21 (bs, 1H), 5.02 (bs, 1H), 2.40-2.28 (m, 2H), 2.24-2.12 (m, 2H), 2.05-1.93 (m, 2H), 1.90-1.79 (m, 2H), 1.02-0.979 (t, 7H) and 0.819 (bs, 7H)

^{13}C-NMR (125 MHz, chloroform-d) δ: 141.03, 136.26, 135.53, 135.32, 133.57, 130.57, 129.59, 128.93, 127.37, 127.04, 125.20, 124.95, 123.67, 122.86, 120.46, 120.15, 58.13, 57.74, 50.69, 25.30, 25.13, 11.66, 11.39.

MALDI-TOF: m/z expected:1264.51 obtained:1264.5043.

Elemental Analysis: Theory %C 77.83, %H 5.42, %N 6.64. Actual %C 76.36, %H 5.55, %N 6.64.

Synthesis of Br-PDIN-benzylF:



In a two-neck 250 mL round bottom flask was transferred Br-PDIN-H (1.3867 g, 2.23 mmol) and K_2CO_3 (0.616 g, 4.46 mmol). The flask was fitted with a reflux condenser, sealed, and then purged with nitrogen for 10 minutes. Approximately 60 mL of dry *N,N*-dimethylformamide was added *via* canula transfer. Para-fluorobenzylbromide (0.631 g, 3.34 mmol) was added to the flask *via* syringe and the reaction mixture was placed in a LabArmor® bead bath and heated at 120 °C for 1 hour and 20 minutes, at which time TLC analysis showed reaction completion. The reaction was taken up in 200 mL of methanol and 30 mL of water and left to stir for 1 hour. Crude solid was recovered *via* vacuum filtration, washing with methanol. The solid was recrystallized by dissolving in a minimal amount of dichloromethane and precipitating with methanol. **Yield:** 1.34 g (82%)

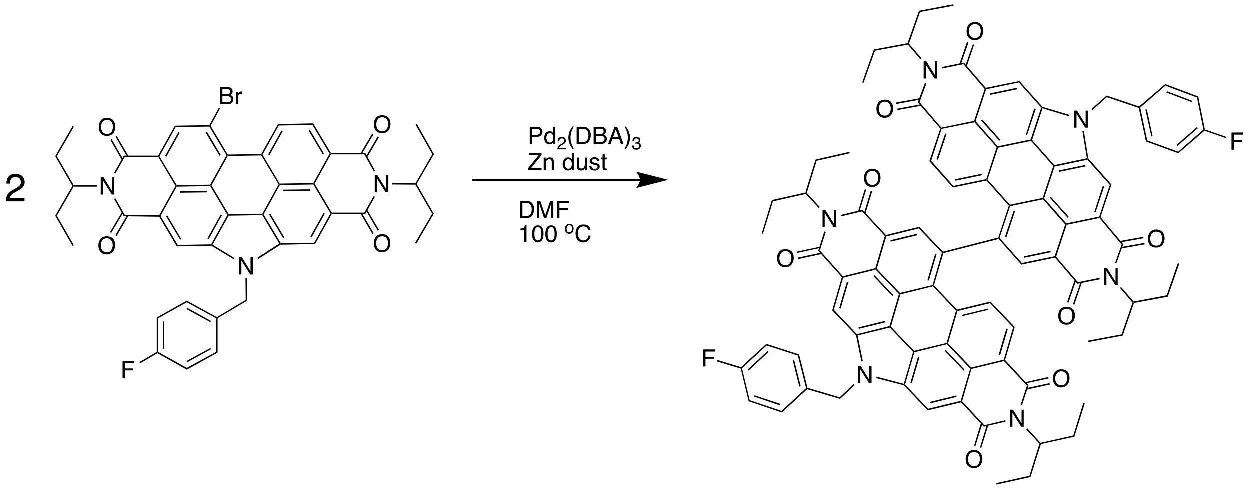
^{1}**H-NMR** (500 MHz, chloroform-d) δ: 10.16-10.11 (d, 1H), 9.02 (s, 1H), 8.95-8.91 (d, 2H), 8.86-8.82 (d, 1H), 7.32-7.26 (m, 2H), 7.05-7.00 (t, 2H), 6.04 (s, 2H), 5.25-5.13 (m, 2H) 2.42-2.27 (m, 4H), 2.10-1.96 (m, 4H), 1.03-0.954 (q, 13H)

^{13}**C-NMR** (125 MHz, chloroform-d) δ: 134.05, 133.81, 131.97, 131.14, 129.99, 128.31, 128.24, 127.14, 123.75, 123.15, 122.79, 121.63, 121.08, 118.53, 118.11, 115.95, 115.75, 57.52, 57.38, 49.07, 24.61, 11.04

^{19}**F-NMR** (390 MHz, chloroform-d) δ: 113.60 (s)

MALDI-TOF: m/z expected: 730.63 obtained: 730.1680

Synthesis of tPDI$_2$N-benzylF (2):



In a 20 mL pressure vial was transferred Br-PDIN-benzylF (511.8 mg, 0.700 mmol) and zinc dust (229 mg, 3.50 mmol). Tris(dibenzylideneacetone)dipalladium(0) (64 mg, 10 mol%) was added under N_2 in the glovebox and the vial was sealed with a Teflon® cap. Out of the glovebox 15 mL of anhydrous *N*,*N*-dimethylformamide was added *via* syringe. The vial was placed in a LabArmor® bead bath and heated at 100 °C for 1 hour and 10 minutes, after which the solution turned purple and TLC analysis showed reaction completion. The reaction mixture was extracted with dichloromethane and passed through a silica plug to remove zinc and palladium catalyst. The solution was then concentrated and passed through a second silica plug to ensure total remove of zinc and catalyst. The dichloromethane was removed *via* rotary evaporation and the crude solid was isolated *via* precipitation from methanol. The solid was purified by in boiling isopropanol for 1.5 hours. The isolated solid was then redissolved in dichloromethane and slurried with Celite 545 and aluminum oxide for 1 hour. The slurry was vacuum filtered, the solvent was removed, and the solid was isolated *via* vacuum filtration following precipitation from methanol. **Yield:** 263.9 mg (58%).

^{1}H-NMR (500 MHz, chloroform-d) δ: 9.20 (s, 1H), 9.03 (s, 1H), 8.88 (s, 1H), 8.01-7.96 (d, 1H), 7.73-7.70 (d, 1H), 7.47-7.42 (dd, 2H), 7.15-7.09 (t, 2H), 6.18 (s, 2H), 5.21 (bs, 1H), 5.03 (bs, 1H), 2.39-2.29 (m, 2H), 2.22-2.12 (m, 2H), 2.04-1.94 (m, 2H), 1.90-1.80 (m, 2H), 1.03-0.974 (t, 6H), 0.820 (bs, 6H)

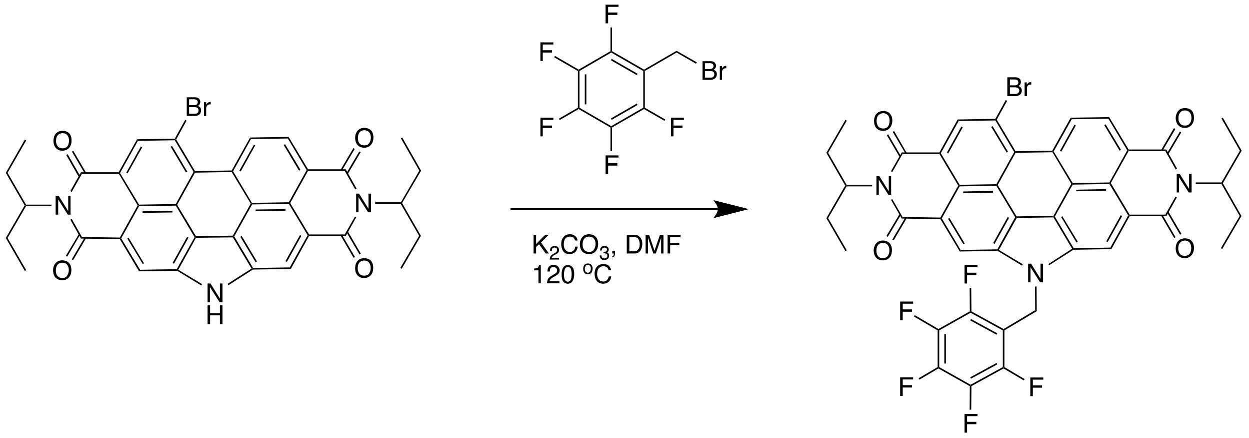
^{13}C-NMR (125 MHz, chloroform-d) δ: 163.21, 161.24, 140.35, 134.70, 134.49, 132.37, 131.42, 131.39, 129.88, 128.50, 128.44, 126.39, 124.51, 124.26, 123.0, 122.17, 119.80, 119.50, 118.42, 116.04, 115.86, 57.48, 57.09, 49.28, 24.61, 24.44, 10.96, 10.69

^{19}F-NMR (390 mHz, chloroform-d) δ: -112.90 (s)

MALDI-TOF: m/z expected:1300.49 obtained:1300.4904.

Elemental Analysis: Theory %C 75,68, %H 5.11, %N 6.46. Actual %C 74.94, %H 5.11, %N 6.27.

Synthesis of Br-PDIN-benzylF$_5$:



In a two-neck 250 mL round bottom flask was transferred Br-PDIN-H (0.9688 g, 1.782 mmol) and K_2CO_3 (0.4926 g, 3.564 mmol). The flask was fitted with a reflux condenser, sealed, and then purged with nitrogen for 10 minutes. Approximately 60 mL of dry *N*,*N*-dimethylformamide was added *via* canula transfer. Pentafluorobenzylbromide (0.6977 g, 2.673 mmol) was added to the flask *via* syringe and the reaction mixture was placed in a LabArmor® bead bath and heated at 120 °C for 3 hours, at which time TLC analysis showed reaction completion. The reaction was taken up in 200 mL of methanol and 30 mL of water and left to stir for 1 hour. The crude solid was loaded on silica gel and purified using column chromatography, eluting with 100% dichloromethane. The solvent was removed using a rotary evaporator and the solid isolated *via* vacuum filtration following precipitation from methanol. **Yield:** 0.9045 g (70%)

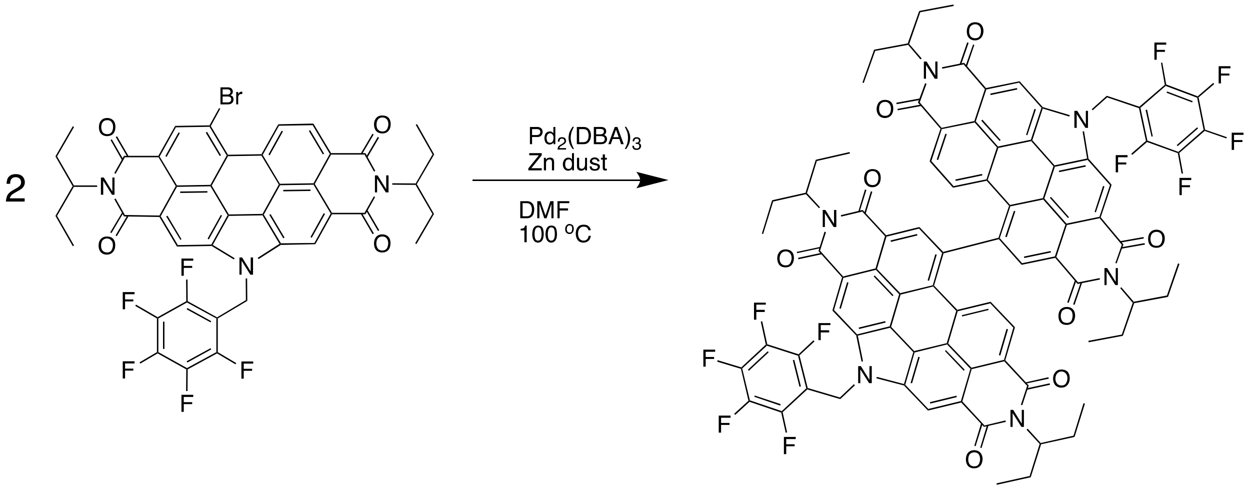
^{1}H-NMR (500 MHz, chloroform-d) δ: 10.28-10.24 (d, 1H), 9.17-9.12 (d, 2H), 9.09-9.06 (s, 1H), 8.93-8.86 (s, 1H), 6.20 (s, 2H), 5.26-5.16 (m, 2H), 2.42-2.30 (m, 4H), 2.09-1.97 (m, 4H), 1.02-0.961 (q, 13H)

^{13}C-NMR (125 MHz, chloroform-d) δ: 145.88, 143.90, 142.63, 138.41, 136.34, 133.52, 131.02, 129.08, 126.38, 122.33, 121.74, 120.73, 117.94, 116.67, 108.82, 57.61, 36.87, 24.60, 11.08

^{19}F-NMR (390 MHz, chloroform-d) δ: -141.60-141.68 (d), -151.45-151.62 (t), -159.79-159.99 (t)

MALDI-TOF: m/z expected:802.60 obtained:802.1343

Synthesis of tPDI$_2$N-benzylF$_5$ (3):



In a 20 mL pressure vial was transferred Br-PDIN-benzylF$_5$ (388.4 mg, 0.4216 mmol) and zinc dust (137.8 mg, 3.156 mmol). Tris(dibenzylideneacetone)dipalladium(0) (38.6 mg, 10 mol%) was added under N_2 in the glovebox and the vial was sealed with a Teflon® cap. Out of the glovebox 15 mL of anhydrous *N,N*-dimethylformamide was added *via* syringe. The vial was placed in a LabArmor® bead bath and heated at 100 °C for 1 hour and 40 minutes, after which the solution turned dark brown and TLC analysis showed reaction completion. The reaction mixture was extracted with dichloromethane and passed through a silica plug to remove zinc and palladium catalyst. The solution was then concentrated and passed through a second silica plug to ensure total remove of zinc and catalyst. The dichloromethane was removed *via* rotary evaporation and the crude solid was isolated *via* precipitation from methanol. The crude solid was loaded on silica gel and purified using column chromatography (100% dichloromethane). The solvent was removed using a rotary evaporator then slurried with Celite 545 and aluminum oxide for 1 hour. The slurry was vacuum filtered, the solvent was removed and the solid was isolated *via* vacuum filtration following precipitation from methanol. **Yield:** 179.6 mg (59%)

^{1}H-NMR (500 MHz, chloroform-d) δ: 9.36 (s, 1H), 9.17 (s, 1H), 8.88 (s, 1H), 7.96 (d, 1H), 7.67-7.64 (d, 1H), 6.29 (s, 2H), 5.22 (bs, 1H), 5.03 (bs, 1H), 2.37 (s, 2H), 2.19 (s, 2H), 2.06-1.97 (m, 2H), 1.92-1.82 (m, 2H), 1.05-0.984 (t, 7H), 0.827 (bs, 8H)

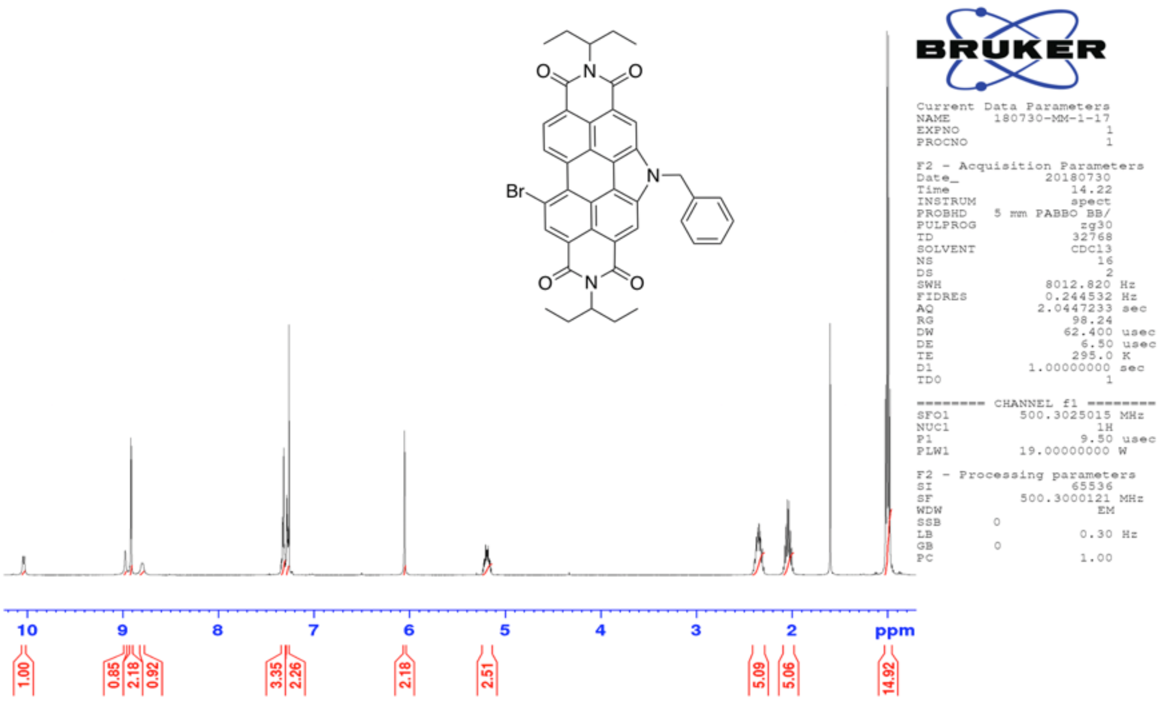
^{13}C-NMR (125 MHz, chloroform-d) δ:140.30, 134.47, 134.24, 132.36, 129.89, 126.39, 126.39, 124.57, 124.30, 122.91, 122.06, 119.90, 119.58, 57.55, 57.15, 37.07, 30.38, 29.13, 24.60, 24.42, 10.97, 10.70

^{19}F-NMR (390 MHz, chloroform-d) δ: -141.40-141.58 (d), -151.41-151.55 (t), -159.67-159.85 (td)

MALDI-TOF: m/z expected:1443.41 obtained:1444.4129.

Elemental Analysis: Theory %C 68.14, %H 4.04, %N 5.81. Actual %C 68.04, %H 4.17, %N 5.69.

3. ^{1}H, ^{13}C, and ^{19}F NMR Spectra:



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PULPROG             zg30
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FIDRES          0.244532 Hz
AQ             2.0447233 sec
RG                 98.24
DW                62.400 usec
DE                  6.50 usec
TE                 295.0 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
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NUC1                  1H
P1                  9.50 usec
PLW1         19.00000000 W

F2 - Processing parameters
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SF           500.3000121 MHz
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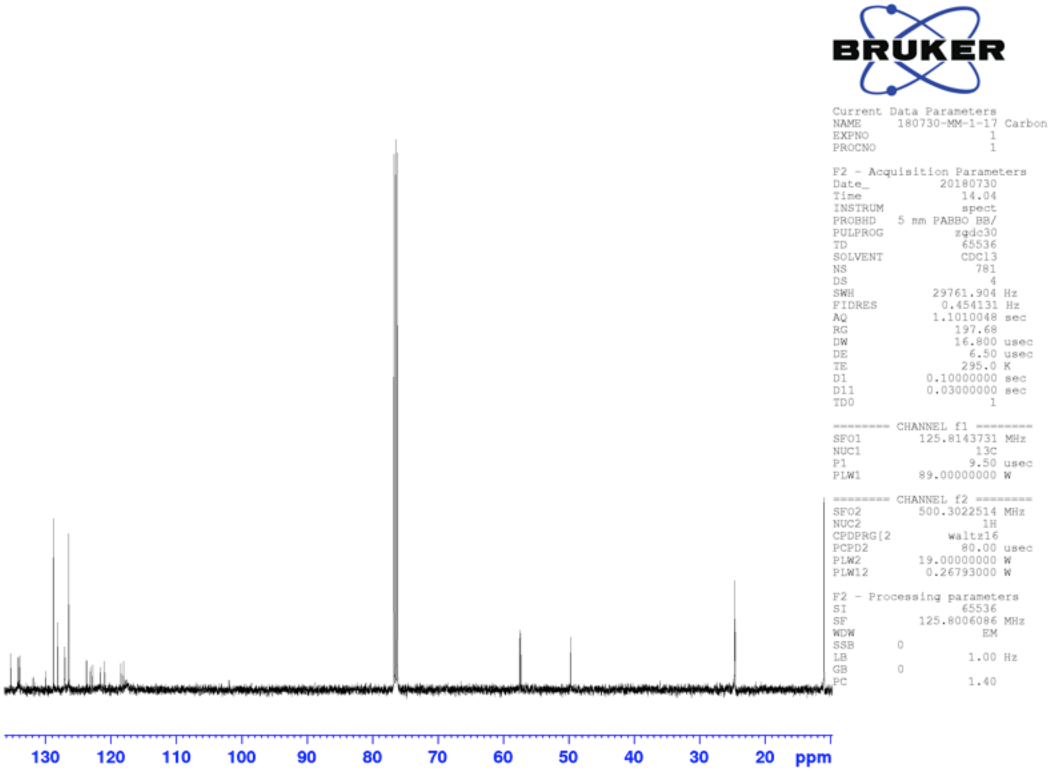
Figure S2: ^{1}H-NMR spectrum of Br-PDIN-benzyl in $CDCl_3$.



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PROCNO                    1

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SWH              29761.904 Hz
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AQ               1.1010048 sec
RG                   197.68
DW                   16.800 usec
DE                     6.50 usec
TE                    295.0 K
D1               0.10000000 sec
D11              0.03000000 sec
TD0                       1

======== CHANNEL f1 ========
SFO1           125.8143731 MHz
NUC1                    13C
P1                     9.50 usec
PLW1            89.00000000 W

======== CHANNEL f2 ========
SFO2           500.3022514 MHz
NUC2                     1H
CPDPRG[2           waltz16
PCPD2                 80.00 usec
PLW2            19.00000000 W
PLW12            0.26793000 W

F2 - Processing parameters
SI                    65536
SF             125.8006086 MHz
WDW                      EM
SSB      0
LB                     1.00 Hz
GB       0
PC                     1.40
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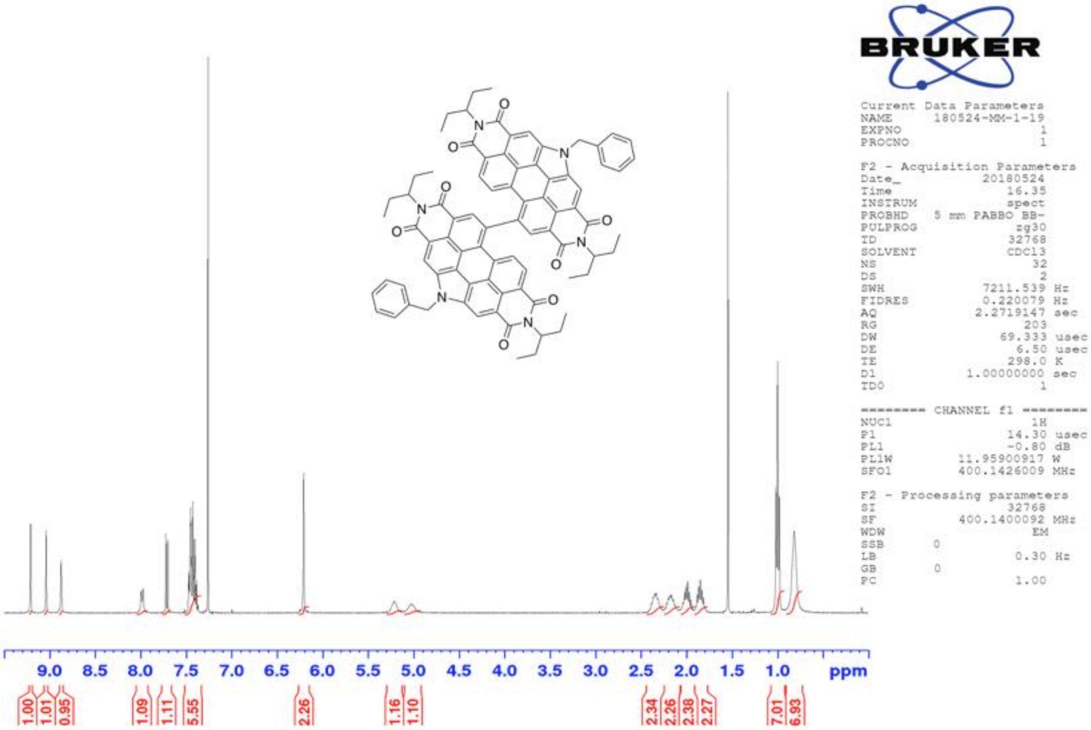
Figure S3: ^{13}C-NMR spectrum of Br-PDIN-benzyl in $CDCl_3$.



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PROCNO                 1

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PULPROG             zg30
TD                 32768
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NS                    32
DS                     2
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ             2.2719147 sec
RG                   203
DW                69.333 usec
DE                  6.50 usec
TE                 298.0 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                  1H
P1                 14.30 usec
PL1                -0.80 dB
PL1W         11.95900917 W
SFO1         400.1426009 MHz

F2 - Processing parameters
SI                 32768
SF           400.1400092 MHz
WDW                   EM
SSB       0
LB                  0.30 Hz
GB        0
PC                  1.00
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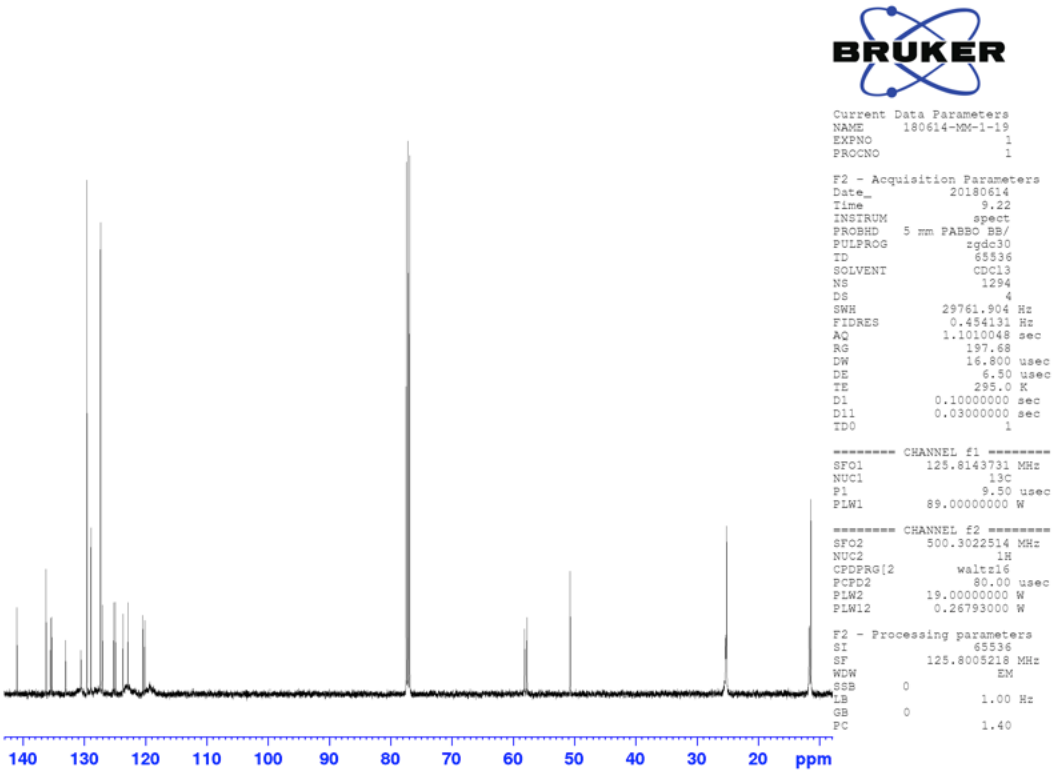
Figure S4: ^{1}H-NMR spectrum of (**1**) tPDI$_2$N-benzyl in CDCl$_3$.



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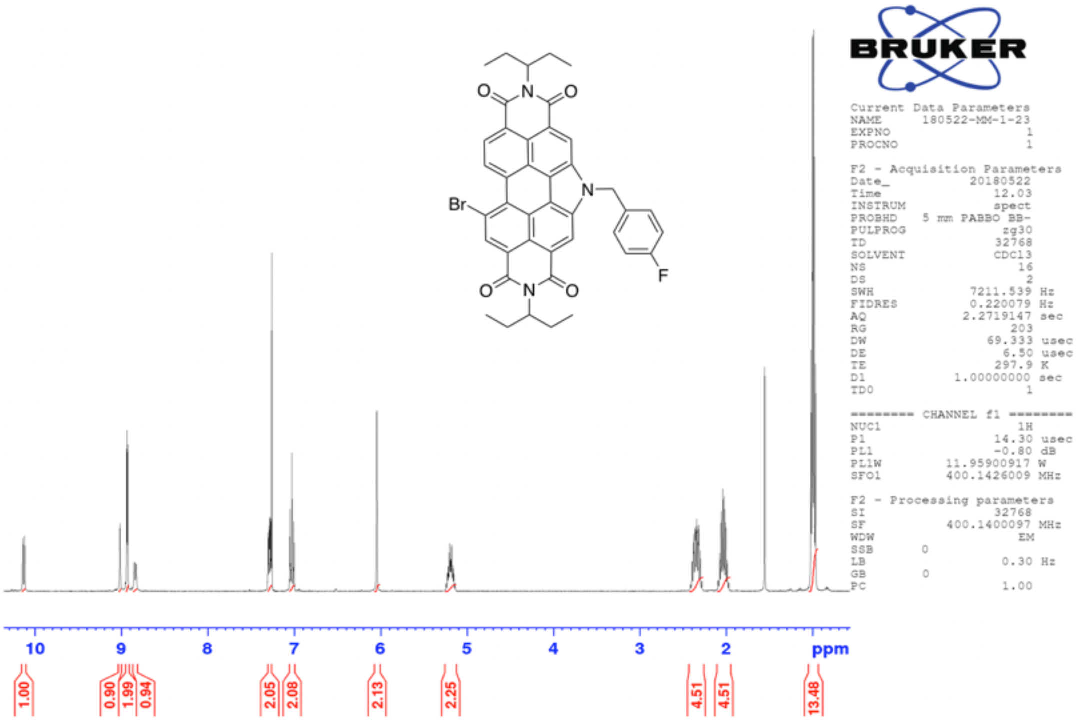
Date_          20180614
Time               9.22
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG          zgdc30
TD                65536
SOLVENT           CDCl3
NS                 1294
DS                    4
SWH           29761.904 Hz
FIDRES         0.454131 Hz
AQ            1.1010048 sec
RG               197.68
DW               16.800 usec
DE                 6.50 usec
TE                295.0 K
D1           0.10000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        125.8143731 MHz
NUC1                13C
P1                 9.50 usec
PLW1        89.00000000 W

======== CHANNEL f2 ========
SFO2        500.3022514 MHz
NUC2                 1H
CPDPRG[2        waltz16
PCPD2             80.00 usec
PLW2        19.00000000 W
PLW12        0.26793000 W

F2 - Processing parameters
SI                65536
SF          125.8005218 MHz
WDW                  EM
SSB      0
LB                 1.00 Hz
GB       0
PC                 1.40
```

Figure S5: ^{13}C-NMR spectrum of (**1**) tPDI$_2$N-benzyl in CDCl$_3$.



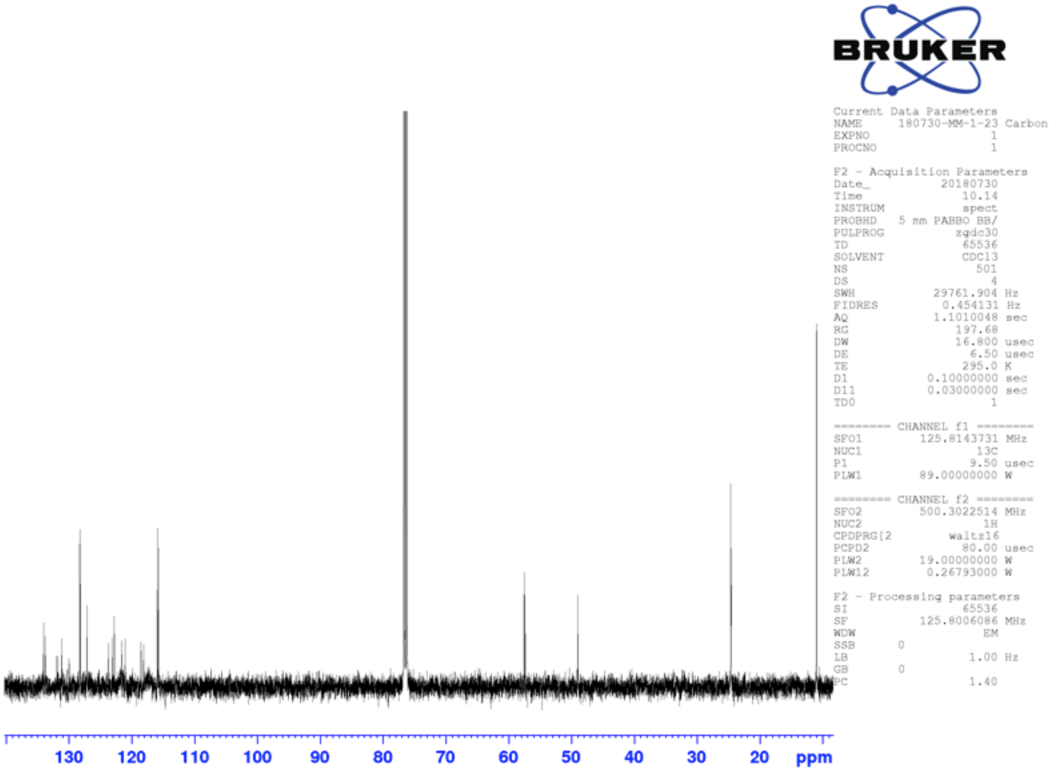
```
Current Data Parameters
NAME     180522-MM-1-23
EXPNO                 1
PROCNO                1

F2 - Acquisition Parameters
Date_          20180522
Time              12.03
INSTRUM           spect
PROBHD   5 mm PABBO BB-
PULPROG            zg30
TD                32768
SOLVENT           CDCl3
NS                   16
DS                    2
SWH            7211.539 Hz
FIDRES         0.220079 Hz
AQ            2.2719147 sec
RG                  203
DW               69.333 usec
DE                 6.50 usec
TE                297.9 K
D1           1.00000000 sec
TD0                   1

======== CHANNEL f1 ========
NUC1                 1H
P1                14.30 usec
PL1               -0.80 dB
PL1W        11.95900917 W
SFO1        400.1426009 MHz

F2 - Processing parameters
SI                32768
SF          400.1400097 MHz
WDW                  EM
SSB      0
LB                 0.30 Hz
GB       0
PC                 1.00
```

Figure S6: ^{1}H-NMR spectrum of Br-PDIN-benzylF in $CDCl_3$.



```
Current Data Parameters
NAME     180730-MM-1-23 Carbon
EXPNO                        1
PROCNO                       1

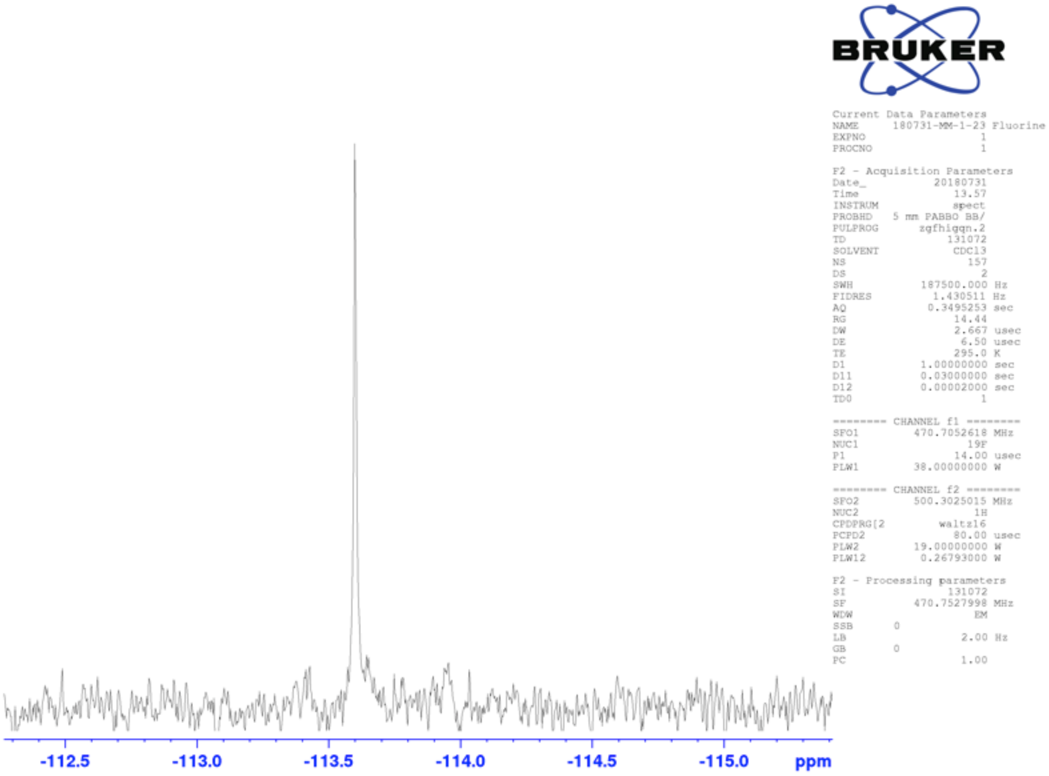
F2 - Acquisition Parameters
Date_                 20180730
Time                     10.14
INSTRUM                  spect
PROBHD    5 mm PABBO BB/
PULPROG                zgdc30
TD                       65536
SOLVENT                  CDCl3
NS                         501
DS                           4
SWH                 29761.904 Hz
FIDRES               0.454131 Hz
AQ                  1.1010048 sec
RG                      197.68
DW                      16.800 usec
DE                        6.50 usec
TE                       295.0 K
D1                  0.10000000 sec
D11                 0.03000000 sec
TD0                          1

======== CHANNEL f1 ========
SFO1               125.8143731 MHz
NUC1                       13C
P1                        9.50 usec
PLW1               89.00000000 W

======== CHANNEL f2 ========
SFO2               500.3022514 MHz
NUC2                        1H
CPDPRG[2              waltz16
PCPD2                    80.00 usec
PLW2               19.00000000 W
PLW12               0.26793000 W

F2 - Processing parameters
SI                       65536
SF                 125.8006086 MHz
WDW                         EM
SSB       0
LB                        1.00 Hz
GB        0
PC                        1.40
```

Figure S7: ^{13}C-NMR spectrum of Br-PDIN-benzylF in CDCl$_3$.



```
Current Data Parameters
NAME      180731-MM-1-23 Fluorine
EXPNO                      1
PROCNO                     1

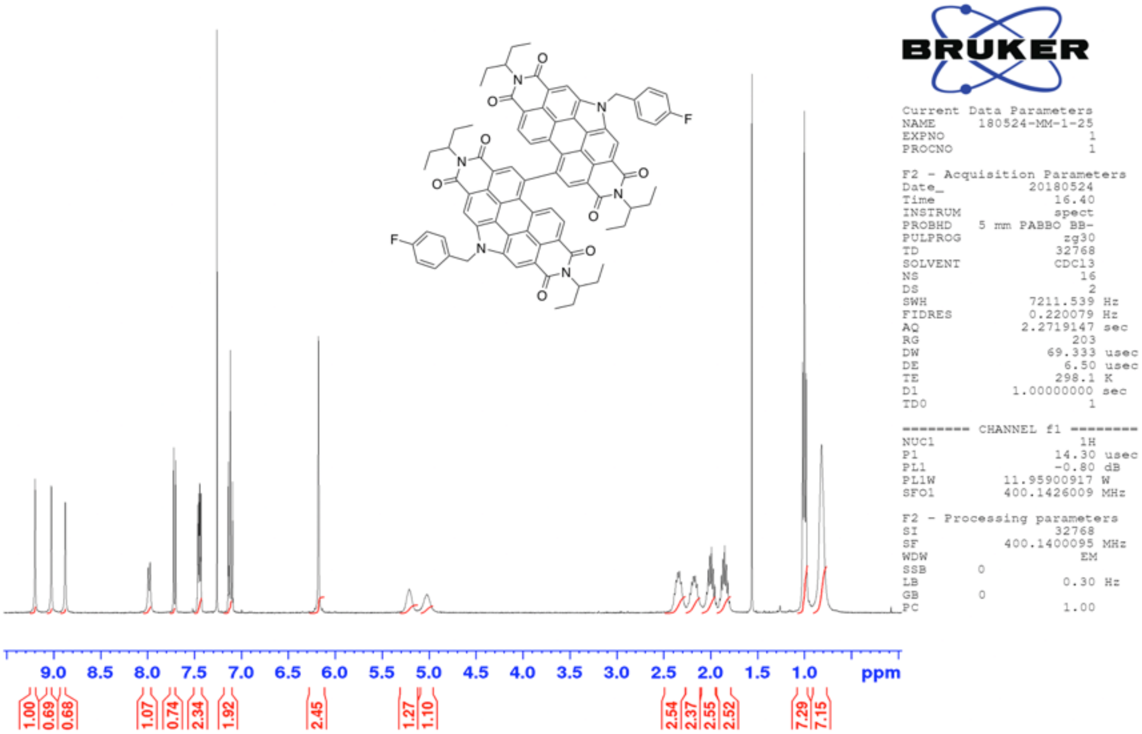
F2 - Acquisition Parameters
Date_             20180731
Time                 13.57
INSTRUM              spect
PROBHD   5 mm PABBO BB/
PULPROG        zgfhigqn.2
TD                  131072
SOLVENT              CDCl3
NS                     157
DS                       2
SWH             187500.000 Hz
FIDRES            1.430511 Hz
AQ               0.3495253 sec
RG                   14.44
DW                   2.667 usec
DE                    6.50 usec
TE                   295.0 K
D1              1.00000000 sec
D11             0.03000000 sec
D12             0.00002000 sec
TD0                      1

======== CHANNEL f1 ========
SFO1           470.7052618 MHz
NUC1                   19F
P1                   14.00 usec
PLW1           38.00000000 W

======== CHANNEL f2 ========
SFO2           500.3025015 MHz
NUC2                    1H
CPDPRG[2           waltz16
PCPD2                80.00 usec
PLW2           19.00000000 W
PLW12           0.26793000 W

F2 - Processing parameters
SI                  131072
SF             470.7527998 MHz
WDW                     EM
SSB      0
LB                    2.00 Hz
GB       0
PC                    1.00
```

Figure S8: ^{19}F-NMR spectrum of Br-PDIN-benzylF in $CDCl_3$.



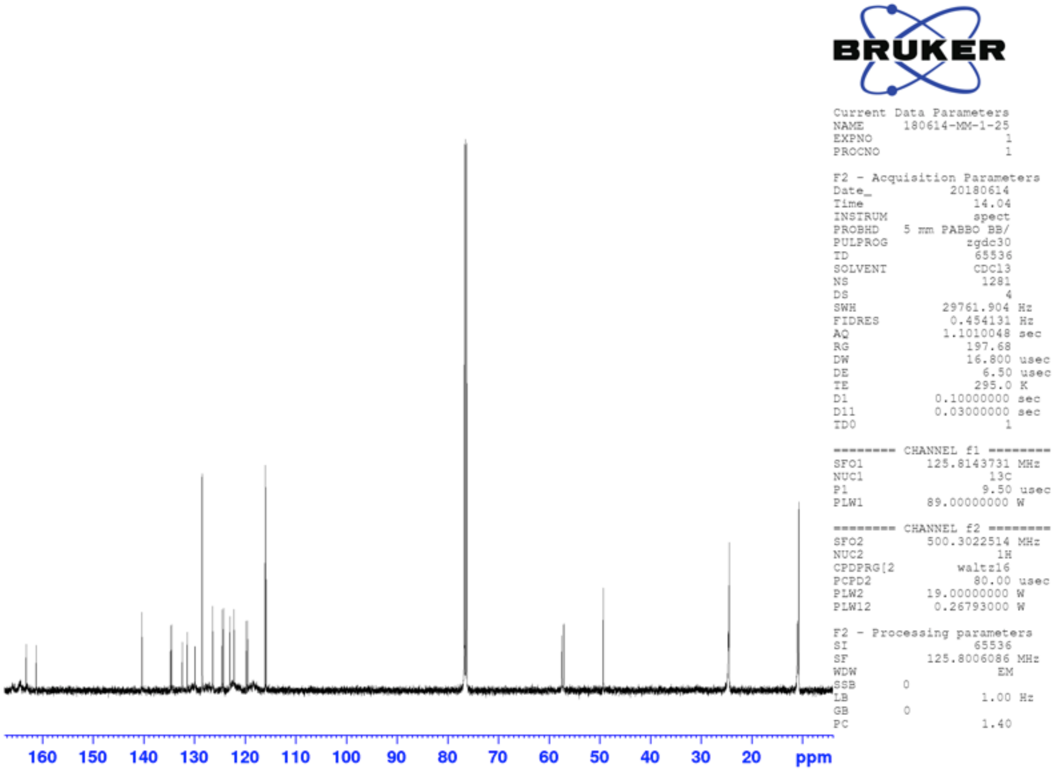
```
Current Data Parameters
NAME      180524-MM-1-25
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20180524
Time               16.40
INSTRUM            spect
PROBHD    5 mm PABBO BB-
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     2
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ             2.2719147 sec
RG                   203
DW                69.333 usec
DE                  6.50 usec
TE                 298.1 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                  1H
P1                 14.30 usec
PL1                -0.80 dB
PL1W         11.95900917 W
SFO1         400.1426009 MHz

F2 - Processing parameters
SI                 32768
SF           400.1400095 MHz
WDW                   EM
SSB       0
LB                  0.30 Hz
GB        0
PC                  1.00
```

Figure S9: ^{1}H-NMR spectrum of (**2**) tPDI$_2$N-benzylF in CDCl$_3$.



```
Current Data Parameters
NAME     180614-MM-1-25
EXPNO                 1
PROCNO                1

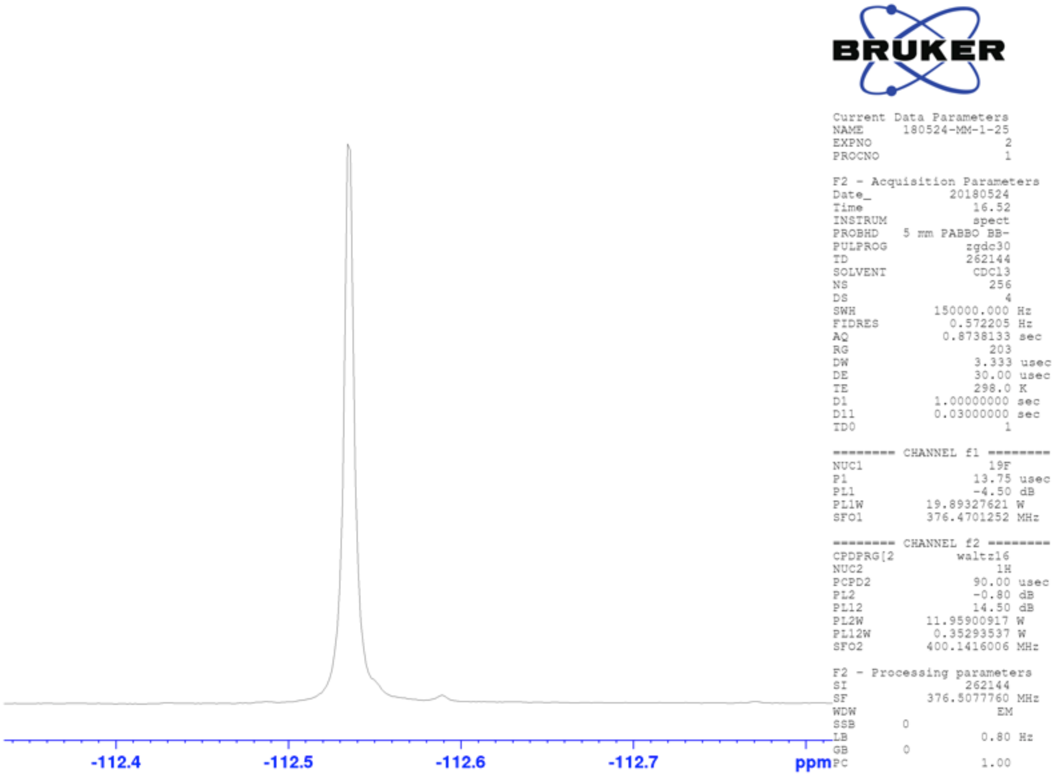
F2 - Acquisition Parameters
Date_          20180614
Time              14.04
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG         zgdc30
TD                65536
SOLVENT           CDCl3
NS                 1281
DS                    4
SWH           29761.904 Hz
FIDRES         0.454131 Hz
AQ            1.1010048 sec
RG               197.68
DW               16.800 usec
DE                 6.50 usec
TE                295.0 K
D1           0.10000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        125.8143731 MHz
NUC1                13C
P1                 9.50 usec
PLW1        89.00000000 W

======== CHANNEL f2 ========
SFO2        500.3022514 MHz
NUC2                 1H
CPDPRG[2        waltz16
PCPD2             80.00 usec
PLW2        19.00000000 W
PLW12        0.26793000 W

F2 - Processing parameters
SI                65536
SF          125.8006086 MHz
WDW                  EM
SSB      0
LB                 1.00 Hz
GB       0
PC                 1.40
```

Figure S10: ^{13}C-NMR spectrum of (**2**) tPDI$_2$N-benzylF in CDCl$_3$.



```
Current Data Parameters
NAME      180524-MM-1-25
EXPNO                  2
PROCNO                 1

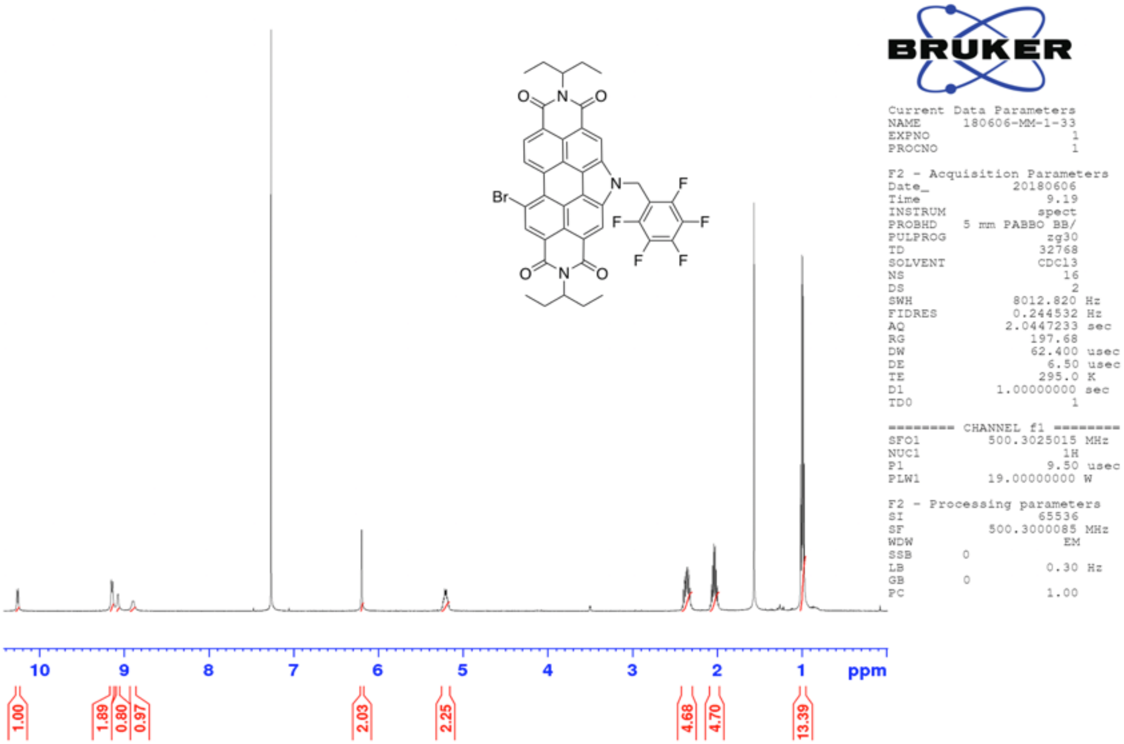
F2 - Acquisition Parameters
Date_           20180524
Time               16.52
INSTRUM            spect
PROBHD    5 mm PABBO BB-
PULPROG          zgdc30
TD                262144
SOLVENT            CDCl3
NS                   256
DS                     4
SWH           150000.000 Hz
FIDRES          0.572205 Hz
AQ             0.8738133 sec
RG                   203
DW                 3.333 usec
DE                 30.00 usec
TE                 298.0 K
D1            1.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 19F
P1                 13.75 usec
PL1                -4.50 dB
PL1W         19.89327621 W
SFO1         376.4701252 MHz

======== CHANNEL f2 ========
CPDPRG[2        waltz16
NUC2                  1H
PCPD2              90.00 usec
PL2                -0.80 dB
PL12               14.50 dB
PL2W         11.95900917 W
PL12W         0.35293537 W
SFO2         400.1416006 MHz

F2 - Processing parameters
SI                262144
SF           376.5077760 MHz
WDW                   EM
SSB       0
LB                  0.80 Hz
GB        0
PC                  1.00
```

Figure S11: ^{19}F-NMR spectrum of (**2**) tPDI$_2$N-benzylF in CDCl$_3$.



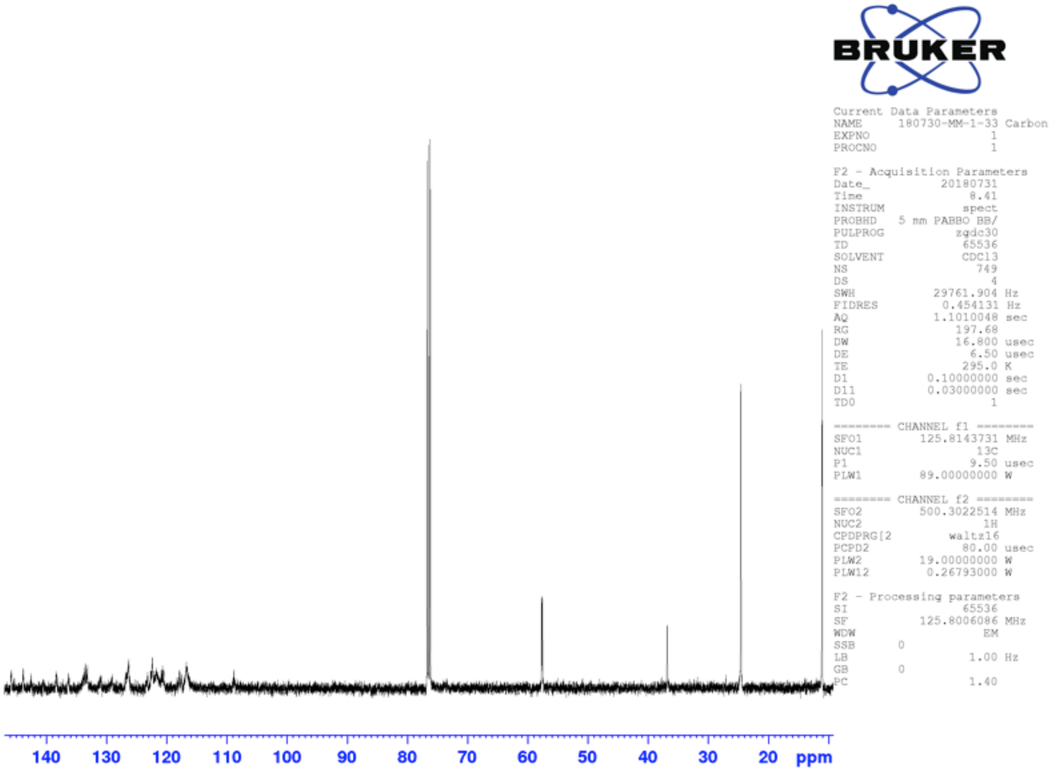
```
Current Data Parameters
NAME      180606-MM-1-33
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20180606
Time                9.19
INSTRUM            spect
PROBHD    5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     2
SWH             8012.820 Hz
FIDRES          0.244532 Hz
AQ             2.0447233 sec
RG                197.68
DW                62.400 usec
DE                  6.50 usec
TE                 295.0 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         500.3025015 MHz
NUC1                  1H
P1                  9.50 usec
PLW1         19.00000000 W

F2 - Processing parameters
SI                 65536
SF           500.3000085 MHz
WDW                   EM
SSB      0
LB                  0.30 Hz
GB       0
PC                  1.00
```

Figure S12: ^{1}H-NMR spectrum of Br-PDIN-benzylF$_5$ in CDCl$_3$.



```
Current Data Parameters
NAME     180730-MM-1-33 Carbon
EXPNO                       1
PROCNO                      1

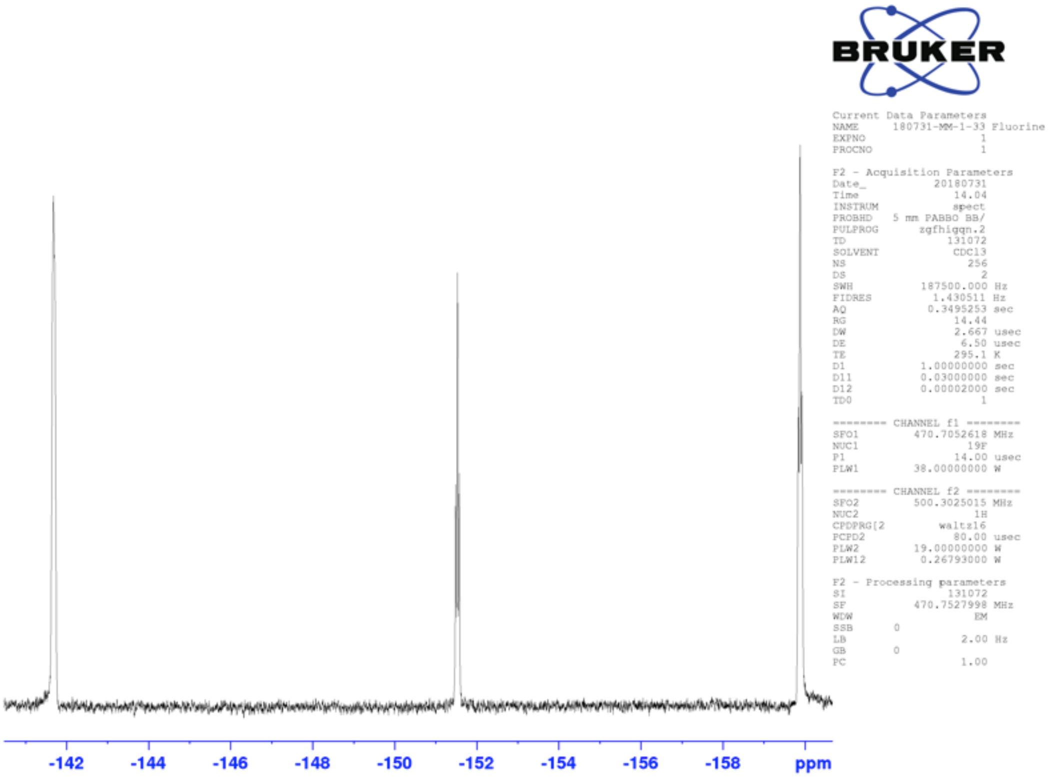
F2 - Acquisition Parameters
Date_                20180731
Time                     8.41
INSTRUM                 spect
PROBHD     5 mm PABBO BB/
PULPROG               zgdc30
TD                      65536
SOLVENT                 CDCl3
NS                        749
DS                          4
SWH                 29761.904 Hz
FIDRES               0.454131 Hz
AQ                  1.1010048 sec
RG                     197.68
DW                     16.800 usec
DE                       6.50 usec
TE                      295.0 K
D1                 0.10000000 sec
D11                0.03000000 sec
TD0                         1

======== CHANNEL f1 ========
SFO1              125.8143731 MHz
NUC1                      13C
P1                       9.50 usec
PLW1              89.00000000 W

======== CHANNEL f2 ========
SFO2              500.3022514 MHz
NUC2                       1H
CPDPRG[2              waltz16
PCPD2                   80.00 usec
PLW2              19.00000000 W
PLW12              0.26793000 W

F2 - Processing parameters
SI                      65536
SF                125.8006086 MHz
WDW                        EM
SSB       0
LB                       1.00 Hz
GB        0
PC                       1.40
```

Figure S13: ^{13}C-NMR spectrum of Br-PDIN-benzylF_5 in $CDCl_3$.



```
Current Data Parameters
NAME      180731-MM-1-33 Fluorine
EXPNO                   1
PROCNO                  1

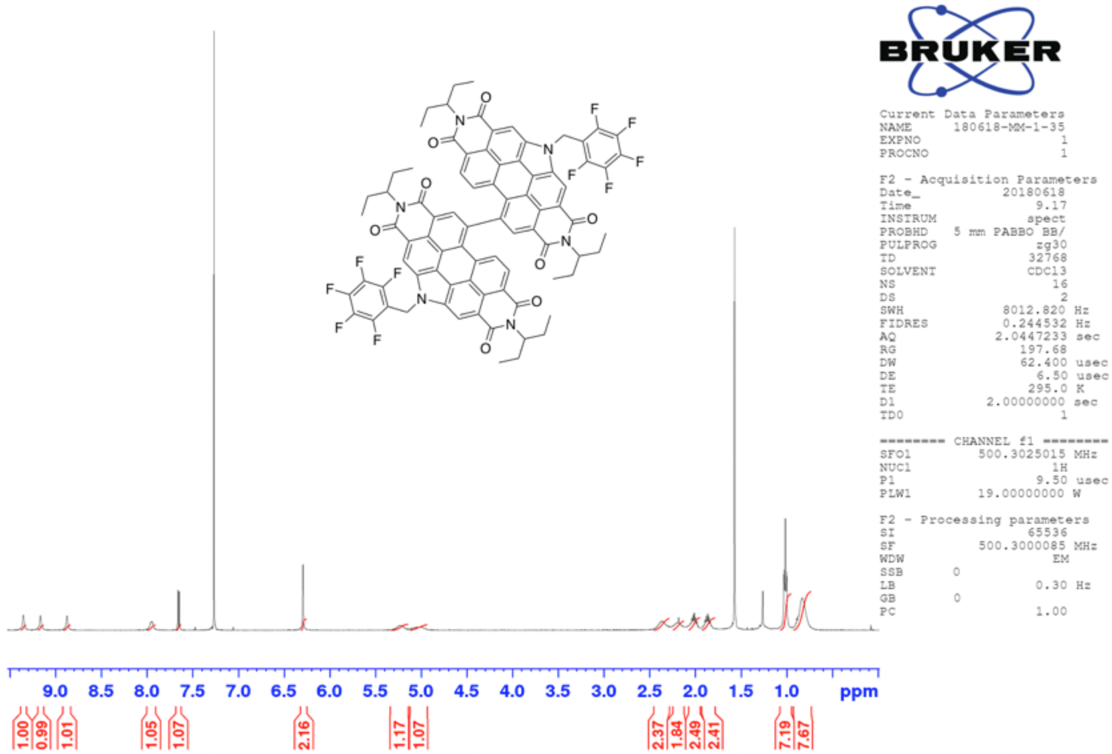
F2 - Acquisition Parameters
Date_            20180731
Time                14.04
INSTRUM             spect
PROBHD   5 mm PABBO BB/
PULPROG        zgfhigqn.2
TD                 131072
SOLVENT             CDCl3
NS                    256
DS                      2
SWH            187500.000 Hz
FIDRES           1.430511 Hz
AQ              0.3495253 sec
RG                  14.44
DW                  2.667 usec
DE                   6.50 usec
TE                  295.1 K
D1             1.00000000 sec
D11            0.03000000 sec
D12            0.00002000 sec
TD0                     1

======== CHANNEL f1 ========
SFO1          470.7052618 MHz
NUC1                  19F
P1                  14.00 usec
PLW1          38.00000000 W

======== CHANNEL f2 ========
SFO2          500.3025015 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2               80.00 usec
PLW2          19.00000000 W
PLW12          0.26793000 W

F2 - Processing parameters
SI                 131072
SF            470.7527998 MHz
WDW                    EM
SSB      0
LB                   2.00 Hz
GB       0
PC                   1.00
```

Figure S14: ^{19}F-NMR spectrum of Br-PDIN-benzylF_5 in $CDCl_3$.



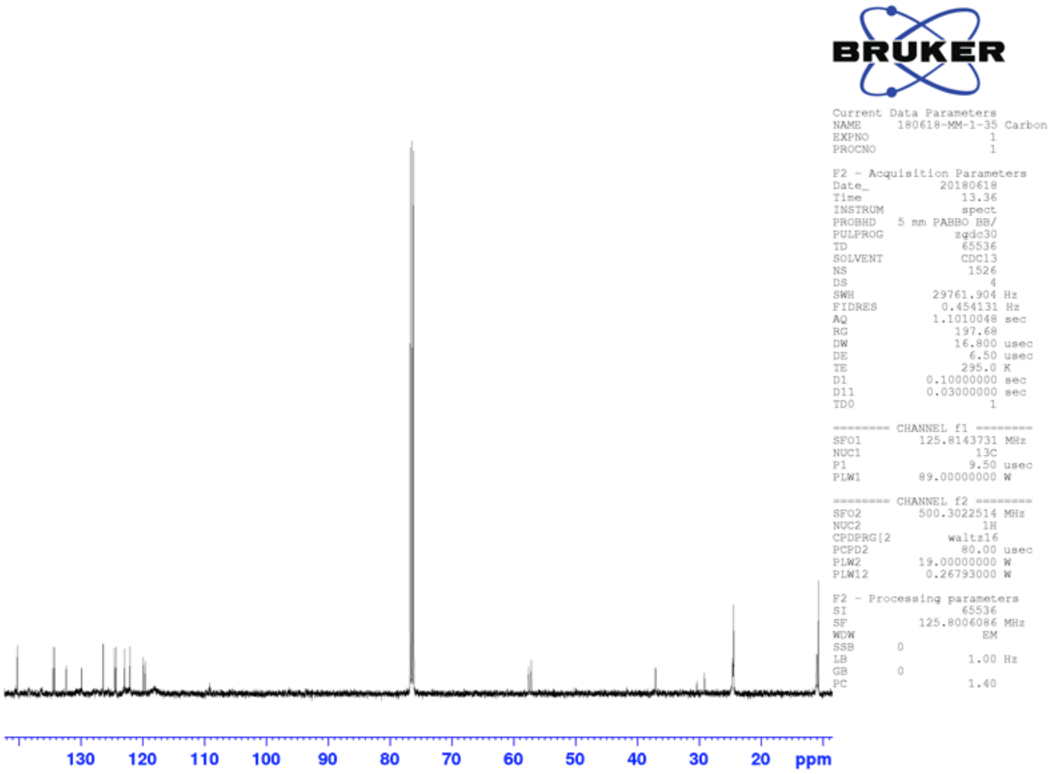
```
Current Data Parameters
NAME      180618-MM-1-35
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20180618
Time                9.17
INSTRUM            spect
PROBHD    5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     2
SWH             8012.820 Hz
FIDRES          0.244532 Hz
AQ             2.0447233 sec
RG                197.68
DW                62.400 usec
DE                  6.50 usec
TE                 295.0 K
D1            2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         500.3025015 MHz
NUC1                  1H
P1                  9.50 usec
PLW1         19.00000000 W

F2 - Processing parameters
SI                 65536
SF           500.3000085 MHz
WDW                   EM
SSB       0
LB                  0.30 Hz
GB        0
PC                  1.00
```

Figure S15: ^{1}H-NMR spectrum of (**3**) tPDI$_2$N-benzylF$_5$ in CDCl$_3$.



```
Current Data Parameters
NAME     180618-MM-1-35 Carbon
EXPNO                 1
PROCNO                1

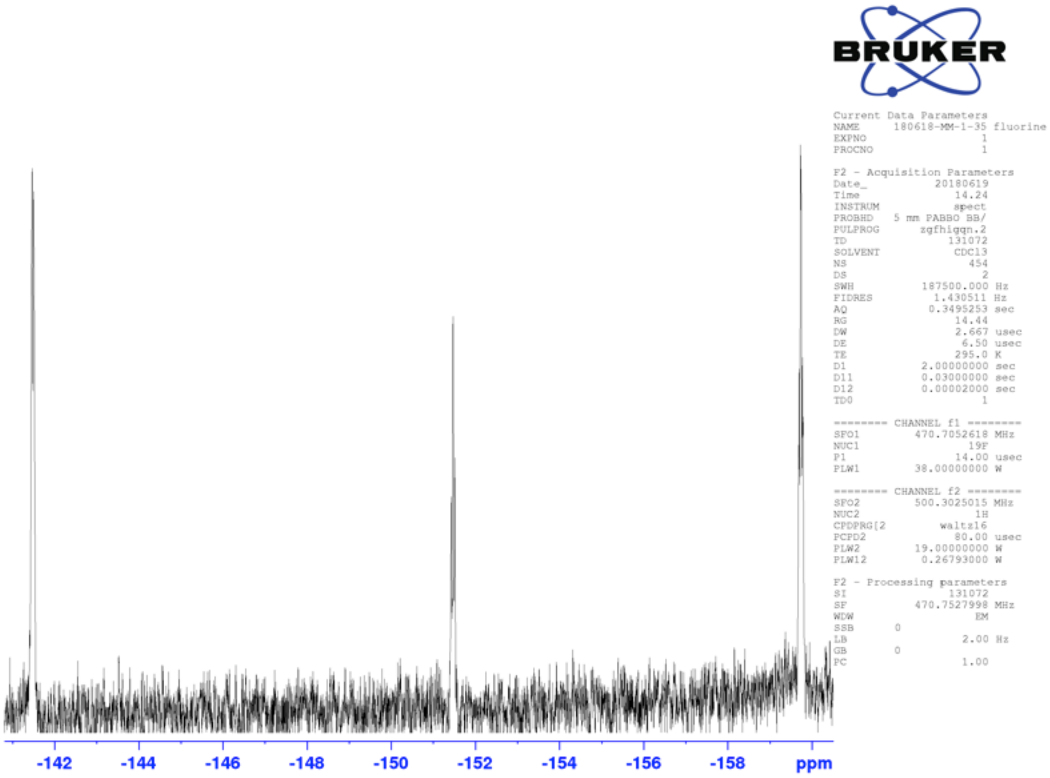
F2 - Acquisition Parameters
Date_          20180618
Time              13.36
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG         zgdc30
TD                65536
SOLVENT           CDCl3
NS                 1526
DS                    4
SWH          29761.904 Hz
FIDRES        0.454131 Hz
AQ           1.1010048 sec
RG               197.68
DW               16.800 usec
DE                 6.50 usec
TE                295.0 K
D1           0.10000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        125.8143731 MHz
NUC1                13C
P1                 9.50 usec
PLW1        89.00000000 W

======== CHANNEL f2 ========
SFO2        500.3022514 MHz
NUC2                 1H
CPDPRG[2        waltz16
PCPD2             80.00 usec
PLW2        19.00000000 W
PLW12        0.26793000 W

F2 - Processing parameters
SI                65536
SF          125.8006086 MHz
WDW                  EM
SSB      0
LB                 1.00 Hz
GB       0
PC                 1.40
```

Figure S16: ^{13}C-NMR spectrum of (**3**) tPDI$_2$N-benzylF$_5$ in CDCl$_3$.



```
Current Data Parameters
NAME      180618-MM-1-35 fluorine
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20180619
Time               14.24
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG      zgfhigqn.2
TD                131072
SOLVENT            CDCl3
NS                   454
DS                     2
SWH           187500.000 Hz
FIDRES          1.430511 Hz
AQ             0.3495253 sec
RG                 14.44
DW                 2.667 usec
DE                  6.50 usec
TE                 295.0 K
D1            2.00000000 sec
D11           0.03000000 sec
D12           0.00002000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         470.7052618 MHz
NUC1                 19F
P1                 14.00 usec
PLW1         38.00000000 W

======== CHANNEL f2 ========
SFO2         500.3025015 MHz
NUC2                  1H
CPDPRG[2         waltz16
PCPD2              80.00 usec
PLW2         19.00000000 W
PLW12         0.26793000 W

F2 - Processing parameters
SI                131072
SF           470.7527998 MHz
WDW                   EM
SSB        0
LB                  2.00 Hz
GB         0
PC                  1.00
```

Figure S17: ^{19}F-NMR spectrum of (**3**) tPDI$_2$N-benzylF$_5$ in CDCl$_3$.

4. Mass Spectrometry:

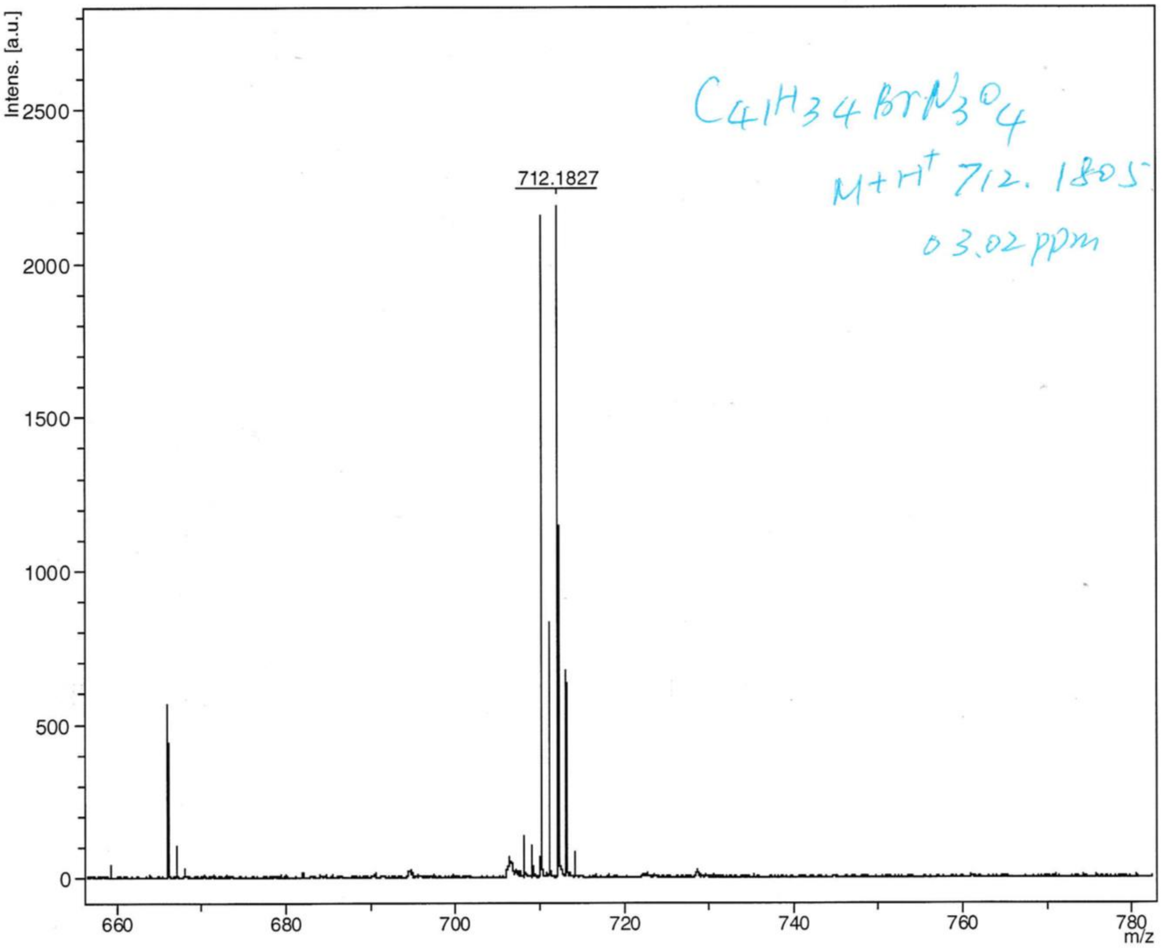


Figure S18: Mass spectrum of Br-PDIN-benzyl.

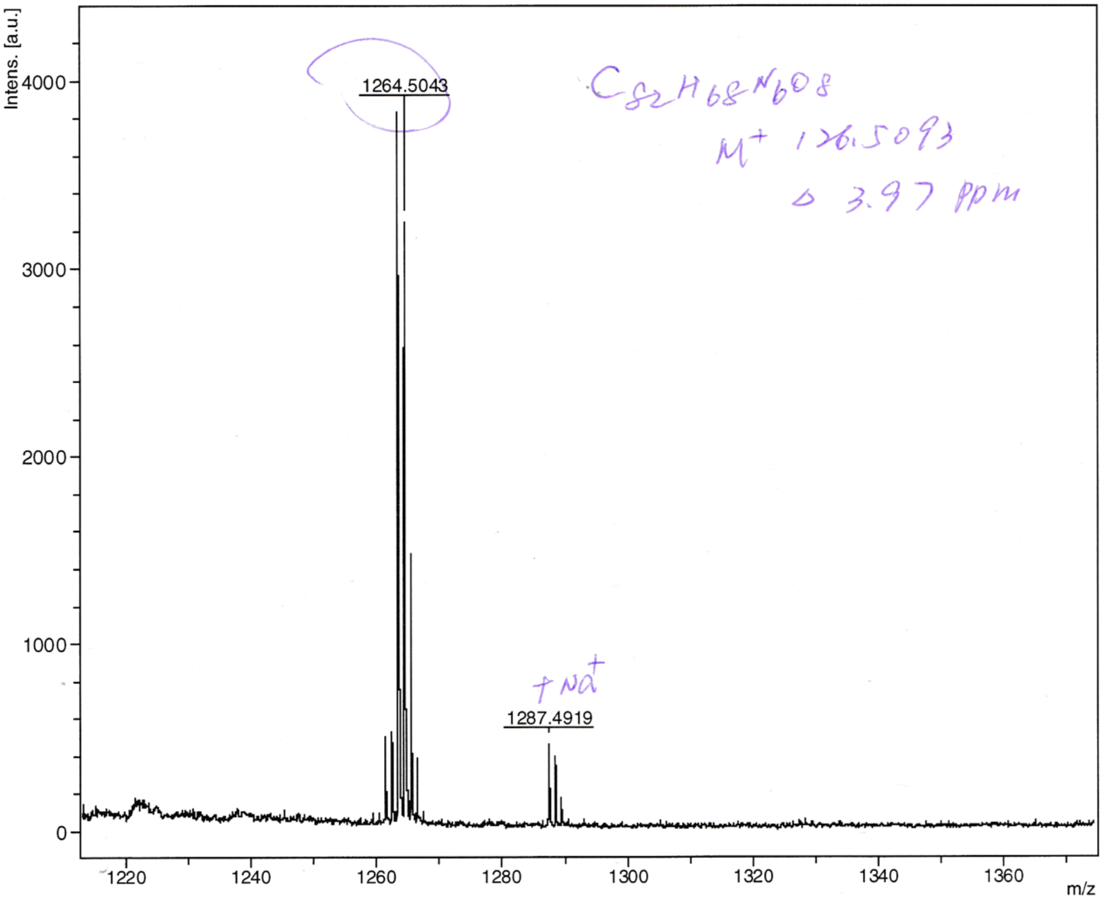


Figure S19: Mass spectrum of (**1**) tPDI$_2$N-benzyl.

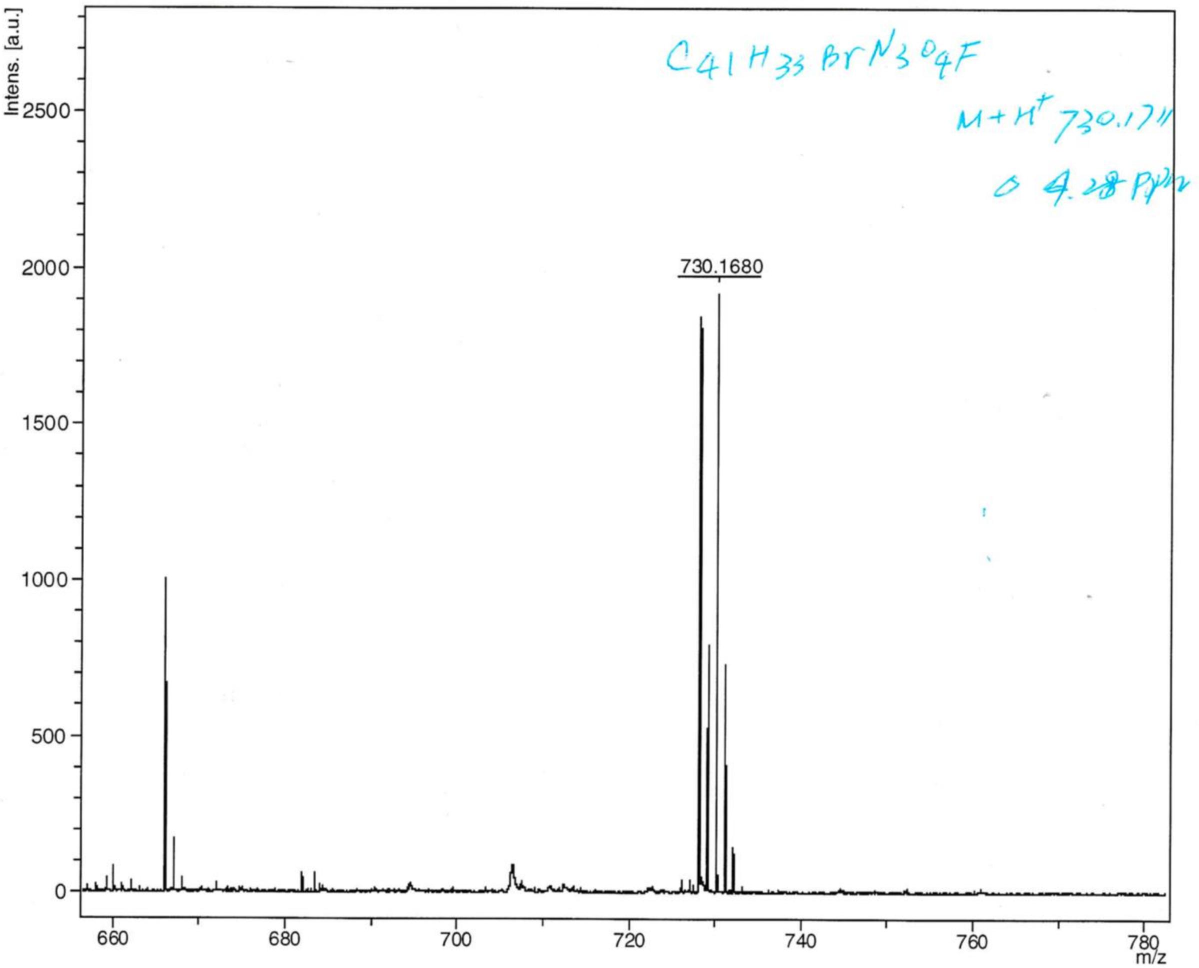
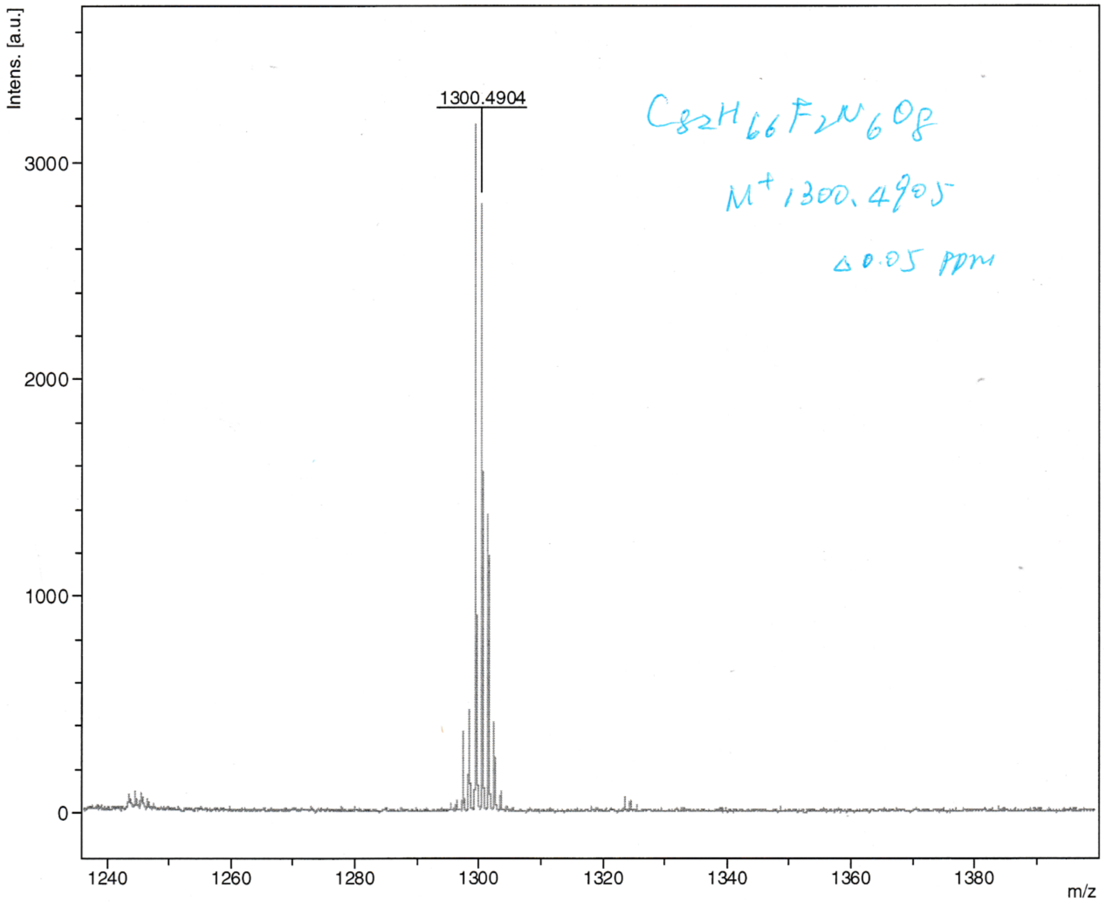


Figure S20: Mass spectrum of Br-PDIN-benzylF.

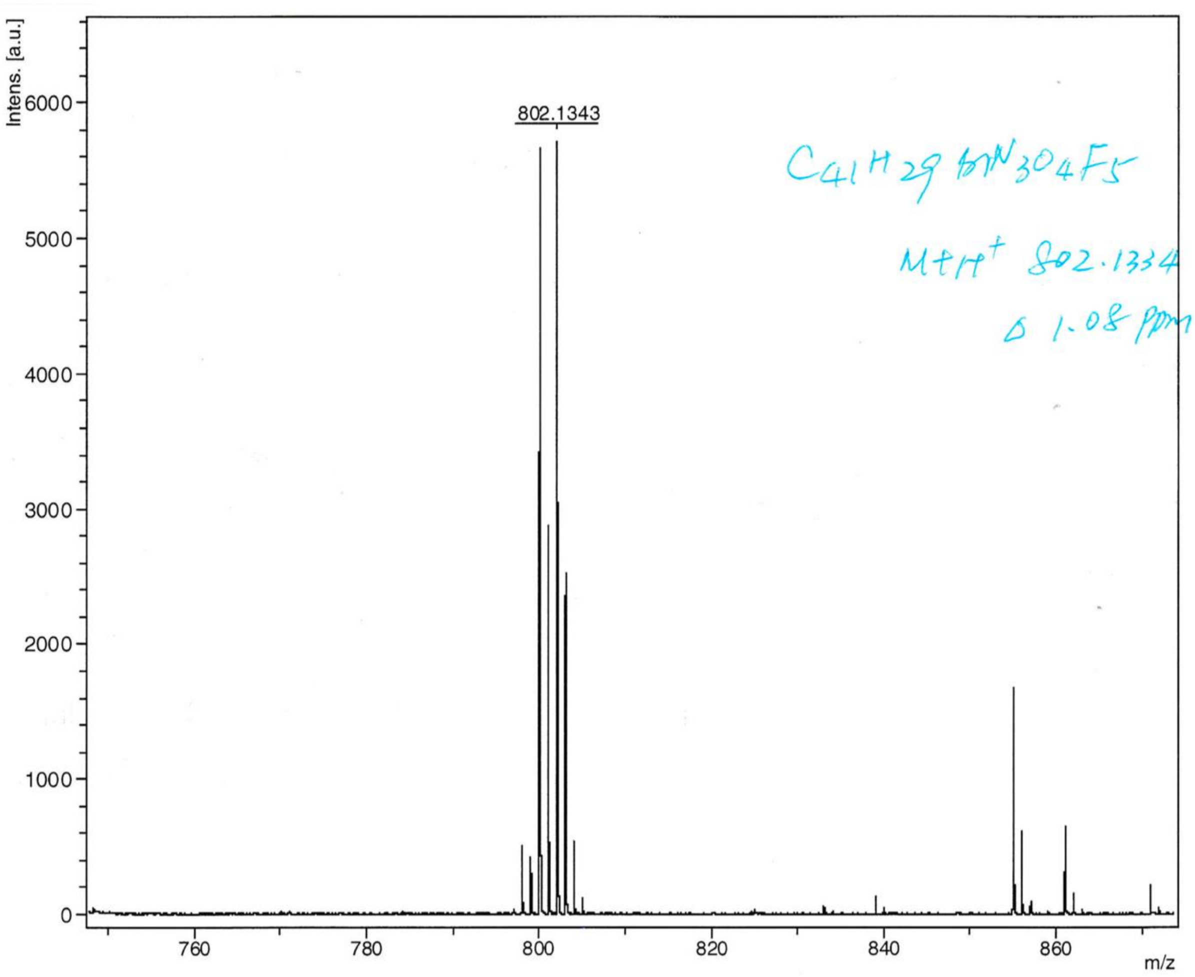


$C_{82}H_{66}F_2N_6O_8$

M^+ 1300.4905

Δ0.05 ppm

Figure S21: Mass spectrum (**2**) tPDI$_2$N-benzylF.

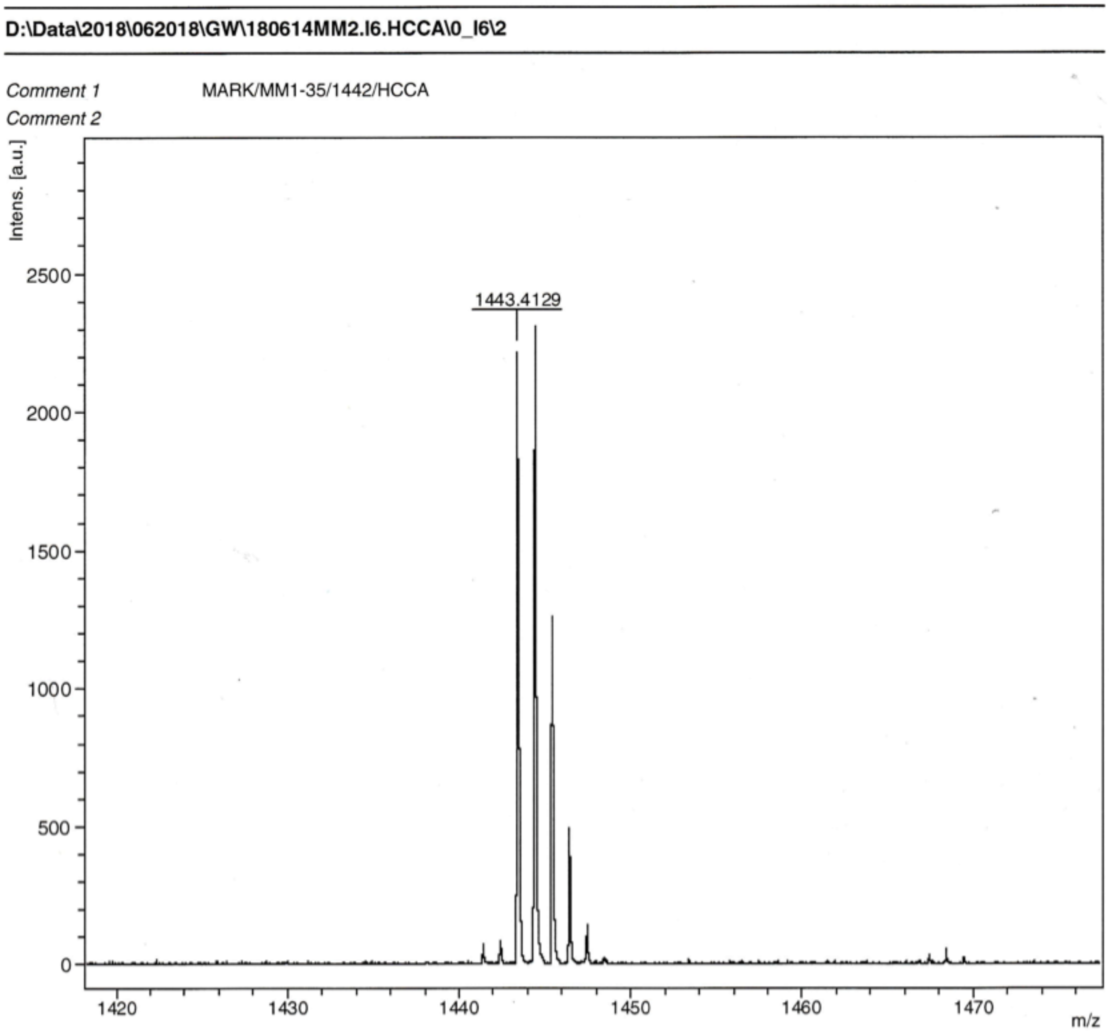


$C_{41}H_{29}BrN_3O_4F_5$

$M+H^+$ 802.1334

Δ 1.08 ppm

Figure S22: Mass spectrum of Br-PDIN-benzylF_5.



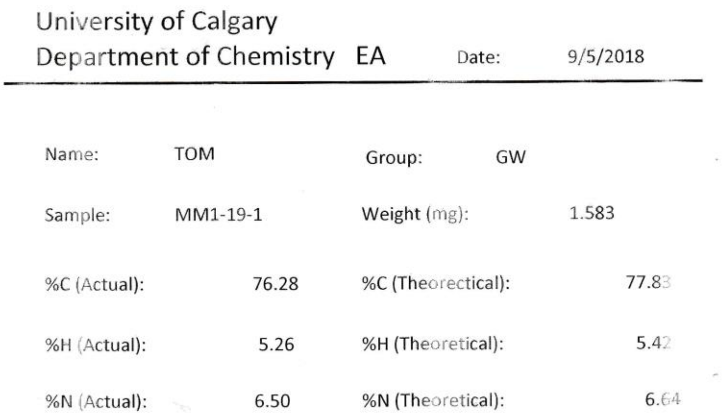
D:\Data\2018\062018\GW\180614MM2.I6.HCCA\0_I6\2

Comment 1 MARK/MM1-35/1442/HCCA

Comment 2

Figure S23: Mass spectrum of (**3**) tPDI$_2$N-benzylF$_5$.

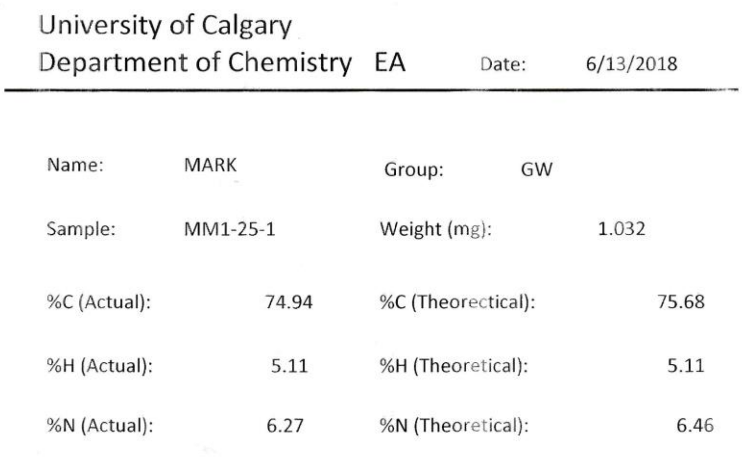
5. Elemental Analysis:



University of Calgary
Department of Chemistry EA Date: 9/5/2018

Name:	TOM	Group:	GW
Sample:	MM1-19-1	Weight (mg):	1.583
%C (Actual):	76.28	%C (Theorectical):	77.83
%H (Actual):	5.26	%H (Theoretical):	5.42
%N (Actual):	6.50	%N (Theoretical):	6.64

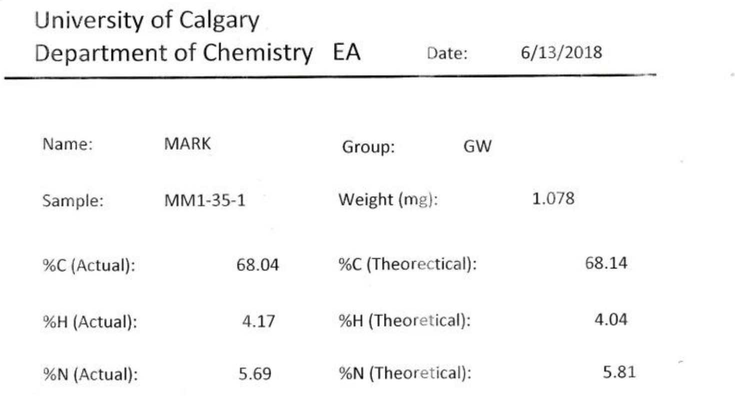
Figure S24. Elemental analysis sheet for compound **1** tPDI$_2$N-benzyl



University of Calgary
Department of Chemistry EA Date: 6/13/2018

Name:	MARK	Group:	GW
Sample:	MM1-25-1	Weight (mg):	1.032
%C (Actual):	74.94	%C (Theorectical):	75.68
%H (Actual):	5.11	%H (Theoretical):	5.11
%N (Actual):	6.27	%N (Theoretical):	6.46

Figure S25. Elemental analysis sheet for compound **2** tPDI$_2$N-benzylF



University of Calgary
Department of Chemistry EA Date: 6/13/2018

Name:	MARK	Group:	GW
Sample:	MM1-35-1	Weight (mg):	1.078
%C (Actual):	68.04	%C (Theorectical):	68.14
%H (Actual):	4.17	%H (Theoretical):	4.04
%N (Actual):	5.69	%N (Theoretical):	5.81

Figure S26. Elemental analysis sheet for compound **3** tPDI$_2$N-benzylF$_5$

6. Thermal Data:

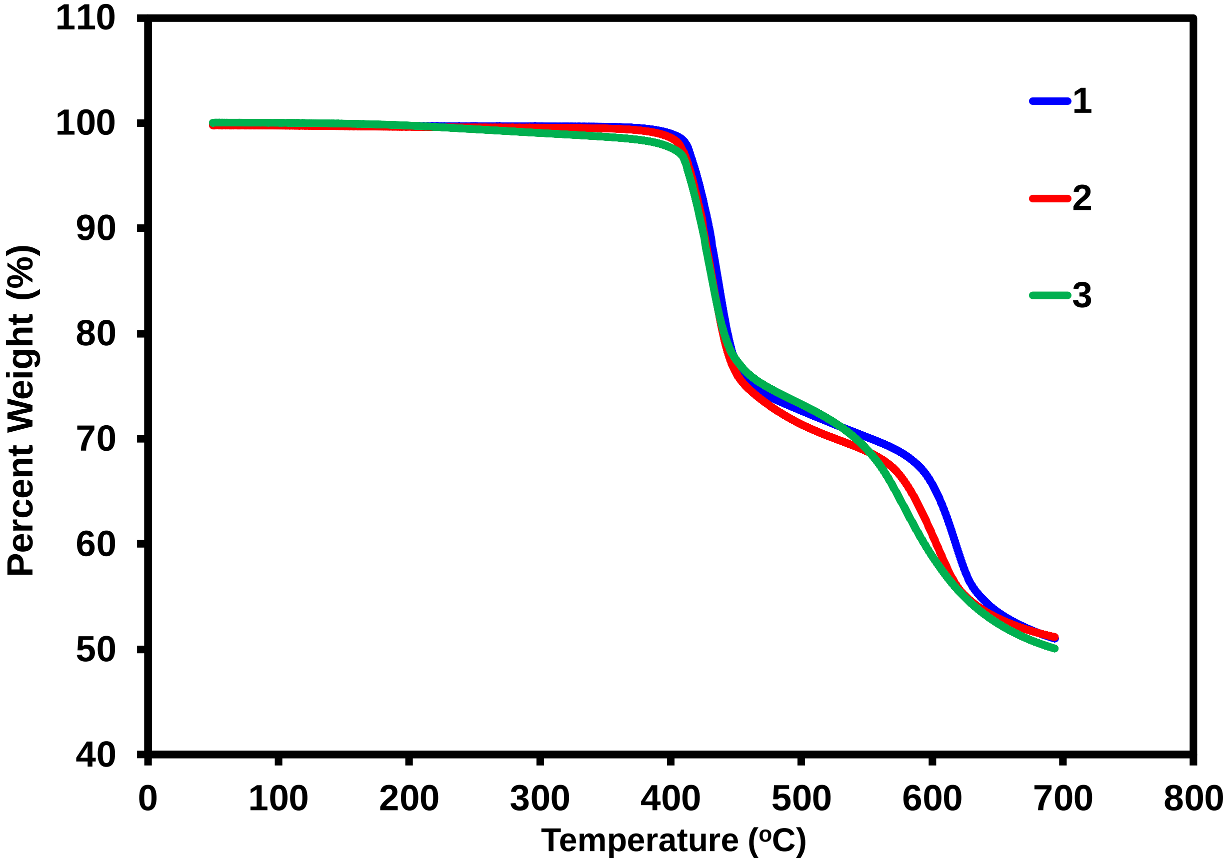


Figure S27: Thermalgravimetric analysis (TGA) plot of PDI materials **1-3**.

7. Electrochemical Data:

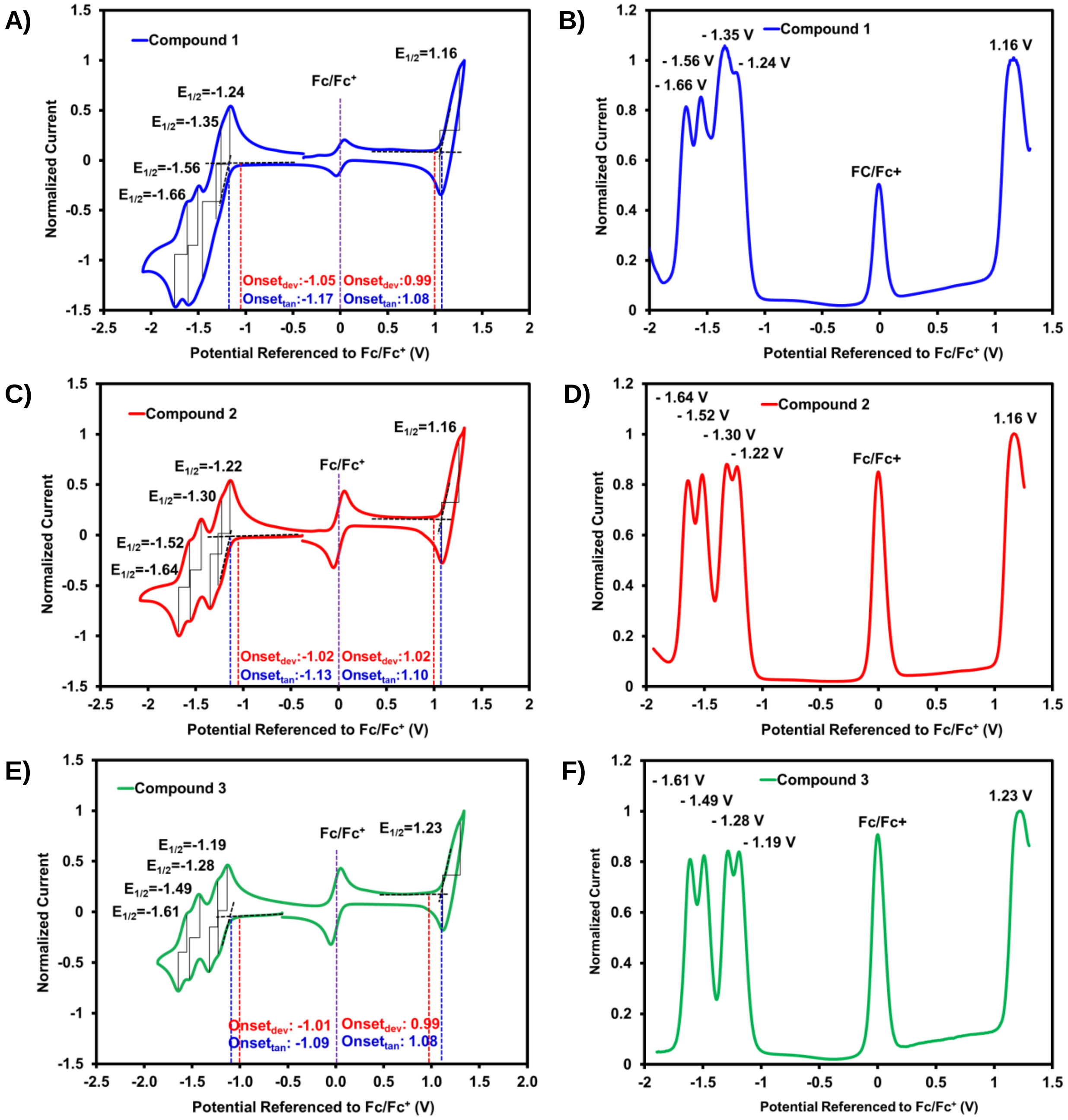


Figure S28. Electrochemical data for PDI materials **1-3**. Cyclic voltammetry traces for (A) **1**, (C) **2**, and (E) **3**. Differential pulse voltammetry traces for (B) **1**, (D) **2**, and (F) **3**. All samples run at 100 mV/s in CH_2Cl_2 solution.

8. Optical Absorption Data:

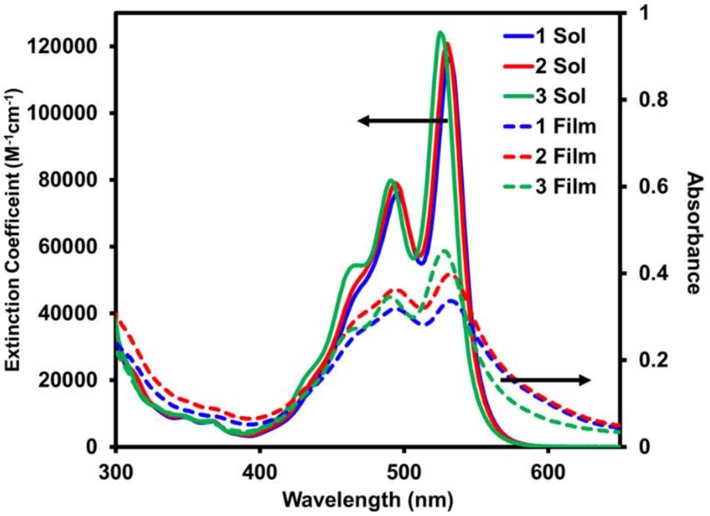


Figure S29. Comparison of solution and film optical absorption spectra of PDI materials **1**-**3**. Solution spectra recorded in $CHCl_3$. Films were cast from 10 mg/mL $CHCl_3$ solutions.

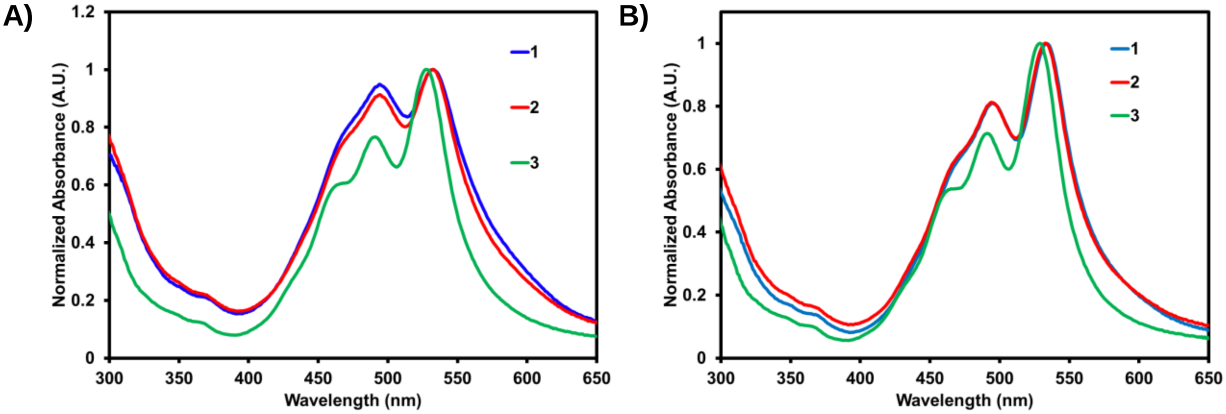


Figure S30. Normalized optical absorption spectra of PDI materials **1**-**3** in (A) as spun-cast films and (B) after thermal annealing at 180 °C for 10 minutes. Films were cast from 10 mg/mL $CHCl_3$ solutions.

9. Computational Analysis

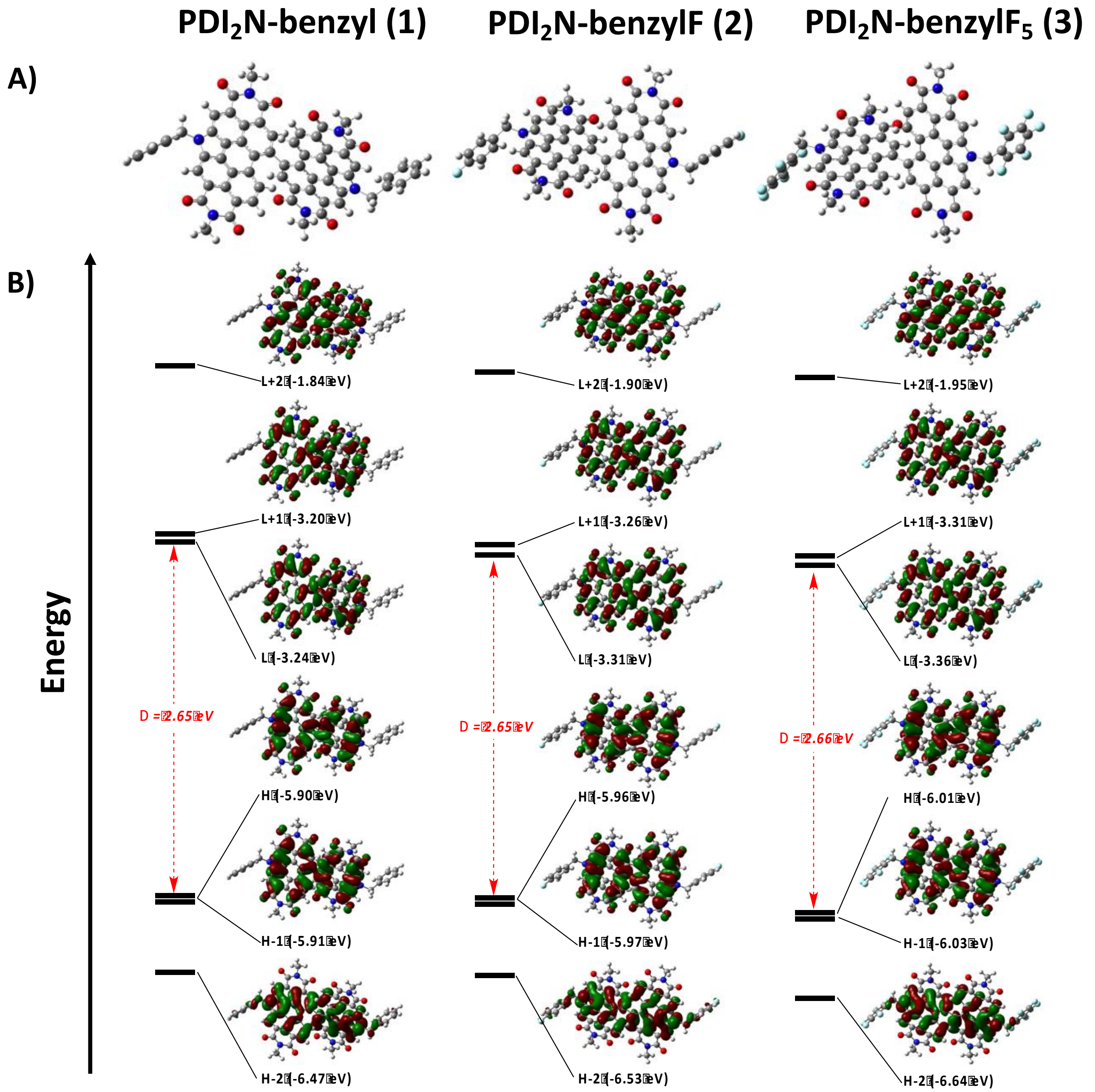


Figure S31: A) Optimized geometry for compounds **1**, **2**, and **3**. B) Calculated electronic energy levels and energy gaps where H = HOMO and L = LUMO. Calculations were done on Gaussian09,[2] input files and results were visualized using GausView05.[3] All alkyl chains were replaced with a methyl group to reduce computational time. The B3LYP[4–6] level of theory with 6-31G(d,p)[7–12] basis set were used for the calculations.

10. Thermal Annealing Study

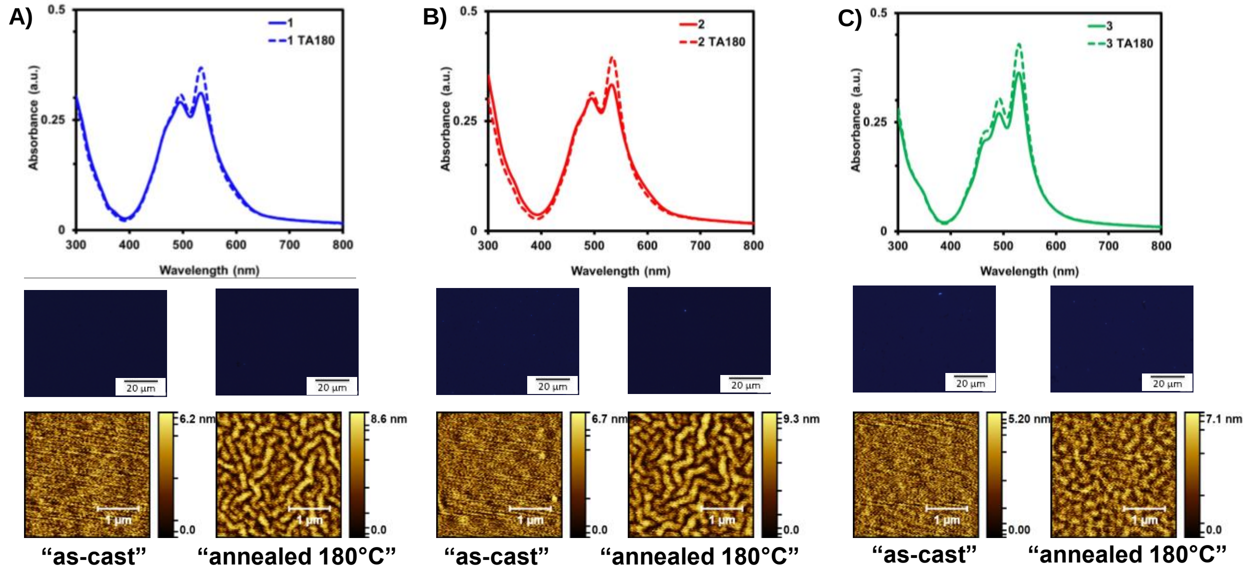


Figure S32. Comparison of films measured 'as-cast' and thermally annealed at 180 °C (TA180) for PDI materials (A) **1**, tPDI$_2$N-benzyl, (B) **2**, tPDI$_2$N-benzylF, and (C) **3**, tPDI$_2$N-benzylF$_5$. TOP = optical absorption spectra, MIDDLE = polarized light microscopy images, BOTTOM = atomic force microscopy height images. All films were spun-cast (1500 rpm) from CHCl$_3$ solutions at room temperature.

11. Organic Thin Film Transistors:

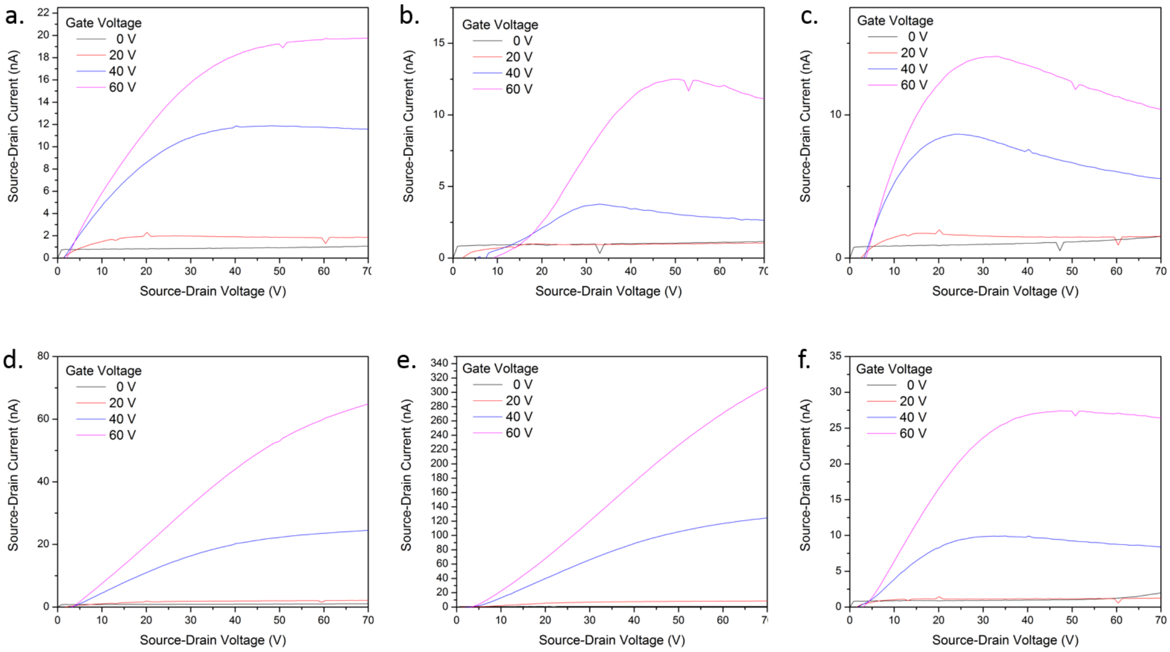


Figure S33: Typical output curves for BGBC OTFTs of **1** (a, d) **2** (b, e) and **3** (c, f) without annealing (a, b, c) and with annealing at 180 °C for 10 minutes (d, e, f).

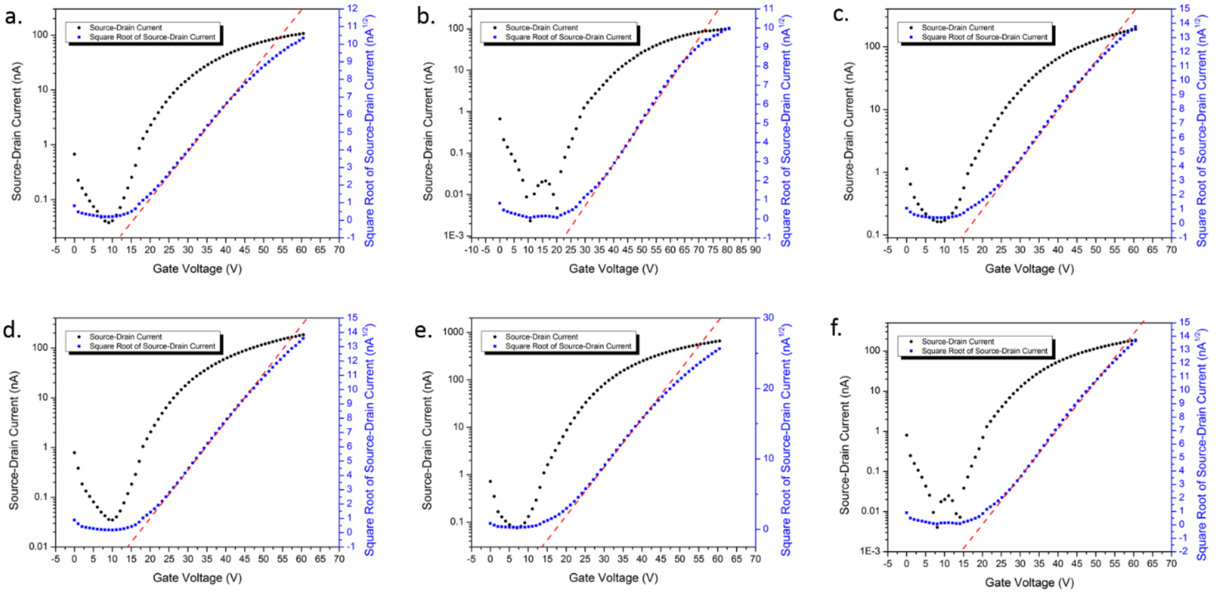


Figure S34: Typical transfer curves with V_{DS} = 70 V for BGBC OTFTs of **1** (a, d) **2** (b, e) and **3** (c, f) without annealing (a, b, c) and with annealing at 180 °C for 10 minutes (d, e, f).

12. Organic Solar Cells:

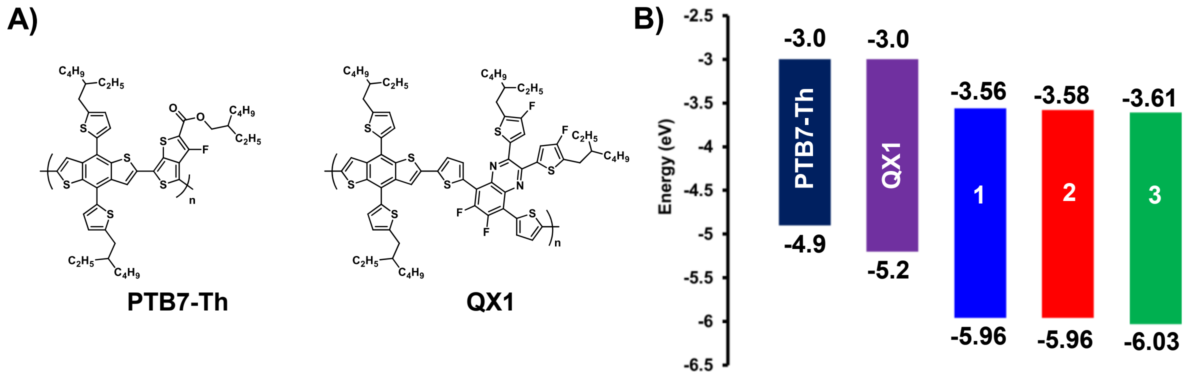


Figure S35. (A) Chemical structures of the donor polymers PTB7-Th and QX1 (TTFQx-T1). (B) Electronic energy levels of donor polymers and PDI materials. Donor polymer HOMO/LUMO energy levels determined from the onsets of oxidation and reduction of the solution cyclic voltammetry measurements, respectively, in our labs. PDI materials HOMO/LUMO energy levels determined from the $E_{1/2}$ value of the first oxidation and reduction events. A conversion value of 4.8 was used (see Materials and Methods section).

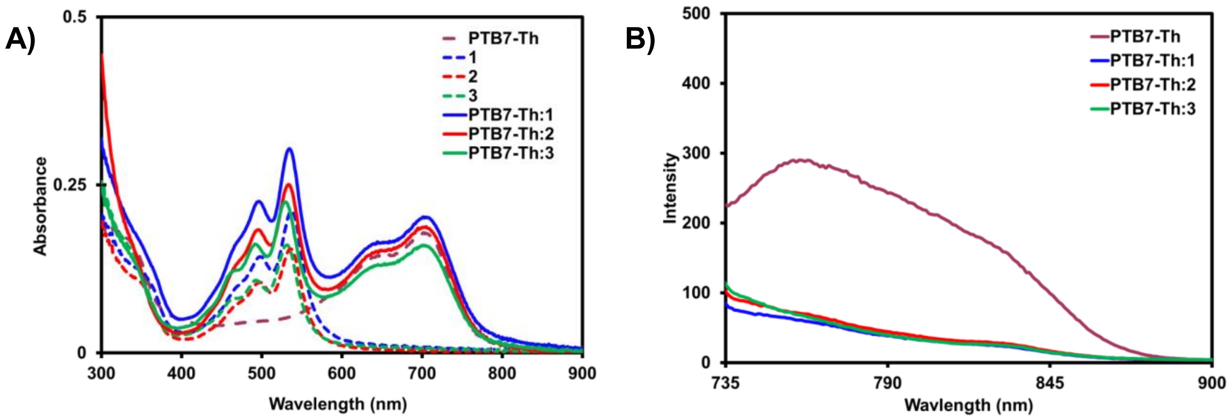


Figure S36. (A) Film optical absorption spectra of donor polymer PTB7-Th, PDI materials **1**-**3**, and BHJ blends. (B) Film photoluminescent spectra of donor polymer PTB7-Th and BHJ blends. Neat films spun-cast from 5 mg/mL C_6H_5Cl solutions. BHJ blend films cast from 1:1 (polymer:PDI) 10 mg/mL total solids concentration C_6H_5Cl solutions.

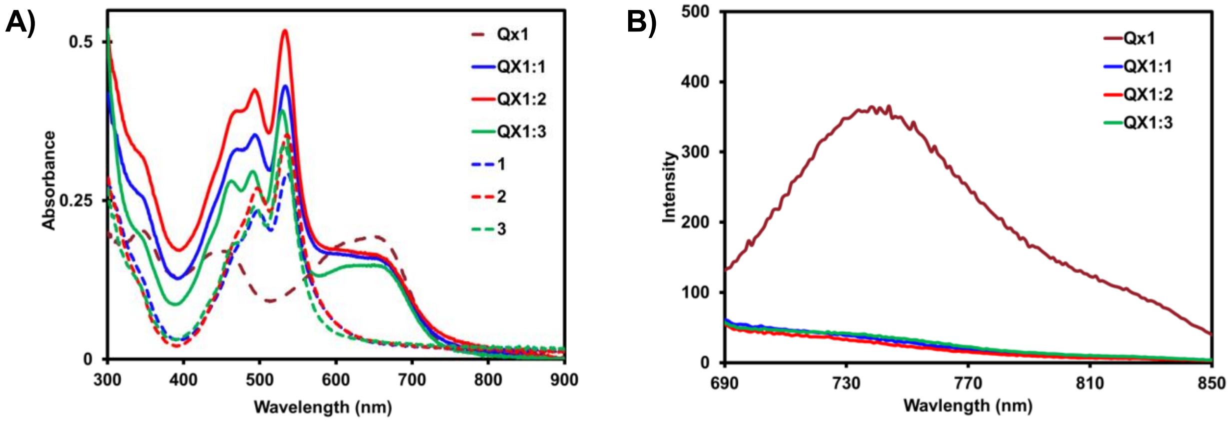


Figure S37. (A) Film optical absorption spectra of donor polymer QX1, PDI materials **1**-**3**, and BHJ blends. (B) Film photoluminescent spectra of donor polymer QX1 and BHJ blends. Neat films spun-cast from 5 mg/mL 2Me-THF solutions. BHJ blend films cast from 1:1 (polymer:PDI) 10 mg/mL total solids concentration 2Me-THF solutions.

Table S1. OSC data of the PTB7-Th: **PDI** material **1-3** blends (1:1) cast from chlorobenzene. Best results are highlighted in bold. Averages are in italics-blue.

blend	V_{OC} (V)	J_{sc} (mA/cm^2)	FF (%)	PCE (%)
PTB7-Th:1	0.93	10.83	48.87	4.92
	0.91	10.38	46.71	4.43
	0.96	**11.65**	**51.10**	**5.70**
	0.93	11.03	50.55	5.19
	0.95	10.85	51.38	5.31
	0.94	10.95	50.95	5.26
	0.93	9.10	50.99	4.31
	0.95	9.87	51.25	4.81
	0.95	9.86	51.23	4.80
	0.93	10.13	48.60	4.60
	0.94	9.72	48.45	4.43
	0.96	9.78	52.57	4.92
	0.94	*10.35*	*50.22*	*4.89*
PTB7-Th:2	**0.90**	**11.02**	**49.25**	**4.89**
	0.89	8.45	44.32	3.33
	0.89	8.77	51.70	4.04
	0.90	9.10	49.29	4.02
	0.84	9.12	39.25	3.00
	0.91	9.88	50.50	4.52
	0.90	9.89	50.28	4.47
	0.91	10.01	50.58	4.61
	0.91	10.05	49.48	4.50
	0.89	9.97	46.27	4.09
	0.90	8.91	51.67	4.16
	0.90	9.27	51.69	4.34
	0.89	*9.54*	*48.69*	*4.17*
PTB7-Th:3	0.87	9.86	45.80	3.92
	0.87	9.89	45.22	3.90
	0.89	**10.18**	**46.67**	**4.21**
	0.82	10.04	37.41	3.08
	0.88	9.14	47.42	3.82
	0.86	9.06	45.58	3.57
	0.88	9.04	49.02	3.88
	0.88	9.50	47.43	3.95
	0.89	8.94	48.24	3.84
	0.88	9.03	47.06	3.74
	0.89	9.36	48.41	4.03
	0.88	9.33	48.50	3.99
	0.89	9.10	50.29	4.09
	0.89	9.05	50.20	4.04
	0.89	8.79	49.96	3.92
	0.88	8.70	49.48	3.80
	0.88	*9.31*	*47.29*	*3.86*

Table S1. OSC data of the QX1: **PDI** material **1-3** blends (4:6) cast from 2Me-THF. Best results are highlighted in bold. Averages are in italics-blue.

blend	**V_{OC} (V)**	**J_{sc} (mA/cm^2)**	**FF (%)**	**PCE (%)**
QX1:1	0.99	13.35	40.35	5.34
	0.98	13.57	40.16	5.34
	0.99	**14.09**	**41.57**	**5.82**
	0.99	14.19	40.99	5.76
	0.99	*13.80*	*40.77*	*5.56*
QX1:2	0.95	14.37	38.99	5.33
	0.96	14.86	40.43	5.77
	0.96	**15.12**	**40.05**	**5.82**
	0.96	14.40	39.33	5.42
	0.96	14.46	40.04	5.53
	0.96	*14.64*	*39.77*	*5.57*
QX1:3	**0.96**	**14.35**	**40.05**	**5.50**
	0.95	13.35	39.47	5.02
	0.95	13.39	39.85	5.09
	0.95	14.33	39.96	5.46
	0.95	*13.86*	*39.83*	*5.27*

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