Supplementary Information (SI) for Organic & Biomolecular Chemistry.
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Supporting Information

Cu-Catalyzed Oxidative Coupling of Alkylarenes with Tertiary C(sp^3)−H Bonds via C–H Activation

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Contents

1. Experimental Section

1.1 General Experimental Procedures

Caution: Di-*tert*-butyl peroxide is a strong oxidizer and can be explosive. It is harmful if exposed by inhalation or skin contact. All experiments involving peroxy compounds should be carried out behind a safety shield and in a fume hood.[1]

All non-aqueous reactions were carried out under an atmosphere of dry argon unless otherwise noted. Commercial reagents were used as received without additional purification unless otherwise noted. Toluene was distilled and degassed and stored in the glovebox. 3-Substituted oxindoles and 9-phenyl-9*H*-xanthenes used in this study were prepared according to the literature.[2] 9-Substituted fluorenes and 6,11-diphenyl-6*H*-isoindolo[2,1-a]indoleused were prepared according to the literature.[3] Reactions were monitored by thin layer chromatography (TLC) using Silicycle glass-backed TLC plates with 250 μm silica and F254 indicator. Visualization was accomplished by UV light.

^{1}H NMR, ^{13}C NMR spectra were recorded on a AM-500 Fourier transform NMR spectrometer at 500 MHz, 125 MHz respectively. Chemical shifts are reported relative to the solvent resonance peak δ 7.26 ($CDCl_3$) for ^{1}H and δ 77.16 ($CDCl_3$) for ^{13}C. Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, b = broad singlet, m = multiplet), coupling constants, and number of protons. Accurate mass measurement analyses were conducted on either a Waters GCT Premier, time-of-flight, an LCT Premier XE, time-of-flight, or a Bruker ScimaX Magnetic Resonance Mass Spectrometer (MRMS) LCMS equipped with electrospray ionization (ESI). Samples were taken up in a suitable solvent for analysis (typically MeCN) and analyzed in positive or negative modes via direct infusion. The signals were mass measured against an internal lock mass reference of leucine enkephalin for ESI-LCMS. The software calibrates the instruments, and reports measurements, by use of neutral atomic masses; Infrared spectra are reported in cm^{-1}. Column chromatography was performed with silica gel (50-63 μm mesh particle size).

General Procedure A – Benzylation of 3-Substituted Oxindoles in Neat Tolyl Substrate: Oxindole (0.15 mmol) was added to a flame-dried 8 mL microwave vial

equipped with stir bar and was brought into the glovebox. CuBr (2.1 mg, 0.178 mmol, 10 mol%), phenanthroline (5.4 mg, 0.03 mmol, 20 mol%), tolyl analog (0.1 M, 1.5 mL) and DTBP (110 µL, 4 equiv) were added to the mixture sequentially. The microwave vial was sealed with a Teflon cap, removed from the glovebox, and placed in a 135 °C oil bath. After 24 h, the mixture was allowed to cool to ambient temperature, diluted with CH_2Cl_2 (1 mL), passed through celite with CH_2Cl_2, and concentrated. The residue was chromatographed (EtOAc/hexanes) to afford the desired product.

General Procedure B – Benzylation of 9-Substituted Fluorenes in Neat Tolyl Substrate: A 9-aryl-9*H*-fluorenyl substrate (0.15 mmol) was added to a flame-dried 8 mL microwave vial equipped with stirbar and was brought into the glovebox. CuBr (2.1 mg, 0.178 mmol, 10 mol%), phenanthroline (5.4 mg, 0.03 mmol, 20 mol%), tolyl analog (0.1 M, 1.5 mL), and DTBP (110 µL, 4 equiv) were added to the mixture sequentially. The microwave vial was sealed with a Teflon cap, removed from the glovebox, and placed in a 135 °C oil bath. After 24 h, the mixture was allowed to cool to ambient temperature, diluted with CH_2Cl_2 (1 mL), passed through celite with CH_2Cl_2, and concentrated. The residue was chromatographed (EtOAc/hexanes) to afford the indicated product.

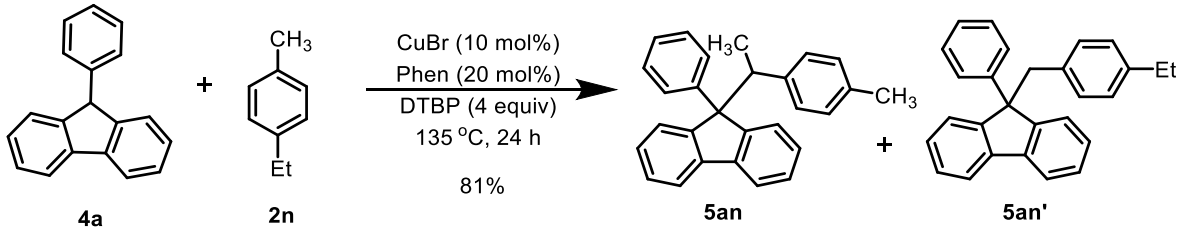
General Procedure C – Benzylation of Substituted Xanthenes in Neat Tolyl Substrate: Xanthene (0.15 mmol) was added to a flame-dried 8 mL microwave vial equipped with stir bar and was brought into the glovebox. CuBr (2.1 mg, 0.178 mmol, 10 mol%), phenanthroline (5.4 mg, 0.03 mmol, 20 mol%), tolyl analog (0.1 M, 1.5 mL) and DTBP (110 µL, 4 equiv) were added to the mixture sequentially. The microwave vial was sealed with a Teflon cap, removed from the glovebox, and placed in a 120 °C oil bath. After 24 h, the mixture was allowed to cool to ambient temperature, diluted with CH_2Cl_2 (1 mL), passed through celite with CH_2Cl_2, and concentrated. The residue was chromatographed (EtOAc/hexanes) to afford the desired product.

General Procedure D – Scale up Benzylation of Fluorene 4c: A 9-(4-methoxyphenyl)-9H-fluorene **4c** (4.0 mmol, 1.1 g) was added to a flame-dried 100 mL flask equipped with stirbar and was brought into the glovebox. CuBr (57.4 mg, 0.4 mmol, 10 mol%), phenanthroline (144.2 mg, 0.8 mmol, 20 mol%), toluene (0.1 M, 40 mL), and DTBP (3.0 mL, 4 equiv) were added to the mixture sequentially. The flask was sealed with a rubber

cap, removed from the glovebox. Under Argon flow, the reaction flask was installed with reflux condenser and placed in a 135 °C oil bath. After 24 h, the mixture was allowed to cool to ambient temperature, diluted with CH_2Cl_2 (30 mL), passed through celite with CH_2Cl_2. The reaction was sequentially washed with 30 mL of 10% sodium sulfite aqueous solution, 30 mL of saturated $NaHCO_3$ aqueous solution and 30 mL of brine. The organic phase was concentrated to dryness. The residue was chromatographed (EtOAc/hexanes 10% EtOAc) to afford 898.9 mg of product **5ca** in 62% yield as an amorphous white solid.

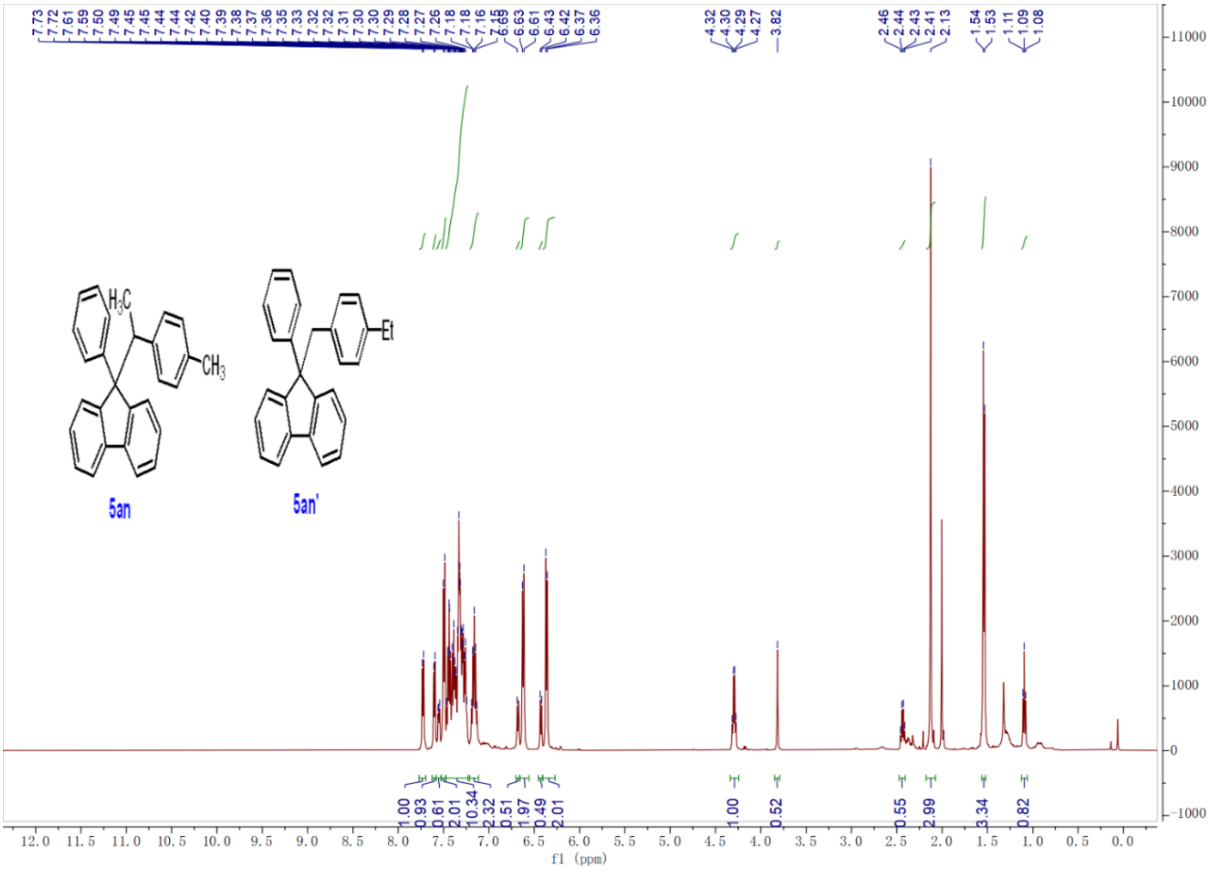
General Procedure E – Demethylation of Fluorene 5ca: Into a stirred solution of 9-benzyl-9-(4-methoxyphenyl)-9H-fluorene **5ca** (800 mg, 2.2 mmol) in dry dichloromethane (8 mL) was dropped, at 0°C, 4.8 mL of a 1M solution of Boron tribromide (2.2 equiv) in dichloromethane. The mixture was allowed to warm to room temperature, stirred for 4 hours. It was then quenched with 2mL of ice–water. The organic phase was further washed with 10 mL of saturated $NaHCO_3$ aqueous solution and 10 mL of brine. The organic phase was concentrated to dryness. The residue was chromatographed (EtOAc/hexanes 20% EtOAc) to afford the desired product.

1.2 Mechanistic Probes: Internal methyl vs ethyl competition experiment:



General procedure B was followed using **4a** (36.3 mg, 0.15 mmol), CuBr (2.1 mg, 0.178 mmol), phenanthroline (5.4 mg, 0.03 mmol) and DTBP (110 µL, 4 equiv) in 1-ethyl-4-methylbenzene (1.5 mL, 0.1 M) at 135 °C for 24 h. Chromatography (hexanes) afforded the products **5an** and **5an'** in a 3.8:1 ratio by ^{1}H NMR spectroscopy with an overall 81% yield as a white solid (inseparable mixture) (Figure S1). **5an**: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.73 (d, *J* = 5.0 Hz, 1H), 7.60 (d, *J* = 10.0 Hz, 1H), 7.49 (d, *J* = 5.0 Hz, 2H), 7.48 -7.24 (m, 7H), 7.19 -7.13 (m, 2H), 6.62 (d, *J* = 10.0 Hz, 2H), 6.37 (d, *J* = 5.0 Hz, 2H), 4.30 (q, *J* = 5.0 Hz, 1H), 2.13 (s, 3H), 1.53 (d, *J* = 5.0 Hz, 3H); **5an'**: ^{1}H NMR (500 MHz, $CDCl_3$) δ

7.54 (d, *J* = 10.0 Hz, 2H), 7.48 -7.24 (m, 11H), 7.14 (d, *J* = 10.0 Hz, 2H), 6.42 (d, *J* = 5.0 Hz, 2H), 3.82 (s, 2H), 2.44 (q, *J* = 5.0 Hz, 2H), 1.09 (d, *J* = 5.0 Hz, 3H); **5an**&**5an'** ^{13}C NMR (150 MHz, $CDCl_3$) δ 151.1, 150.8, 148.1, 144.8, 143.5, 142.7, 141.6, 140.9, 139.6, 138.4, 135.2, 133.8, 130.1, 128.8, 128.6, 127.6, 127.5, 127.4, 127.2, 127.1, 126.9, 126.8, 126.6, 126.4, 125.2, 124.9, 120.0, 119.9, 119.5, 63.9, 60.1, 46.4, 43.7, 28.3, 20.9, 17.9, 15.5.



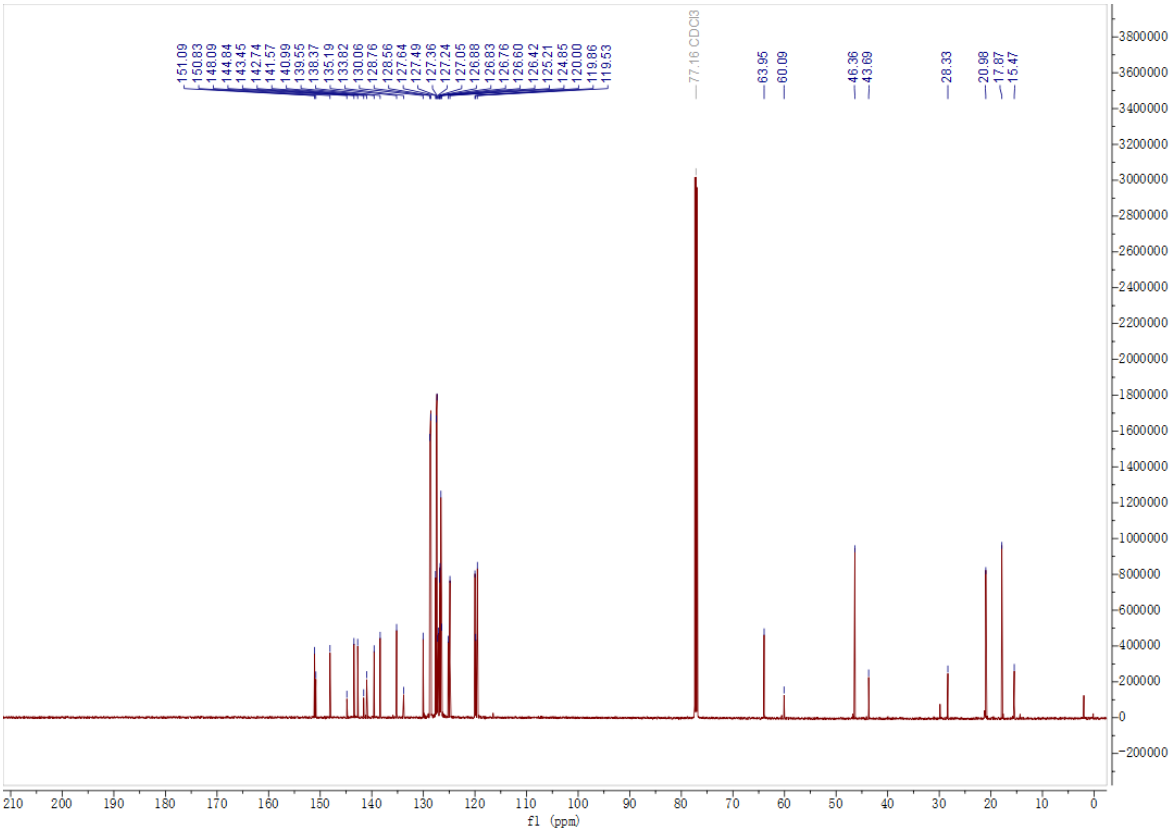
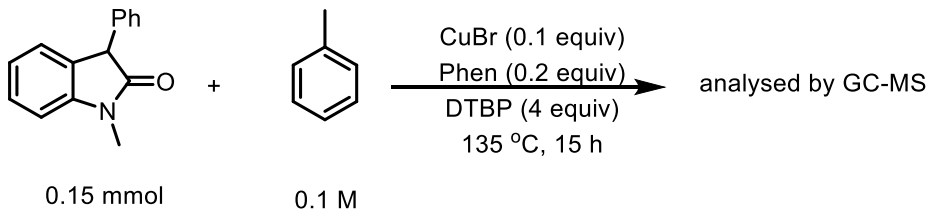
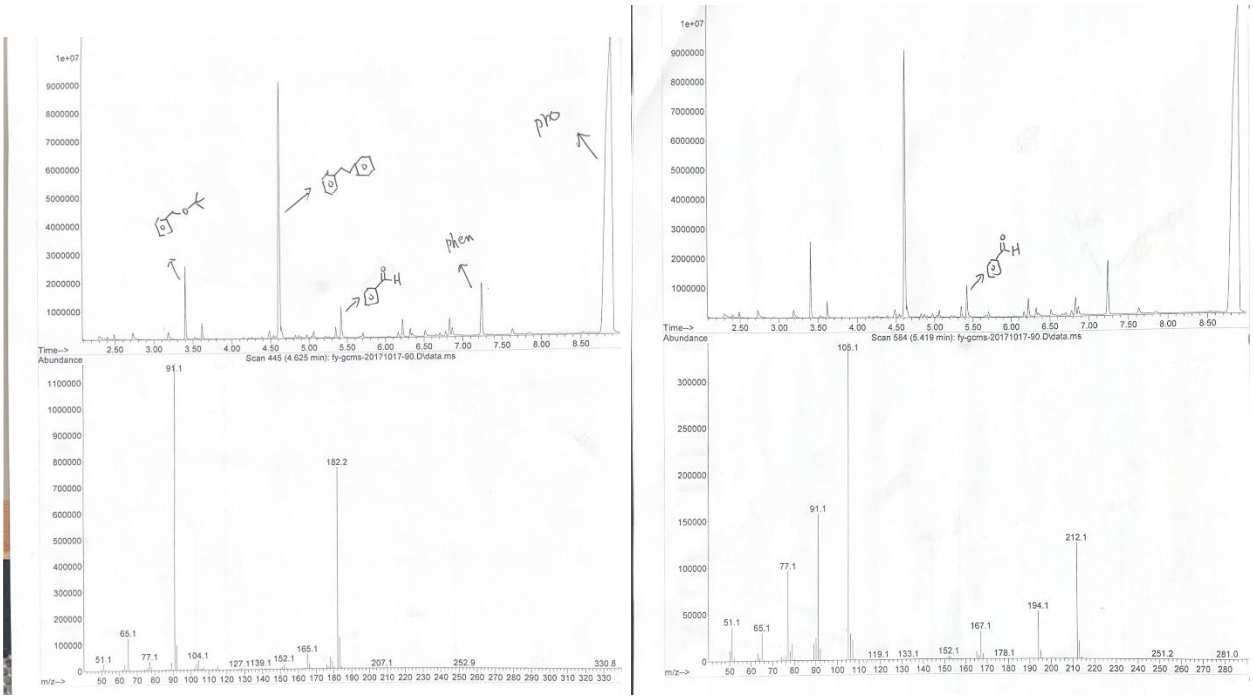


Figure S1. ^{1}H NMR ^{13}CNMR spectra of the mixture of the product **5an** and **5an'**

Byproduct analysis:





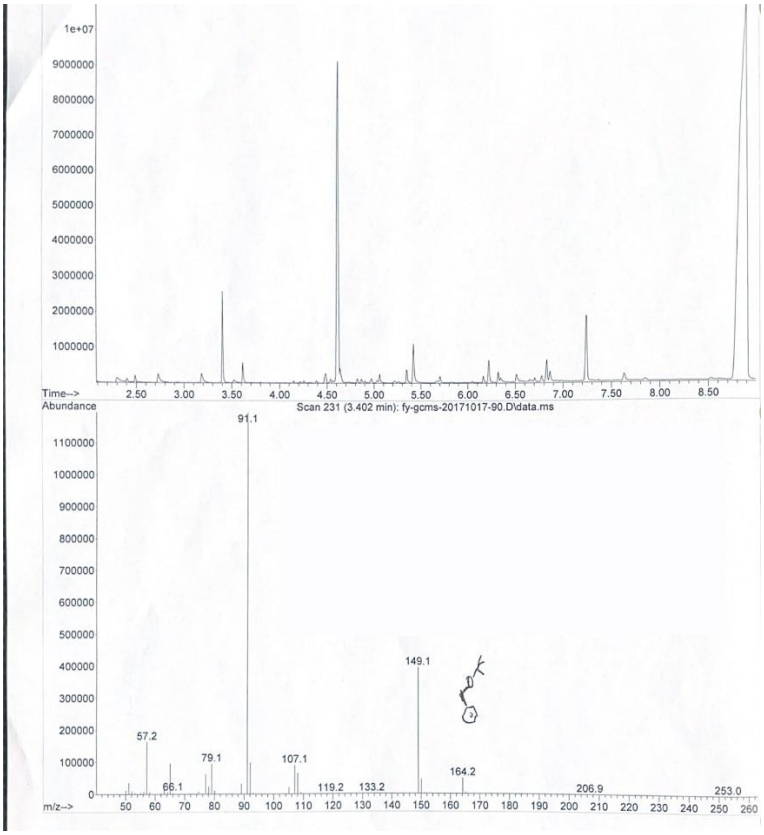
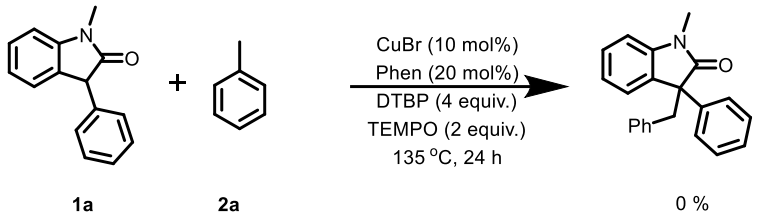


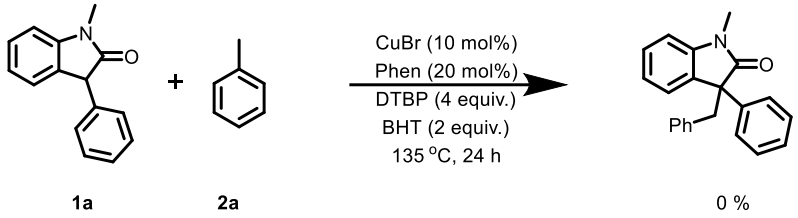
Figure S2. GS-MS spectra of the crude mixture.

Radical trapping experiment:



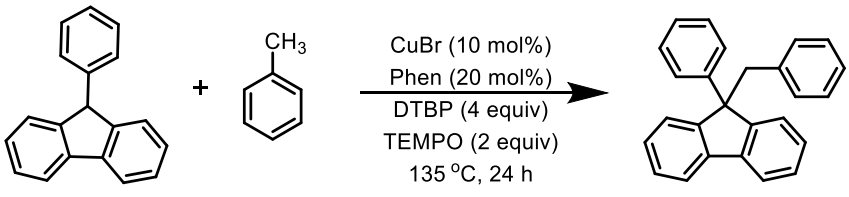
1a **2a** 0 %

1a (33.4 mg, 0.15 mmol) was added to a flame-dried 8 mL microwave vial equipped with a stirbar and was brought into the glovebox. CuBr (2.1 mg, 0.178 mmol, 10 mol%), phenanthroline (5.4 mg, 0.03 mmol, 20 mol%), TEMPO (46.8 mg, 2 equiv), toluene (0.1 M, 1.5 mL), and DTBP (110 µL, 4 equiv) were added to the mixture sequentially. The microwave vial was sealed with a Teflon cap, removed from the glovebox, and placed in a 135 °C oil bath. After 24 h, the mixture was allowed to cool to ambient temperature. The reaction solution was passed through a short pad of celite and analyzed by ESI-MS.



1a **2a** 0 %

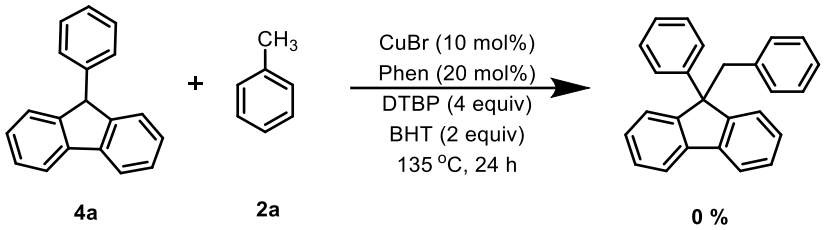
When the BHT (66.1 mg. 2 equiv) was added to the reaction of **1a** with **2a** under the standard conditions, no desired product **3aa** was detected.



4a **2a** **0 %**

9-Phenylfluorene (36.3 mg, 0.15 mmol) was added to a flame-dried 8 mL microwave vial equipped with stir bar and was brought into the glovebox. CuBr (2.1 mg, 0.178 mmol, 10 mol%), phenanthroline (5.4 mg, 0.03 mmol, 20 mol%), TEMPO (46.8 mg, 2 equiv), toluene (0.1 M, 1.5 mL), and DTBP (110 µL, 4 equiv) were added to the mixture sequentially. The microwave vial was sealed with a Teflon cap, removed from the

glovebox, and placed in a 135 °C oil bath. After 24 h, the mixture was allowed to cool to ambient temperature. The reaction solution was passed through a short pad of celite and the mixture was subjected to ESI-MS. None of the benzylated product was observed.



4a **2a** **0 %**

When the BHT (66.1 mg, 2 equiv) was added to the reaction under the standard conditions, no benzylated product was detected.

KIE experiment

(1) Competitive KIE Experiment:

Toluene-D_8 (99.5%, cat. No. DLM-5-10) was purchased from Cambridge Isotope Laboratories. The isotope reagent was used without further purification. Compound **1a** (33.4 mg, 0.15 mmol) was added to a flame-dried 8 mL microwave vial equipped with stirbar and was brought into the glovebox. CuBr (2.1 mg, 0.178 mmol, 10 mol%), phenanthroline (5.4 mg, 0.03 mmol, 20 mol%), 1.5 mL of toluene/D_8-toluene (1:1), and DTBP (110 µL, 4 equiv) were added to the mixture sequentially. The microwave vial was sealed with a Teflon cap, removed from the glovebox, and placed in a 135 °C oil bath. After 16 h, the mixture was allowed to cool to ambient temperature, diluted with CH_2Cl_2 (1 mL), passed through celite with CH_2Cl_2, and concentrated. The residue was chromatographed (EtOAc/hexanes) to afford the corresponding product. The product was analyzed by ^{1}HNMR (Figure S3):

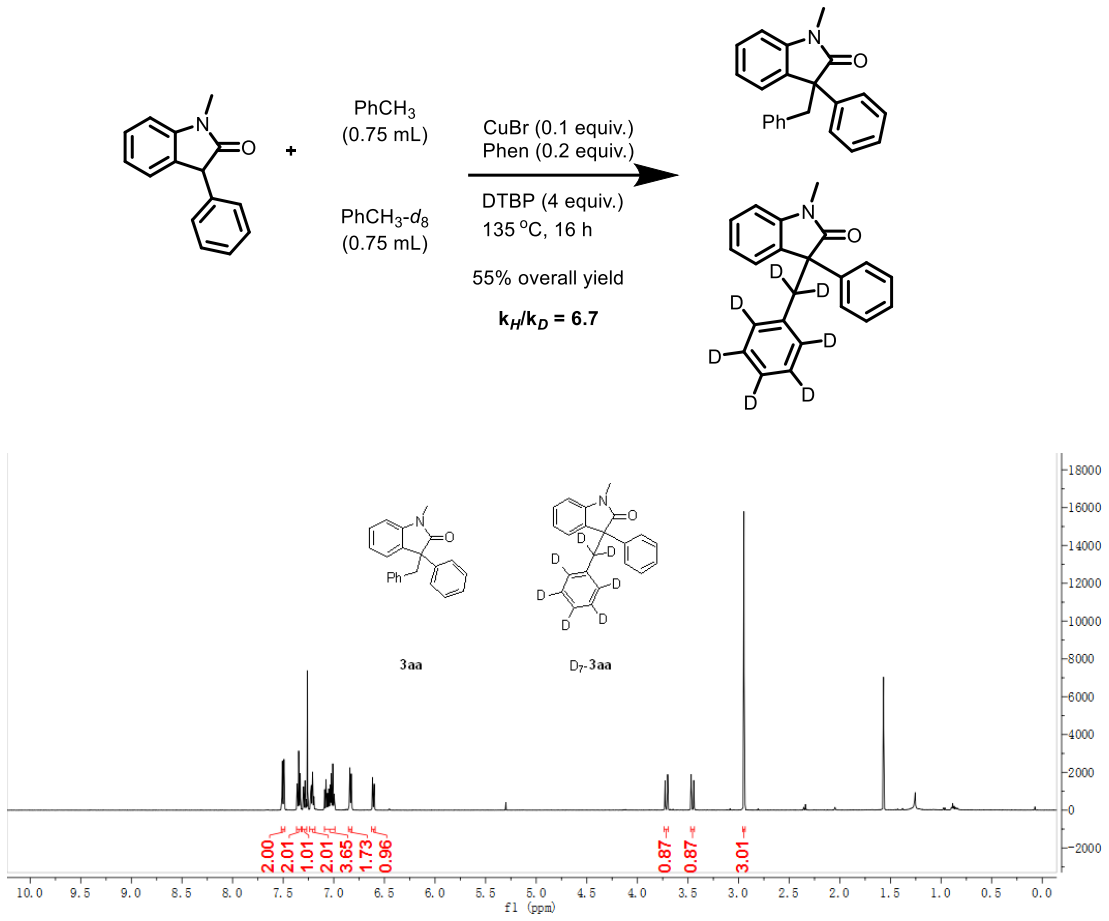
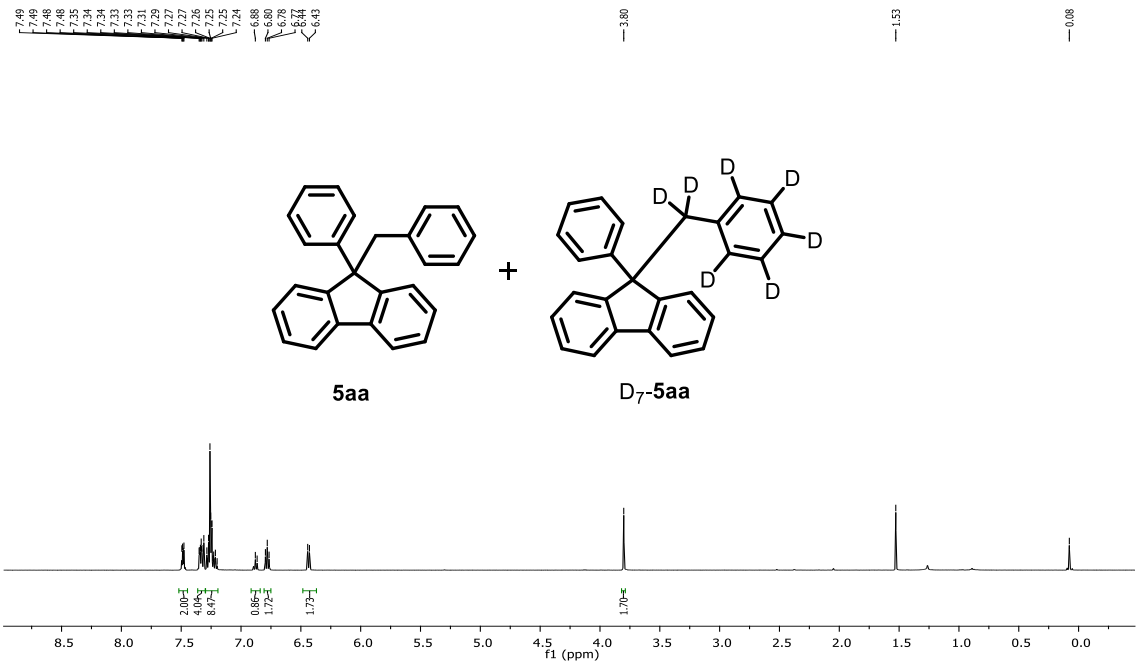


Figure S3. ^{1}H NMR spectra of the mixture of the product **3aa** and D_7-**3aa**.

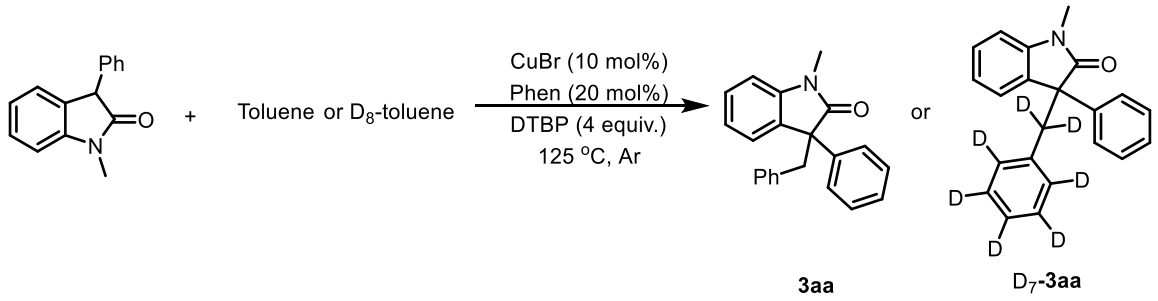
9-Phenyl-9*H*-fluorene (36.3 mg, 0.15 mmol) was added to a flame-dried 8 mL microwave vial equipped with stirbar and was brought into the glovebox. CuBr (2.1 mg, 0.178 mmol, 10 mol%), phenanthroline (5.4 mg, 0.03 mmol, 20 mol%), of toluene/D_8-toluene (1:1, 1.5 mL) and DTBP (110 μL, 4 equiv) were added to the mixture sequentially. The microwave vial was sealed with a Teflon cap, removed from the glovebox, and placed in a 135 °C oil bath. After 16 h, the mixture was allowed to cool to ambient temperature, diluted with CH_2Cl_2 (1 mL), passed through celite with CH_2Cl_2, and concentrated. The residue was chromatographed (hexanes) to afford the corresponding product. The product was analyzed by ^{1}H NMR spectroscopy (Figure S4):



Time (min)	30	60	90	120	150
Concentration **3aa** (M)	0.003	0.017	0.036	0.045	0.052
Concentration D_7-**3aa** (M)	0.002	0.011	0.016	0.026	0.033

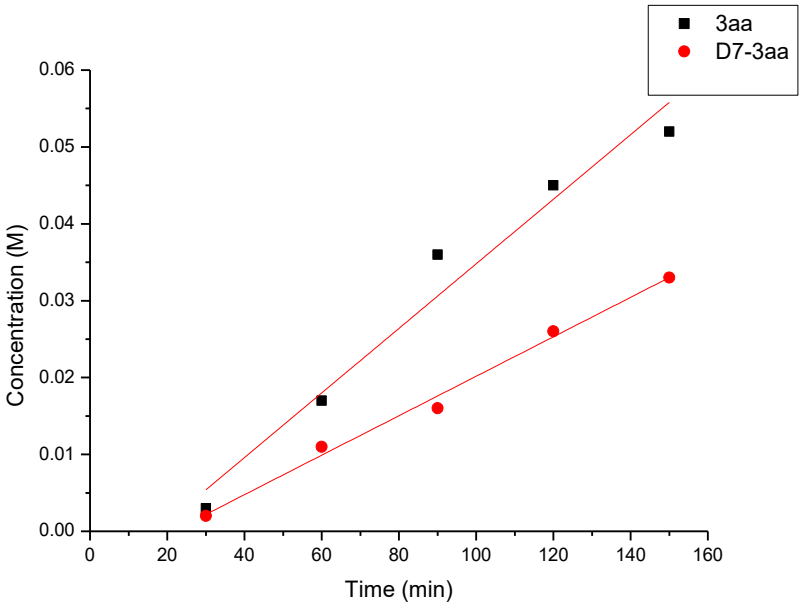
Figure S4. ^{1}H NMR spectra of the mixture of the product **5aa** and D_7-**5aa**

(2) Parallel KIE Experiments:



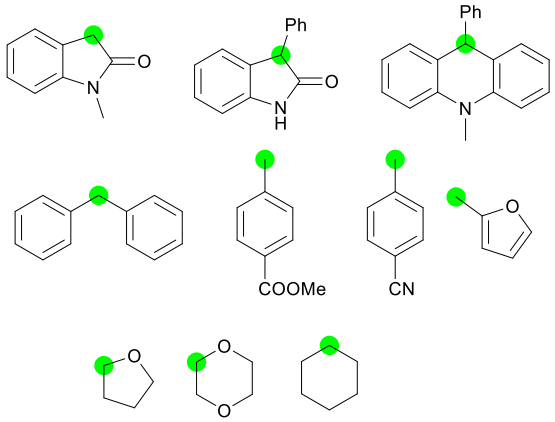
Toluene-D_8 (99.5%, cat. No. DLM-5-10) was purchased from Cambridge Isotope Laboratories. The isotopically labelled reagent was used without further purification. Substrate **1a** (22.3 mg, 0.1 mmol) was added to a flame-dried 8 mL microwave vial equipped with stir bar and was brought into the glovebox. CuBr (1.4 mg, 0.01 mmol, 10

mol%), phenanthroline (3.6 mg, 0.02 mmol, 20 mol%), toluene or D_8-toluene (1.0 mL), and DTBP (73 μL, 4 equiv) were added to the mixture sequentially. The microwave vial was sealed with a Teflon cap, removed from the glovebox, and placed in a 125 °C oil bath. After the indicated time, the mixture was allowed to cool to ambient temperature, diluted with CH_2Cl_2 (1 mL), passed through celite with CH_2Cl_2, and concentrated. The residue was analyzed by ^1H NMR in $CDCl_3$ using CH_2Br_2 as an internal standard.

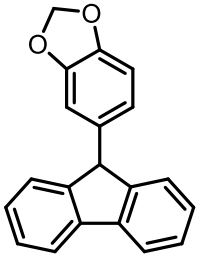


Equation for **3aa**: y = 0.00042x-0.0072 R^2 = 0.9904
Equation for D_7-**3aa**: y = 0.00026x-0.0055 R^2 = 0.95645
k_H/k_D = 0.00042/0.00026 = 1.6

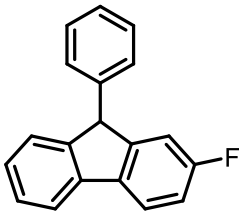
1.3 Summary of unsuccessful substrates



Characterization Data of Products

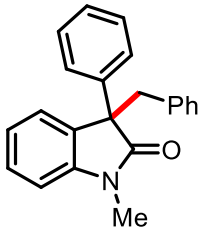


5-(9*H*-Fluoren-9-yl)benzo[*d*][1,3]dioxole. Obtained according to a reported procedure[3] in 92% yield (400 mg) as an amorphous white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.77 (d, *J* = 7.6 Hz, 2H), 7.36 (t, *J* = 7.4 Hz, 2H), 7.31 (d, *J* = 7.5 Hz, 2H), 7.26-7.23 (m, 2H), 6.73 (d, *J* = 2.1 Hz, 2H), 6.35 (s, 1H), 5.87 (s, 2H), 4.95 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 148.02, 148.01, 146.6, 141.0, 135.4, 127.48, 127.46, 125.3, 121.8, 120.0, 108.4, 108.3, 101.0, 54.2; IR (film) 2888, 1501, 1485, 1440, 1246, 1235, 1184, 1117, 1101, 1089, 1039, 932, 884, 862, 802, 740, 725, 643, 621, 554 cm^{-1}; HRMS (EI-TOF) calcd for $C_{20}H_{14}O_2$ $[M]^+$ m/z = 286.0994; found 286.1009.



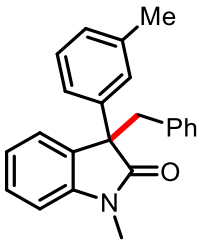
2-Fluoro-9-phenyl-9*H*-fluorene: Obtained according to a reported procedure[3] in 95% yield (250 mg) as an amorphous white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.74-7.70 (m, 2H), 7.37 (t, *J* = 7.7 Hz, 1H), 7.30-7.22 (m, 5H), 7.07 (d, *J* = 6.6 Hz, 3H), 7.00 (d, *J* = 9.9 Hz, 1H), 5.01 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 162.8 (d, *J* = 245.5 Hz), 150.2 (d, *J* = 8.1 Hz), 147.8 (d, *J* = 1.7 Hz), 141.0, 140.3, 137.1 (d, *J* = 2.3 Hz), 128.9, 128.4, 127.6, 127.2, 127.1, 125.4, 120.9 (d, *J* = 8.8 Hz), 119.7, 114.7 (d, *J* = 23.1 Hz), 112.8 (d, *J* = 23.0 Hz), 54.6; IR (film) 2991, 1588, 1493, 1486, 1467, 1454, 1421, 1270, 1254, 1232, 1198, 1125, 944, 865, 830, 766, 754, 740, 721, 710, 696 cm^{-1}. HRMS (EI-TOF) calcd for $C_{19}H_{13}F$ $[M]^+$ m/z = 260.1001; found 260.0997.

3-Benzyl-1-methyl-3-phenylindolin-2-one (3aa)



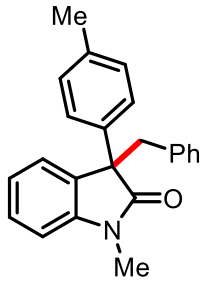
The general procedure **A** was followed by using **1a** and toluene. Column chromatography (6% EtOAc/hexanes) afforded **3aa** (39.0 mg) in 83% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.50 (d, *J* = 7.5 Hz, 2H), 7.35 (t, *J* = 7.5 Hz, 2H), 7.28 (t, *J* = 7.5 Hz, 1H), 7.23-7.19 (m, 2H), 7.10-6.99 (m, 4H), 6.83 (d, *J* = 5.6 Hz, 2H), 6.61 (d, *J* = 6.0 Hz, 1H), 3.71 (d, *J* = 13.0 Hz, 1H), 3.46 (d, *J* = 13.0 Hz, 1H), 2.95 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 177.9, 143.9, 139.9, 135.8, 131.4, 130.1, 128.7, 128.3, 127.6, 127.5, 127.4, 126.6, 125.6, 122.3, 108.1, 58.4, 44.1, 26.2; HRMS (ESI-FTICR) calcd for $C_{22}H_{20}NO$ $[M+H]^+$ m/z = 314.1545; found 314.1544. Spectral data match those previously reported.[4]

3-Benzyl-1-methyl-3-(m-tolyl)indolin-2-one (3ba)



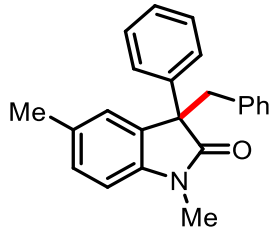
The general procedure **A** was followed using 1-methyl-3-(m-tolyl)indolin-2-one and toluene. Chromatography (6% EtOAc/hexanes) afforded **3ba** (30.4 mg) in 63% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.32-7.19 (m, 5H), 7.11-6.99 (m, 5H), 6.83 (d, *J* = 7.0 Hz, 2H), 6.60 (d, *J* = 7.5 Hz, 1H), 3.71 (d, *J* = 12.5 Hz, 1H), 3.44 (d, *J* = 12.5 Hz, 1H), 2.94 (s, 3H), 2.35 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.9, 143.9, 139.8, 138.3, 135.9, 131.7, 130.1, 128.6, 128.4, 128.2, 128.0, 127.5, 126.6, 125.5, 124.4, 122.3, 108.1, 58.4, 44.0, 26.2, 21.8; IR (film) 3030, 2922, 1711, 1611, 1493, 1470, 1373, 1349, 1257, 1127, 1088, 1022, 754, 699 cm^{-1}; HRMS (EI-TOF) calcd for $C_{23}H_{21}NO$ $[M]^+$ m/z = 327.1623; found 327.1623.

3-Benzyl-1-methyl-3-(p-tolyl)indolin-2-one (3ca)



The general procedure **A** was followed using 1-methyl-3-(*p*-tolyl)indolin-2-one and toluene. Chromatography (6% EtOAc/hexanes) afforded **3ca** (32.4 mg) in 66% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (d, *J* = 8.0 Hz, 2H), 7.21-7.16 (m, 2H), 7.13 (d, *J* = 8.0 Hz, 2H), 7.07-6.96 (m, 4H), 6.81 (d, *J* = 6.5 Hz, 2H), 6.58 (d, *J* = 8.5 Hz, 1H), 3.68 (d, *J* = 12.5 Hz, 1H), 3.40 (d, *J* = 12.5 Hz, 1H), 2.92 (s, 3H), 2.31 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 177.8, 143.7, 137.0, 136.7, 135.7, 131.3, 129.9, 129.2, 128.0, 127.3, 127.0, 126.3, 125.3, 122.0, 107.8, 57.9, 43.9, 25.9, 20.9; HRMS (ESI-FTICR) calcd for $C_{23}H_{22}NO$ $[M+H]^+$ m/z = 328.1701; found 328.1699. Spectral data match those previously reported.[4]

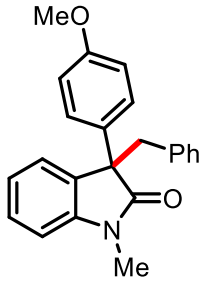
3-Benzyl-1,5-dimethyl-3-phenylindolin-2-one (3da)



The general procedure **A** was followed using 1,5-dimethyl-3-phenylindolin-2-one and toluene. Chromatography (6% EtOAc/hexanes) afforded **3da** (32.6 mg) in 66% yield as amorphous yellow solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49 (d, *J* = 8.0 Hz, 2H), 7.35 (t, *J* = 7.0 Hz, 2H), 7.28 (d, *J* = 7.0 Hz, 1H), 7.07-6.99 (m, 5H), 6.83 (d, *J* = 6.5 Hz, 2H), 6.49 (d, *J* = 8.5 Hz, 1H), 3.68 (d, *J* = 13.0 Hz, 1H), 3.44 (d, *J* = 13.0 Hz, 1H), 2.92 (s, 3H), 2.35 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 177.9, 141.5, 140.1, 135.9, 131.8, 131.5, 130.2, 128.7, 128.5, 127.5, 127.4, 126.6, 126.3, 107.8, 58.5, 44.0, 26.2, 21.4; HRMS (ESI-

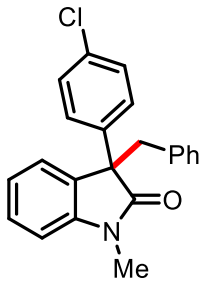
FTICR) calcd for $C_{23}H_{22}NO$ $[M+H]^+$ m/z = 328.1701; found 328.1699. Spectral data match those previously reported.[4]

3-Benzyl-3-(4-methoxyphenyl)-1-methylindolin-2-one (3ea)



The general procedure **A** was followed using 3-(4-methoxyphenyl)-1-methylindolin-2-one and toluene. Chromatography (9% EtOAc/hexanes) afforded **3ea** (44.8 mg) in 87% yield as amorphous pale yellow solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.42 (d, *J* = 9.0 Hz, 2H), 7.23-7.18 (m, 2H), 7.09-6.98 (m, 4H), 6.87 (d, *J* = 9.0 Hz, 2H), 6.83 (d, *J* = 6.5 Hz, 2H), 6.60 (d, *J* = 7.5 Hz, 1H), 3.79 (s, 3H), 3.66 (d, *J* = 12.5 Hz, 1H), 3.41 (d, *J* = 12.5 Hz, 1H), 2.94 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 178.2, 159.0, 143.9, 135.9, 131.9, 131.5, 130.1, 128.5, 128.2, 127.5, 126.5, 125.6, 122.2, 114.1, 108.1, 57.7, 55.4, 44.3, 26.2; HRMS (ESI-FTICR) calcd for $C_{23}H_{22}NO_2$ $[M+H]^+$ m/z = 344.1651; found 344.1648. Spectral data match those previously reported.[5]

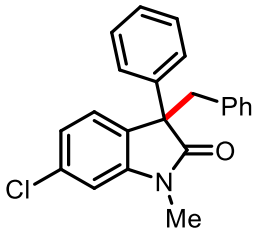
3-Benzyl-3-(4-chlorophenyl)-1-methylindolin-2-one (3fa)



The general procedure **A** was followed using 3-(4-chlorophenyl)-1-methylindolin-2-one and toluene. Chromatography (6% EtOAc/hexanes) afforded **3fa** (32.3 mg) in 62% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.43 (d, *J* = 8.5 Hz, 2H), 7.29 (d, *J* = 8.5 Hz, 2H), 7.21 (t, *J* = 7.5 Hz, 1H), 7.15 (d, *J* = 7.5 Hz, 1H), 7.09-6.97 (m, 4H), 6.79 (d, *J* = 7.0 Hz, 2H), 6.60 (d, *J* = 7.5 Hz, 1H), 3.63 (d, *J* = 13.0 Hz, 1H), 3.38 (d, *J* = 13.0 Hz, 1H), 2.93 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 177.7, 143.8, 139.6, 134.4, 132.6, 131.5, 131.0, 128.8, 128.5, 127.7, 127.6, 127.3, 125.5, 122.4, 108.4, 58.2, 43.3, 26.2;

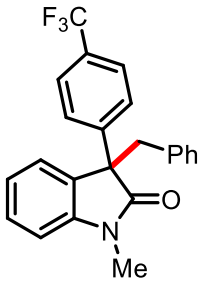
HRMS (ESI-FTICR) calcd for $C_{22}H_{19}ClNO$ $[M+H]^+$ m/z = 348.1155; found 348.1153. Spectral data match those previously reported.[4]

3-Benzyl-6-chloro-1-methyl-3-phenylindolin-2-one (3ga)



The general procedure **A** was followed using 6-chloro-1-methyl-3-phenylindolin-2-one and toluene. Chromatography (6% EtOAc/hexanes) afforded **3ga** (32.4 mg) in 62% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.46 (d, *J* = 7.5 Hz, 2H), 7.35 (t, *J* = 7.0 Hz, 2H), 7.30 (t, *J* = 7.5 Hz, 1H), 7.12-7.03 (m, 5H), 6.84 (d, *J* = 7.0 Hz, 2H), 6.62 (d, *J* = 1.5 Hz, 1H), 3.69 (d, *J* = 12.5 Hz, 1H), 3.44 (d, *J* = 12.5 Hz, 1H), 2.94 (s, 3H); ^{13}C NMR (125 MHz, CDCl3) δ 177.9, 145.1, 139.3, 135.5, 134.1, 130.1, 129.8, 128.8, 127.8, 127.7, 127.3, 126.9, 126.5, 122.1, 108.9, 58.1, 44.0, 26.3; IR (film) 3029, 2928, 1717, 1607, 1495, 1454, 1367, 1246, 1069, 953, 727, 698 cm^{-1}; HRMS (EI-TOF) calcd for $C_{22}H_{18}ClNO$ $[M]^+$ m/z = 347.1077; found 347.1078.

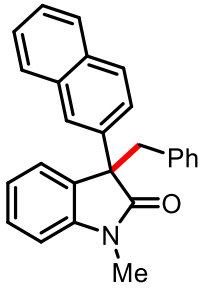
3-Benzyl-1-methyl-3-(4-(trifluoromethyl)phenyl)indolin-2-one (3ha)



The general procedure **A** was followed using 1-methyl-3-(4-(trifluoromethyl)phenyl)indolin-2-one and toluene. Chromatography (6% EtOAc/hexanes) afforded **3ha** (38.3 mg) in 67% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8.5 Hz, 2H), 7.60 (d, *J* = 8.5 Hz, 2H), 7.27-7.19 (m, 2H), 7.13-7.00 (m, 4H), 6.82 (d, *J* = 7.0 Hz, 2H), 6.63 (d, *J* = 7.5 Hz, 1H), 3.71 (d, *J* = 13.0 Hz, 1H), 3.44 (d, *J* = 13.0 Hz, 1H), 2.96 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.2, 143.9, 135.3, 130.6,

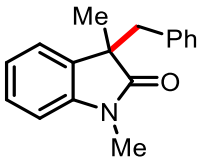
130.2, 130.0, 129.7, 128.8, 128.0, 127.7, 126.9, 125.7, 125.6 (q, J_{C-F} = 14.5 Hz), 125.4 (q, J_{C-F} = 270.6 Hz), 122.6, 108.5, 58.4, 44.3, 26.3; IR (film) 2926, 1712, 1611, 1494, 1327, 1258, 1123, 754, 699 cm^{-1}; HRMS (EI-TOF) calcd for $C_{23}H_{18}F_3NO$ $[M]^+$ *m/z* = 381.1340; found 381.1355.

3-Benzyl-1-methyl-3-(naphthalen-2-yl)indolin-2-one (3ia)



The general procedure **A** was followed using 1-methyl-3-(naphthalen-2-yl)indolin-2-one and toluene. Chromatography (7% EtOAc/hexanes) afforded **3ia** (30.1 mg) in 55% yield as amorphous yellow solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.91 (d, *J* = 2.0 Hz, 1H), 7.83-7.79 (m, 3H), 7.61 (dd, *J* = 8.5, 2.0 Hz, 1H), 7.48-7.45 (m, 2H), 7.25-7.23 (m, 2H), 7.12-7.00 (m, 4H), 6.86 (d, *J* = 6.5 Hz, 2H), 6.64 (d, *J* = 8.5 Hz, 1H), 3.82 (d, *J* = 12.5 Hz, 1H), 3.58 (d, *J* = 12.5 Hz, 1H), 2.98 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 177.7, 143.7, 137.1, 135.6, 133.2, 132.6, 131.3, 130.0, 128.3, 128.2, 128.1, 127.4, 127.3, 126.5, 126.1, 126.0, 125.9, 125.4, 125.3, 122.2, 108.0, 58.4, 43.7, 26.0; HRMS (ESI-FTICR) calcd for $C_{26}H_{22}NO$ $[M+H]^+$ m/z = 364.1701; found 364.1704. Spectral data match those previously reported.[4]

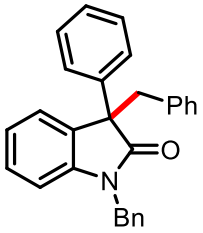
3-Benzyl-1,3-dimethylindolin-2-one (3ja)



The general procedure **A** was followed using 1,3-dimethylindolin-2-one and toluene. Chromatography (6% EtOAc/hexanes) afforded **3ja** (11.3 mg) in 30% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.18 (t, *J* = 7.5 Hz, 1H), 7.12 (d, *J* = 7.5 Hz, 1H), 7.08-7.01 (m, 4H), 6.86-6.83 (m, 2H), 6.61 (d, *J* = 7.5 Hz, 1H), 3.11 (d, *J* = 13.0 Hz, 1H), 3.01 (d, *J* = 13.0 Hz, 1H), 2.99 (s, 3H), 1.47 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 180.1, 143.3, 136.3, 133.1, 130.0, 127.9, 127.6, 126.5, 123.4, 122.2, 107.9, 50.1, 44.7, 26.0,

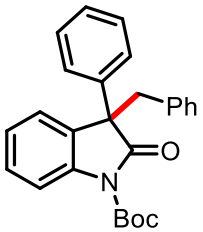
22.9; IR (film) 2927, 1712, 1613, 1494, 1377, 1259, 1122, 752, 699 cm^{-1}; HRMS (EI-TOF) calcd for $C_{17}H_{17}NO$ $[M]^+$ *m/z* = 251.1310; found 251.1299.

1,3-Dibenzyl-3-phenylindolin-2-one (3ka)



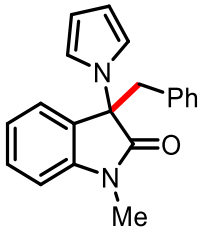
The general procedure **A** was followed using 1-benzyl-3-phenylindolin-2-one and toluene. Chromatography (7% EtOAc/hexanes) afforded **3ka** (45.6 mg) in 78% yield as amorphous yellow solid: ^1H NMR (500 MHz, $CDCl_3$) δ 7.53 (d, *J* = 7.0 Hz, 2H), 7.39-7.28 (m, 4H), 7.17-7.03 (m, 8H), 6.93 (d, *J* = 7.0 Hz, 2H), 6.68 (d, *J* = 6.5 Hz, 2H), 6.45-6.42 (m, 1H), 4.88 (d, *J* = 16.0 Hz, 1H), 4.54 (d, *J* = 16.0 Hz, 1H), 3.83 (d, *J* = 13.0 Hz, 1H), 3.53 (d, *J* = 13.0 Hz, 1H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 177.8, 143.1, 140.4, 135.9, 135.4, 131.4, 130.6, 128.8, 128.7, 128.3, 127.9, 127.6, 127.2, 126.8, 126.7, 125.5, 122.4, 109.6, 58.5, 43.8, 43.7; HRMS (ESI-FTICR) calcd for $C_{28}H_{24}NO$ $[M+H]^+$ m/z = 390.1858; found 390.1856. Spectral data match those previously reported.[4]

***tert*-Butyl 3-benzyl-2-oxo-3-phenylindoline-1-carboxylate (3la)**



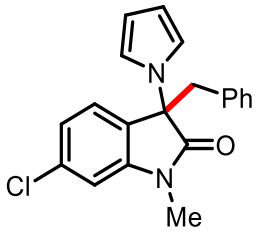
The general procedure **A** was followed using tert-butyl 2-oxo-3-phenylindoline-1-carboxylate and toluene. Chromatography (9% EtOAc/hexanes) afforded **3la** (13.3 mg) in 22% yield as amorphous white solid: ^1H NMR (500 MHz, $CDCl_3$) δ 7.62 (d, *J* = 8.0 Hz, 1H), 7.44 (d, *J* = 8.0 Hz, 2H), 7.34 (t, *J* = 7.5 Hz, 2H), 7.30-7.21 (m, 2H), 7.17-7.14 (m, 2H), 7.06 (t, *J* = 7.5 Hz, 1H), 7.01 (t, *J* = 7.5 Hz, 2H), 6.81 (d, *J* = 6.5 Hz, 2H), 3.78 (d, *J* = 13.0 Hz, 1H), 3.43 (d, *J* = 13.0 Hz, 1H), 1.53 (s, 9H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 176.6, 149.0, 140.1, 139.7, 135.2, 130.2, 128.8, 128.6, 127.9, 127.8, 127.7, 126.9, 125.6, 124.2, 115.1, 84.2, 58.7, 44.9, 28.2; HRMS (ESI-FTICR) calcd for $C_{26}H_{25}NNaO_3$ $[M+Na]^+$ m/z = 422.1732; found 422.1727. Spectral data match those previously reported.[6]

3-Benzyl-1-methyl-3-(1H-pyrrol-1-yl)indolin-2-one (3ma)



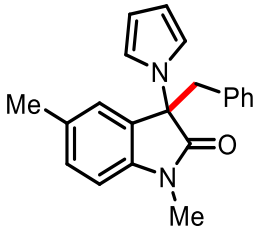
The general procedure **A** was followed using 1-methyl-3-(1*H*-pyrrol-1-yl)indolin-2-one and toluene. Chromatography (6% EtOAc/hexanes) afforded **3ma** (38.6 mg) in 85% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.29 (td, *J* = 8.0, 1.5 Hz, 1H), 7.16 (d, *J* = 6.5 Hz, 1H), 7.13-7.04 (m, 4H), 6.97 (t, *J* = 2.5 Hz, 2H), 6.77 (d, *J* = 7.0 Hz, 2H), 6.65 (d, *J* = 8.0 Hz, 1H), 6.22 (t, *J* = 2.0 Hz, 2H), 3.62 (d, *J* = 13.0 Hz, 1H), 3.61 (d, *J* = 13.0 Hz, 1H), 2.97 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 174.3, 143.8, 133.5, 130.3, 130.1, 127.9, 127.2, 126.9, 126.0, 122.6, 119.4, 108.9, 108.6, 67.5, 43.8, 26.2; IR (film) 2974, 1721, 1615, 1492, 1382, 1250, 1099, 736 cm^{-1}; HRMS (EI-TOF) calcd for $C_{20}H_{18}N_2O$ $[M]^+$ *m/z* = 302.1419; found 302.1431.

3-Benzyl-6-chloro-1-methyl-3-(1H-pyrrol-1-yl)indolin-2-one (3na)



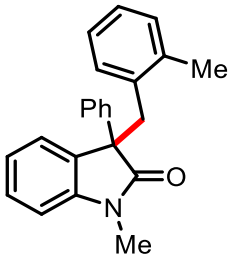
The general procedure **A** was followed using 6-chloro-1-methyl-3-(1H-pyrrol-1-yl)indolin-2-one and toluene. Chromatography (7% EtOAc/hexanes) afforded **3na** (28.1 mg) in 56% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.15 (t, *J* = 7.5 Hz, 1H), 7.09 (t, *J* = 7.5 Hz, 2H), 7.07-7.02 (m, 2H), 6.93 (t, *J* = 2.5 Hz, 2H), 6.77 (d, *J* = 7.0 Hz, 2H), 6.67 (d, *J* = 1.0 Hz, 1H), 6.23 (t, *J* = 2.0 Hz, 2H), 3.63 (d, *J* = 13.0 Hz, 1H), 3.57 (d, *J* = 13.0 Hz, 1H), 2.97 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 174.3, 144.9, 136.0, 133.2, 130.3, 128.1, 127.4, 126.9, 125.3, 122.5, 119.3, 109.4, 109.2, 67.2, 43.6, 26.4; IR (film) 2925, 1727, 1609, 1496, 1371, 1266, 1101, 723, 700 cm^{-1}; HRMS (EI-TOF) calcd for $C_{20}H_{17}ClN_2O$ $[M]^+$ *m/z* = 336.1029; found 336.1031.

3-Benzyl-1,5-dimethyl-3-(1H-pyrrol-1-yl)indolin-2-one (3oa)



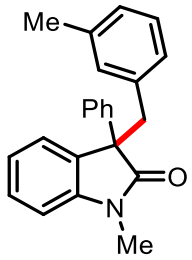
The general procedure **A** was followed using 1,5-dimethyl-3-(1*H*-pyrrol-1-yl)indolin-2-one and toluene. Chromatography (6% EtOAc/hexanes) afforded **3oa** (32.8 mg) in 69% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.14-7.04 (m, 4H), 6.98-6.96 (m, 3H), 6.77 (d, *J* = 7.5 Hz, 2H), 6.54 (d, *J* = 8.0 Hz, 1H), 6.23 (t, *J* = 2.0 Hz, 2H), 3.62 (d, *J* = 13.0 Hz, 1H), 3.58 (d, *J* = 13.0 Hz, 1H), 2.94 (s, 3H), 2.33 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 174.2, 141.4, 133.6, 132.2, 130.4, 130.3, 127.8, 127.2, 127.0, 126.6, 119.4, 108.9, 108.3, 67.7, 43.7, 26.2, 21.3; IR (film) 2921, 1721, 1501, 1364, 1099, 725, 700 cm^{-1}; HRMS (EI-TOF) calcd for $C_{21}H_{20}N_2O$ $[M]^+$ *m/z* = 316.1576; found 316.1579.

1-Methyl-3-(2-methylbenzyl)-3-phenylindolin-2-one (3ab)



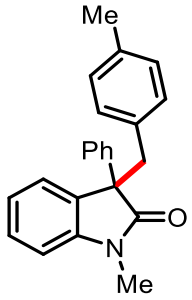
The general procedure **A** was followed using **1a** and *o*-xylene. Chromatography (6% EtOAc/hexanes) afforded **3ab** (44.2 mg) in 90% yield as a colorless oil: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.54 (d, *J* = 8.0 Hz, 2H), 7.35 (t, *J* = 7.5 Hz, 2H), 7.32-7.23 (m, 2H), 7.02-6.95 (m, 4H), 6.83 (t, *J* = 7.5 Hz, 1H), 6.72 (d, *J* = 7.5 Hz, 1H), 6.67 (d, *J* = 7.5 Hz, 1H), 3.63 (s, 2H), 3.06 (s, 3H), 2.06 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 178.2, 143.8, 139.7, 137.2, 134.5, 130.8, 130.1, 129.6, 128.5, 128.3, 127.5, 127.4, 126.6, 125.9, 124.9, 121.9, 108.0, 57.6, 39.9, 26.2, 20.1; IR (film) 2924, 1712, 1611, 1492, 1470, 1373, 1348, 754, 696 cm^{-1}; HRMS (EI-TOF) calcd for $C_{23}H_{21}NO$ $[M]^+$ *m/z* = 327.1623; found 327.1618.

1-Methyl-3-(3-methylbenzyl)-3-phenylindolin-2-one (3ac)



The general procedure **A** was followed using **1a** and *m*-xylene. Chromatography (6% EtOAc/hexanes) afforded **3ac** (39.8 mg) in 81% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.31 (s, 1H), 7.29-7.19 (m, 4H), 7.11-6.99 (m, 5H), 6.83 (d, *J* = 7.0 Hz, 2H), 6.60 (d, *J* = 7.5 Hz, 1H), 3.72 (d, *J* = 13.0 Hz, 1H), 3.44 (d, *J* = 13.0 Hz, 1H), 2.94 (s, 3H), 2.35 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.9, 143.9, 139.8, 138.3, 135.9, 131.7, 130.1, 128.6, 128.4, 128.2, 128.0, 127.5, 126.6, 125.5, 124.4, 122.3, 108.1, 58.4, 44.0, 26.2, 21.8; IR (film) 2922, 1709, 1611, 1493, 1470, 1373, 1349, 754, 696 cm^{-1}; HRMS (EI-TOF) calcd for $C_{23}H_{21}NO$ $[M]^+$ *m/z* = 327.1623; found 327.1612.

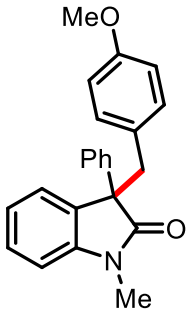
1-Methyl-3-(4-methylbenzyl)-3-phenylindolin-2-one (3ad)



The general procedure **A** was followed using **1a** and *p*-xylene. Chromatography (6% EtOAc/hexanes) afforded **3ad** (36.8 mg) in 75% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49 (d, *J* = 8.0 Hz, 2H), 7.34 (t, *J* = 7.0 Hz, 2H), 7.27 (t, *J* = 7.5 Hz, 1H), 7.24-7.19 (m, 2H), 7.07 (td, *J* = 7.5, 1.0 Hz, 1H), 6.81 (d, *J* = 8.0 Hz, 2H), 6.71 (d, *J* = 8.0 Hz, 2H), 6.63 (d, *J* = 8.0 Hz, 1H), 3.65 (d, *J* = 13.0 Hz, 1H), 3.43 (d, *J* = 13.0 Hz, 1H), 2.97 (s, 3H), 2.19 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 178.0, 143.9, 139.9, 136.1, 132.7, 131.5, 130.0, 128.7, 128.3, 128.2, 127.5, 127.4, 125.7, 122.2, 108.2, 58.4, 43.7,

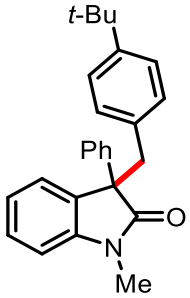
26.2, 21.1; HRMS (ESI-FTICR) calcd for $C_{23}H_{22}NO$ $[M+H]^+$ m/z = 328.1701; found 328.1698. Spectral data match those previously reported.[4]

3-(4-Methoxybenzyl)-1-methyl-3-phenylindolin-2-one (3ae)



The general procedure **A** was followed using **1a** and 1-methoxy-4-methylbenzene. Chromatography (8% EtOAc/hexanes) afforded **3ae** (28.3 mg) in 55% yield as a colorless oil: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49 (d, *J* = 7.5 Hz, 2H), 7.34 (t, *J* = 7.0 Hz, 2H), 7.28 (d, *J* = 7.0 Hz, 1H), 7.24-7.20 (m, 2H), 7.08 (t, *J* = 7.0 Hz, 1H), 6.74 (d, *J* = 8.5 Hz, 2H), 6.63 (d, *J* = 8.0 Hz, 1H), 6.55 (d, *J* = 8.5 Hz, 2H), 3.69 (s, 3H), 3.64 (d, *J* = 13.0 Hz, 1H), 3.41 (d, *J* = 13.0 Hz, 1H), 2.97 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.9, 158.3, 143.9, 139.9, 131.5, 131.1, 128.7, 128.3, 127.9, 127.5, 127.4, 125.6, 122.3, 112.9, 108.2, 58.5, 55.2, 43.3, 26.2; IR (film) 2924, 1709, 1611, 1511, 1493, 1469, 1373, 1348, 1248, 1034, 751, 696 cm^{-1}; HRMS (EI-TOF) calcd for $C_{23}H_{21}NO_2$ $[M]^+$ *m/z* = 343.1572; found 343.1561.

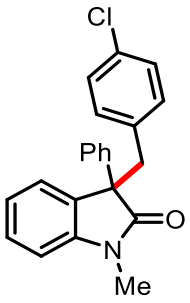
3-(4-(*tert*-Butyl)benzyl)-1-methyl-3-phenylindolin-2-one (3af)



The general procedure **A** was followed using **1a** and 1-(*tert*-butyl)-4-methylbenzene. Chromatography (7% EtOAc/hexanes) afforded **3af** (43.7 mg) in 79% yield as a colorless oil: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.50 (d, *J* = 7.0 Hz, 2H), 7.34 (t, *J* = 7.0 Hz, 2H), 7.29 (d,

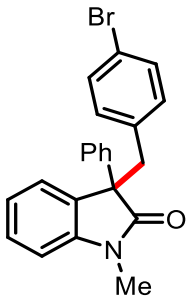
J = 7.0 Hz, 1H), 7.25-7.18 (m, 2H), 7.08 (td, *J* = 7.5, 1.0 Hz, 1H), 7.02 (d, *J* = 8.5 Hz, 2H), 6.73 (d, *J* = 8.0 Hz, 2H), 6.61 (d, *J* = 8.0 Hz, 1H), 3.62 (d, *J* = 13.0 Hz, 1H), 3.45 (d, *J* = 13.0 Hz, 1H), 2.92 (s, 3H), 1.20 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.9, 149.5, 143.9, 139.9, 132.7, 131.6, 129.7, 128.7, 128.2, 127.5, 127.4, 125.6, 124.4, 122.2, 108.1, 58.4, 43.7, 34.4, 31.4, 26.2; IR (film) 2961, 1713, 1612, 1494, 1470, 1372, 1348, 1257, 1022, 752, 697 cm^{-1}; HRMS (EI-TOF) calcd for $C_{26}H_{27}NO$ $[M]^+$ *m/z* = 369.2093; found 369.2097.

3-(4-Chlorobenzyl)-1-methyl-3-phenylindolin-2-one (3ag)



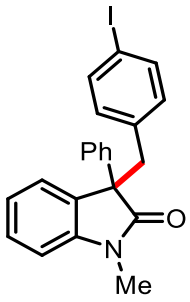
The general procedure **A** was followed using **1a** and 4-chlorotoluene. Chromatography (6% EtOAc/hexanes) afforded **3ag** (20.8 mg) in 40% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.47 (d, *J* = 7.0 Hz, 2H), 7.34 (t, *J* = 7.0 Hz, 2H), 7.29 (d, *J* = 7.5 Hz, 1H), 7.27-7.21 (m, 2H), 7.09 (t, *J* = 7.0 Hz, 1H), 6.98 (d, *J* = 8.5 Hz, 2H), 6.77 (d, *J* = 8.5 Hz, 2H), 6.65 (d, *J* = 8.0 Hz, 1H), 3.68 (d, *J* = 13.0 Hz, 1H), 3.41 (d, *J* = 13.0 Hz, 1H), 2.97 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.5, 143.6, 139.4, 134.1, 132.4, 131.3, 130.8, 128.6, 128.3, 127.5, 127.4, 127.1, 125.3, 122.2, 108.2, 58.0, 43.1, 26.0; IR (film) 2925, 1709, 1611, 1492, 1470, 1373, 1093, 753, 696 cm^{-1}; HRMS (EI-TOF) calcd for $C_{22}H_{18}ClNO$ $[M]^+$ *m/z* = 347.1077; found 347.1084.

3-(4-Bromobenzyl)-1-methyl-3-phenylindolin-2-one (3ah)



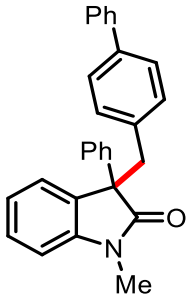
The general procedure **A** was followed using **1a** and 4-bromotoluene. Chromatography (6% EtOAc/hexanes) afforded **3ah** (24.6 mg) in 42% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.47 (d, *J* = 7.5 Hz, 2H), 7.34 (t, *J* = 7.0 Hz, 2H), 7.29 (t, *J* = 7.5 Hz, 1H), 7.22 (t, *J* = 8.0 Hz, 2H), 7.14 (d, *J* = 8.5 Hz, 2H), 7.09 (t, *J* = 7.5 Hz, 1H), 6.71 (d, *J* = 8.5 Hz, 2H), 6.66 (d, *J* = 7.5 Hz, 1H), 3.66 (d, *J* = 12.5 Hz, 1H), 3.39 (d, *J* = 12.5 Hz, 1H), 2.98 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.7, 143.8, 139.6, 134.9, 131.9, 130.9, 130.7, 128.8, 128.5, 127.7, 127.3, 125.5, 122.4, 120.8, 108.4, 58.2, 43.4, 26.3; IR (film) 2925, 1710, 1611, 1489, 1470, 1373, 1012, 753, 696 cm^{-1}; HRMS (EI-TOF) calcd for $C_{22}H_{18}BrNO$ $[M]^+$ *m/z* = 391.0572; found 391.0581.

3-(4-Iodobenzyl)-1-methyl-3-phenylindolin-2-one (3ai)



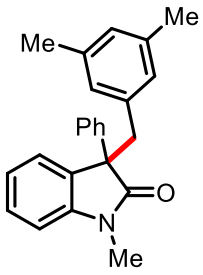
The general procedure **A** was followed using **1a** and *p*-iodotoluene. Chromatography (6% EtOAc/hexanes) afforded **3ai** (29.6 mg) in 45% yield as amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.47 (d, *J* = 7.0 Hz, 2H), 7.36-7.32 (m, 4H), 7.30-7.20 (m, 3H), 7.08 (t, *J* = 7.5 Hz, 1H), 6.66 (d, *J* = 8.0 Hz, 1H), 6.58 (d, *J* = 8.0 Hz, 2H), 3.64 (d, *J* = 13.0 Hz, 1H), 3.38 (d, *J* = 13.0 Hz, 1H), 2.98 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.6, 143.8, 139.6, 136.7, 135.5, 132.2, 130.9, 128.8, 128.6, 127.7, 127.3, 125.5, 122.4, 108.4, 92.4, 58.1, 43.5, 26.3; IR (film) 2926, 1709, 1610, 1493, 1470, 1375, 1009, 751, 699 cm^{-1}; HRMS (EI-TOF) calcd for $C_{22}H_{18}INO$ $[M]^+$ *m/z* = 439.0433; found 439.0439.

3-([1,1'-Biphenyl]-4-ylmethyl)-1-methyl-3-phenylindolin-2-one (3aj)



The general procedure **A** was followed using **1a** and 4-phenyltoluene. Chromatography (7% EtOAc/hexanes) afforded **3aj** (33.3 mg) in 57% yield as a colorless oil: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.54-7.48 (m, 4H), 7.40-7.34 (m, 4H), 7.29 (t, *J* = 7.5 Hz, 3H), 7.25-7.20 (m, 3H), 7.09 (t, *J* = 7.5 Hz, 1H), 6.90 (d, *J* = 8.0 Hz, 2H), 6.62 (d, *J* = 8.0 Hz, 1H), 3.74 (d, *J* = 13.0 Hz, 1H), 3.50 (d, *J* = 13.0 Hz, 1H), 2.97 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.9, 143.9, 140.8, 139.8, 139.3, 134.9, 131.4, 130.6, 128.8, 128.7, 128.4, 127.6, 127.4, 127.3, 126.9, 126.2, 125.6, 122.4, 108.3, 58.4, 43.8, 26.3; IR (film) 2923, 1711, 1611, 1488, 1470, 1372, 1023, 755, 696 cm^{-1}； HRMS (EI-TOF) calcd for $C_{28}H_{23}NO$ $[M]^+$ *m/z* = 389.1780; found 389.1766.

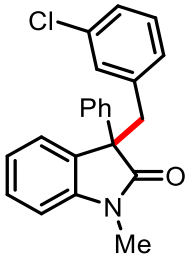
3-(3,5-Dimethylbenzyl)-1-methyl-3-phenylindolin-2-one (3ak)



The general procedure **A** was followed using **1a** and mesitylene. Chromatography (6% EtOAc/hexanes) afforded **3ak** (35.3 mg) in 69% yield as a colorless oil: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.50-7.47 (m, 2H), 7.32 (t, *J* = 7.0 Hz, 2H), 7.28-7.25 (m, 1H), 7.21-7.16 (m, 2H), 7.04 (td, *J* = 7.0, 1.0 Hz, 1H), 6.66-6.59 (m, 2H), 6.41 (s, 2H), 3.60 (d, *J* = 12.5 Hz, 1H), 3.35 (d, *J* = 12.5 Hz, 1H), 2.94 (s, 3H), 2.06 (s, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.8, 143.8, 139.7, 136.6, 135.4, 131.3, 128.4, 128.0, 127.8, 127.7, 127.2, 125.5,

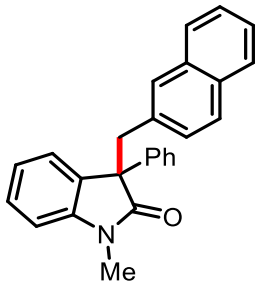
121.9, 107.8, 99.9, 58.1, 43.9, 25.9, 20.9; IR (film) 2963, 1713, 1614, 1492, 1470, 1375, 752, 699 cm^{-1}; HRMS (EI-TOF) calcd for $C_{24}H_{23}NO$ $[M]^+$ *m/z* = 341.1780; found 341.1777.

3-(3-Chlorobenzyl)-1-methyl-3-phenylindolin-2-one (3al)



The general procedure **A** was followed using **1a** and 3-chlorotoluene. Chromatography (6% EtOAc/hexanes) afforded **3al** (18.8 mg) in 36% yield as a colorless oil: ^1H NMR (500 MHz, $CDCl_3$) δ 7.48 (d, *J* = 7.5 Hz, 2H), 7.35 (t, *J* = 7.0 Hz, 2H), 7.29 (t, *J* = 7.0 Hz, 1H), 7.22 (t, *J* = 7.0 Hz, 2H), 7.10 (td, *J* = 8.0, 1.0 Hz, 1H), 7.05-7.02 (m, 1H), 6.95 (t, *J* = 8.0 Hz, 1H), 6.80 (t, *J* = 2.0 Hz, 1H), 6.75 (d, *J* = 7.5 Hz, 1H), 6.65 (d, *J* = 7.5 Hz, 1H), 3.68 (d, *J* = 13.0 Hz, 1H), 3.40 (d, *J* = 13.0 Hz, 1H), 2.98 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.6, 143.8, 139.5, 137.9, 133.3, 130.9, 130.1, 128.8, 128.7, 128.6, 128.4, 127.7, 127.3, 126.8, 125.5, 122.5, 108.3, 58.2, 43.7, 26.2; IR (film) 2927, 1710, 1611, 1492, 1470, 1373, 1082, 753, 696 cm^{-1}; HRMS (EI-TOF) calcd for $C_{22}H_{18}ClNO$ $[M]^+$ *m/z* = 347.1077; found 347.1061.

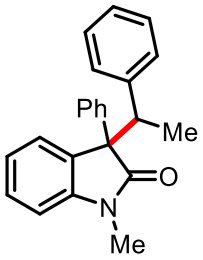
1-Methyl-3-(naphthalen-2-ylmethyl)-3-phenylindolin-2-one (3am)



The general procedure **A** was followed using **1a** and methylnaphthalene. Chromatography (7% EtOAc/hexanes) afforded **3am** (19.1 mg) in 35% yield as a colorless oil: ^1H NMR (500 MHz, $CDCl_3$) δ 7.70-7.67 (m, 1H), 7.61-7.59 (m, 1H), 7.54 (d, *J* = 7.5 Hz, 2H), 7.48 (d, *J* = 8.5 Hz, 1H), 7.39-7.27 (m, 7H), 7.17 (td, *J* = 7.5, 1.5 Hz, 1H),

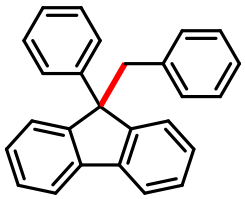
7.08 (td, *J* = 7.5, 1.0 Hz, 1H), 6.96 (dd, *J* = 8.5, 2.0 Hz, 1H), 6.53 (d, *J* = 8.0 Hz, 1H), 3.87 (d, *J* = 13.0 Hz, 1H), 3.62 (d, *J* = 13.0 Hz, 1H), 2.90 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.9, 143.9, 139.9, 133.5, 133.1, 132.7, 132.2, 131.3, 128.9, 128.7, 128.5, 128.4, 127.8, 127.6, 127.5, 127.4, 126.9, 125.7, 125.5, 122.3, 108.3, 58.4, 44.2, 26.2; IR (film) 2923, 1710, 1611, 1492, 1470, 1373, 1023, 750, 696 cm^{-1}; HRMS (EI-TOF) calcd for $C_{26}H_{21}NO$ $[M]^+$ *m/z* = 363.1623; found 363.1612.

1-methyl-3-phenyl-3-(1-phenylethyl)indolin-2-one (3an)



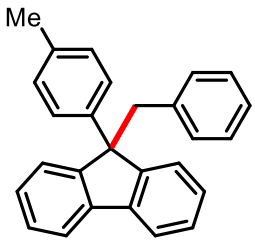
The general procedure **A** was followed using **1a** and ethylbenzene. Chromatography (6% EtOAc/hexanes) afforded **3an** (36.2 mg) in 74% yield (2:1 dr) as a colorless oil: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.67 (d, *J* = 7.0 Hz, 0.6H), 7.61 (d, *J* = 7.0 Hz, 1.4H), 7.37 (t, *J* = 7.5 Hz, 0.6H), 7.34-7.28 (m, 2.0H), 7.25-7.18 (m, 1.4H), 7.12-6.94 (m, 5.0H), 6.86 (d, *J* = 7.5 Hz, 1.3H), 6.80 (d, *J* = 7.0 Hz, 0.7H), 6.70 (d, *J* = 7.5 Hz, 0.6H), 6.56 (d, *J* = 7.5 Hz, 0.3H), 4.06 (q, *J* = 7.0 Hz, 0.3H), 3.99 (q, *J* = 7.0 Hz, 0.6H), 3.12 (s, 2.0H), 2.69 (s, 1.0H), 1.37 (d, *J* = 7.0 Hz, 1.0H), 1.27 (d, *J* = 7.0 Hz, 2.0H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 177.7, 177.4, 144.6, 143.7, 140.7, 140.4, 138.9, 138.0, 129.8, 129.3, 128.7 (2C), 128.6, 128.4, 128.1 (2C), 127.9, 127.5, 127.3 (2C), 127.2, 126.9, 126.8 (2C), 126.6, 121.1 (2C), 108.3, 107.9, 61.9, 61.0, 47.6, 47.5, 26.2, 25.9, 15.7, 15.4; IR (film) 2972, 1707, 1610, 1493, 1470, 1372, 1079, 758, 698 cm^{-1}; HRMS (EI-TOF) calcd for $C_{23}H_{21}NO$ $[M]^+$ *m/z* = 327.1623; found 327.1610.

9-benzyl-9-phenyl-9*H*-fluorene (5aa)



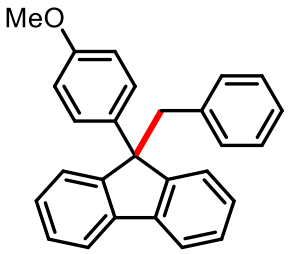
The general procedure **B** was followed using 9-phenyl-9*H*-fluorene and toluene. Chromatography (hexanes) afforded the product **5aa** (35 mg) in 71% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49-7.48 (m, 2H), 7.35-7.31 (m, 4H), 7.27 (t, *J* = 4.3 Hz, 2H), 7.25-7.24 (m, 4H), 7.22-7.20 (m, 1H), 6.88 (t, *J* = 7.4 Hz, 1H), 6.78 (t, *J* = 7.6 Hz, 2H), 6.44 (d, *J* = 7.2 Hz, 2H), 3.80 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.7, 144.7, 141.0, 136.6, 130.1, 128.5, 127.3, 127.2, 127.0, 126.9, 126.7, 125.8, 125.2, 119.8, 60.1, 44.1; IR (film) 3032, 2923, 1596, 1499, 1262, 1078, 732, 697, 628 cm^{-1}; HRMS (EI-TOF) calcd for fragments $C_{19}H_{13}$ $[M]^+$ *m*/*z* = 241.1017 found 241.1030 and C_7H_7 $[M]^+$ *m*/*z* = 91.0548 found 91.0537.

9-Benzyl-9-(p-tolyl)-9*H*-fluorene (5ba)



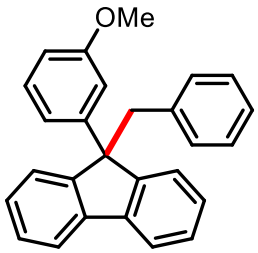
The general procedure **B** was followed 9-(*p*-tolyl)-9*H*-fluorene and toluene. Chromatography (hexanes) afforded the product **5ba** (31 mg) in 61% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.58-7.47 (m, 2H), 7.34-7.33 (m, 2H), 7.24 (dd, *J* = 5.6, 3.1 Hz, 4H), 7.20 (d, *J* = 8.2 Hz, 2H), 7.08 (d, *J* = 7.9 Hz, 2H), 6.88 (t, *J* = 7.4 Hz, 1H), 6.78 (t, *J* = 7.5 Hz, 2H), 6.43 (d, *J* = 7.2 Hz, 2H), 3.78 (s, 2H), 2.31 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.8, 141.7, 140.9, 136.7, 136.2, 130.1, 129.2, 127.25, 127.20, 126.9, 126.8, 125.7, 125.1, 119.8, 59.8, 44.2, 21.0; IR (film) 3061, 3028, 2921, 2857, 1511, 1496, 1475, 1449, 1032, 840, 795, 776, 747, 731, 699, 622, 611, 590, 557, 506 cm^{-1}; HRMS (EI-TOF) calcd for $C_{27}H_{22}$ $[M]^+$ *m*/*z* = 346.1722; found 346.1717.

9-Benzyl-9-(4-methoxyphenyl)-9*H*-fluorene (5ca)



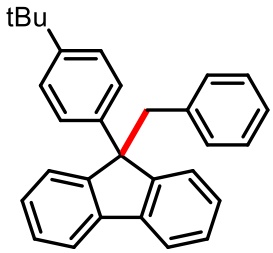
The general procedure **A** was followed using 9-(4-methoxyphenyl)-9*H*-fluorene and toluene. Chromatography (hexanes) afforded the product **5ca** (33mg) in 61% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49-7.47 (m, 2H), 7.34 -7.32 (m, 2H), 7.25-7.23 (m, 6H), 6.88 (t, *J* = 7.4 Hz, 1H), 6.81 (d, *J* =8.9 Hz, 2H), 6.79 (d, *J* =7.5 Hz, 2H), 6.43 (d, *J* = 7.1 Hz, 2H), 3.77 (s, 3H), 3.76 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 158.3, 150.9, 140.9, 136.7, 130.1, 128.0, 127.2, 127.1, 126.88, 126.82, 125.7, 125.1, 119.8, 113.8, 59.5, 55.3, 44.3; IR (film) 3030, 2930, 2835, 1608, 1506, 1449, 1285, 1250, 1183, 1118, 1033, 843, 806, 776, 748, 732, 700, 611, 563, 526 cm^{-1}; HRMS (EI-TOF) calcd for $C_{27}H_{22}O$ $[M]^+$ *m*/*z* = 362.1671; found = 362.1671.

9-Benzyl-9-(3-methoxyphenyl)-9*H*-fluorene (5da)



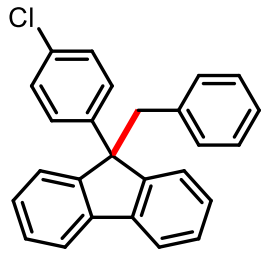
The general procedure **B** was followed using 9-(3-methoxyphenyl)-9*H*-fluorene and toluene. Chromatography (hexanes) afforded the product **5da** (30 mg) in 56% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49-7.45 (m, 2H), 7.36 -7.34 (m, 2H), 7.25-7.22 (m, 3H), 7.19 (d, *J* = 7.2 Hz, 2H), 6.92-6.86 (m, 3H), 6.80 (s, 1H), 6.78-6.74 (m, 2H), 6.44 (d, *J* = 7.0 Hz, 2H), 3.77 (s, 2H), 3.73 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 159.6, 150.5, 146.4, 140.9, 136.6, 130.1, 129.4, 127.3, 127.2, 126.8, 125.8, 125.1, 119.8, 119.6, 113.8, 111.1, 60.0, 55.2, 44.1; IR (film) 3029, 2924, 1599, 1583, 1488, 1450, 1431, 1292, 1257, 1153, 1053, 841, 776, 746, 731, 698, 606 cm^{-1}; HRMS (EI-TOF) calcd for $C_{27}H_{22}O$ $[M]^+$ *m/z* = 362.1671; found = 362.1664.

9-Benzyl-9-(4-(tert-butyl)phenyl)-9*H*-fluorene (5ea)



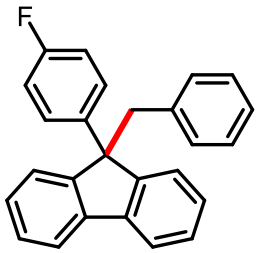
The general procedure **B** was followed using 9-(4-(tert-butyl)phenyl)-9*H*-fluorene and toluene. Chromatography (hexanes) afforded the product **5ea** (28 mg) in 48% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49-7.47 (m, 2H), 7.40-7.38 (m, 2H), 7.28-7.27-7.24 (m, 8H), 6.88 (t, *J* = 7.4 Hz, 1H), 6.78 (t, *J* = 7.6 Hz, 2H), 6.44 (d, *J* = 7.1 Hz, 2H), 3.80 (s, 2H), 1.29 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.7, 149.4, 141.5, 141.0, 136.7, 130.1, 127.2, 127.1, 126.8, 126.5, 125.7, 125.4, 125.2, 119.8, 59.8, 44.3, 34.4, 31.4; IR (film) 3031, 2962, 2866, 1513, 1496, 1448, 1363, 1270, 1018, 846, 807, 776, 749, 734, 699, 624, 607, 556 cm^{-1}; HRMS (EI-TOF) calcd for $C_{30}H_{28}$ [M]+ m/z = 388.2191; found = 388.2193.

9-Benzyl-9-(4-chlorophenyl)-9*H*-fluorene (5fa)



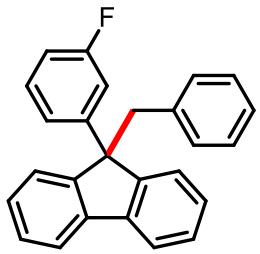
The general procedure **B** was followed using 9-(4-chlorophenyl)-9*H*-fluorene and toluene. Chromatography (hexanes) afforded the product **5fa** (43 mg) in 79% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.48 -7.46 (m, 2H), 7.28-7.26 (m, 2H), 7.25 -7.12 (m, 7H), 6.87 (t, *J* = 7.4 Hz, 2H), 6.77 (t, *J* = 7.6 Hz, 2H), 6.40 (d, *J* = 7.2 Hz, 2H), 3.73 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.3, 143.4, 140.9, 136.2, 132.5, 130.1, 128.6, 128.58, 127.5, 127.3, 126.9, 125.9, 125.0, 119.9, 59.6, 44.0; IR (film) 3031, 2923, 1492, 1149, 1094, 1013, 845, 801, 757, 734, 699, 604, 515 cm^{-1}; HRMS (EI-TOF) calcd for $C_{26}H_{19}Cl$ $[M]^+$ *m*/*z* = 366.1175; found 366.1189.

9-Benzyl-9-(4-fluorophenyl)-9H-fluorene(5ga)



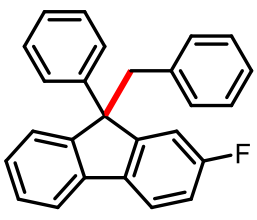
The general procedure **B** was followed using 9-(4-fluorophenyl)-9*H*-fluorene and toluene. Chromatography (hexanes) afforded the product **5ga** (33 mg) in 63% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.50-7.46 (m, 2H), 7.30-7.29 (m, 2H), 7.28-7.24 (m, 6H), 6.95 (t, *J* = 8.7 Hz, 2H), 6.88 (t, *J* = 7.4 Hz, 1H), 6.78 (t, *J* = 7.6 Hz, 2H), 6.42 (t, *J* = 7.2 Hz, 2H), 3.76 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.7 (d, J_{C-F} = 245.3 Hz), 150.5, 140.9, 140.4 (d, *J* = 3.1 Hz), 136.3, 130.1, 128.63 (d, J_{C-F} = 7.8 Hz), 127.4, 127.3, 126.9, 125.9, 125.0, 119.9, 115.2 (d, J_{C-F} = 21.0 Hz), 59.5, 44.3; IR (film) 3030, 2923, 1603, 1507, 1449, 1233, 1162, 1107, 1015, 847, 807, 776, 749, 731, 700, 610, 556, 520 cm^{-1}; HRMS (EI-TOF) calcd for $C_{26}H_{19}F$ $[M]^+$ *m*/*z* = 350.1471; found 350.1454.

9-Benzyl-9-(3-fluorophenyl)-9*H*-fluorene (5ha)



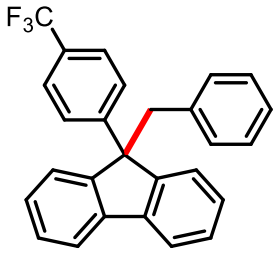
The general procedure **B** was followed using 9-(3-fluorophenyl)-9*H*-fluorene and toluene. Chromatography (hexanes) afforded the product **5ha** (38 mg) in 73% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.48-7.45 (m, 2H), 7.32-7.30 (ddd, *J* = 7.5, 4.1, 3.1 Hz, 2H), 7.26 (s, 1H), 7.25-7.24 (m, 3H), 7.22-7.19 (m, 1H), 7.09-7.07 (m, 1H), 7.01-6.98 (m, 1H), 6.91-6.85 (m, 2H), 6.77 (t, *J* = 7.6 Hz, 2H), 6.41 (d, *J* = 7.1 Hz, 2H), 3.73 (d, *J* = 11.5 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 163.02 (d, J_{C-F} = 245.2 Hz), 150.1, 147.62 (d, J_{C-F} = 6.8 Hz), 141.0, 136.2, 130.1, 129.92 (d, J_{C-F} = 8.3 Hz), 127.9, 127.3, 126.9, 125.9, 125.1, 122.74 (d, J_{C-F} = 2.8 Hz), 120.0, 114.27 (d, *J* = 22.3 Hz), 113.63 (d, *J* = 21.1 Hz), 59.9, 44.1; IR (film) 3032, 2923, 1613, 1588, 1485, 1450, 1246, 854, 777, 747, 730, 695, 604 cm^{-1}; HRMS (EI-TOF) calcd for $C_{26}H_{19}F$ $[M]^+$ m/z = 350.1471; found = 350.1463.

9-Benzyl-2-fluoro-9-phenyl-9*H*-fluorene (5ia)



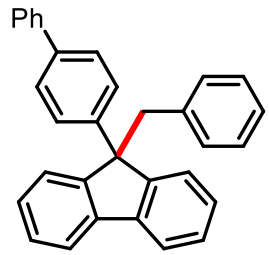
The general procedure **B** was followed using 2-fluoro-9-phenyl-9*H*-fluorene and toluene. Chromatography (hexanes) afforded the product **5ia** (37.3 mg) in 71% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45-7.38 (m, 2H), 7.36-7.28 (m, 4H), 7.28 -7.21 (m, 4H), 7.03 (dd, *J* = 8.9, 2.4 Hz, 1H), 6.99 -6.87 (m, 2H), 6.81 (t, *J* = 7.6 Hz, 2H), 6.45 (d, *J* = 8.1 Hz, 2H), 3.80 (d, *J* = 12.8 Hz, 1H), 3.76 (d, *J* = 12.7 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) 162.4 (d, $J_{C\text{-}F}$ = 244.1 Hz), 152.8 (d, $J_{C\text{-}F}$ = 7.5 Hz), 150.4 (d, $J_{C\text{-}F}$ = 1.7 Hz), 143.9, 139.9, 136.7 (d, $J_{C\text{-}F}$ = 2.2 Hz), 136.0, 129.9, 128.5, 127.3, 126.8, 126.78, 126.76, 12672, 125.7, 124.9, 120.6 (d, $J_{C\text{-}F}$ = 8.6 Hz), 119.3, 114.3 (d, $J_{C\text{-}F}$ = 22.8 Hz), 112.1 (d, $J_{C\text{-}F}$ = 22.8 Hz), 60.0 (d, $J_{C\text{-}F}$ = 2.3 Hz), 43.9; IR (film) 2923, 2852, 1591, 1491, 1467, 1452, 1265, 1240, 891, 855, 772, 756, 746, 728, 697, 623, 613, 587, 568, 563 cm^{-1}; HRMS (EI-TOF) calcd for $C_{26}H_{19}F$ $[M]^+$ *m*/*z* = 350.1471; found = 350.1457.

9-Benzyl-9-(4-(trifluoromethyl)phenyl)-9*H*-fluorene (5ja)



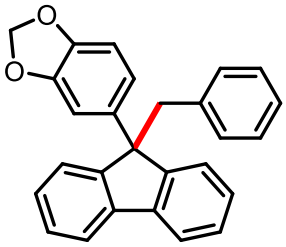
The general procedure **B** was followed using 9-(4-(trifluoromethyl)phenyl)-9*H*-fluorene and toluene. Chromatography (hexanes) afforded the product **5ja** (39 mg) in 65% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.51 (t, *J* = 8.3 Hz, 4H), 7.41 (d, *J* = 8.3 Hz, 2H), 7.31-7.25 (m, 6H), 6.89 (t, *J* = 7.4 Hz, 1H), 6.79 (t, *J* = 7.6 Hz, 2H), 6.43 (d, *J* = 8.2 Hz, 2H), 3.79 (s, Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 149.8, 148.9, 140.8, 135.8, 129.9, 127.5, 127.2, 127.1, 126.8, 125.8, 125.3 (q, $J_{C\text{-}F}$ = 3.5 Hz), 125.1(q, $J_{C\text{-}F}$ = 270.6 Hz), 124.8, 119.8, 59.8, 43.7; IR (film) 3031, 1619, 1449, 1409, 1328, 1167, 1118, 1070, 1017, 852, 809, 749, 732, 699, 604 cm^{-1}; HRMS (EI-TOF) calcd for $C_{27}H_{19}F_3$ [M]+ m/z = 400.1439; found = 400.1424.

9-([1,1'-biphenyl]-4-yl)-9-benzyl-9*H*-fluorene (5ka)



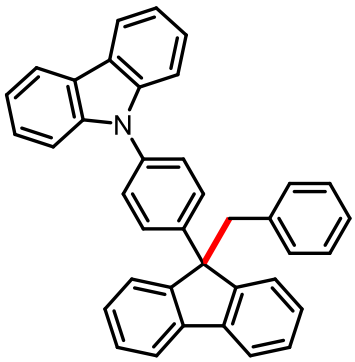
The general procedure **B** was followed using 9-([1,1'-biphenyl]-4-yl)-9*H*-fluorene and toluene. Chromatography (hexanes) afforded the product **5ka** (45 mg) in 73% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 (d, *J* = 7.1 Hz, 2H), 7.51-7.49 (m, 3H), 7.42 (d, *J* = 7.5 Hz, 1H), 7.40-7.38 (m, 4H), 7.32 (t, *J* = 6.8 Hz, 1H), 7.28-7.26 (m, 6H), 6.89 (t, *J* = 7.4 Hz, 1H), 6.79 (t, *J* = 7.6 Hz, 2H), 6.46 (d, *J* = 7.1 Hz, 2H), 3.84 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.6, 143.8, 141.0, 140.8, 139.5, 136.5, 130.1, 128.8, 127.46, 127.40, 127.3, 127.27, 127.25, 127.1, 126.9, 125.8, 125.2, 119.9, 59.9, 44.2; IR (film) 3030, 2921, 1610, 1585, 1481, 852, 773, 698 cm^{-1}; HRMS (EI-TOF) calcd for $C_{32}H_{24}$ $[M]^+$ m/z = 408.1878; found = 408. 1889.

5-(9-benzyl-9*H*-fluoren-9-yl)benzo[d][1,3]dioxole (5la)



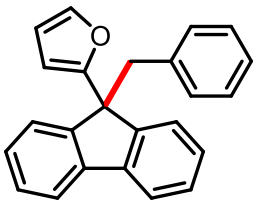
The general procedure **A** was followed using 5-(9*H*-fluoren-9-yl)benzo[*d*][1,3]dioxole and toluene. Chromatography (2% EtOAc/hexanes) afforded the product **5la** (33 mg) in 59% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.48-7.46 (m, 2H), 7.33 (dd, *J* = 5.8, 2.8 Hz, 2H), 7.25-7.23 (m, 4H), 6.93 (dd, *J* = 8.2, 1.8 Hz, 1H), 6.88 (t, *J* = 7.3 Hz, 1H), 6.79-6.74 (m, 3H), 6.64 (s, 1H), 6.42 (d, *J* = 7.2 Hz, 2H), 5.89 (s, 2H), 3.73 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.7, 147.8, 146.3, 140.8, 138.6, 136.5, 130.1, 127.3, 127.2, 126.8, 125.8, 125.0, 119.88, 119.81, 108.08, 108.06, 101.0, 59.8, 44.3; IR (film) 2923, 1501, 1487, 1449, 1238, 1040, 935, 798, 751, 733, 701, 648 cm^{-1}; HRMS (EI-TOF) calcd for $C_{27}H_{20}O_2$ $[M]^+$ *m*/*z* = 376.1463; found = 376.1453.

9-(4-(9-Benzyl-9*H*-fluoren-9-yl)phenyl)-9*H*-carbazole (5ma)



The general procedure **B** was followed using 9-(4-(9*H*-fluoren-9-yl)phenyl)-9*H*-carbazole and toluene. Chromatography (3% EtOAc/hexanes) afforded the product **5ma** (25 mg) in 41% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.13 (d, *J* = 7.8 Hz, 2H), 7.55-.7.53 (m, 4H), 7.47 (dd, *J* = 8.6, 1.7 Hz, 4H), 7.42 -7.38 (m, 4H), 7.35 -7.28 (m, 6H), 6.92 (t, *J* = 7.3 Hz, 1H), 6.82 (t, *J* = 7.6 Hz, 2H), 6.49 (d, *J* = 7.3 Hz, 2H), 3.90 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.3, 144.0, 141.09, 141.03, 136.3, 136.2, 130.1, 128.5, 127.6, 127.3, 127.0, 126.9, 126.0, 125.9, 125.2, 123.4, 120.4, 120.0, 120.0, 110.0, 60.0, 44.3; IR (film) 3061, 2925, 1726, 1599, 1513, 1479, 1452, 1335, 1318, 1231, 1119, 749, 735, 725, 700, 631, 603 cm^{-1} ; HRMS (EI-TOF) calcd for $C_{31}H_{21}N$ $[M]^+$ *m*/*z* = 407.1674; found = 407.1683.

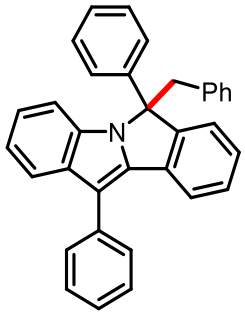
2-(9-Benzyl-9*H*-fluoren-9-yl)furan (5na)



The general procedure **B** was followed using 2-(9*H*-fluoren-9-yl)furan and toluene. Chromatography (hexanes) afforded the product **5na** (15 mg) in 31% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.63 (d, *J* = 7.5 Hz, 2H), 7.50 (dd, *J* = 1.8, 0.8 Hz, 1H), 7.43 (d, *J* = 7.5 Hz, 2H), 7.34 (td, *J* = 7.4, 1.1 Hz, 2H), 7.28 (dd, *J* = 7.5, 1.2 Hz, 2H), 7.05 (t, *J* = 6.1 Hz, 1H), 6.99 (t, *J* = 7.4 Hz, 2H), 6.58 (d, *J* = 8.5 Hz, 2H), 6.24 (dd, *J* = 3.2, 1.9 Hz, 1H), 5.85 (dd, *J* = 3.2, 0.7 Hz, 1H), 3.56 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.2, 147.3, 142.1, 140.3, 136.9, 130.42, 127.8 127.3, 127.0, 126.3,

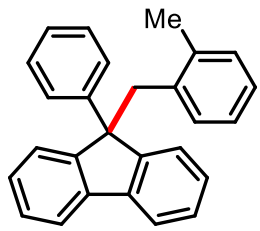
125.6, 120.0, 110.3, 106.6, 56.5, 44.8; ^{13}C DEPT-135 NMR (126 MHz, $CDCl_3$) δ 142.1, 130.3, 127.8, 127.3, 127.0, 126.3, 125.6, 120.0, 110.2, 106.6, 44.8; IR (film) 3062, 3030, 2923, 1603, 1497, 1477, 1448, 1223, 1180, 1144, 1078, 1016, 977, 884, 802, 771, 744, 729, 700, 597 cm^{-1}; HRMS (EI-TOF) calcd for $C_{24}H_{18}O$ $[M]^+$ *m*/*z* = 322.1358; found = 322.1357.

6-Benzyl-6,11-diphenyl-6*H*-isoindolo[2,1-a]indole (5oa)



The general procedure **C** was followed using 6,11- diphenyl-6*H*-isoindolo[2,1-a]indole and toluene. The column chromatography in 3% EtOAc:hexanes afforded **5oa** in 62% yield (41.6 mg) as a white amorphous solid. 1H NMR (500 MHz, CDCl3) δ 7.80 (d, J = 7.1 Hz, 1H), 7.52 – 7.42 (m, 7H), 7.39 (t, J = 7.3 Hz, 2H), 7.36 - 7.31 (m, 3H), 7.23 (t, J = 7.4 Hz, 1H), 7.17 – 7.11 (m, 4H), 6.91 (t, J = 7.4 Hz, 1H), 6.74 (t, J = 7.2 Hz, 2H), 6.22 (d, J = 7.6 Hz, 2H), 4.08 (d, J = 13.1 Hz, 1H), 4.02 (d, J = 13.2 Hz, 1H). 13C NMR (125 MHz, CDCl3) δ 150.4, 141.73, 139.2, 135.0, 134.5, 133.2, 132.2, 132.1, 129.8, 129.4, 129.1, 128.7, 128.04, 127.95, 127.2, 126.5, 126.3 , 123.3, 122.2 , 120.7, 120.6, 120.0 , 110.9, 109.2, 72.2, 42.8; IR (film) 2950, 1602, 1448, 1345, 741, 700 cm-1 ; HRMS (EI-TOF) calcd for C34H25N [M]+ m/z = 447.1987; found = 447.1985

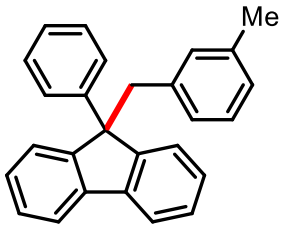
9-(2-Methylbenzyl)-9-phenyl-9*H*-fluorene (5ab)



The general procedure **B** was followed using **4a** and *o*-xylene. Chromatography (hexanes) afforded the product **5ab** (42 mg) in 83% yield as an amorphous white solid: ^{1}H NMR (500

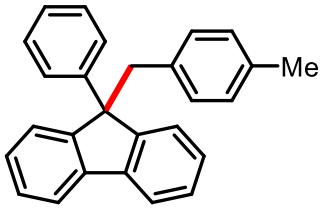
MHz, $CDCl_3$) δ 7.49-7.45 (m, 2H), 7.32-7.30 (d, *J* = m, 4H), 7.26 (d, *J* = 7.2 Hz, 1H), 7.27-7.18 (m, 6H), 6.68-6.63 (m, 2H), 6.22-6.20 (m, 2H), 3.73 (s, 2H), 1.93 (s, 3H);^{13}C NMR (125 MHz, $CDCl_3$) δ 150.8, 144.7, 141.0, 136.4, 136.2, 131.1, 128.5, 127.2, 127.18, 127.13, 127.0, 126.7, 126.6, 126.4, 125.2, 119.8, 60.1, 44.1, 21.1; IR (film) 3061, 2925, 1602, 1495, 1450, 1034, 733, 698, 644, 605 cm^{-1}; HRMS (EI-TOF) calcd for $C_{27}H_{22}$ $[M]^+$ *m*/*z* = 346.1722; found = 346.1740.

9-(3-Methylbenzyl)-9-phenyl-9*H*-fluorene (5ac)



The general procedure **B** was followed using **4a** and *m*-xylene. Chromatography (hexanes) afforded the product **5ac** (45 mg) in 88% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 (d, *J* = 7.6 Hz, 2H), 7.40 (d, *J* = 7.8 Hz, 2H), 7.31-7.27 (m, 4H), 7.23 (d, *J* = 7.3 Hz, 1H), 7.21-7.17 (m, 4H), 6.89 (t, *J* = 7.4 Hz, 1H), 6.84 (d, *J* = 7.2 Hz, 1H), 6.69 (t, *J* = 7.2 Hz, 1H), 6.49 (d, *J* = 7.7 Hz, 1H), 3.76 (s, 2H), 1.82 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.8, 144.3, 140.6, 137.3, 135.9, 129.9, 129.7, 128.5, 127.4, 127.2, 127.0, 126.8, 126.2, 125.5, 124.8, 119.9, 60.2, 39.9, 20.1; IR (film) 3060, 2922, 2856, 1606, 1496, 1449, 1158, 1034, 789, 753, 733, 708, 696, 648, 623, 606, 582 cm^{-1}; HRMS (EI-TOF) calcd for $C_{27}H_{22}$ $[M]^+$ *m*/*z* = 346.1722; found = 346.1743.

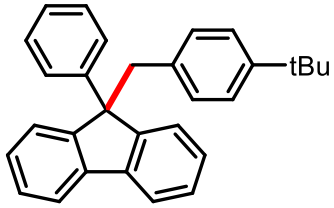
9-(4-Methylbenzyl)-9-phenyl-9*H*-fluorene (5ad)



The general procedure **B** was followed using **4a** and *p*-xylene. Chromatography (hexanes) afforded the product **5ad** (35 mg) in 67% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.51 (m, 2H), 7.34-7.30 (m, 4H), 7.28-7.24 (m, 6H), 7.21-7.19 (m, 1H), 6.60 (d, *J* = 7.8 Hz, 2H), 6.34 (d, *J* = 8.0 Hz, 2H), 3.76 (s, 2H), 2.08 (s, 3H); ^{13}C NMR (125

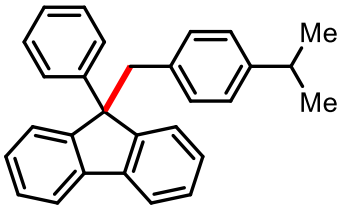
MHz, $CDCl_3$) δ 150.8, 144.8, 141.0, 135.1, 133.5, 130.0, 128.5, 127.6, 127.2, 127.1, 127.0, 126.6, 125.2, 119.8, 60.1, 43.6, 21.0; IR (film) 2921, 1449, 813, 734, 697, 600 cm^{-1}; HRMS (EI-TOF) calcd for $C_{27}H_{22}$ $[M]^+$ *m*/*z* = 346.1722; found = 346.1747.

9-(4-(*tert*-Butyl)benzyl)-9-phenyl-9*H*-fluorene (5ae)



The general procedure **B** was followed using **4a** and 1-(*tert*-butyl)-4-methylbenzene. Chromatography (hexanes) afforded the product **5ae** (33 mg) in 57% yield as an amorphous white solid: ^1H NMR (500 MHz, $CDCl_3$) δ 7.51-7.50 (m, 2H), 7.34-7.30 (m, 4H), 7.28-7.23 (m, 6H), 7.22-7.19 (m, 1H), 6.83 (d, *J* = 8.4 Hz, 2H), 6.41 (d, *J* = 8.3 Hz, 2H), 3.75 (s, 2H), 1.13 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.8, 148.5, 144.8, 140.9, 133.7, 129.7, 128.5, 127.2, 127.12, 127.10, 126.6, 125.2, 123.8, 119.8, 60.1, 43.6, 34.2, 31.3; IR (film) cm^{-1} 3059, 2961, 2925, 2865, 1515, 1496, 1475, 1449, 1412, 1364, 1269, 1108, 1033, 833, 743, 731, 697, 633, 623, 604 cm^{-1}; HRMS (EI-TOF) calcd for $C_{30}H_{28}$ $[M]^+$ *m*/*z* = 388.2191; found = 388.2191 (calcd and found are identical).

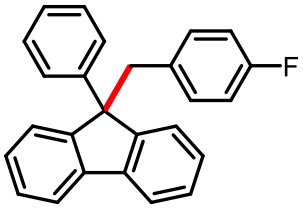
9-(4-*iso*-Propylbenzyl)-9-phenyl-9*H*-fluorene (5af)



The general procedure **B** was followed using **4a** and *p*-cymene. Chromatography (hexanes) afforded the product **5af** (30 mg) in 52% yield as an amorphous white solid: ^1H NMR (500 MHz, $CDCl_3$) δ 7.51-7.49 (m, 2H), 7.32 (dd, *J* = 8.3, 5.1 Hz, 4H), 7.28-7.29 (m, 7H), 6.66 (d, *J* = 8.1 Hz, 2H), 6.39 (d, *J* = 8.0 Hz, 2H), 3.76 (s, 2H), 2.65 (m, 1H), 1.06 (d, *J* = 6.9 Hz, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.8, 146.2, 144.8, 141.0, 134.0, 130.0, 128.51, 127.2, 127.1, 127.0, 126.6, 125.2, 124.9, 119.8, 60.1, 43.7, 33.5, 23.9; IR (film)

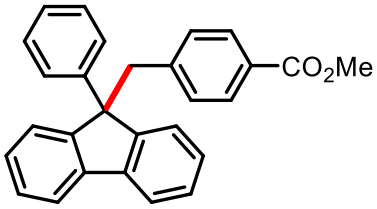
2959, 2862, 1450, 732 cm^{-1}; HRMS (EI-TOF) calcd for $C_{29}H_{26}$ $[M]^+$ *m*/*z* = 388.2035; found = 388.2028.

9-(4-Fluorobenzyl)-9-phenyl-9*H*-fluorene (5ag)



The general procedure **B** was followed using **4a** and 4-fluorotoluene. Chromatography (hexanes) afforded the product **5ag** (30 mg) in 58% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49-7.46 (m, 2H), 7.32-7.27 (m, 4H), 7.25-7.23 (m, 6H), 7.20 (t, *J* = 6.8 Hz, 1H), 6.44 (t, *J* = 8.7 Hz, 2H), 6.33 (dd, *J* = 8.5, 5.7 Hz, 2H), 3.74 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.2 (d, J_{C-F} = 243.8 Hz), 150.5, 144.5, 141.0, 132.2 (d, J_{C-F} = 3.3 Hz), 131.3 (d, J_{C-F} = 7.9 Hz), 128.5, 127.4, 127.3, 127.0, 126.8, 125.0, 119.9, 113.6 (d, J_{C-F} = 20.9 Hz), 60.0, 43.3; IR (film) 3061, 2924, 1601, 1508, 1476, 1450, 1220, 1158, 1096, 1034, 834, 765, 752, 698, 637, 623, 599, 532, 488 cm^{-1}; HRMS (EI-TOF) calcd for $C_{26}H_{19}F$ $[M]^+$ *m*/*z* = 350.1471; found = 350.1467.

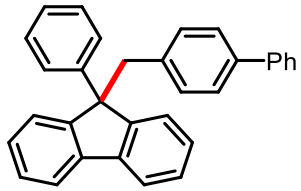
Methyl 4-((9-phenyl-9*H*-fluoren-9-yl)methyl)benzoate (5ah)



The general procedure **B** was followed using **4a** and methyl 4-methylbenzoate. Chromatography (hexanes) afforded the product **5ah** (19.3 mg) in 33% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.48-7.45 (m, 2H), 7.44 (d, *J* = 8.3 Hz, 2H), 7.36 -7.33 (m, 2H), 7.28 (d, *J* = 6.5 Hz, 4H), 7.25 -7.22 (m, 5H), 6.47 (d, *J* = 8.3 Hz, 2H), 3.85 (s, 2H), 3.78 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.3, 150.2, 144.4, 142.2, 140.9, 130.0, 128.6, 128.1, 127.6, 127.5, 127.3, 126.9, 126.8, 125.0, 120.0, 59.9, 51.9, 44.1; IR (film) 2914, 2854, 1719, 1609, 1450, 1435, 1311, 1279, 1181, 1109, 1021,

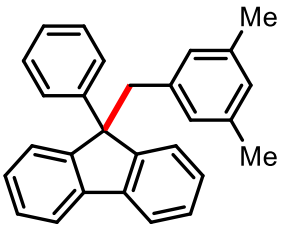
855, 779, 754, 734, 711, 698, 623, 601 cm^{-1}; HRMS (EI-TOF) calcd for $C_{28}H_{22}O_2$ $[M]^+$ *m/z* = 390.1620; found = 390.1646.

9-([1,1'-Biphenyl]-4-ylmethyl)-9-phenyl-9*H*-fluorene (5ai)



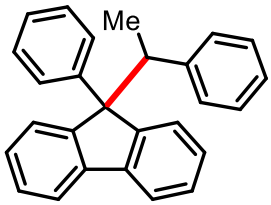
The general procedure **B** was followed using **4a** and 4-methyl-1,1'-biphenyl. Chromatography (hexanes) afforded the product **5ai** (31 mg) in 51% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.50 (dd, *J* = 6.2, 2.5 Hz, 2H), 7.40 (d, *J* = 7.1 Hz, 2H), 7.37-7.32 (m, 5H), 7.30 (d, *J* = 6.4 Hz, 1H), 7.28 -7.25 (m, 6H), 7.24-.21 (m, 2H), 7.04 (d, *J* = 8.3 Hz, 2H), 6.51 (d, *J* = 8.2 Hz, 2H), 3.82 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.7, 144.7, 141.0, 140.9, 138.3, 135.9, 130.5, 128.6, 128.5, 127.3, 127.2, 127.07, 127.01, 126.8, 126.7, 125.5, 125.1, 120.0, 60.1, 43.8; IR (film) 3030, 2923, 2854, 1600, 1488, 1449, 1408, 1158, 1110, 1077, 1034, 1008, 840, 754, 734, 697, 642, 623, 603, 501 cm^{-1}; HRMS (EI-TOF) calcd for $C_{29}H_{26}$ $[M]^+$ *m/z* = 408.1878; found = 408.1859.

9-(3,5-Dimethylbenzyl)-9-phenyl-9*H*-fluorene (5aj)



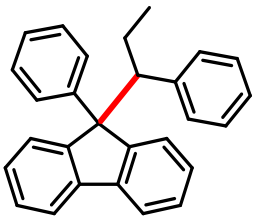
The general procedure **B** was followed using **4a** and mesitylene. Chromatography (hexanes) afforded the product **5aj** (49 mg) in 91% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.50-7.48 (m, 2H), 7.33-7.31 (m, 4H), 7.28 (d, *J* = 7.2 Hz, 2H), 7.25-7.21 (m, 5H), 6.50 (s, 1H), 6.02 (s, 2H), 3.70 (s, 2H), 1.91 (s, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.9, 144.7, 141.0, 136.3, 136.0, 128.5, 128.2, 127.2, 127.1, 127.0, 126.6, 125.2, 119.7, 60.1, 44.0, 21.0; IR (film) 2920, 1449, 847, 733, 697 cm^{-1}; HRMS (EI-TOF) calcd for $C_{28}H_{24}$ $[M]^+$ *m/z* = 360.1878; found = 360.1881.

9-Phenyl-9-(1-phenylethyl)-9*H*-fluorene (5ak)



The general procedure **B** was followed using **4a** and ethyl benzene. Chromatography (hexanes) afforded the product **5ak** (35 mg) in 68% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.2 Hz, 1H), 7.53 (d, *J* = 6.5 Hz, 1H), 7.45 (d, *J* = 7.4 Hz, 2H), 7.42-7.37 (m, 2H), 7.32 (d, *J* = 7.1 Hz, 2H), 7.29 (d, *J* = 7.7 Hz, 2H), 7.22 (t, *J* = 7.3 Hz, 1H), 7.13 (t, *J* = 7.4 Hz, 1H), 7.08 (t, *J* = 7.9 Hz, 1H), 6.85 (t, *J* = 7.3 Hz, 1H), 6.74 (t, *J* = 7.7 Hz, 2H), 6.39 (d, *J* = 7.3 Hz, 2H), 4.26 (q, 1H), 1.53 (d, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.1, 147.8, 143.2, 142.8, 141.3, 139.4, 128.9, 128.6, 127.7, 127.5, 126.98, 126.93, 126.8, 126.67, 126.61, 126.5, 125.8, 124.7, 119.9, 119.4, 63.9, 46.8, 17.7; IR (film) 3060, 3030, 2980, 2932, 1600, 1494, 1450, 1376, 1265, 1034, 1012, 771, 746, 731, 698, 647, 620, 599, 582, 526 cm^{-1}; HRMS (EI-TOF) calcd for $C_{27}H_{22}$ $[M]^+$ m/z = 346.1722; found = 346.1729.

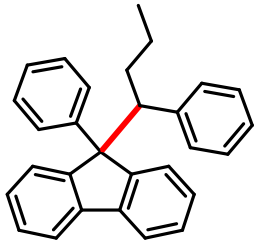
9-Phenyl-9-(1-phenylpropyl)-9*H*-fluorene (5al)



The general procedure **B** was followed using **4a** and propyl benzene. Chromatography (hexanes) afforded the product **5al** (35 mg) in 65% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.65 (d, *J* = 7.0 Hz, 1H), 7.53 (d, *J* = 7.2 Hz, 1H), 7.43-7.36 (m, 4H), 7.30 (d, *J* = 7.4 Hz, 2H), 7.28-7.27 (m, 2H), 7.22 (t, *J* = 7.2 Hz, 1H), 7.10 (t, *J* = 7.4 Hz, 1H), 7.04 (t, *J* = 7.9 Hz, 1H), 6.83 (t, *J* = 7.3 Hz, 1H), 6.72 (t, *J* = 7.7 Hz, 2H), 6.33 (d, *J* = 7.2 Hz, 2H), 3.87 (dd, *J* = 11.9, 1.8 Hz, 1H), 2.27-2.20 (m, 1H), 2.02-1.93 (m, 1H), 0.78 (t, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.5, 148.0, 143.7, 143.2, 139.2, 139.1, 129.4,

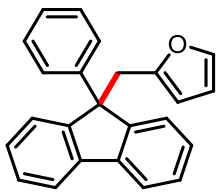
128.6, 127.8, 127.2, 127.1, 126.9, 126.66, 126.62, 126.58, 126.54, 125.8, 124.4, 119.9, 119.4, 64.1, 55.3, 24.8, 13.2; IR (film) 3060, 3028, 2962, 2929, 2871, 1600, 1494, 1475, 1266, 1031, 781, 756, 743, 731, 698, 656, 643, 626, 616 cm^{-1}; HRMS (EI-TOF) calcd for fragments $C_{22}H_{19}$ $[M]^+$ *m*/*z* = 283.1487; found = 283.1490 and C_6H_5 $[M]^+$ *m*/*z* = 77.0391; found = 77.0399.

9-Phenyl-9-(1-phenylbutyl)-9*H*-fluorene (5am)



The general procedure **B** was followed using **4a** and butyl benzene. Chromatography (hexanes) afforded the product **5am** (47 mg) in 82% yield as an amorphous white solid: ^1H NMR (500 MHz, $CDCl_3$) δ 7.67 (d, *J* = 6.4 Hz, 1H), 7.53 (d, *J* = 7.5 Hz, 1H), 7.44-7.37 (m, 4H), 7.32-7.28 (m, 3H), 7.24-7.20 (m, 2H), 7.10 (t, *J* = 8.0 Hz, 1H), 7.03 (t, *J* = 7.4 Hz, 1H), 6.82 (t, *J* = 7.9 Hz, 1H), 6.71 (t, *J* = 7.7 Hz, 2H), 6.33 (d, *J* = 8.1 Hz, 2H), 4.0-3.99 (m, 1H), 2.17-2.11 (m, 1H), 2.02-1.94 (m, 1H), 1.24-1.10 (m, 2H), 0.86 (t, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.6, 147.9, 143.7, 143.2, 139.5, 139.1, 129.3, 128.6, 127.7, 127.28, 127.23, 126.9, 126.64, 126.62, 126.57, 126.52, 125.7, 124.4, 119.9, 119.4, 64.0, 53.0, 33.8, 21.7, 14.2; IR (film) 3060, 3028, 2955, 2870, 1600, 1495, 1450, 1378, 1263, 1102, 1070, 1032, 794, 754, 731, 698, 654, 643, 628, 618 cm^{-1} ; HRMS (EI-TOF) calcd for $C_{29}H_{26}$ $[M]^+$ *m*/*z* = 374.2035; found = 374.2034.

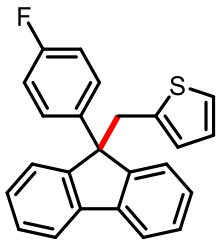
2-((9-Phenyl-9*H*-fluoren-9-yl)methyl)furan (5ao)



The general procedure **B** was followed using **4a** and 2-methyl furan. Chromatography (hexanes) afforded the product **5ao** (26 mg) in 54% yield as an amorphous white solid:

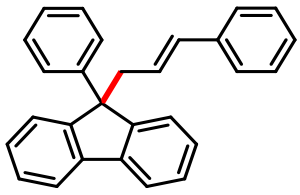
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.66 (d, *J* = 7.5 Hz, 2H), 7.34-7.27 (m, 4H), 7.25-7.29 (m, 6H), 6.97 (s, 1H), 5.95 (dd, *J* = 3.1, 1.9 Hz, 1H), 5.25 (d, *J* = 3.1 Hz, 2H), 3.78 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.9, 150.9, 143.8, 140.6, 140.6, 128.5, 127.5, 127.4, 126.9, 126.7, 124.9, 119.9, 109.9, 107.2, 58.8, 36.6; IR (film) 3062, 2922, 1596, 1499, 1476, 1449, 1262, 1149, 1078, 1014, 920, 805, 733, 697, 628, 599, 583, 499 cm^{-1}; HRMS (EI-TOF) calcd for $C_{24}H_{18}O$ $[M]^+$ *m/z* = 322.1358; found = 322.1352.

2-((9-(4-Fluorophenyl)-9*H*-fluoren-9-yl)methyl)thiophene (5gq)



Th general procedure **B** was followed using 9-(4-fluorophenyl)-9*H*-fluorene and 2-methylthiophene. Chromatography (hexanes) afforded the product **5gq** (33 mg) in 62% yield as an amorphous white solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.62 (d, *J* = 7.5 Hz, 2H), 7.35-7.32 (m, 2H), 7.29-7.26 (m, 6H), 6.96 (t, *J* = 8.7 Hz, 2H), 6.81 (dd, *J* = 5.1, 1.0 Hz, 1H), 6.56 (dd, *J* = 5.1, 3.5 Hz, 1H), 6.18 (d, *J* = 3.2 Hz, 1H), 3.98 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.8 (d, $J_{C\text{-}F}$ = 245.6 Hz), 150.3, 141.0, 139.8 (d, $J_{C\text{-}F}$ = 3.1 Hz), 138.6, 128.5 (d, $J_{C\text{-}F}$ = 7.9 Hz), 127.7, 127.9, 127.0, 125.5, 124.8, 123.9, 120.1, 115.3 (d, $J_{C\text{-}F}$ = 21.1 Hz), 59.2, 38.8; IR (film) 3029, 1506, 1221, 807, 734, 695, 639, 622, 605, 503 cm^{-1}; HRMS (EI-TOF) calcd for fragments $C_{19}H_{12}F$ $[M]^+$ *m*/*z* = 259.0923; found = 259. 0922 and C_5H_5S $[M]^+$ *m*/*z* = 97.0112; found = 97.0097.

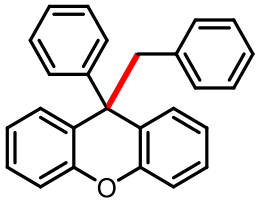
9-cinnamyl-9-phenyl-9*H*-fluorene (5ap)



The general procedure **B** was followed using **4a** and allyl benzene. Chromatography (hexanes) afforded the product **5ap** (43mg) in 81% yield as an amorphous white solid: ^{1}H

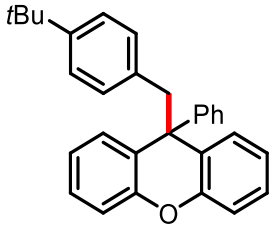
NMR (500 MHz, $CDCl_3$) δ 7.75 (d, *J* = 7.5 Hz, 2H), 7.34 (t, *J* = 7.4 Hz, 2H), 7.31 (d, *J* = 7.5 Hz, 2H), 7.27-7.24 (m, 5H), 7.22-7.18 (m, 2H), 7.16 (d, *J* = 7.7 Hz, 2H), 7.11 (t, *J* = 7.2 Hz, 1H), 7.03 (d, *J* = 7.0 Hz, 2H), 6.18 (d, *J* = 15.8 Hz, 1H), 5.70 (dt, *J* = 15.6, 7.2 Hz, 1H), 3.33 (d, *J* = 7.2 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.3, 144.2, 140.6, 137.7, 133.1, 128.6, 128.4, 127.9, 127.4, 127.0, 126.9, 126.6, 126.1, 125.9, 124.8, 120.1, 59.0, 41.7; IR (film) 3026, 1598, 1495, 1448, 962, 743, 733, 697 cm^{-1}; HRMS (EI-TOF) calcd for $C_{28}H_{22}$ $[M]^+$ *m*/*z* = 358.1722; found = 358.1702.

9-Benzyl-9-phenyl-9*H*-xanthene (7aa)



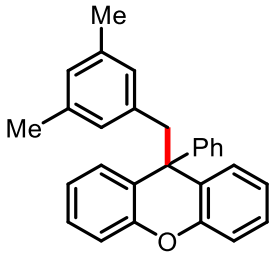
The general procedure **C** was followed using 9-phenyl-9*H*-xanthene and toluene. The column chromatography in 5% EtOAc:hexanes afforded **7aa** in 53% yield (27.6 mg) as a white amorphous solid. 1H NMR (500 MHz, CDCl3) δ 7.51 (d, *J* = 7.9 Hz, 2H), 7.37 (t, *J* = 7.7 Hz, 2H), 7.29 (d, *J* = 7.4 Hz, 1H), 7.13 (t, *J* = 8.2 Hz, 2H), 7.06 (t, *J* = 7.3 Hz, 1H), 6.97 (t, *J* = 7.4 Hz, 2H), 6.89 (t, *J* = 7.2 Hz, 4H), 6.78 (d, *J* = 8.2 Hz, 2H), 6.13 (d, *J* = 7.7 Hz, 2H), 3.53 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.3, 149.7, 136.8, 130.3, 129.8, 129.4, 128.2, 127.7, 127.2, 127.0, 126.5, 126.2, 122.9, 115.7, 50.9, 48.8; IR (film) 3030, 1600, 1573, 1495, 1453, 1440, 1291, 1121, 1098, 886, 762, 751 cm^{-1}; HRMS (EI-TOF) calcd for $C_{19}H_{13}O$ $[M]^+$ *m/z* = 257.0966; found = 257.0878 and C7H7 [M]+ m/z = 91.0548; found 91.0540.

9-(4-(Tert-butyl)benzyl)-9-phenyl-9*H*-xanthene (7ab)



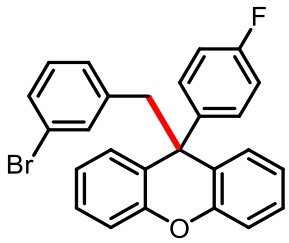
The general procedure **C** was followed using 9-phenyl-9*H*-xanthene and 4-tButyltoluene. Chromatography in 2% EtOAc:hexanes afforded the product **7ab** in 40% yield (24.3 mg) as a white amorphous solid.^{1}H NMR (500 MHz, $CDCl_3$) δ 7.50 (d, *J* = 7.9 Hz, 2H), 7.34 (d, *J* = 7.9 Hz, 2H), 7.21 (s, 1H), 7.13 – 7.10 (m, 2H), 6.94 (t, *J* = 7.5 Hz, 2H), 6.88 (d, *J* = 7.1 Hz, 4H), 6.75 (d, *J* = 8.2 Hz, 2H), 6.06 (d, *J* = 8.2 Hz, 2H), 3.49 (s, 2H), 1.20 (s, 9H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.3, 150.2, 149.9, 148.9 , 133.6 , 129.8, 129.8 , 129.4 , 128.8, 128.5 , 128.1 , 128.0 , 127.6 , 127.1, 126.4, 124.0, 123.3, 122.7, 116.6, 115.7 , 50.2 , 48.8 , 34.3 , 31.4; IR (film) 2961, 1801, 1574, 1479, 1445, 1309, 1253, 1097, 887, 836, 754, 699, 590 cm^{-1}; HRMS (EI-TOF) calcd for $C_{30}H_{28}O$ $[M]^+$ *m/z* =404.2140; found = 404.2140.

9-(3,5-Dimethylbenzyl)-9-phenyl-9*H*-xanthene (7ac)



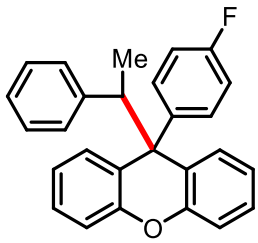
The general procedure **C** was followed using 9-phenyl-9*H*-xanthene and mesitylene. The column chromatography in hexanes afforded the product **7ac** in 56% yield (31.6 mg) as a white amorphous solid.^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 –7.41 (m, 2H), 7.28 (dd, *J* = 8.4, 6.8 Hz, 2H), 7.20 (d, *J* = 7.2 Hz, 1H), 7.03 (ddd, *J* = 8.5, 7.1, 1.7 Hz, 2H), 6.87 (td, *J* = 7.4, 1.3 Hz, 2H), 6.78 (d, *J* = 1.7 Hz, 1H), 6.76 (d, *J* = 1.7 Hz, 1H), 6.68 (dd, *J* = 8.2, 1.3 Hz, 2H), 6.61 (s, 1H), 5.59 (s, 2H), 3.32 (s, 2H), 1.88 (s, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.5, 149.6, 136.6, 136.3, 129.8, 129.6 , 128.3, 128.2, 127.64, 127.58, 127.3, 126.5, 122.8, 115.4, 51.0, 49.1, 21.1; IR (film) 2918, 1601, 1479, 1443, 1311, 1251, 848, 753, 700 cm^{-1}; HRMS (EI-TOF) calcd for $C_{28}H_{24}O[M]^+$ *m/z* = 376.1827; found = 376.1833.

9-(3-Bromobenzyl)-9-(4-fluorophenyl)-9H-xanthene (7bd)



The general procedure **C** was followed using 9-(4- fluorophenyl)-9*H*-xanthene and 3-bromotoluene. The column chromatography in hexanes afforded product **7bd** in 65% (43.3 mg) yield as a white amorphous solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45 (dd, *J* = 8.5, 5.3 Hz, 2H), 7.18 (d, *J* = 8.3 Hz, 1H), 7.15 (d, *J* = 7.3 Hz, 2H), 7.06 (t, *J* = 8.6 Hz, 2H), 6.99 (t, *J* = 7.4 Hz, 2H), 6.83 (d, *J* = 7.9 Hz, 2H), 6.81 (d, *J* = 8.2 Hz, 2H), 6.74 (t, *J* = 7.9 Hz, 1H), 6.16 (s, 1H), 6.03 (d, *J* = 7.7 Hz, 1H), 3.42 (s, 2H); ^{13}C NMR (125 MHz, Chloroform-d) δ 161.5 (d, *J* = 246.2 Hz), 151.3, 145.1, 138.9, 133.4, 130.9 (d, *J* = 7.8 Hz), 129.5, 128.9, 128.6, 128.2, 126.3, 123.2, 121.3, 116.0, 115.1(d, *J* = 21.3 Hz), 50.9, 48.4; IR (film) 3061, 1568, 1507, 1479, 1443, 1311, 1252, 1162, 852, 755, 700 cm^{-1}; HRMS (EI-TOF) calcd for $C_{26}H_{17}BrFO$ $[M-H]^+$ *m/z* = 443.0447; found = 443.0450

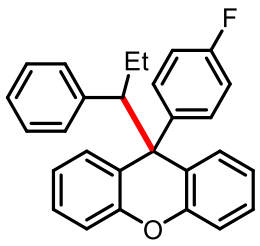
9-(4-Fluorophenyl)-9-(1-phenylethyl)-9*H*-xanthene (7be)



The general procedure **C** was followed using 9-(4-fluorophenyl)-9*H*-xanthene and ethylbenzene. The column chromatography in 1% EtOAc:hexanes afforded product **7be** in 79% (45 mg) yield as a white amorphous solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.52 – 7.49 (m, 2H), 7.32 (t, J = 8.3 Hz, 1H), 7.09 –7.09 - 7.05 (m, 4H), 7.02- 6.99 (m, *J* = 9.7 Hz, 2H), 6.95 - 6.90 (m, *J* = 8.0 Hz, 4H), 6.76 (d, *J* = 7.8 Hz, 1H), 6.59 (d, *J* = 8.1 Hz, 1H), 6.23 (d, *J* = 7.8 Hz, 2H), 3.83 (d, *J* = 7.0 Hz, 1H), 1.45 (d, *J* = 7.0 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.2 (d, *J* = 246.2 Hz), 152.9, 150.3, 142.9 , 141.7 , 132.1 (d, *J* = 7.9 Hz), 132.0, 129.2, 129.0, 128.4 , 127.4 , 127.0 , 126.4, 125.6 , 123.4 , 122.7 , 121.6 , 115.9 ,

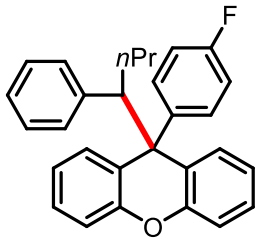
115.5 , 114.7 (d, J = 21.1 Hz), 52.3, 50.0 , 17.2; IR (film) 2972, 1601, 1508, 1478, 1443, 1309, 1280, 1245, 1163, 874, 819, 756, 700 cm^{-1} ; HRMS (EI-TOF) calcd for $C_{27}H_{21}FO$ $[M]^+$ *m/z* = 380.1576; found = 380.1568.

9-(4-Fluorophenyl)-9-(1-phenylpropyl)-9*H*-xanthene (7bf)



The general procedure **C** was followed using 9-(4- fluorophenyl)-9*H*-xanthene and *n*-propylbenzene. The column chromatography in 1% EtOAc:hexanes afforded product **7bf** in 97% (57.3 mg) yield as a white amorphous solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 (s, 2H), 7.30 (t, *J* = 7.3 Hz, 1H), 7.09 - 7.03 (m, *J* = 8.1 Hz, 4H), 7.01 – 6.96 (m, 2H), 6.96 – 6.86 (m, 4H), 6.74 (d, *J* = 7.8 Hz, 1H), 6.56 (d, *J* = 8.1 Hz, 1H), 6.23 (d, *J* = 7.5 Hz, 2H), 3.45 (app d, *J* = 11.7 Hz, 1H), 2.26 – 2.21 (m, 1H), 1.64 -1.56 (m, 1H), 0.78 (t, J = 7.3 Hz, 3H) ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.1 (d, *J* = 245.9 Hz), 152.7, 150.0, 143.3 (d, *J* = 3.2 Hz), 139.5, 131.8 (d, *J* = 4.3 Hz), 131.6, 129.7, 128.9, 128.5, 128.3, 127.2, 126.9, 126.3, 123.9, 122.6, 121.6, 115.8 , 115.4, 114.7 (d, *J* = 21.1 Hz), 58.7, 52.4, 23.9, 12.4; IR (film) 3030, 2965, 1601, 1572, 1508, 1478, 1443, 1309, 1279, 1264, 1241, 1163, 1122, 875, 816, 753, 701, 518 cm^{-1}

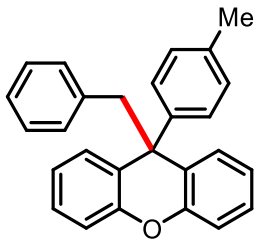
9-(4-Fluorophenyl)-9-(1-phenylbutyl)-9*H*-xanthene (7bg)



The general procedure **C** was followed using 9-(4- fluorophenyl)-9*H*-xanthene and n-butylbenzene. The column chromatography in 1% EtOAc:hexanes afforded the product **7bg** in 56% (34.3 mg) yield as a white amorphous solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.45 - 7.43 (m, 2H), 7.30 (t, *J* = 7.6 Hz, 1H), 7.08 - 7.00 (m, 5H), 6.98 - 6.85 (m, 5H), 6.73

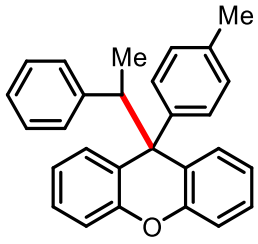
(d, *J* = 7.9 Hz, 1H), 6.55 (d, *J* = 8.1 Hz, 1H), 6.21 (d, *J* = 7.6 Hz, 2H), 3.55 (app d, *J* = 11.8 Hz, 1H), 2.17 - 2.11 (m, 1H), 1.61 – 1.53 (m, 1H), 1.22 – 1.16 (m, 1H), 1.08 (s, 1H), 0.86 (d, J = 7.2 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.21 (d, J = 245.9 Hz), 152.8, 150.1, 143.4 (d, J = 3.2 Hz), 139.9, 132.0 (d, *J* = 4.3 Hz), 131.8, 129.7, 129.0, 128.6, 128.4, 127.3, 127.0, 126.3, 124.0, 122.7, 121.7, 115.9 , 115.5, 114.7 (d, J = 21.1 Hz), 56.7, 52.3, 33.0, 21.2, 14.3; IR (film) 2956, 1600, 1508, 1478, 1443, 1308, 1259, 1239, 1163, 873, 818, 754, 701 cm-1. ; HRMS (EI-TOF) calcd for $C_{29}H_{25}FO$ $[M]^+$ *m/z* =408.1889; found = 408.1874.

9-Benzyl-9-(p-tolyl)-9H-xanthene (7ca)



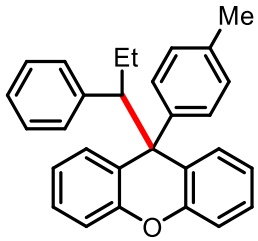
The general procedure **C** was followed using 9-(p-tolyl)-9*H*-xanthene and toluene. The column chromatography in hexanes afforded product **7ca** in 58% yield (31.5 mg) as a white amorphous solid. ^{1}H NMR (500 MHz, CDCl3) δ 7.42 (d, J = 8.1 Hz, 2H), 7.21 (d, J = 7.8 Hz, 2H), 7.15 (t, J = 7.6 Hz, 2H), 7.09 (t, J = 7.4 Hz, 1H), 7.00 (t, J = 7.2 Hz, 2H), 6.96 - 6.91 (m, 4H), 6.80 (d, J = 8.1 Hz, 2H), 6.16 (d, J = 7.4 Hz, 2H), 3.54 (s, 2H), 2.41 (s, 3H).^{13}C NMR (125 MHz, $CDCl_3$) δ 151.3, 146.9, 137.1, 137.0, 136.0, 130.4, 130.3, 129.8, 129.3, 129.0, 128.90, 128.53, 127.7, 127.2, 127.16, 127.13, 126.2, 122.9, 116.1, 115.7, 51.0, 48.6, 21.2; IR (film) 2922, 1574, 1479, 1443, 1311, 1254, 797, 750, 699 cm^{-1} ; HRMS (EI-TOF) calcd for $C_{27}H_{22}O$ $[M]^+$ *m/z* = 376.1671; found = 376.1678.

9-(1-Phenylethyl)-9-(p-tolyl)-9*H*-xanthene (7ce)



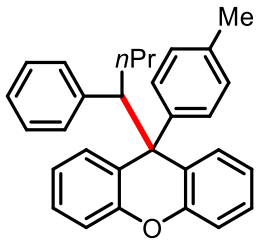
The general procedure **C** was followed using 9-(p-tolyl)-9*H*- xanthene and ethylbenzene. The column chromatography in hexanes afforded the product **7ce** in 73% yield (42 mg) as a white amorphous solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.41 (d, *J* = 8.0 Hz, 2H), 7.31-7.29 (m, 1H), 7.19 (d, *J* = 8.0 Hz, 2H), 7.08 (d, *J* = 7.3 Hz, 1H), 7.05 (d, *J* = 4.4 Hz, 2H), 6.98 (t, *J* = 7.6 Hz, 1H), 6.94 – 6.86 (m, 4H), 6.81 (d, *J* = 7.9 Hz, 1H), 6.58 (d, *J* = 9.1 Hz, 1H), 6.24 (d, *J* = 7.3 Hz, 2H), 3.86 (q, J = 7.0 Hz, 1H), 2.40 (s, 3H), 1.46 (d, J = 7.0 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 153.0, 150.3, 144.2, 142.1, 135.8 , 132.2, 130.5, 129.3, 129.2, 129.1, 128.6, 128.1, 127.2, 126.9, 126.3, 123.8, 122.6, 121.4, 115.8, 115.4, 52.5, 49.9, 21.1, 17.3; IR (film) 3029,1572, 1477, 1442, 1307, 1279, 1246, 873, 755, 700 cm-1 ; HRMS (EI-TOF) calcd for $C_{20}H_{15}O$ $[M]^+$ *m/z* = 271.1123; found = 271.1140 and C_8H_9 [M]+ m/z = 105.0705 ; found 105.0671

9-(1-Phenylpropyl)-9-(p-tolyl)-9H-xanthene (7cf)



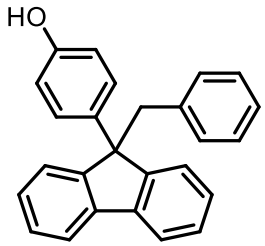
The general procedure **C** was followed using 9-(p-tolyl)-9*H*-xanthene and propylbenzene. The column chromatography in hexanes afforded the product **7cf** in 84% yield (49.1 mg) as a white amorphous solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35 (d, J = 7.8 Hz, 2H), 7.28 (m, 1H), 7.18 (d, J = 7.8 Hz, 2H), 7.07–7.02 (m, 3H), 6.97-6.89 (m, 4H), 6.85 (t, J = 7.5 Hz, 1H), 6.78 (dd, J = 7.9, 1.7 Hz, 1H), 6.54 (d, J = 8.0 Hz, 1H), 6.23 (d, J = 7.6 Hz, 2H), 3.47 (dd, J = 12.0, 1.9 Hz, 1H), 2.38 (s, 3H), 2.29 (m, 1H), 1.58 (m, 1H), 0.77 (t, J = 7.2 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 152.9, 150.1, 144.7, 139.9, 135.8, 131.9, 130.3, 129.8, 129.1, 129.0, 128.6, 128.1, 127.1, 127.0, 126.2, 124.4, 122.6, 121.5, 115.8, 115.4, 58.7 , 52.6 , 24.0, 21.1, 12.5; IR (film) 3029, 2964, 1600, 1572, 1477, 1443,1307, 1262, 1241, 1123, 875, 801, 752, 701 cm-1 ; HRMS (EI-TOF) calcd for $C_{20}H_{15}O$ [M]+ m/z = 271.1123; found = 272.1139 and C_9H_{11} $[M]^+$ *m/z* = 118.0783; found 118.0746.

9-(1-Phenylbutyl)-9-(p-tolyl)-9*H*-xanthene (7cg)



The general procedure **C** was followed using 9-(p-tolyl)-9*H*-xanthene and *n*-butylbenzene. The column chromatography in hexanes afforded the product **7cg** in 71% yield (43.1 mg) as a white amorphous solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (d, *J* = 7.6 Hz, 2H), 7.29 (t, *J* = 7.5 Hz, 1H), 7.19–7.13 (m, 3H), 7.10–6.99 (m, 4H), 6.98 – 6.84 (m, 5H), 6.79 (d, *J* = 7.1 Hz, 1H), 6.54 (d, *J* = 8.1 Hz, 1H), 3.59 (app d, *J* = 11.6 Hz, 1H), 2.39 (s, 3H), 2.23-2.17 (m, 1H), 1.61 – 1.53 (m, 1H), 1.23-1.17 (m, 1H), 1.10 - 1.05 (m, 1H), 0.86 (t, *J* = 7.3 Hz, 3H);^{13}C NMR (125 MHz, $CDCl_3$) δ 152.9, 150.1, 144.7, 140.3, 135.8, 131.9, 130.3, 129.8, 129.1, 128.6, 128.1, 127.1, 126.9, 126.2, 124.3, 123.3, 122.6, 121.6, 115.8, 115.4, 56.5, 52.5, 44.1, 33.1, 21.1, 14.4; IR (film) 2955, 1599, 1572, 1477, 1443, 1307, 1257, 1239, 1122, 872, 803, 754, 701 cm-1 ; HRMS (EI-TOF) calcd for $C_{30}H_{28}O$ [M]+ m/z = 404.2140; found = 404.2144.

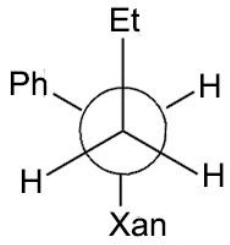
3-(4-Methoxybenzyl)-1-methyl-3-phenylindolin-2-one (8)



The general procedure **E** was followed using **5c**. Chromatography (20% EtOAc/hexanes) afforded **8** (761.3 mg) in 99% yield as a white amorphous solid: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.48 (t, *J* = 5.0 Hz, 2H), 7.33 (t, *J* = 5.0 Hz, 2H), 7.26 – 7.24 (m, 4H), 7.18 (d, *J* = 5.0 Hz, 2H), 6.88 (t, *J* = 5.0 Hz, 1H), 6.78 (t, *J* = 5.0 Hz, 2H), 6.73 (d, *J* = 10.0 Hz, 2H), 6.42 (d, *J* = 5.0 Hz, 2H), 4.67 (s, 1H), 3.75 (s, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 154.3, 150.9, 140.9, 136.9, 136.7, 130.1, 128.3, 127.3, 127.2, 126.9, 125.8, 125.1, 119.8, 115.3, 59.5, 44.4; HRMS (ESI-FTICR) calcd for $C_{26}H_{19}O$ $[M-H]^-$ m/z = 347.1436; found 347.1430.

XRD analysis

After analyzing the NMR data, following Gaussian configuration for 9-(4-Fluorophenyl)-9-(1-phenylbutyl)-9*H*-xanthene was proposed. X-ray study was necessary to confirm the proposed configuration shown below.

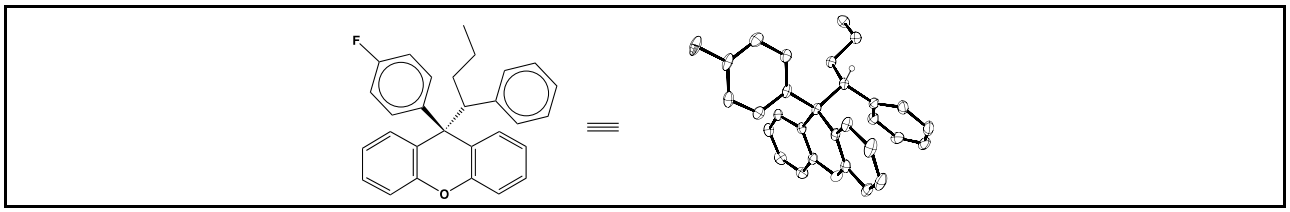


This configuration shows that we should observe two dihedral angles. First one between H1 and H2 which equals -60° (theoretically) and the other one between H1 and H3 which equals 180° (theoretically). These dihedral correspond to a coupling constant of 2.0 Hz and 11.0 Hz, based on Karplus Equation, respectively.
The dihedral angle values obtained from the XRD data show an angle of -65.15° between H1 and H2 atoms whereas the dihedral angle between H1 and H3 measures 177.5°. When these values are calculated according to the calculations demonstrated in literature[15], we get the following values for coupling constants.

Atoms considered	Dihedral Angle (°)	Coupling constant (*J*)
H1-H2 (theoretical)	-60	2.0
H1-H3 (theoretical)	180	11.0
H1-H2 (experimental)	-65.2	2.5
H1-H3 (experimental)	177.5	12.3

In the NMR spectra for the compound, we observe a coupling constant of 11.8 Hz, which is in propensity to the coupling constant value calculated from the XRD data. This proves that the proposed configuration is correct.

Crystallographic Data for Compound 7cg



Compound 8057, $C_{29}H_{25}FO$, crystallizes in the monoclinic space group $P2_1$ (systematic absences 0k0: k=odd) with a=8.9195(5)Å, b=13.0385(7)Å, c=9.2973(5)Å, β=97.357(2)°, V=1072.35(10)Å^3, Z=2, and d_{calc}=1.265 g/cm$_3$. X-ray intensity data were collected on a Bruker D8QUEST [1] CMOS area detector employing graphite-monochromated Mo-Kα radiation (λ=0.71073Å) at a temperature of 100K. Preliminary indexing was performed from a series of twenty-four 0.5° rotation frames with exposures of 10 seconds. A total of 1192 frames were collected with a crystal to detector distance of 33.0 mm, rotation widths of 0.5° and exposures of 15 seconds:

scan type	2θ	ω	φ	χ	Frames
	3.18	196.87	72.00	54.72	304
	3.18	196.87	0.00	54.72	304
	3.18	196.87	216.00	54.72	304
	3.18	196.87	144.00	54.72	280

Rotation frames were integrated using SAINT [2], producing a listing of unaveraged F^2 and σ(F^2) values. A total of 22247 reflections were measured over the ranges 6.25 ≤ 2θ ≤ 50.764°, -10 ≤ h ≤ 10, -15 ≤ k ≤ 15, -11 ≤ l ≤ 11 yielding 3940 unique reflections (R_{int} = 0.0412). The intensity data were corrected for Lorentz and polarization effects and for absorption using SADABS [3] (minimum and maximum transmission 0.7143, 0.7452). The structure was solved by direct methods - ShelXT [4]. Refinement was by full-matrix least squares based on F^2 using SHELXL-2018 [5]. All reflections were used during refinement. The weighting scheme used was w=1/[$\sigma^2(F_o^2)$+ (0.0444P)^2 + 0.1873P] where P = (F_o^2 + 2F_c^2)/3. Non-hydrogen atoms were refined anisotropically and hydrogen atoms were refined using a riding model. Refinement converged to R1=0.0354 and wR2=0.0816 for 3655 observed reflections for which F > 4σ(F) and R1=0.0406 and wR2=0.0847 and

GOF =1.079 for all 3940 unique, non-zero reflections and 281 variables. The maximum Δ/σ in the final cycle of least squares was 0.000 and the two most prominent peaks in the final difference Fourier were +0.18 and -0.23 e/Å^3.

Table 1. lists cell information, data collection parameters, and refinement data. Final positional and equivalent isotropic thermal parameters are given in Tables 2. and 3. Anisotropic thermal parameters are in Table 4. Tables 5. and 6. list bond distances and bond angles. Figure 1. is an ORTEP representation of the molecule with 50% probability thermal ellipsoids displayed. The crystal structure of **7cg** has been deposited at the Cambridge Crystallographic. Data Centre and allocated the deposition number: CCDC: **1939223**

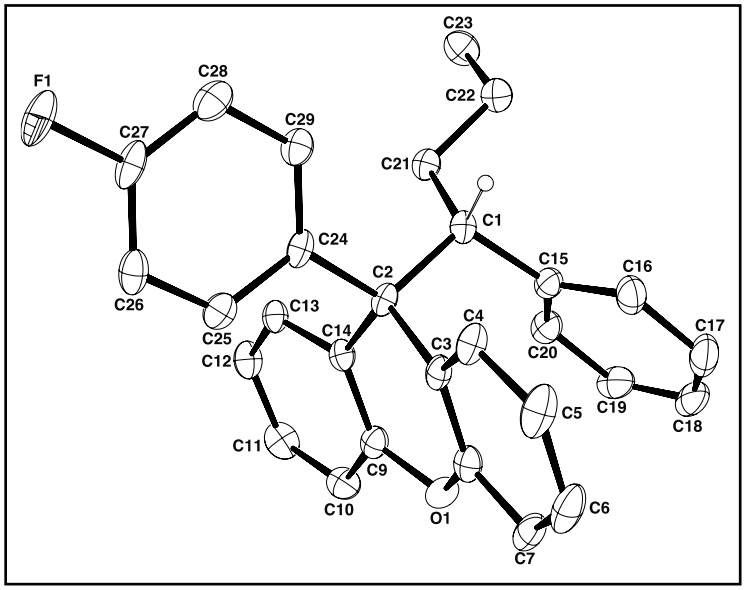


Figure S5. ORTEP drawing of the title compound with 50% thermal ellipsoids.

Table 1. Summary of Structure Determination of Compound 8057

Empirical formula	$C_{29}H_{25}FO$
Formula weight	408.49
Temperature/K	100
Crystal system	monoclinic
Space group	$P2_1$
a	8.9195(5)Å
b	13.0385(7)Å
c	9.2973(5)Å
β	97.357(2)°
Volume	1072.35(10)Å^3
Z	2
d_{calc}	1.265 g/cm^3
μ	0.081 mm^{-1}
F(000)	432.0
Crystal size, mm	0.22 × 0.15 × 0.06
2θ range for data collection	6.25 - 50.764°
Index ranges	-10 ≤ h ≤ 10, -15 ≤ k ≤ 15, -11 ≤ l ≤ 11
Reflections collected	22247
Independent reflections	3940[R(int) = 0.0412]
Data/restraints/parameters	3940/1/281
Goodness-of-fit on F^2	1.079
Final R indexes [I>=2σ (I)]	R_1 = 0.0354, wR_2 = 0.0816
Final R indexes [all data]	R_1 = 0.0406, wR_2 = 0.0847
Largest diff. peak/hole	0.18/-0.23 eÅ^{-3}
Flack parameter	0.4(3)

Table 2. Refined Positional Parameters for Compound 8057

Atom	*x*	*y*	*z*	U(eq)
F1	0.14762(17)	0.49709(14)	0.95048(15)	0.0313(4)
O1	0.60263(19)	0.31619(14)	0.30615(18)	0.0211(4)
C1	0.4468(3)	0.57962(19)	0.3544(3)	0.0174(5)
C2	0.4379(3)	0.47595(19)	0.4435(2)	0.0164(5)
C3	0.6006(3)	0.4441(2)	0.4959(3)	0.0178(5)
C4	0.6847(3)	0.4951(2)	0.6114(2)	0.0209(5)
C5	0.8372(3)	0.4754(2)	0.6486(3)	0.0284(6)
C6	0.9080(3)	0.4025(2)	0.5717(3)	0.0296(7)
C7	0.8262(3)	0.3493(2)	0.4590(3)	0.0242(6)
C8	0.6738(3)	0.37121(19)	0.4222(3)	0.0187(5)
C9	0.4467(3)	0.3202(2)	0.2800(3)	0.0194(5)
C10	0.3800(3)	0.2483(2)	0.1823(3)	0.0243(6)
C11	0.2241(3)	0.2467(2)	0.1495(3)	0.0268(6)
C12	0.1365(3)	0.3155(2)	0.2157(3)	0.0237(6)
C13	0.2051(3)	0.3862(2)	0.3136(3)	0.0184(5)
C14	0.3621(3)	0.39180(19)	0.3459(2)	0.0167(5)
C15	0.5648(3)	0.5680(2)	0.2505(3)	0.0202(5)
C16	0.7127(3)	0.6019(2)	0.2911(3)	0.0263(6)
C17	0.8260(3)	0.5806(2)	0.2055(4)	0.0353(7)
C18	0.7924(3)	0.5270(2)	0.0767(4)	0.0364(8)
C19	0.6459(3)	0.4972(2)	0.0315(3)	0.0306(7)
C20	0.5326(3)	0.5179(2)	0.1175(3)	0.0239(6)
C21	0.2946(3)	0.6171(2)	0.2760(3)	0.0185(5)
C22	0.3051(3)	0.7222(2)	0.2035(3)	0.0237(6)
C23	0.1563(3)	0.7523(2)	0.1156(3)	0.0283(6)

C24	0.3554(3)	0.4875(2)	0.5785(2)	0.0167(5)
C25	0.3385(3)	0.3982(2)	0.6599(3)	0.0203(5)
C26	0.2709(3)	0.4009(2)	0.7860(3)	0.0224(6)
C27	0.2189(3)	0.4937(2)	0.8289(2)	0.0223(6)
C28	0.2358(3)	0.5830(2)	0.7562(3)	0.0251(6)
C29	0.3058(3)	0.5786(2)	0.6295(3)	0.0209(5)

Table 3. Positional Parameters for Hydrogens in Compound 8057

Atom	*x*	*y*	*z*	U(eq)
H1	0.484424	0.634011	0.425822	0.021
H4	0.636376	0.544243	0.665364	0.025
H5	0.893275	0.511555	0.726432	0.034
H6	1.012809	0.389136	0.5965	0.036
H7	0.873765	0.298425	0.407483	0.029
H10	0.440589	0.200681	0.138164	0.029
H11	0.17729	0.198323	0.081651	0.032
H12	0.029504	0.314104	0.193933	0.028
H13	0.143985	0.432092	0.360086	0.022
H16	0.736195	0.639942	0.378257	0.032
H17	0.926507	0.602941	0.235477	0.042
H18	0.870385	0.510785	0.019815	0.044
H19	0.622035	0.462485	-0.058415	0.037
H20	0.431634	0.497556	0.085017	0.029
H21a	0.256234	0.566175	0.201154	0.022
H21b	0.22076	0.62133	0.346709	0.022

H22a	0.333653	0.774634	0.278962	0.028
H22b	0.385178	0.720037	0.139008	0.028
H23a	0.077987	0.758217	0.180066	0.042
H23b	0.12677	0.699888	0.041897	0.042
H23c	0.16813	0.818425	0.068083	0.042
H25	0.374378	0.334675	0.627712	0.024
H26	0.260783	0.340402	0.840945	0.027
H28	0.201233	0.646325	0.790273	0.03
H29	0.319329	0.640095	0.577916	0.025

Table 4. Refined Thermal Parameters (U's) for Compound 8057

Atom	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
F1	0.0270(8)	0.0544(11)	0.0147(7)	-0.0049(7)	0.0108(6)	-0.0057(8)
O1	0.0202(9)	0.0247(10)	0.0188(9)	-0.0022(8)	0.0040(7)	0.0035(8)
C1	0.0166(12)	0.0209(12)	0.0146(12)	-0.0004(10)	0.0024(9)	-0.0038(10)
C2	0.0123(12)	0.0234(13)	0.0135(11)	-0.0012(10)	0.0019(9)	-0.0016(10)
C3	0.0151(12)	0.0235(13)	0.0155(12)	0.0049(10)	0.0039(9)	-0.0009(10)
C4	0.0160(12)	0.0310(14)	0.0160(12)	0.0002(11)	0.0034(9)	-0.0025(11)
C5	0.0178(13)	0.0494(18)	0.0175(12)	0.0020(12)	0.0002(10)	-0.0050(12)
C6	0.0131(13)	0.0489(18)	0.0267(15)	0.0090(13)	0.0021(11)	0.0010(12)
C7	0.0189(13)	0.0338(15)	0.0215(13)	0.0062(11)	0.0083(10)	0.0053(11)
C8	0.0195(13)	0.0248(13)	0.0121(12)	0.0040(10)	0.0029(10)	-0.0020(10)
C9	0.0192(12)	0.0241(13)	0.0152(12)	0.0032(10)	0.0032(10)	0.0000(11)
C10	0.0339(15)	0.0228(13)	0.0168(13)	-0.0023(11)	0.0057(11)	0.0010(11)
C11	0.0341(15)	0.0271(14)	0.0178(13)	-0.0034(11)	-0.0021(11)	-0.0062(12)

C12	0.0220(13)	0.0296(14)	0.0189(13)	-0.0006(11)	-0.0002(10)	-0.0085(12)
C13	0.0195(13)	0.0222(12)	0.0139(12)	0.0007(10)	0.0038(10)	-0.0032(10)
C14	0.0204(13)	0.0200(12)	0.0099(11)	0.0028(10)	0.0030(9)	-0.0017(10)
C15	0.0194(13)	0.0220(12)	0.0201(13)	0.0069(11)	0.0058(10)	0.0031(11)
C16	0.0218(14)	0.0276(15)	0.0299(15)	0.0093(12)	0.0046(11)	-0.0018(11)
C17	0.0207(14)	0.0382(17)	0.0484(19)	0.0209(15)	0.0104(12)	0.0006(13)
C18	0.0336(17)	0.0362(16)	0.0451(19)	0.0192(14)	0.0265(14)	0.0121(14)
C19	0.0420(18)	0.0302(15)	0.0231(13)	0.0071(12)	0.0180(12)	0.0100(14)
C20	0.0249(14)	0.0280(15)	0.0197(13)	0.0064(11)	0.0058(10)	0.0030(11)
C21	0.0190(12)	0.0225(12)	0.0140(11)	-0.0008(10)	0.0025(9)	-0.0010(10)
C22	0.0229(13)	0.0248(14)	0.0233(14)	0.0009(11)	0.0026(10)	-0.0012(11)
C23	0.0307(15)	0.0261(14)	0.0267(15)	0.0036(12)	-0.0016(12)	0.0002(12)
C24	0.0102(11)	0.0281(13)	0.0113(11)	-0.0017(10)	-0.0005(8)	-0.0044(10)
C25	0.0150(12)	0.0265(14)	0.0187(12)	-0.0009(10)	0.0000(9)	-0.0001(10)
C26	0.0174(12)	0.0343(15)	0.0155(13)	0.0058(11)	0.0015(10)	-0.0042(11)
C27	0.0148(12)	0.0428(15)	0.0095(11)	-0.0026(12)	0.0022(9)	-0.0049(12)
C28	0.0229(14)	0.0331(15)	0.0195(13)	-0.0073(11)	0.0036(10)	-0.0002(12)
C29	0.0201(13)	0.0259(13)	0.0167(13)	-0.0019(11)	0.0029(10)	-0.0024(11)

Table 5. Bond Distances in Compound 8057, Å

F1-C27	1.366(3)	O1-C8	1.381(3)	O1-C9	1.382(3)
C1-C2	1.593(3)	C1-C15	1.524(3)	C1-C21	1.536(3)
C2-C3	1.528(3)	C2-C14	1.526(3)	C2-C24	1.542(3)
C3-C4	1.398(3)	C3-C8	1.383(4)	C4-C5	1.384(4)

C5-C6	1.389(4)	C6-C7	1.384(4)	C7-C8	1.388(4)
C9-C10	1.386(4)	C9-C14	1.391(3)	C10-C11	1.385(4)
C11-C12	1.385(4)	C12-C13	1.382(4)	C13-C14	1.396(3)
C15-C16	1.397(4)	C15-C20	1.396(4)	C16-C17	1.392(4)
C17-C18	1.386(5)	C18-C19	1.377(4)	C19-C20	1.393(4)
C21-C22	1.535(4)	C22-C23	1.518(4)	C24-C25	1.407(4)
C24-C29	1.374(4)	C25-C26	1.386(4)	C26-C27	1.374(4)
C27-C28	1.365(4)	C28-C29	1.402(4)		

Table 6. Bond Angles in Compound 8057, °

C8-O1-C9	117.99(19)	C15-C1-C2	109.2(2)	C15-C1-C21	111.8(2)
C21-C1-C2	114.66(19)	C3-C2-C1	106.79(19)	C3-C2-C24	107.44(18)
C14-C2-C1	110.41(18)	C14-C2-C3	109.0(2)	C14-C2-C24	109.42(19)
C24-C2-C1	113.7(2)	C4-C3-C2	120.7(2)	C8-C3-C2	121.2(2)
C8-C3-C4	117.8(2)	C5-C4-C3	121.1(2)	C4-C5-C6	119.7(2)
C7-C6-C5	120.2(2)	C6-C7-C8	119.2(2)	O1-C8-C3	123.0(2)
O1-C8-C7	115.1(2)	C3-C8-C7	121.9(2)	O1-C9-C10	115.3(2)
O1-C9-C14	122.6(2)	C10-C9-C14	122.1(2)	C11-C10-C9	119.3(2)
C10-C11-C12	120.0(2)	C13-C12-C11	119.8(2)	C12-C13-C14	121.6(2)
C9-C14-C2	121.3(2)	C9-C14-C13	117.2(2)	C13-C14-C2	121.4(2)
C16-C15-C1	120.1(2)	C20-C15-C1	121.8(2)	C20-C15-C16	117.9(2)
C17-C16-C15	120.8(3)	C18-C17-C16	120.2(3)	C19-C18-C17	119.9(3)
C18-C19-C20	120.0(3)	C19-C20-C15	121.2(3)	C22-C21-C1	113.1(2)
C23-C22-C21	111.7(2)	C25-C24-C2	116.9(2)	C29-C24-C2	125.0(2)

C29-C24-C25	117.9(2)	C26-C25-C24	121.5(2)	C27-C26-C25	117.9(2)
F1-C27-C26	118.6(2)	C28-C27-F1	118.4(2)	C28-C27-C26	123.0(2)
C27-C28-C29	118.1(2)	C24-C29-C28	121.5(2)		

This report has been created with Olex2[7] compiled on 2018.05.29 svn.r3508 for OlexSys

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Copies of ^{1}H NMR and ^{13}C NMR

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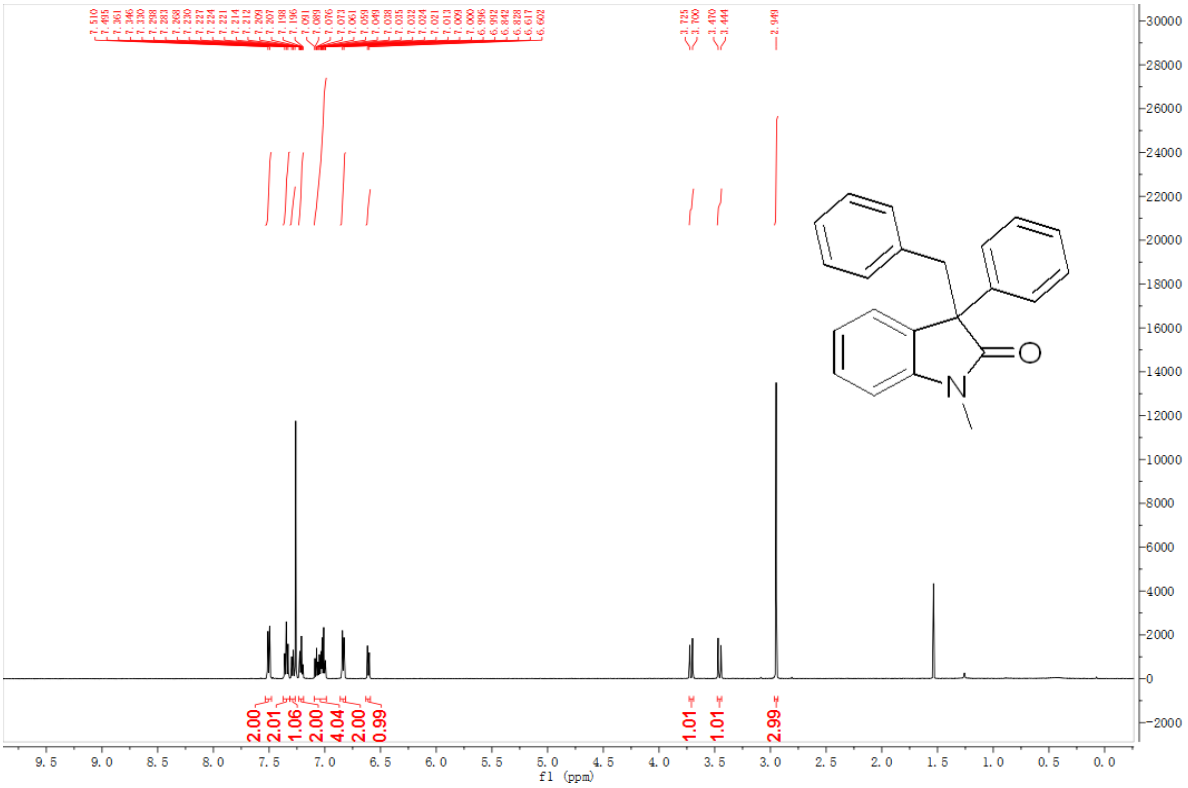
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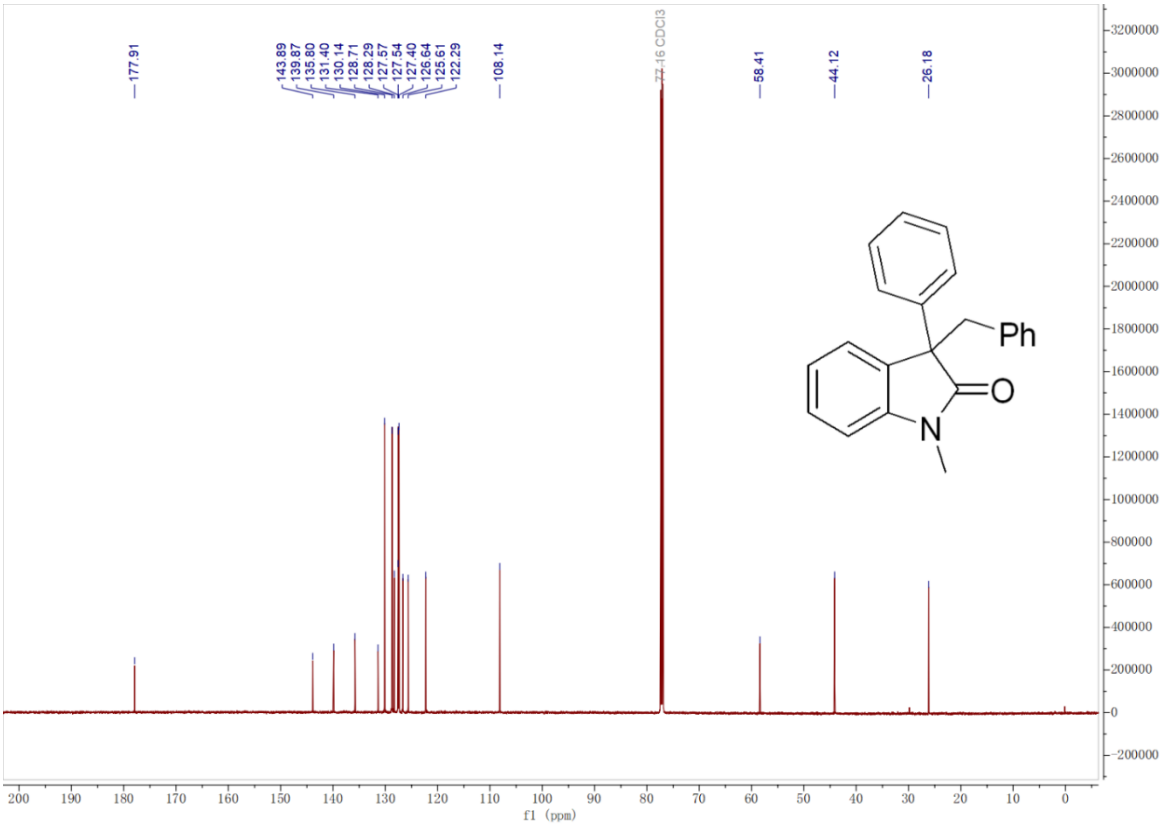
f1 (ppm)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f1 (ppm)

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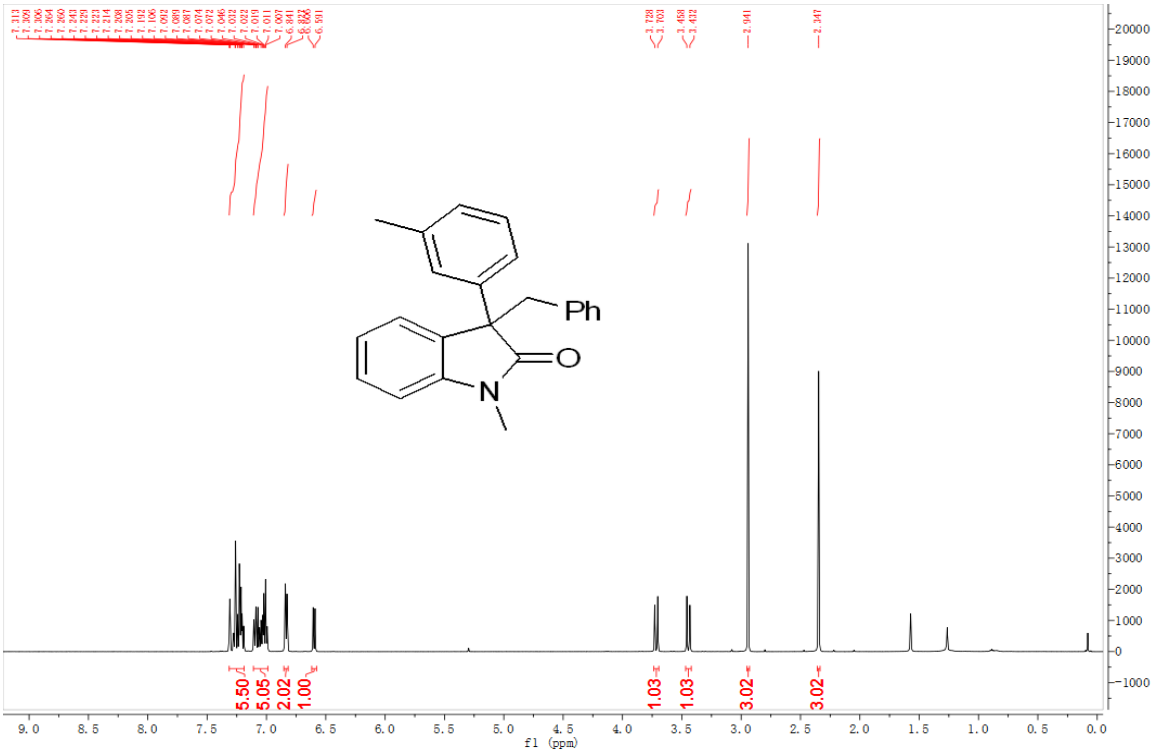

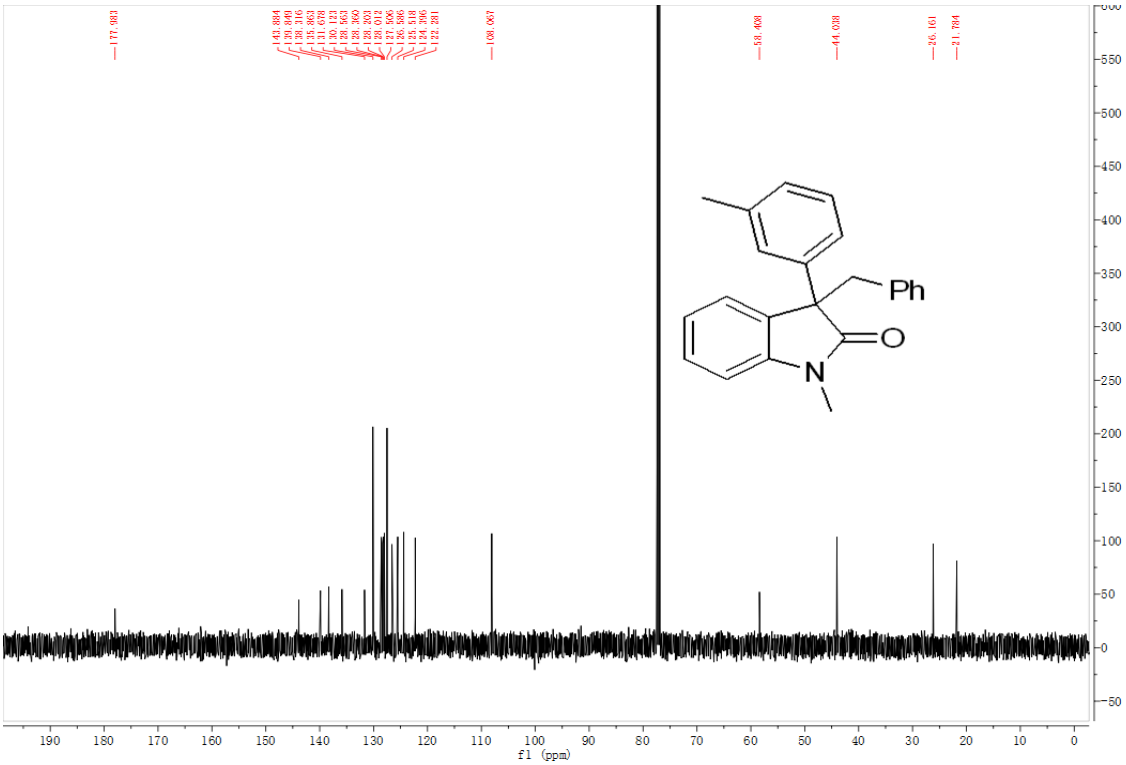

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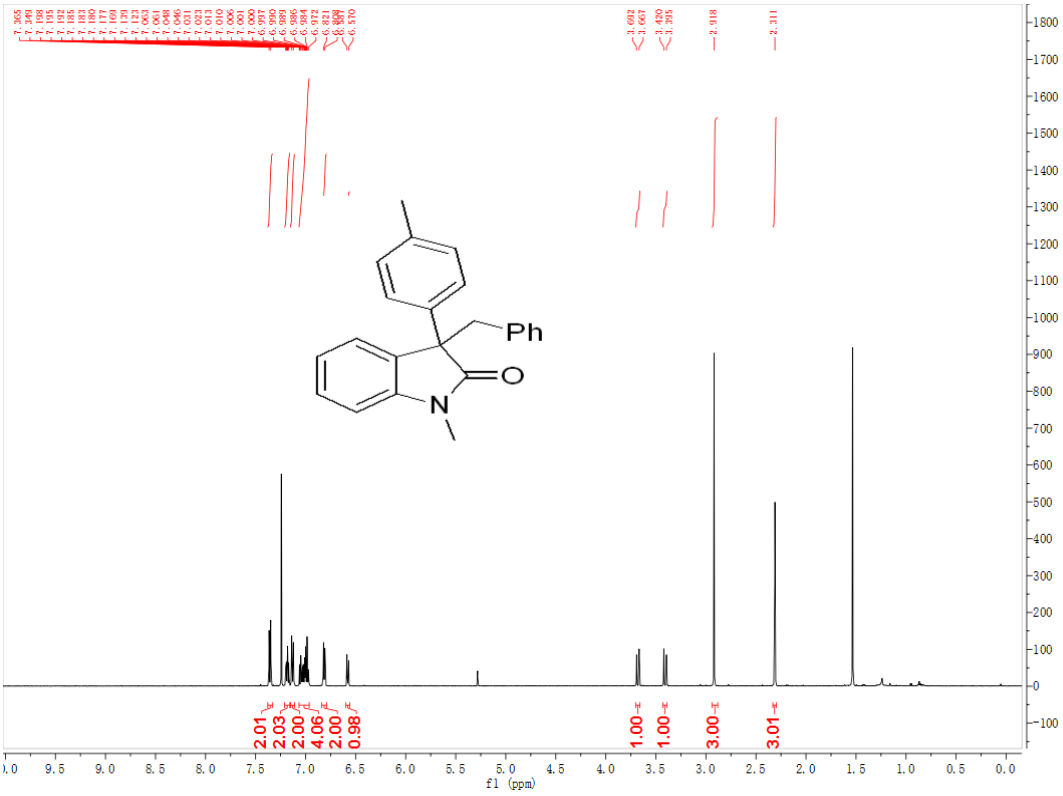
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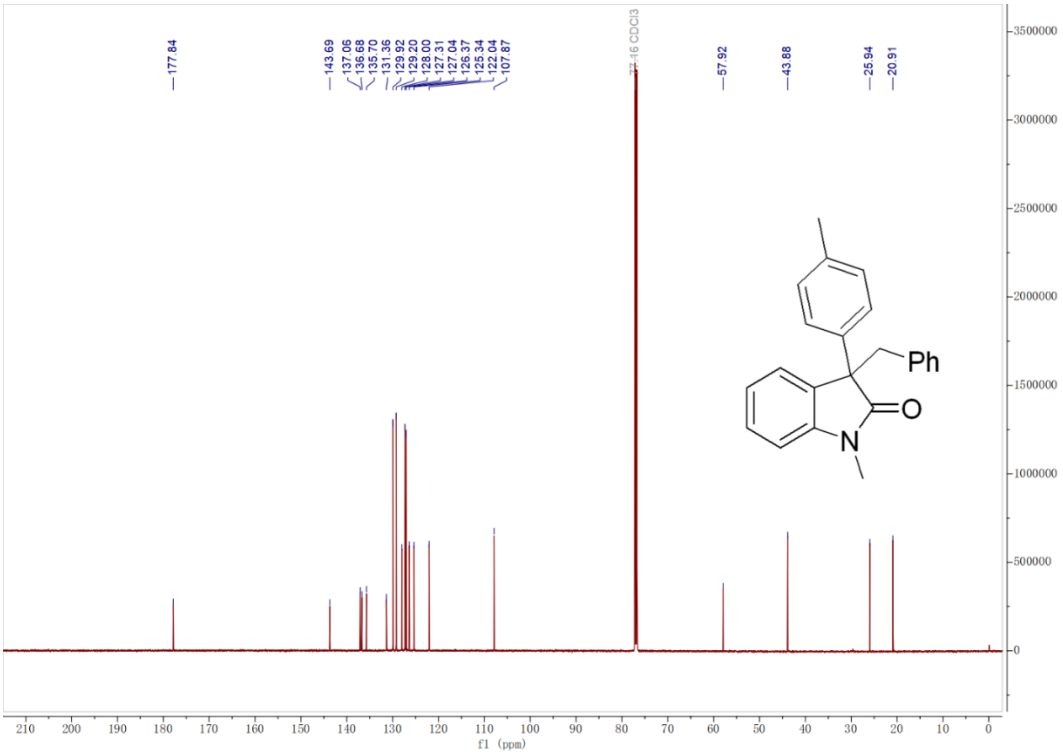
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f1 (ppm)

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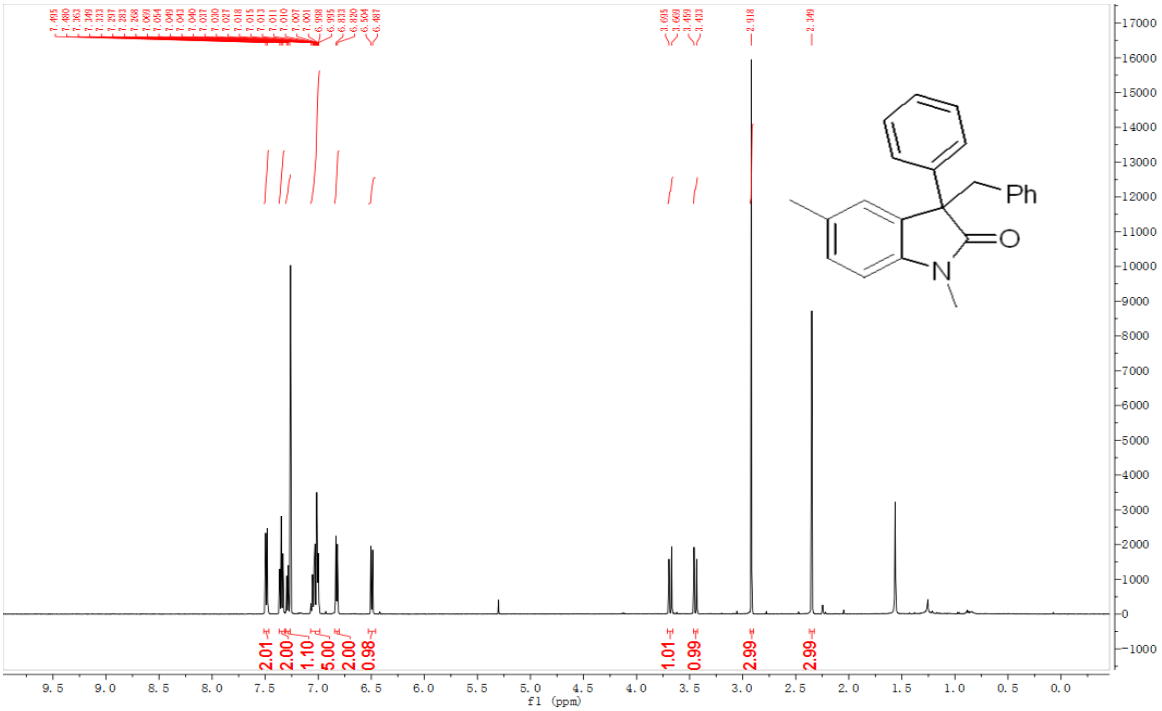
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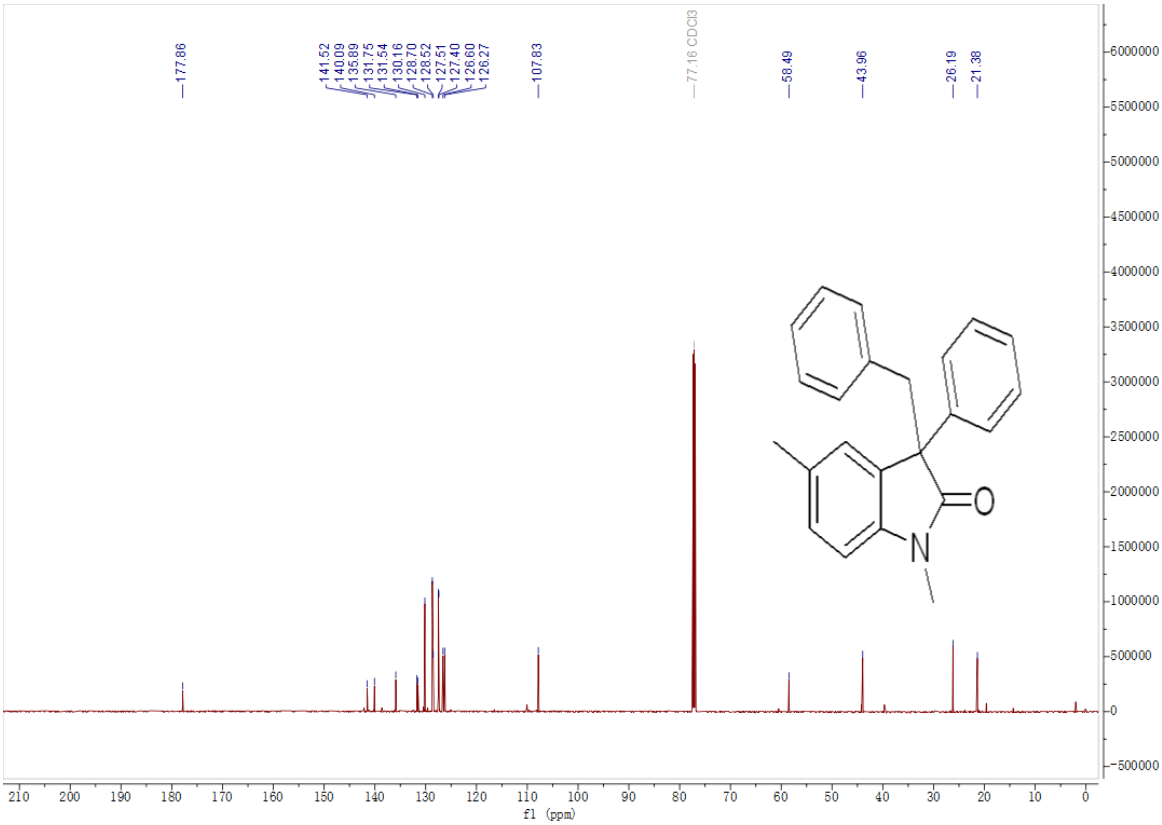
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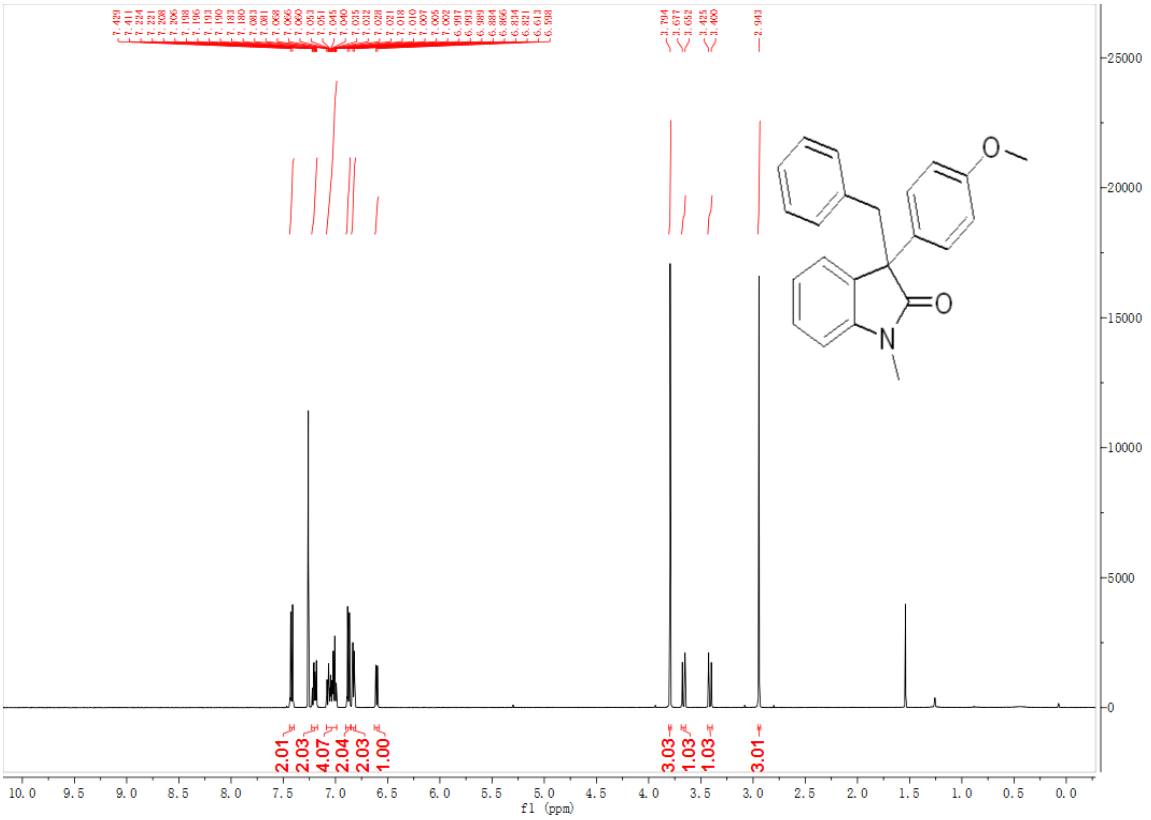
f1 (ppm)

3ea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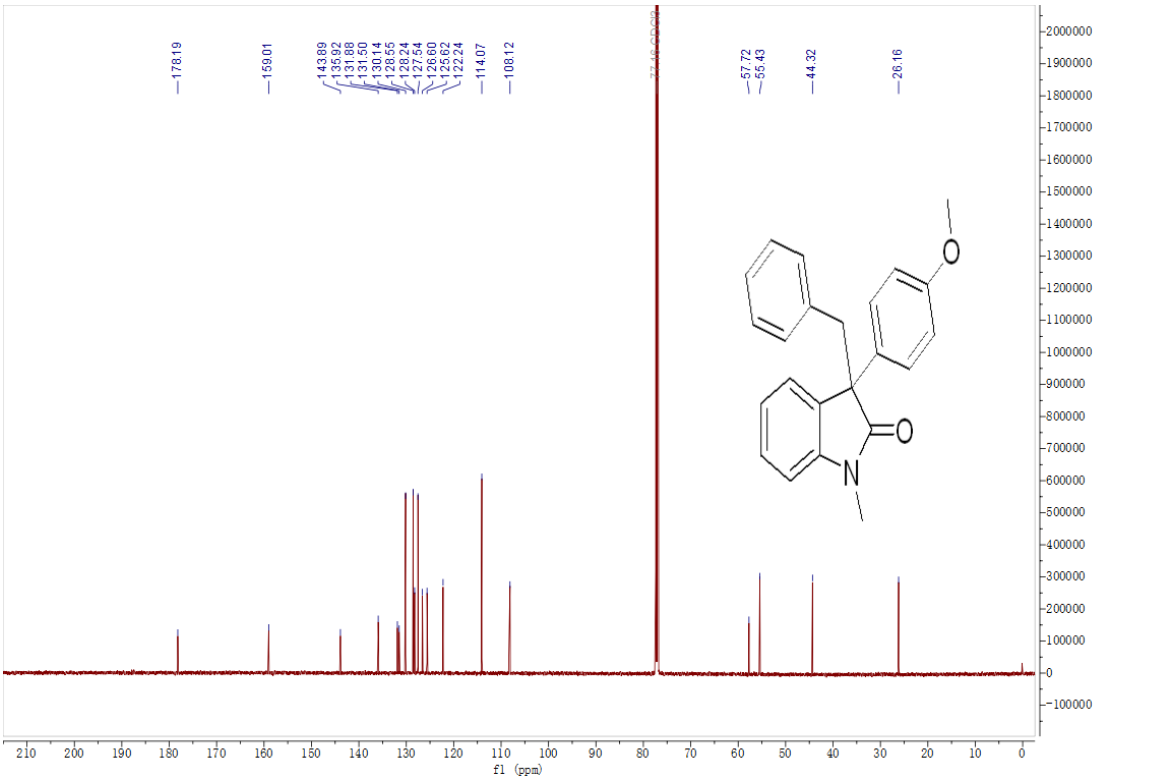
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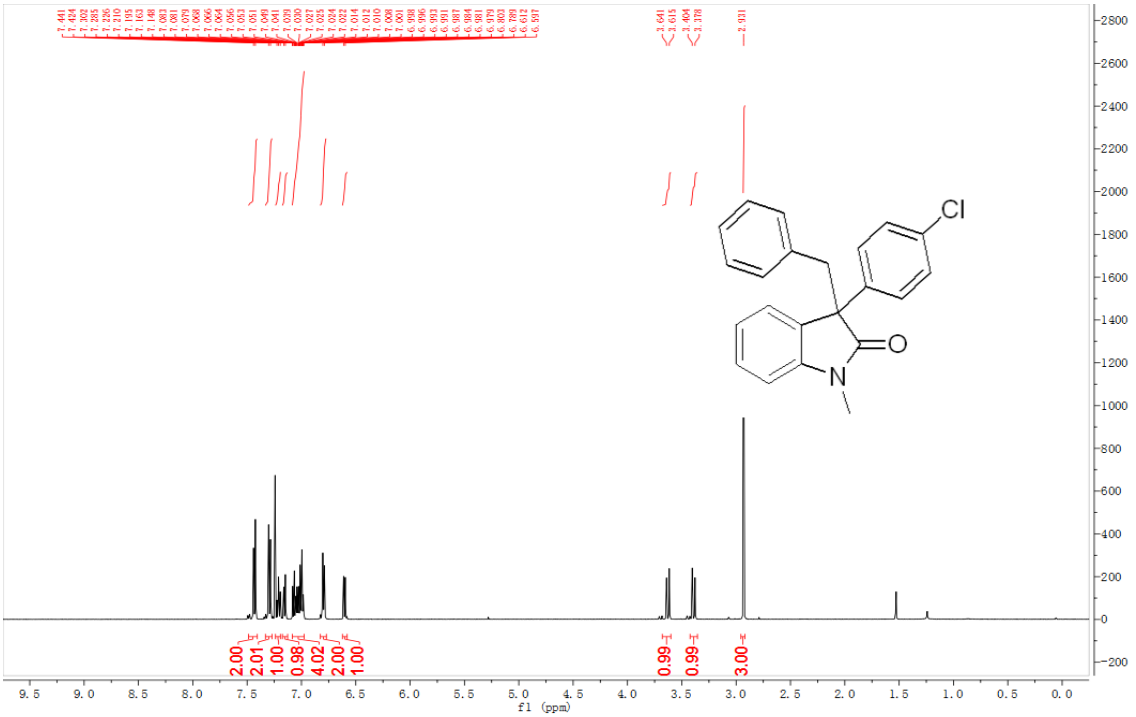
f1 (ppm)

3fa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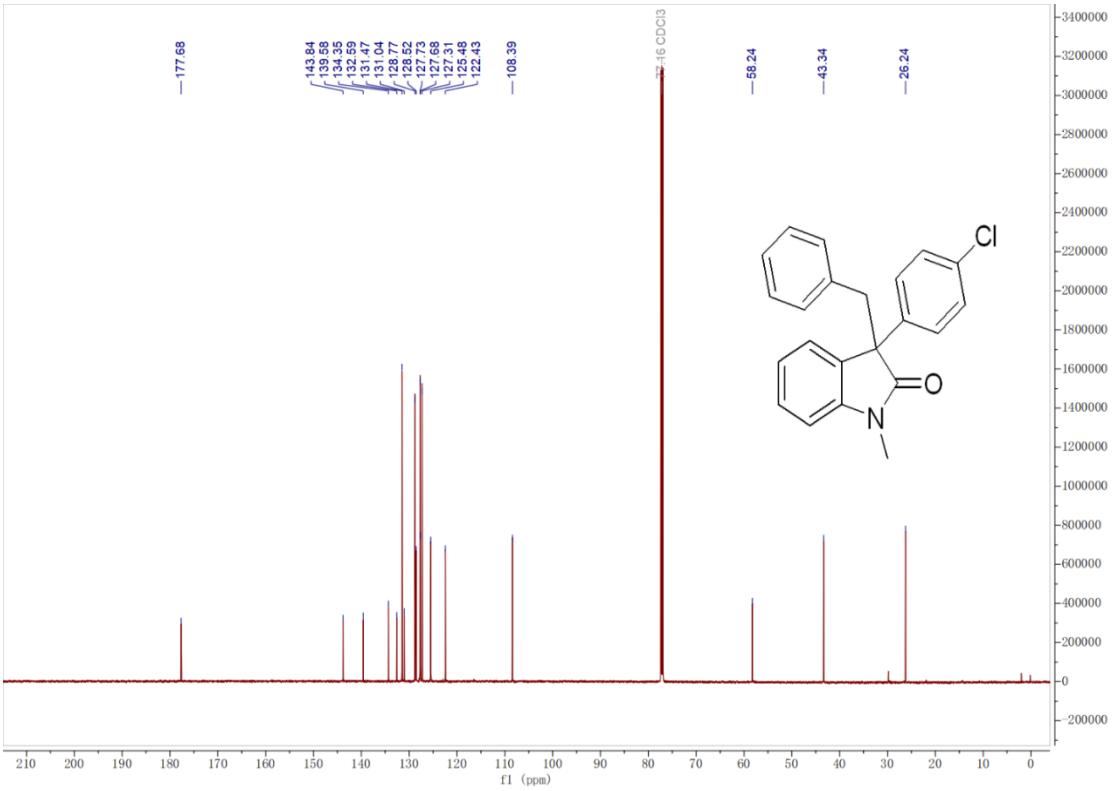
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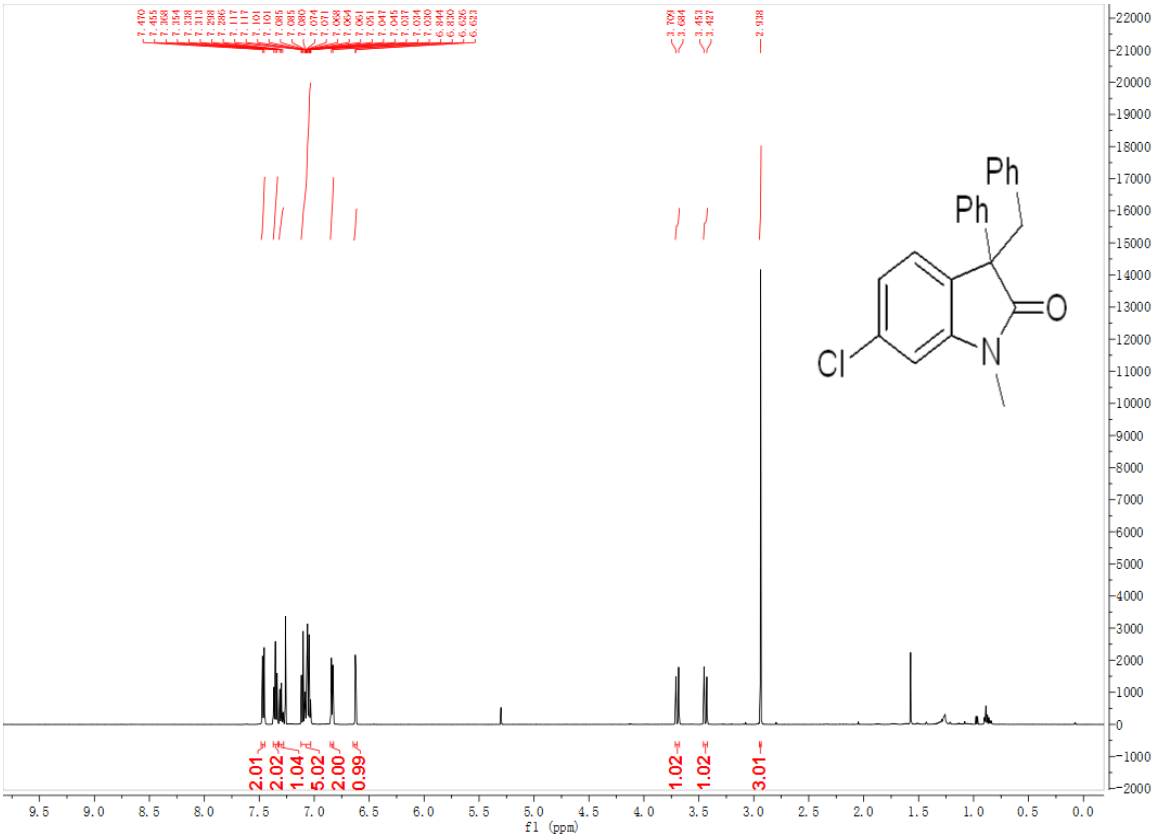
Cl
O
N
f1 (ppm)

3ga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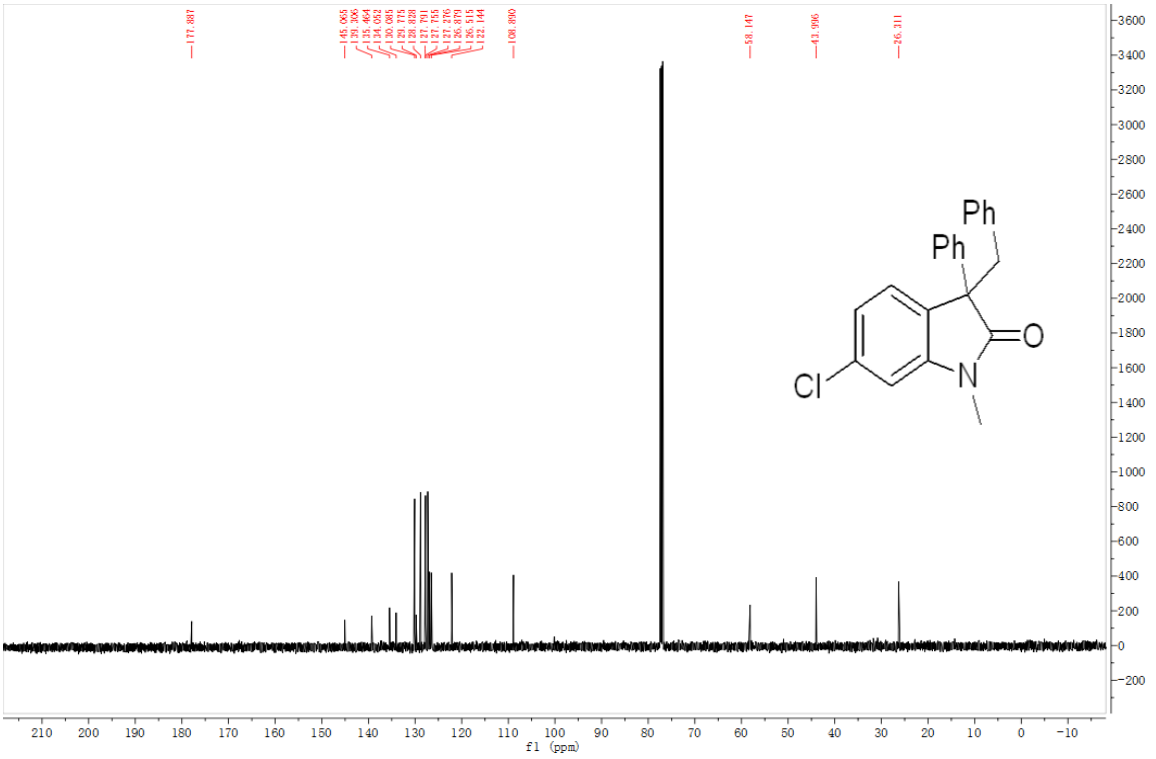
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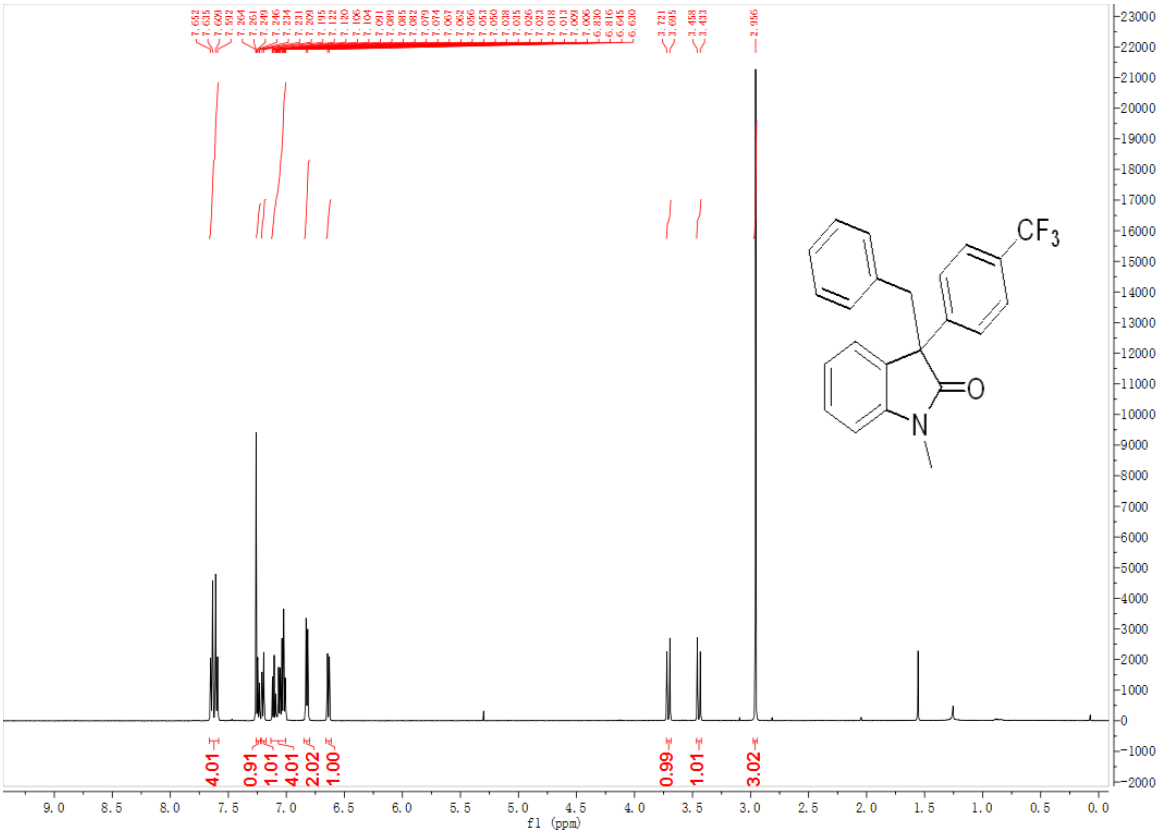

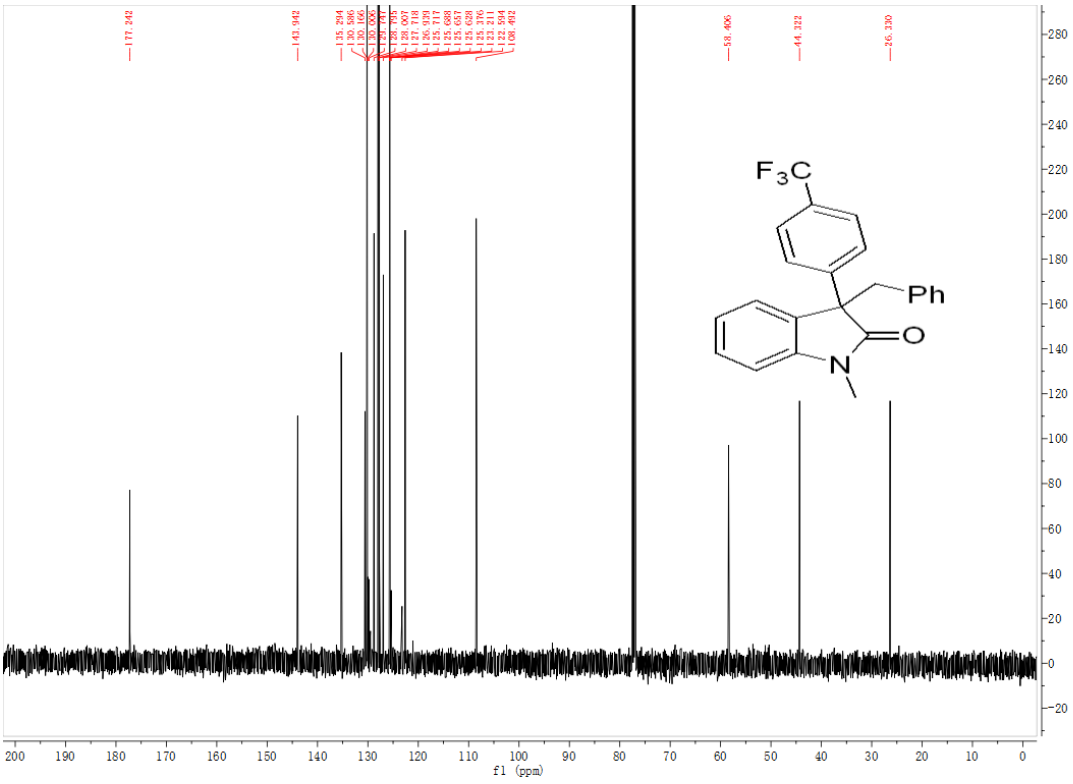

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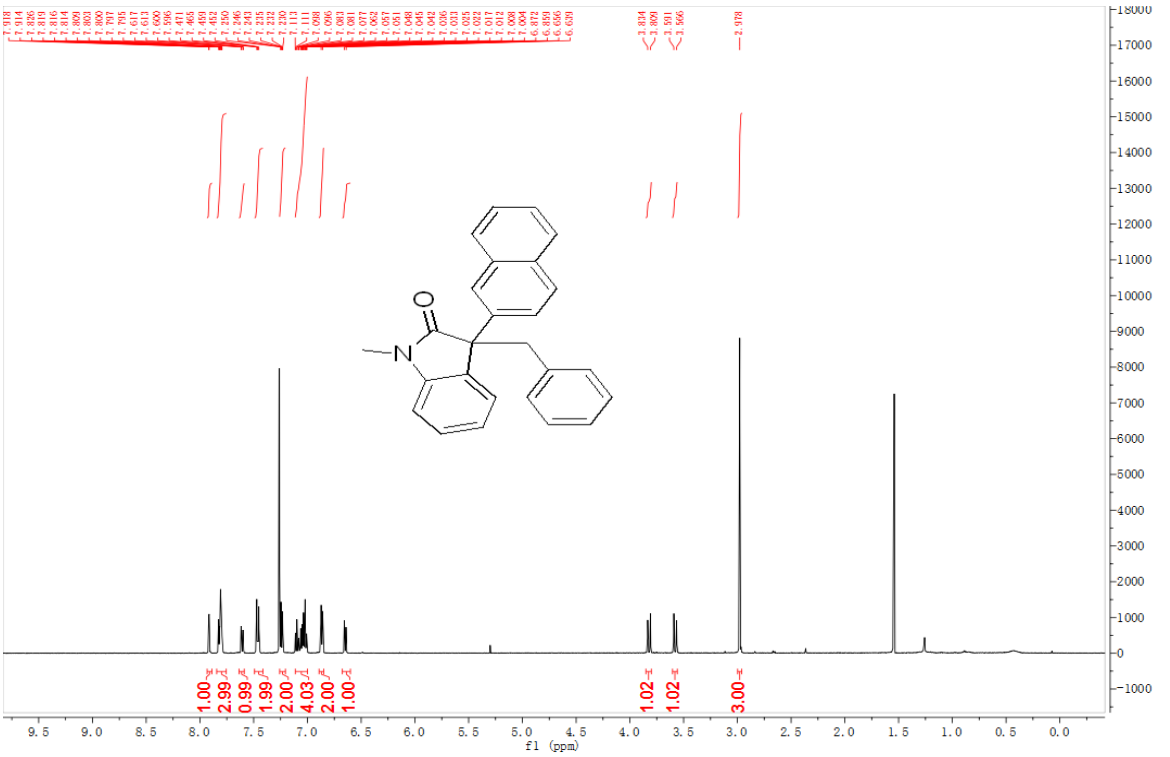
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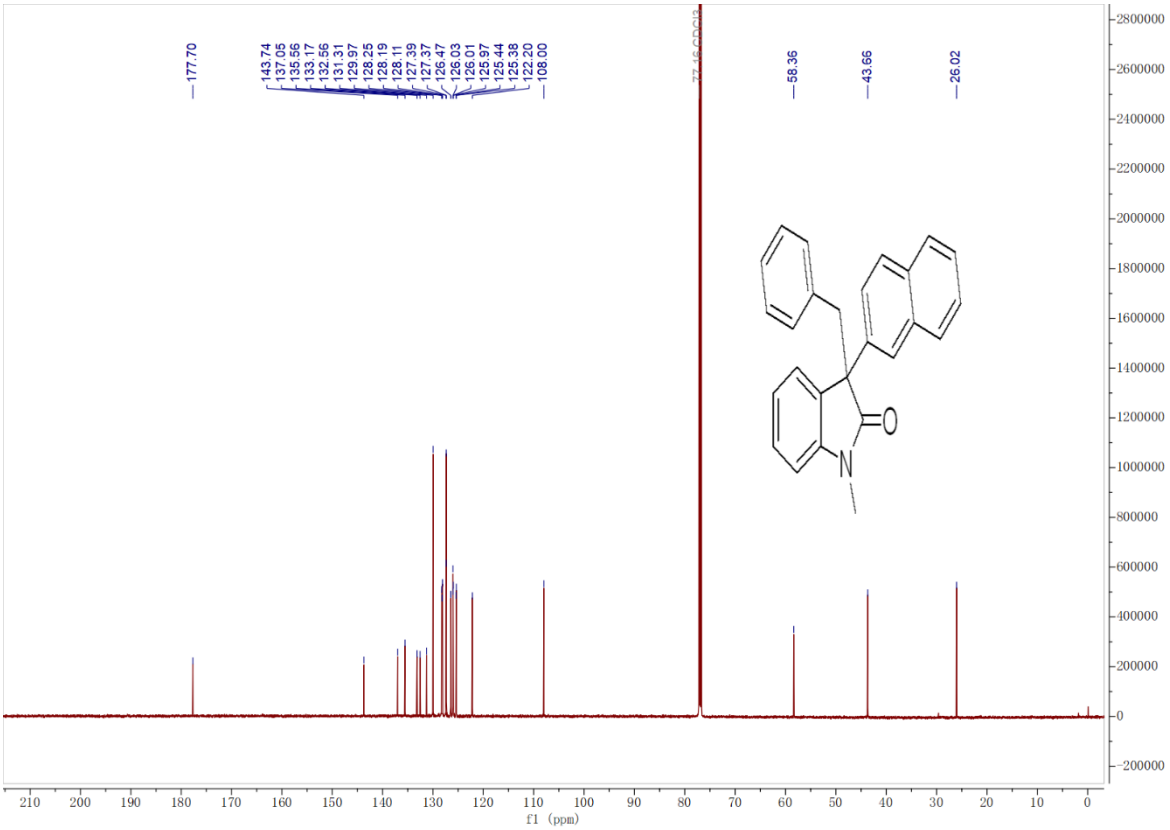
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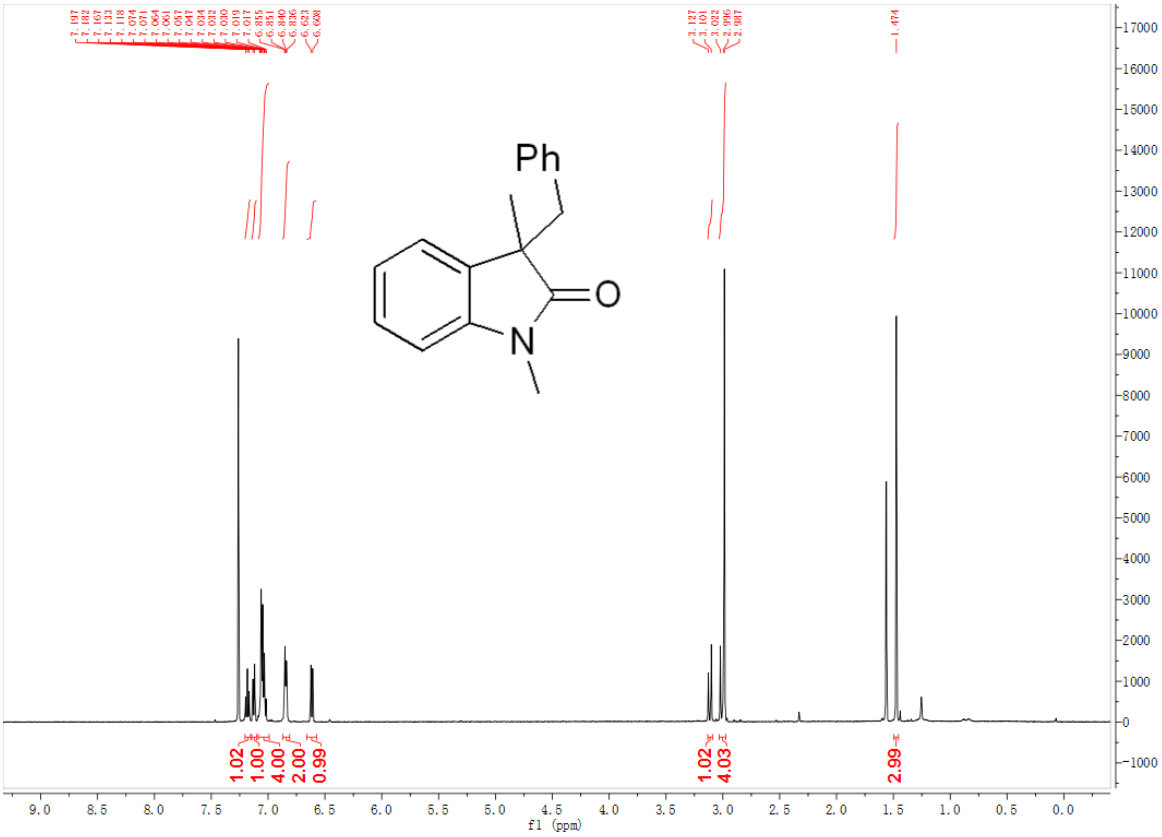
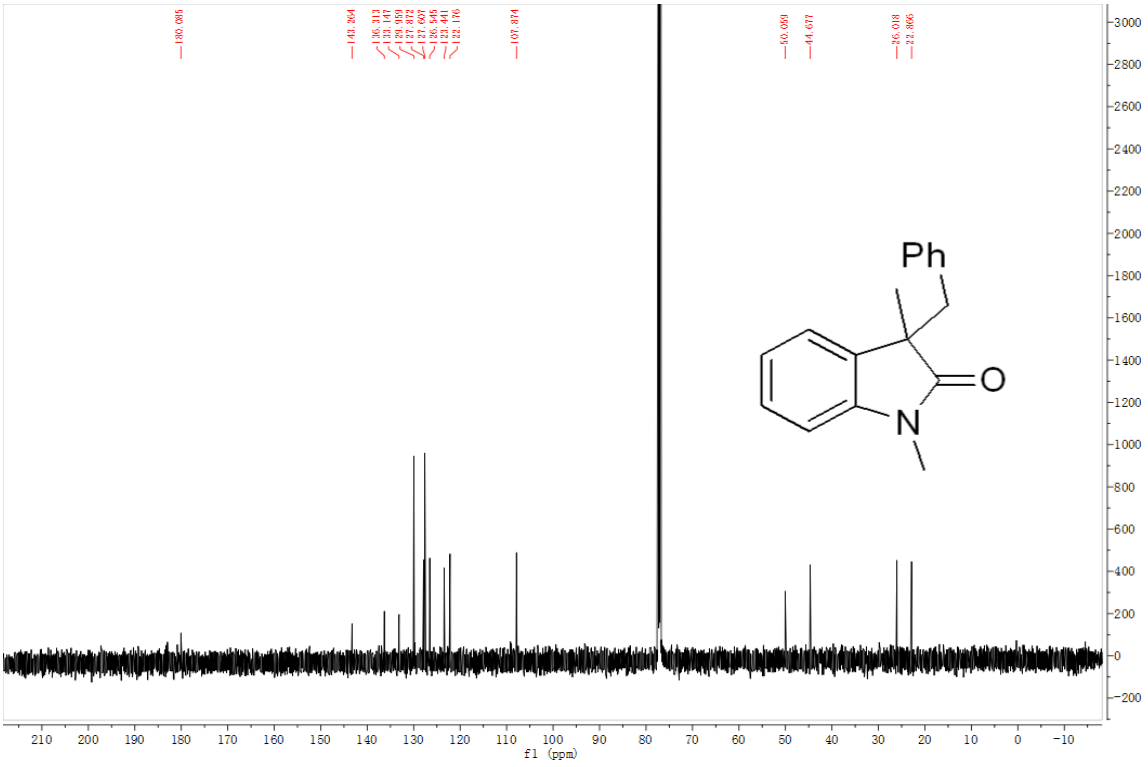
f1 (ppm)

3ja





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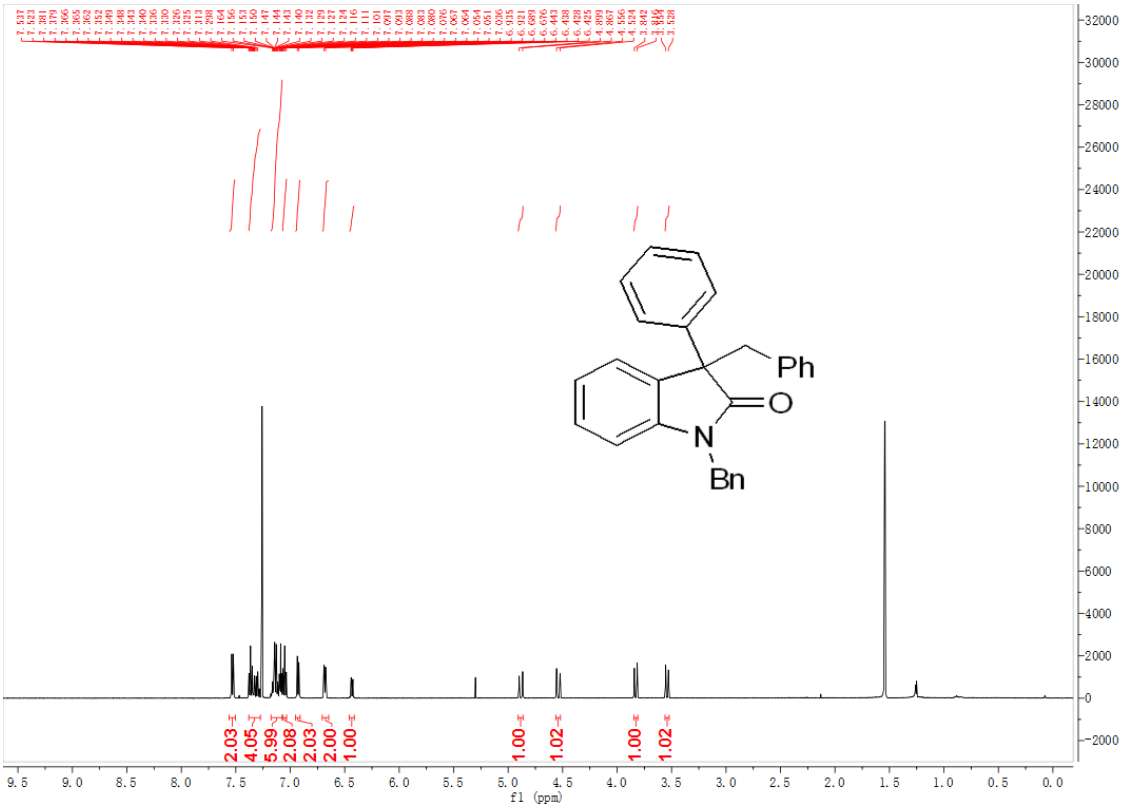
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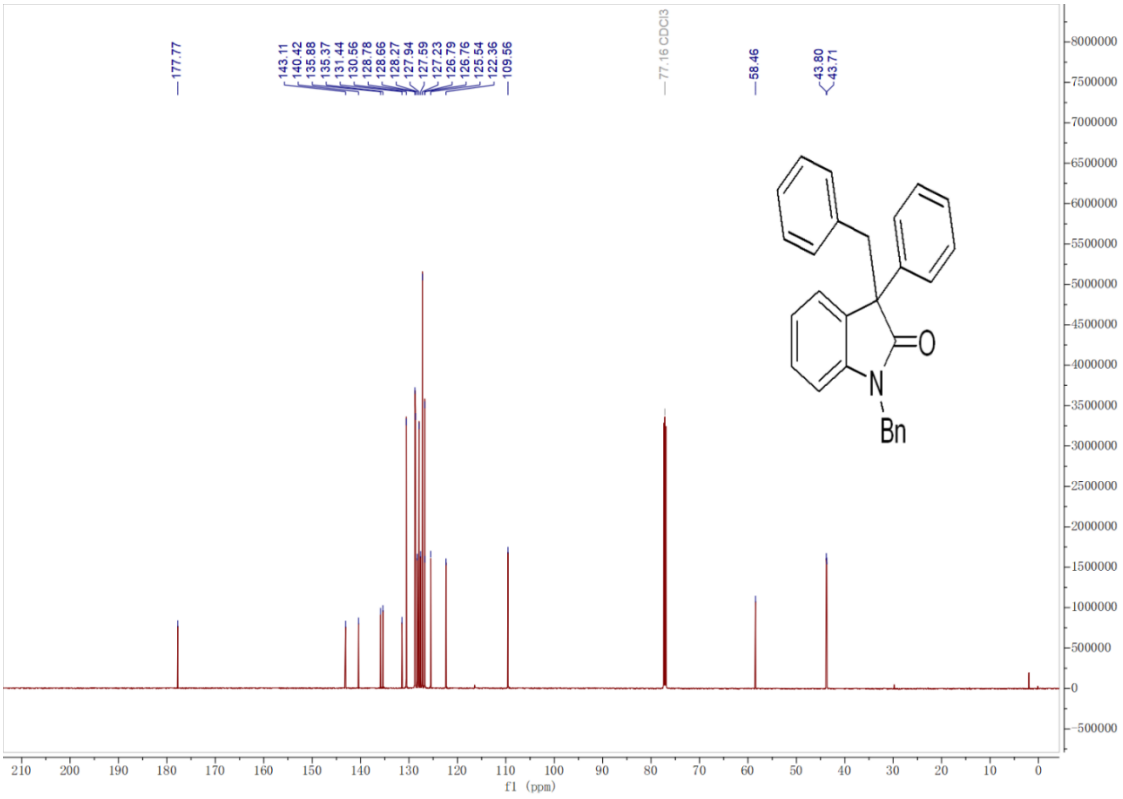
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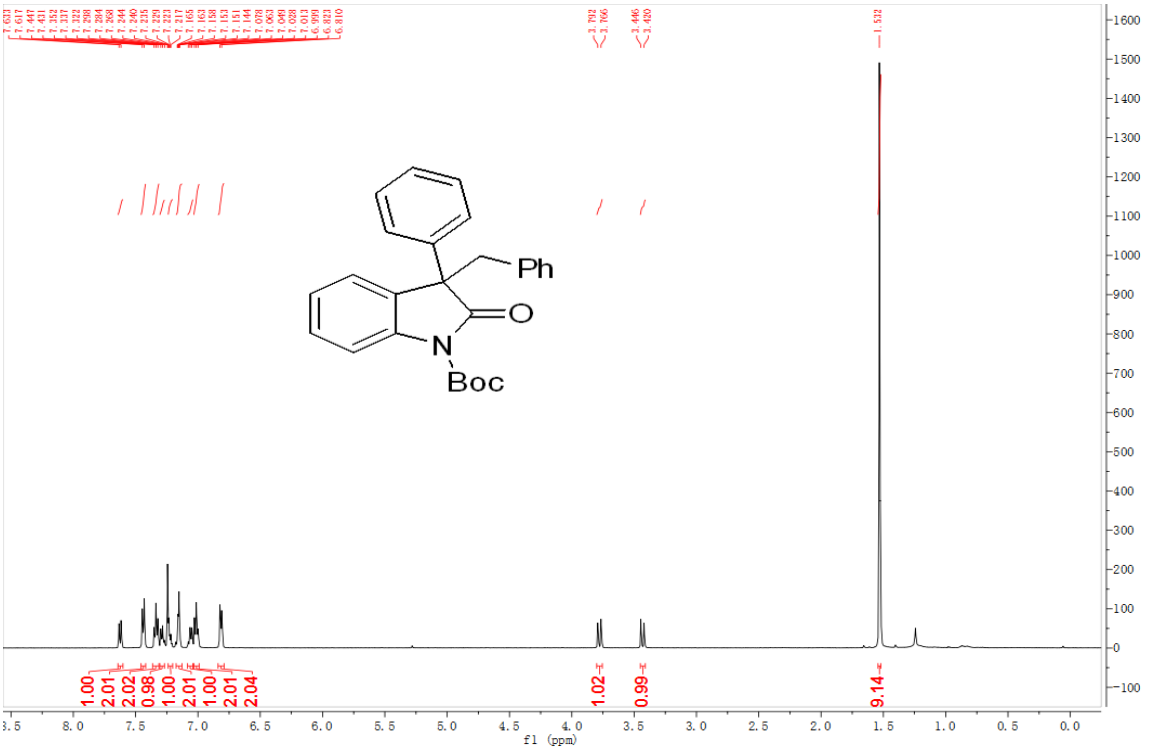
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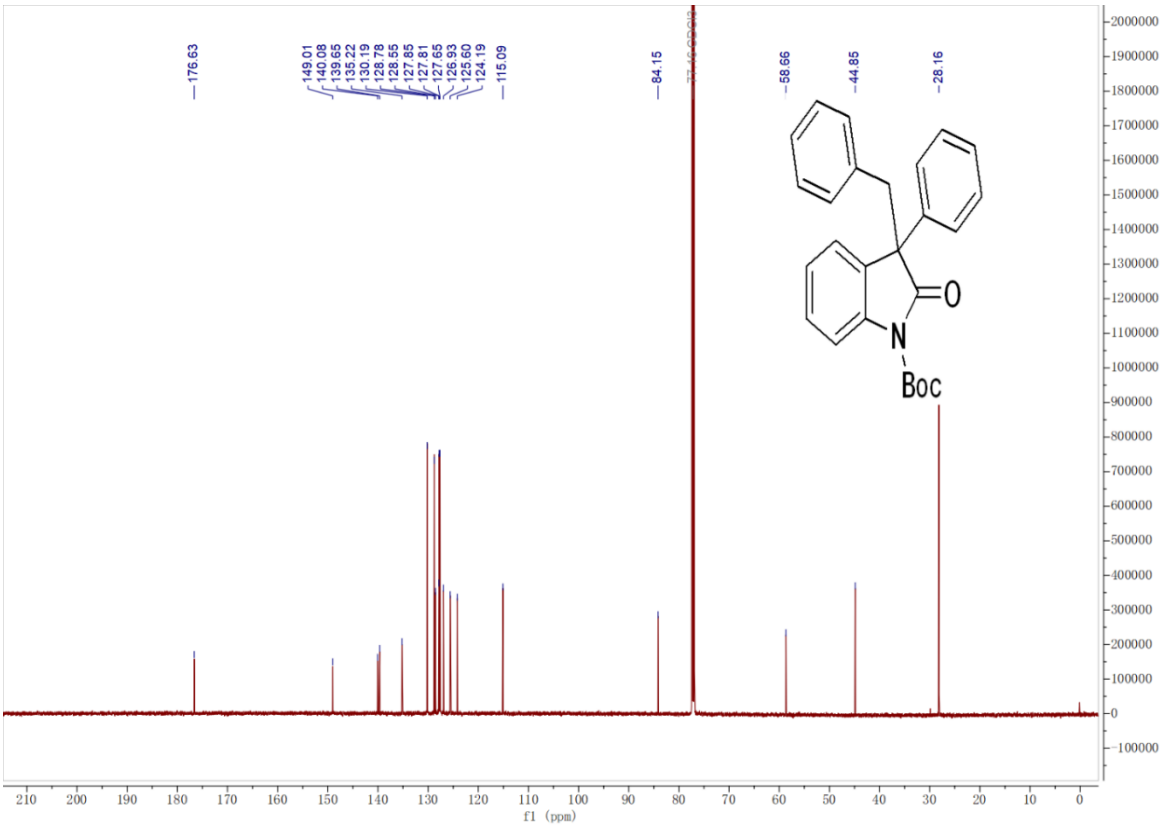
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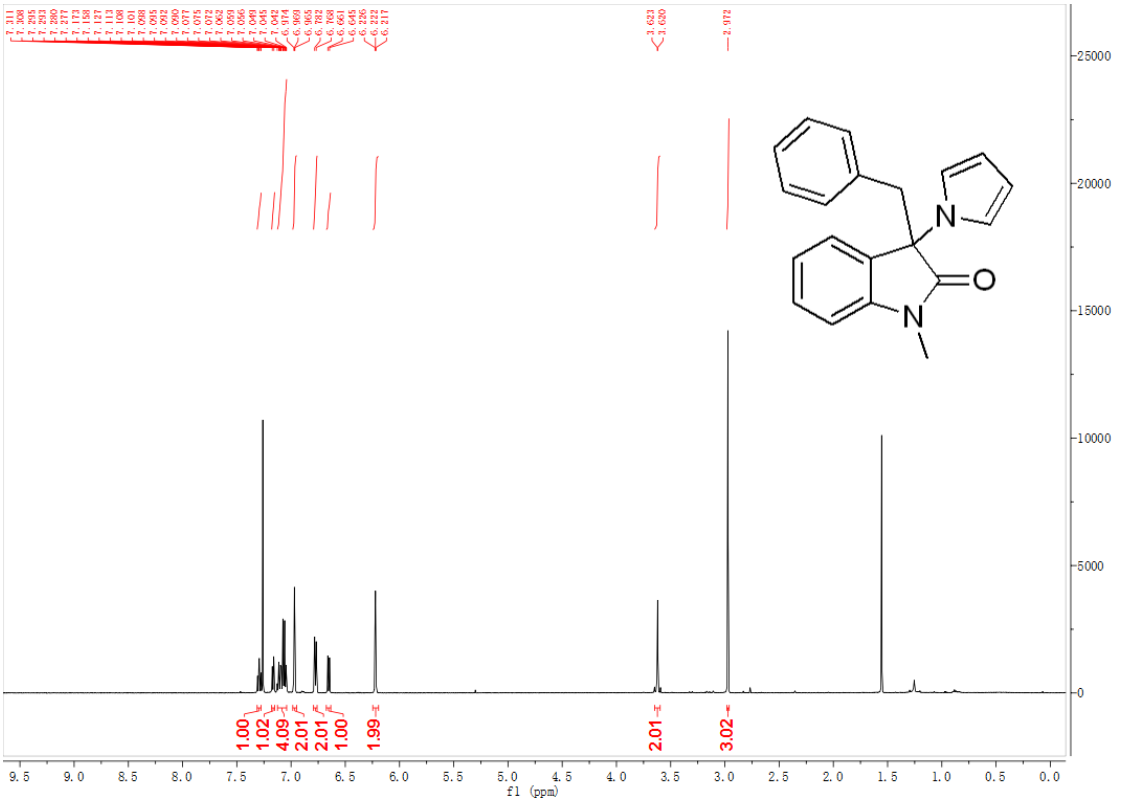
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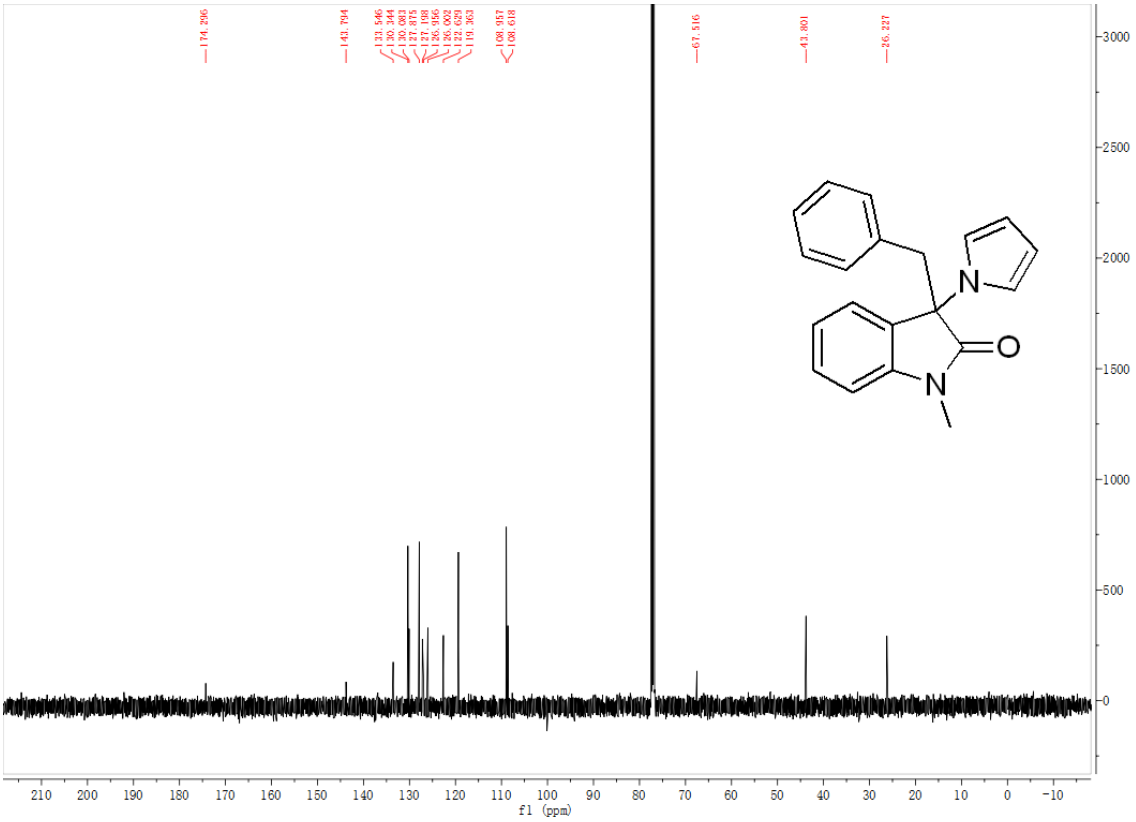
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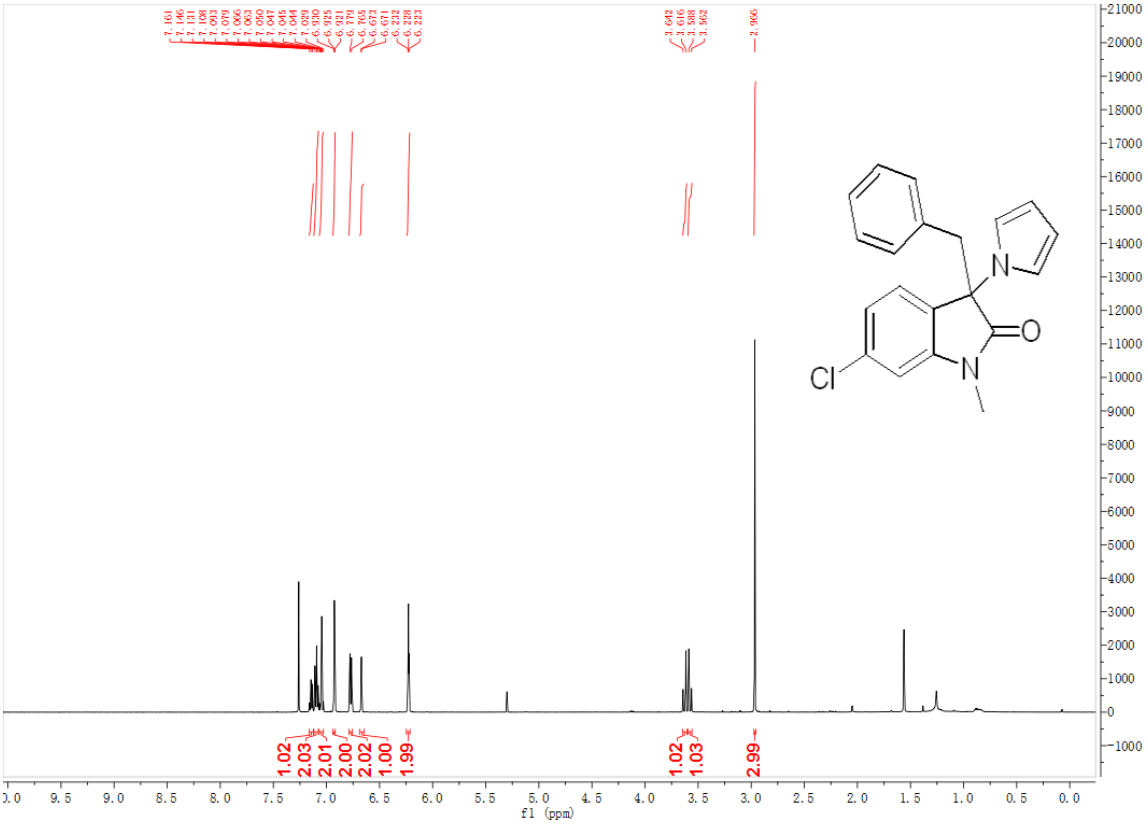
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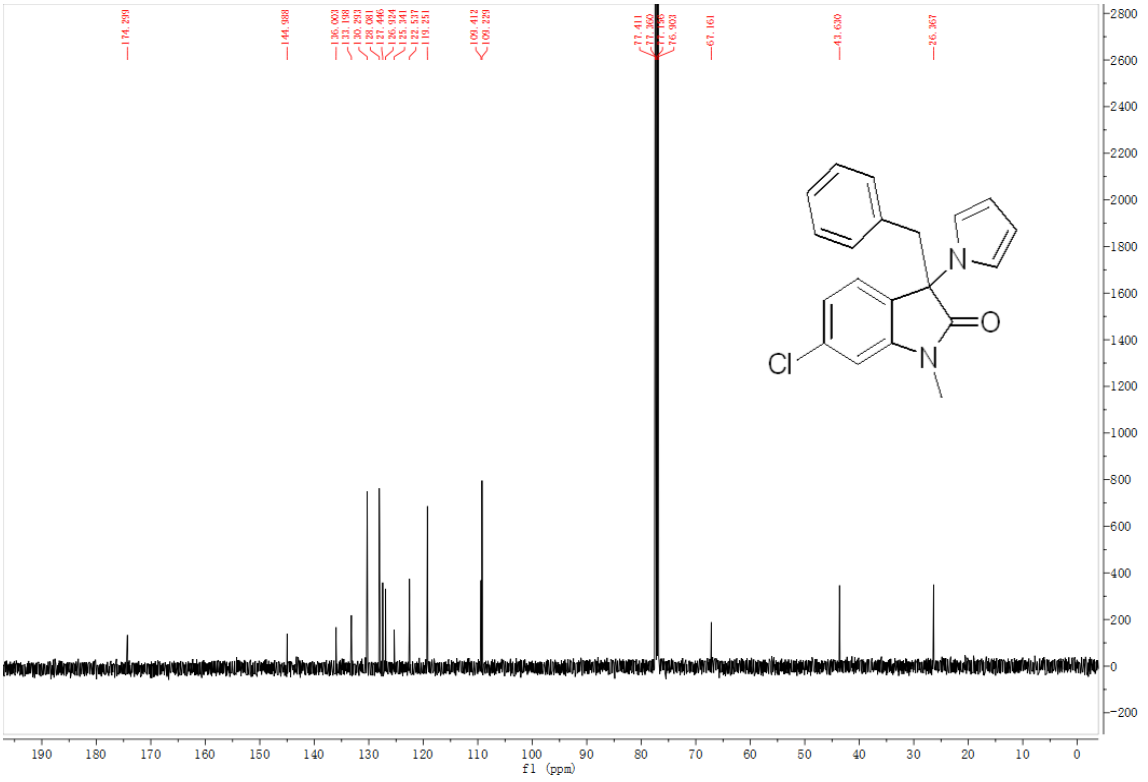
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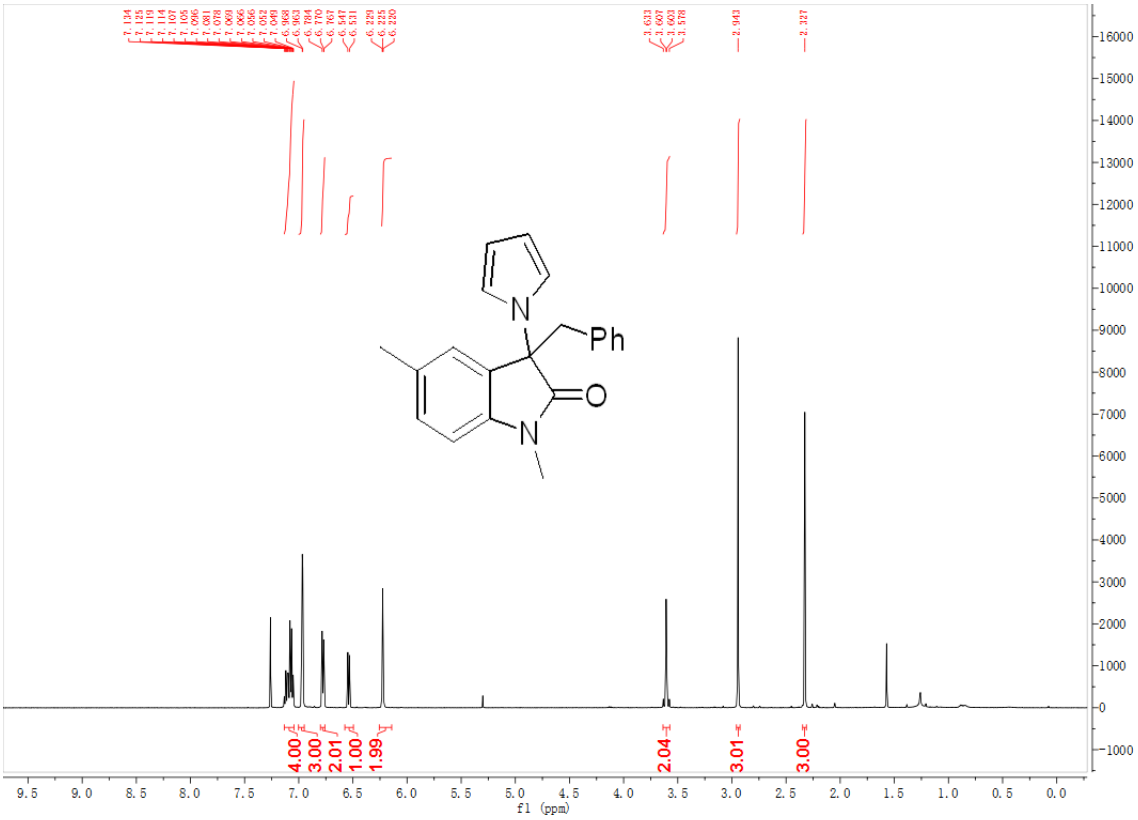
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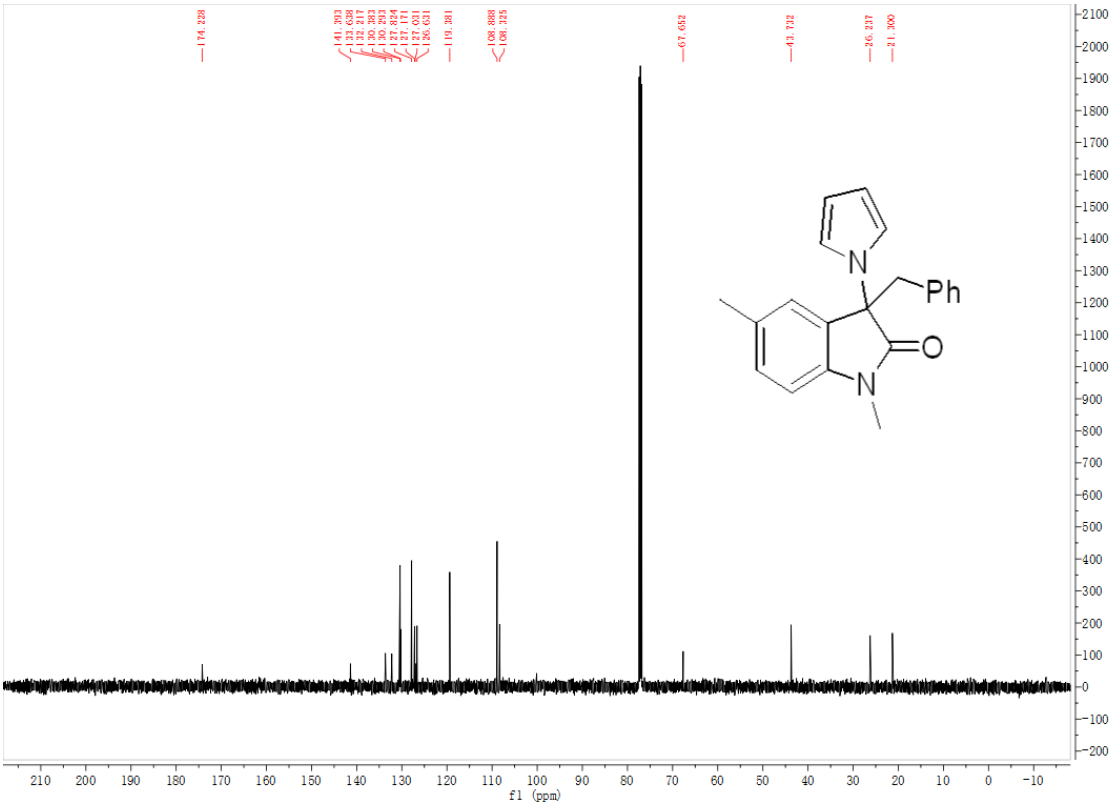
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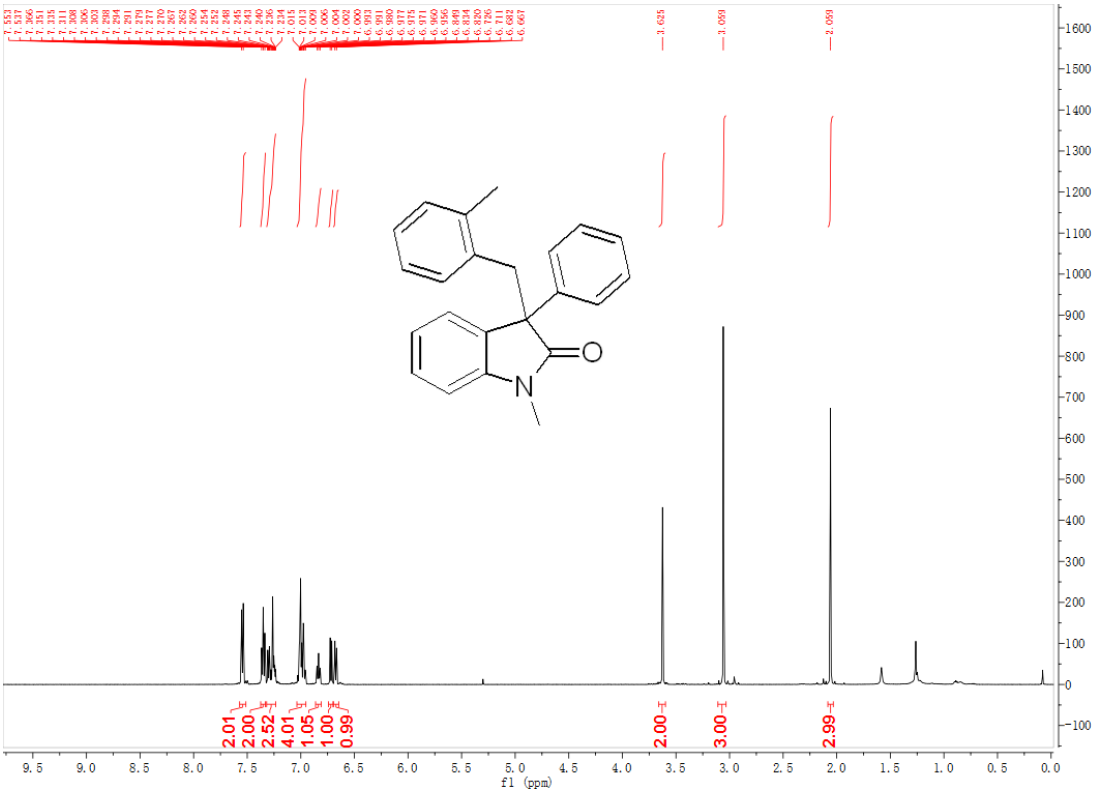
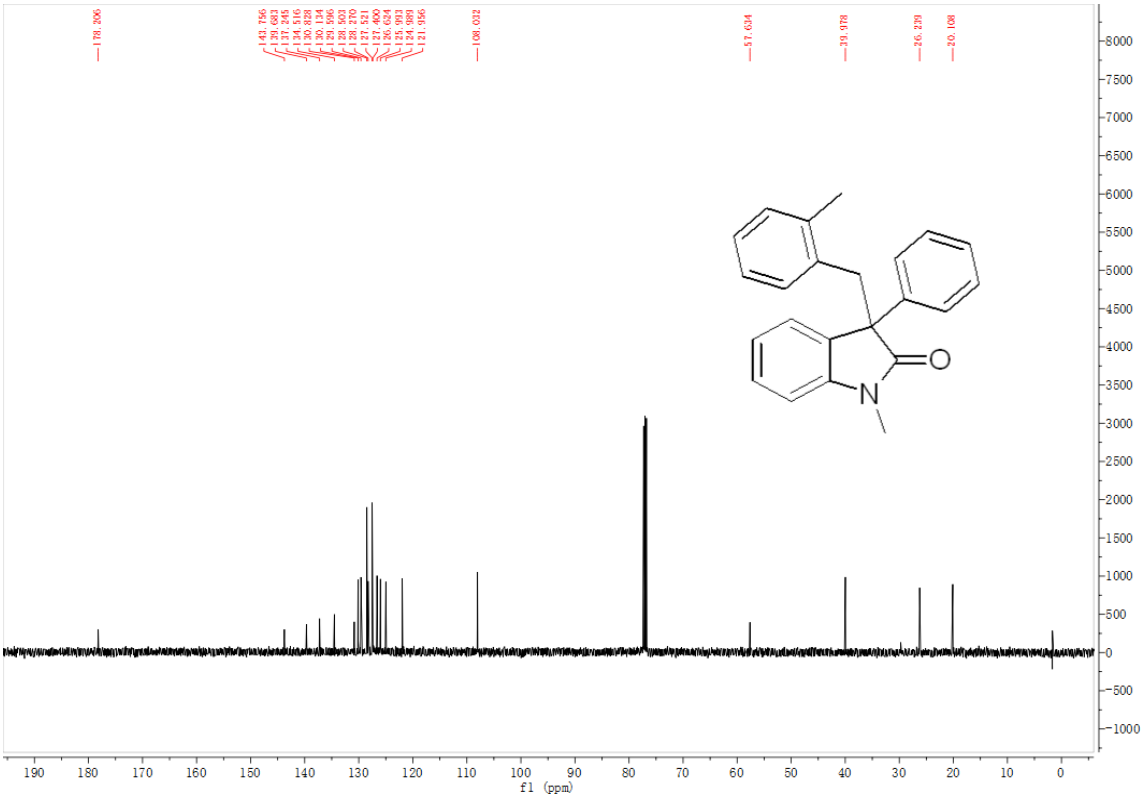
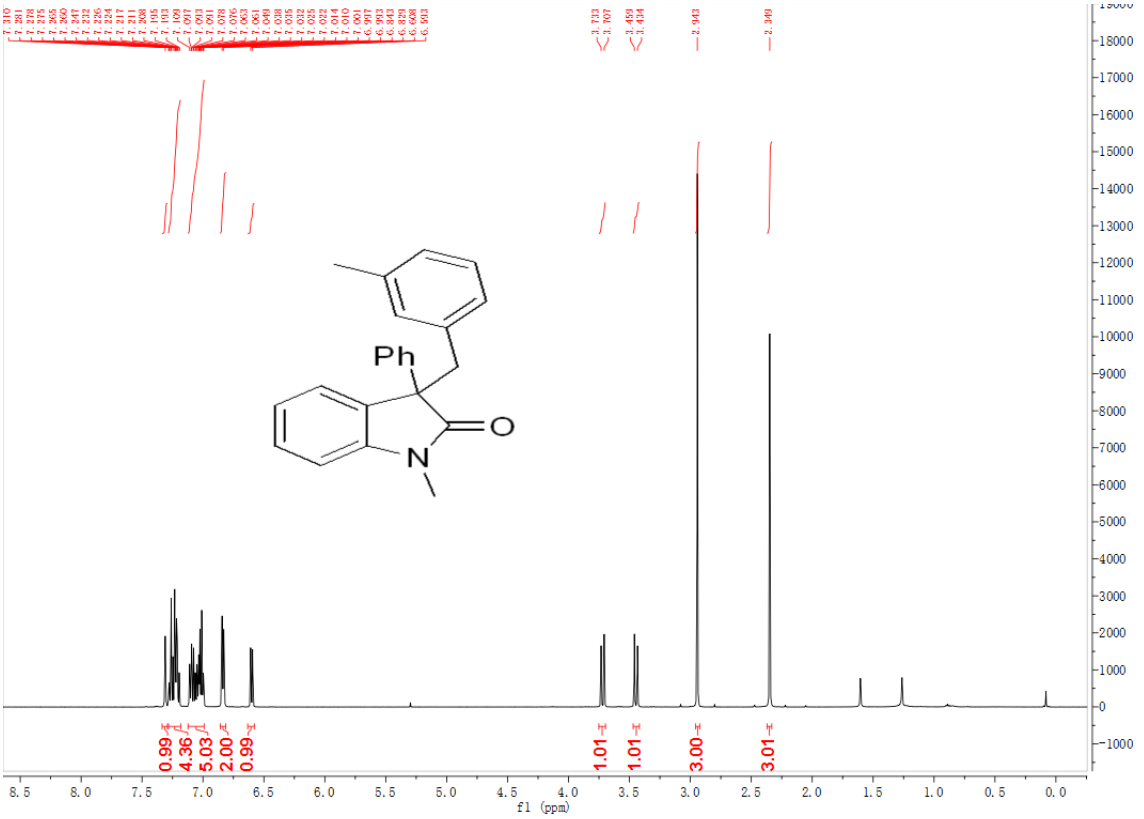
127.824
127.171
127.031
126.631
119.381
108.888
108.325
67.652
43.712
26.237
21.300
Ph
O
N
f1 (ppm)

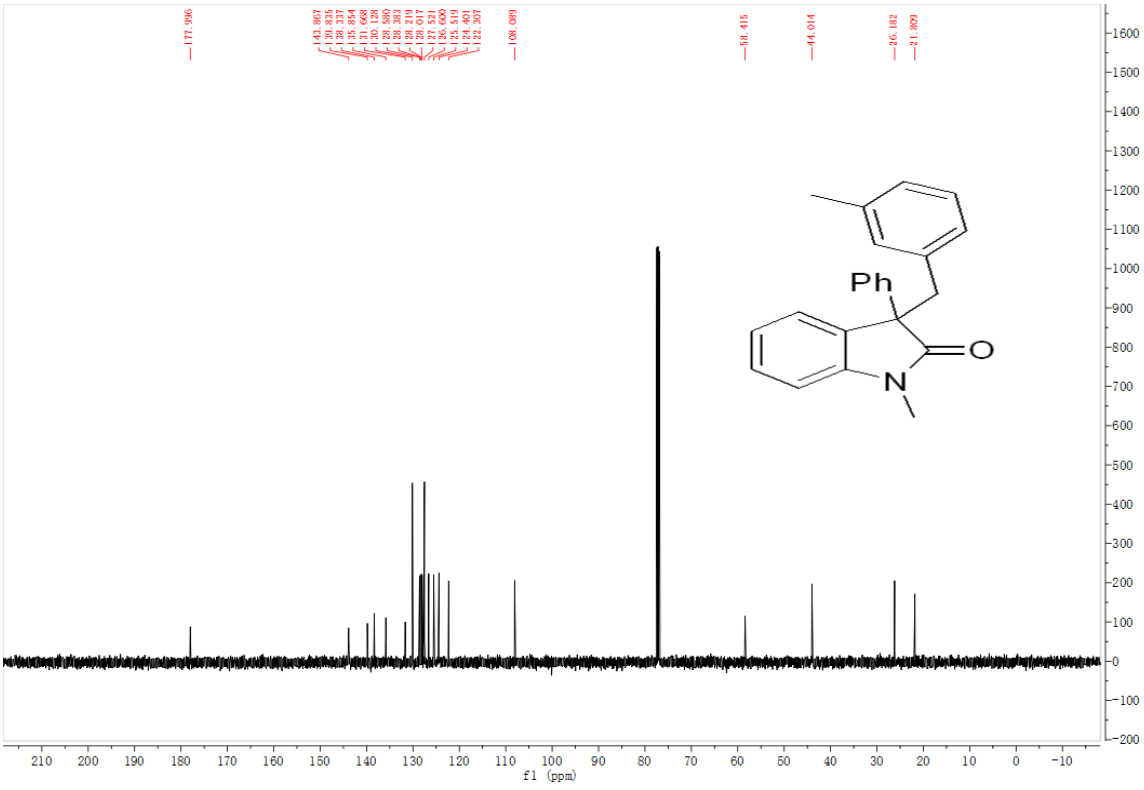
3ab


7.553
7.537
7.366
7.351
7.335
7.311
7.308
7.306
7.303
7.298
7.294
7.291
7.279
7.277
7.270
7.267
7.262
7.260
7.254
7.252
7.248
7.245
7.243
7.240
7.236
7.234
7.015
7.011
7.009
7.006
7.004
7.002
6.999
6.993
6.991
6.980
6.977
6.975
6.971
6.960
6.956
6.894
6.884
6.820
6.726
6.711
6.682
6.667
3.625
3.069
2.059
2.01
2.00
2.52
4.01
1.05
1.00
0.99
2.00
3.00
2.99
f1 (ppm)

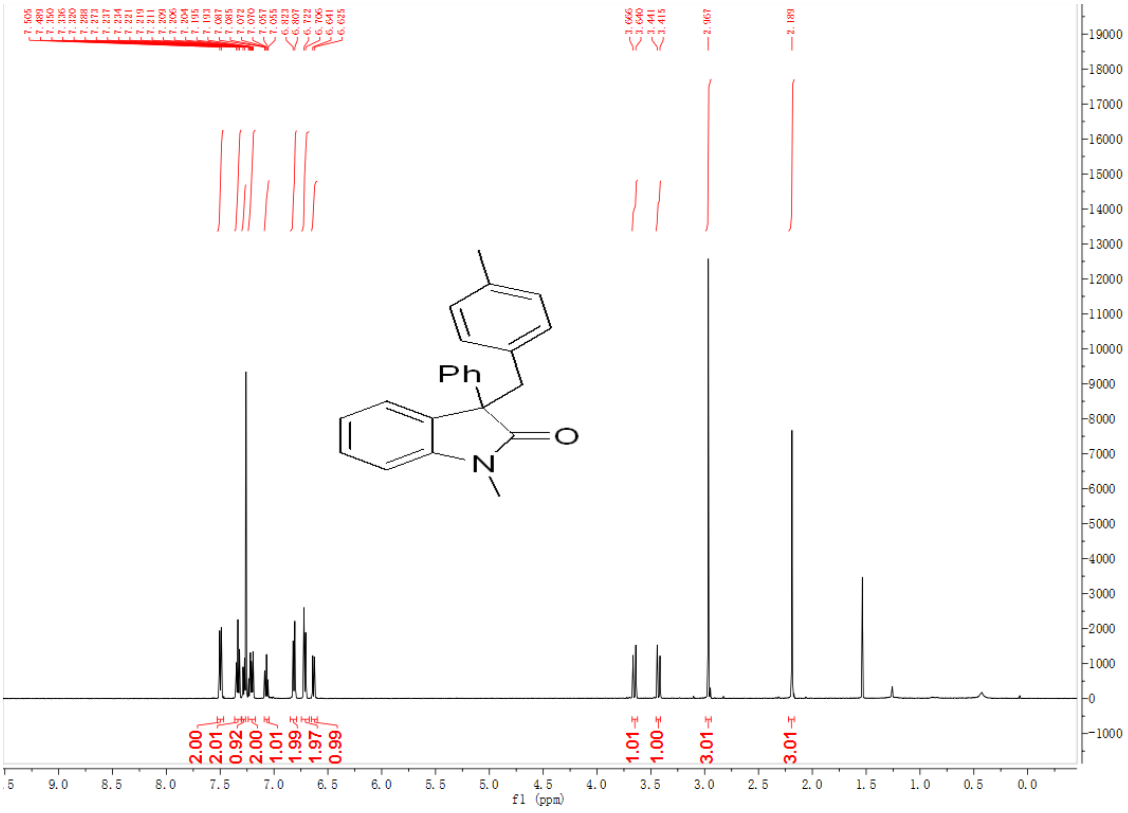

178.306
143.156
139.683
137.248
134.516
130.828
130.134
129.956
128.953
128.270
127.521
127.400
126.624
126.093
124.989
121.956
108.032
57.634
39.978
26.239
20.108
f1 (ppm)

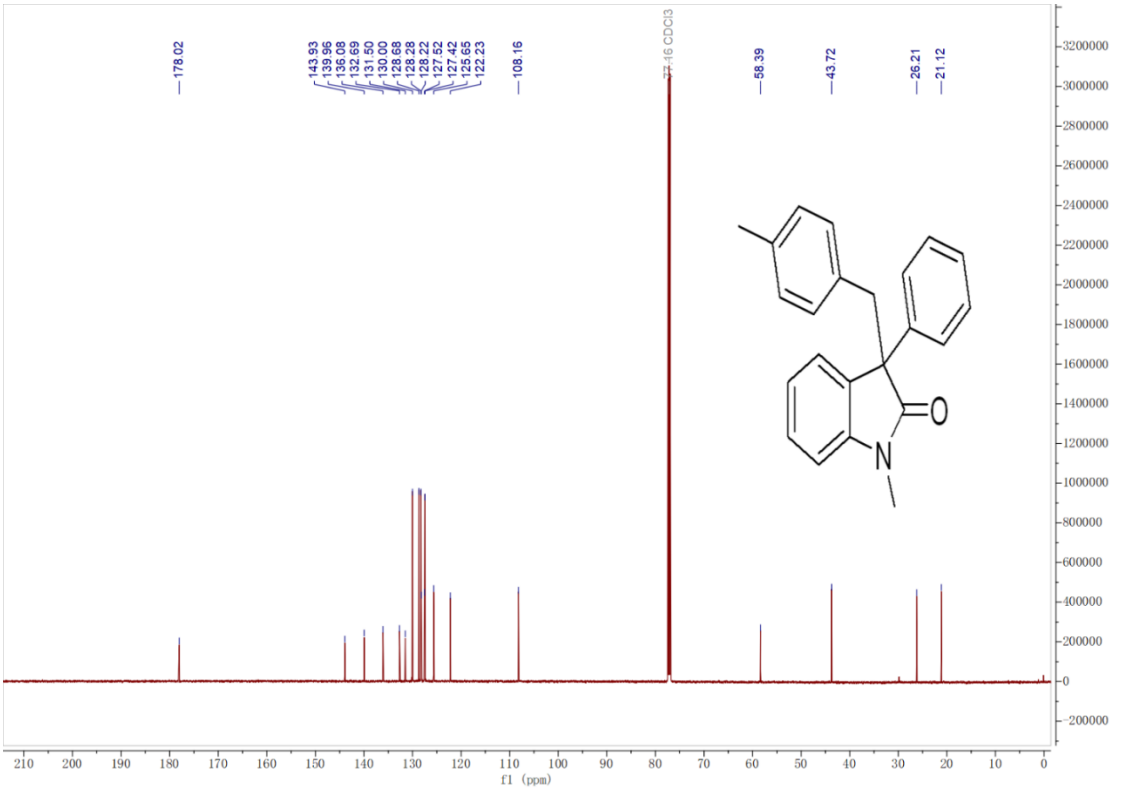
3ac



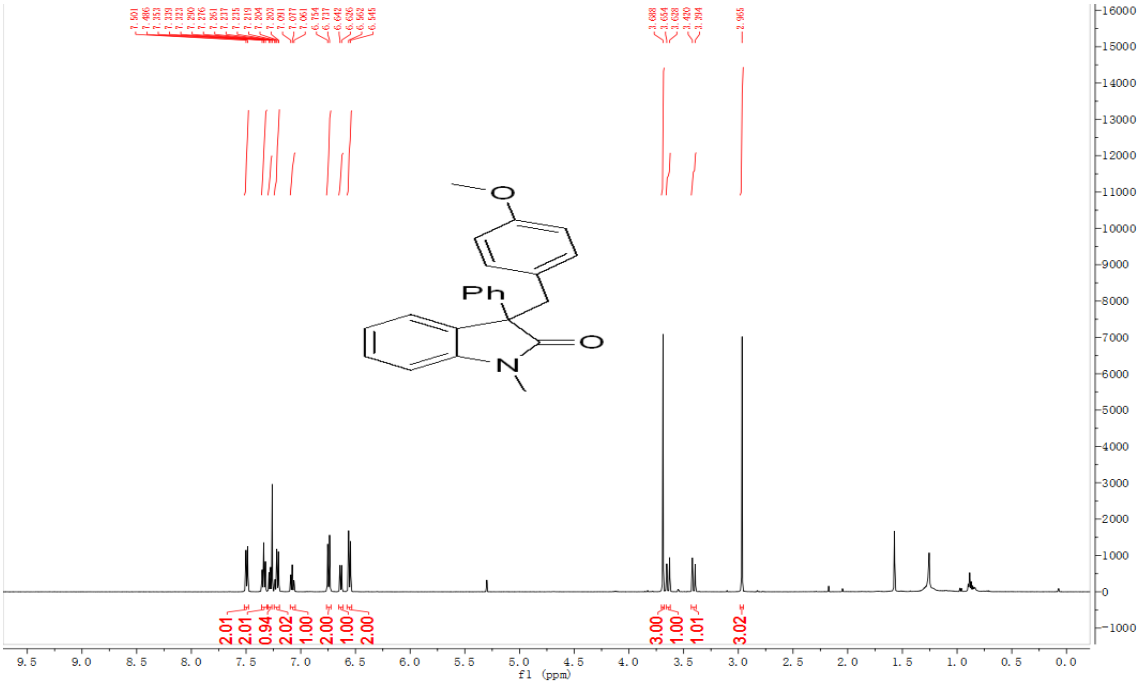


3ad


Ph
O
N
fl (ppm)


178.02
143.93
139.96
136.08
132.69
131.50
130.00
128.68
128.28
128.22
127.52
127.42
125.65
122.23
108.16
77.16 CDCl3
58.39
43.72
26.21
21.12
O
N
fl (ppm)

3ae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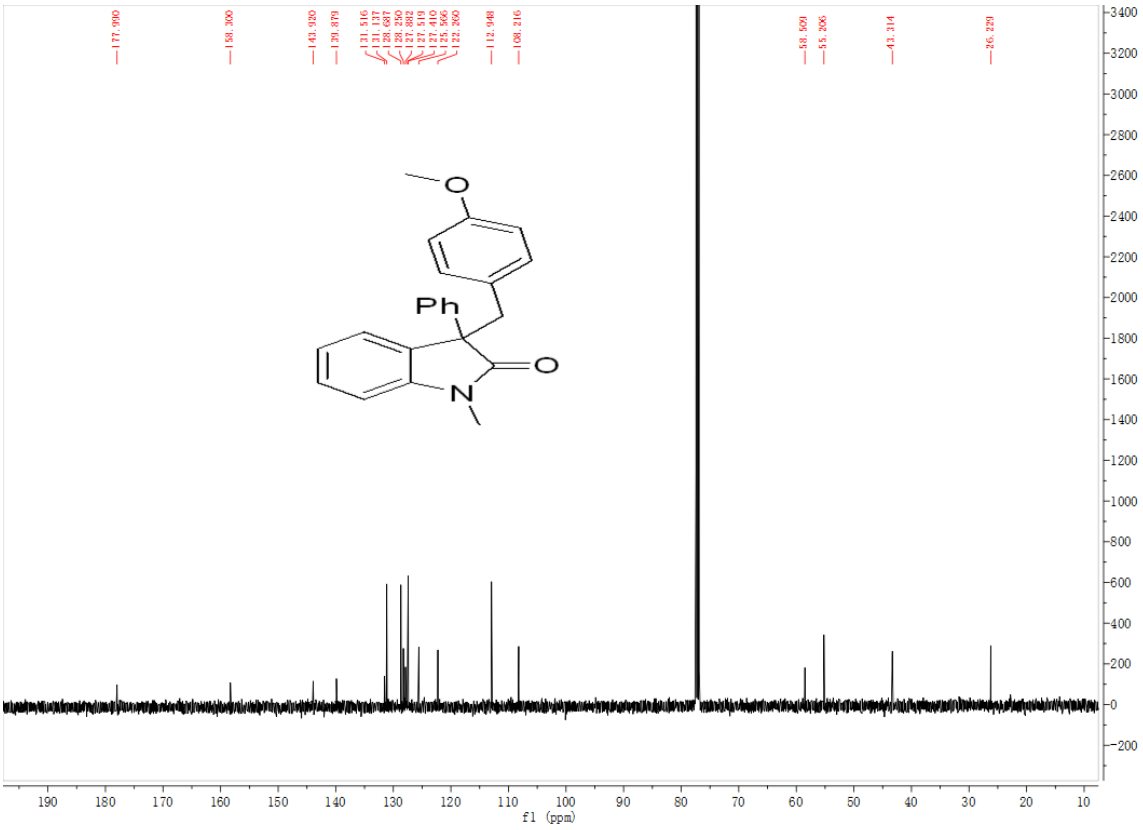
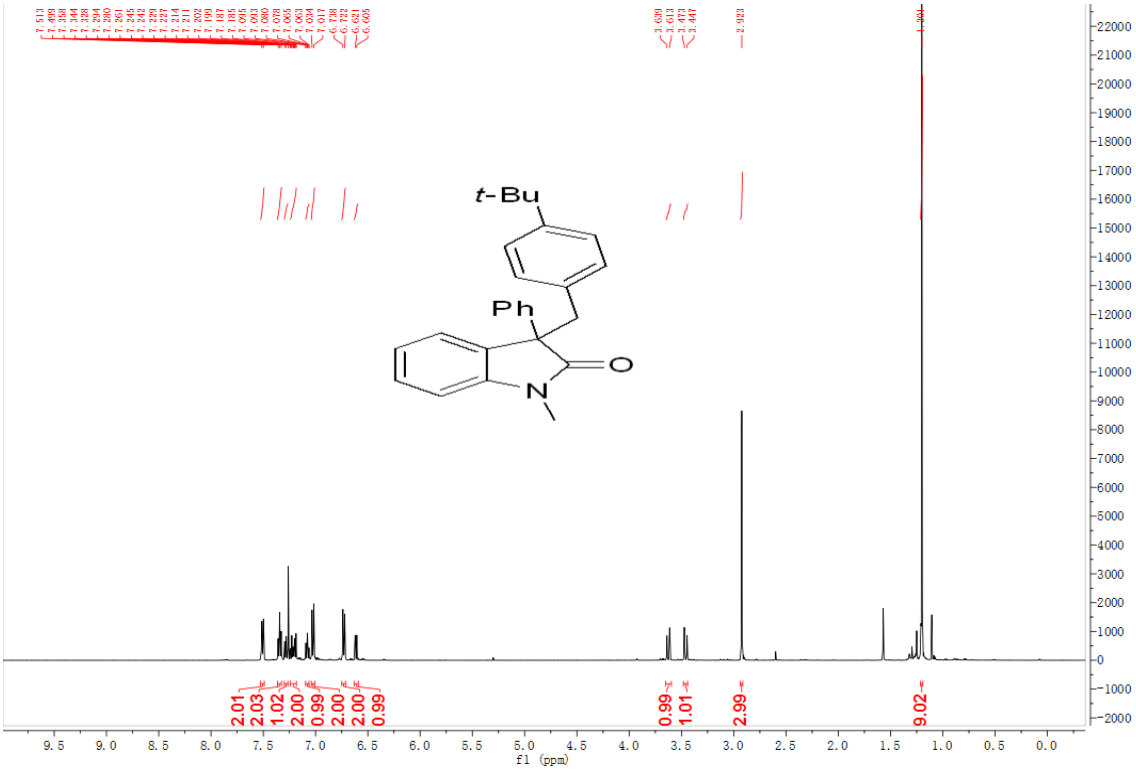
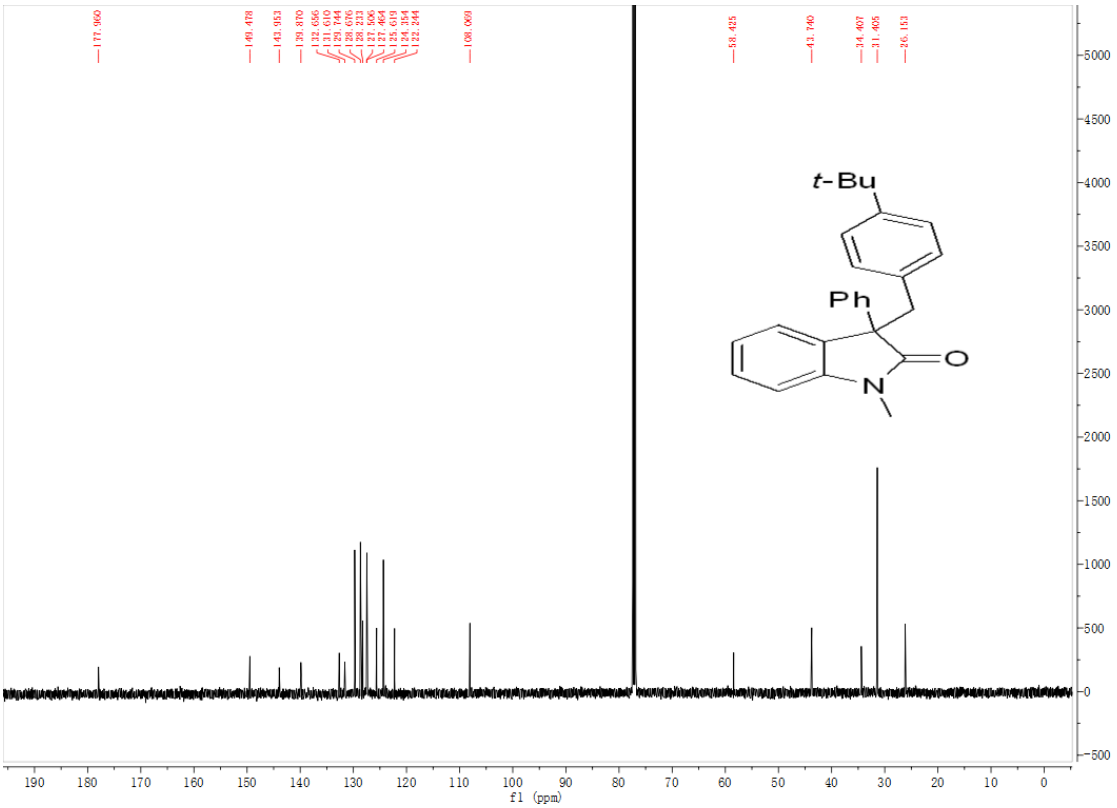
7.486
7.355
7.339
7.323
7.290
7.270
7.265
7.237
7.215
7.219
7.304
7.303
7.091
7.077
7.061
6.754
6.717
6.642
6.626
6.562
6.546
3.698
3.654
3.638
3.420
3.394
2.965
O
Ph
O
N
2.01
2.01
0.94
2.02
1.00
2.00
1.00
2.00
3.00
1.00
1.01
3.02
f1 (ppm)

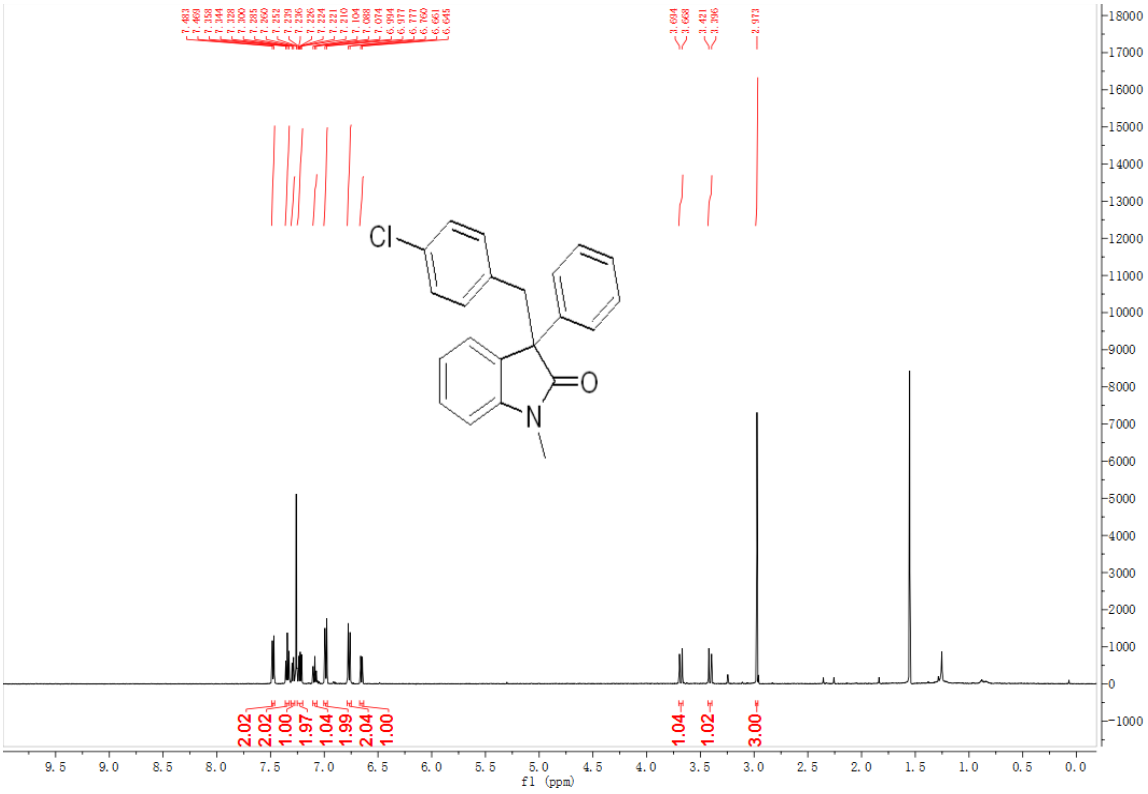

177.999
158.300
143.920
139.879
131.516
131.137
128.697
128.350
127.882
127.519
127.410
125.966
122.260
112.948
108.216
58.929
55.266
43.314
26.229
O
Ph
O
N
f1 (ppm)

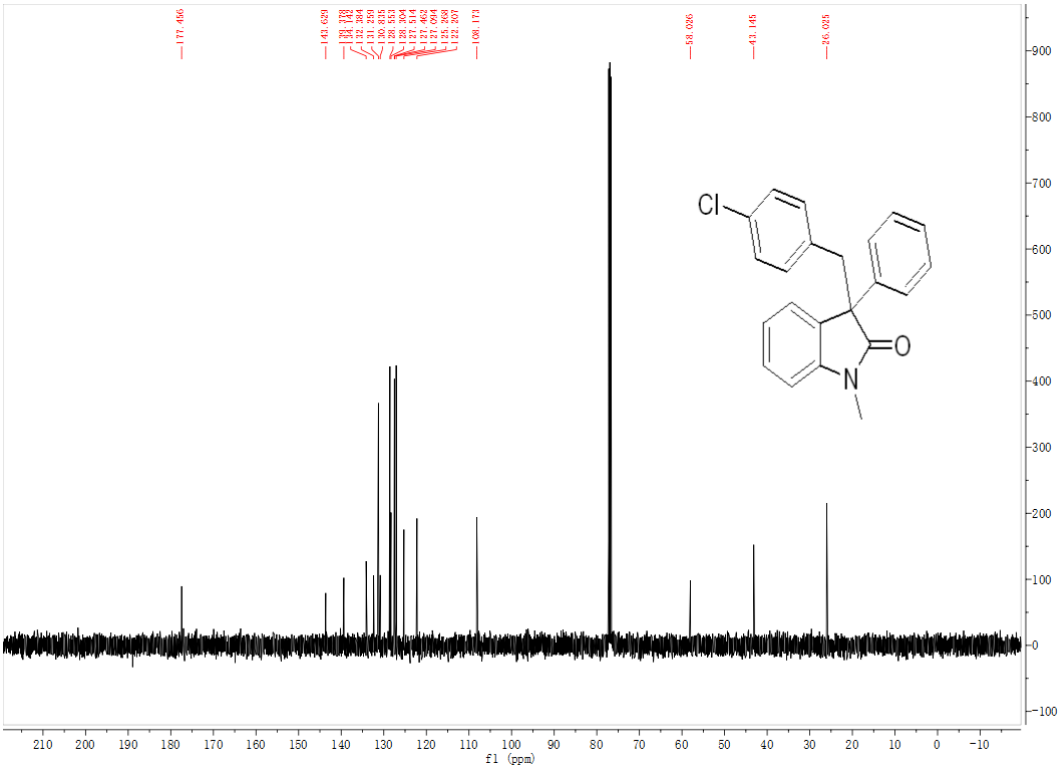
3af



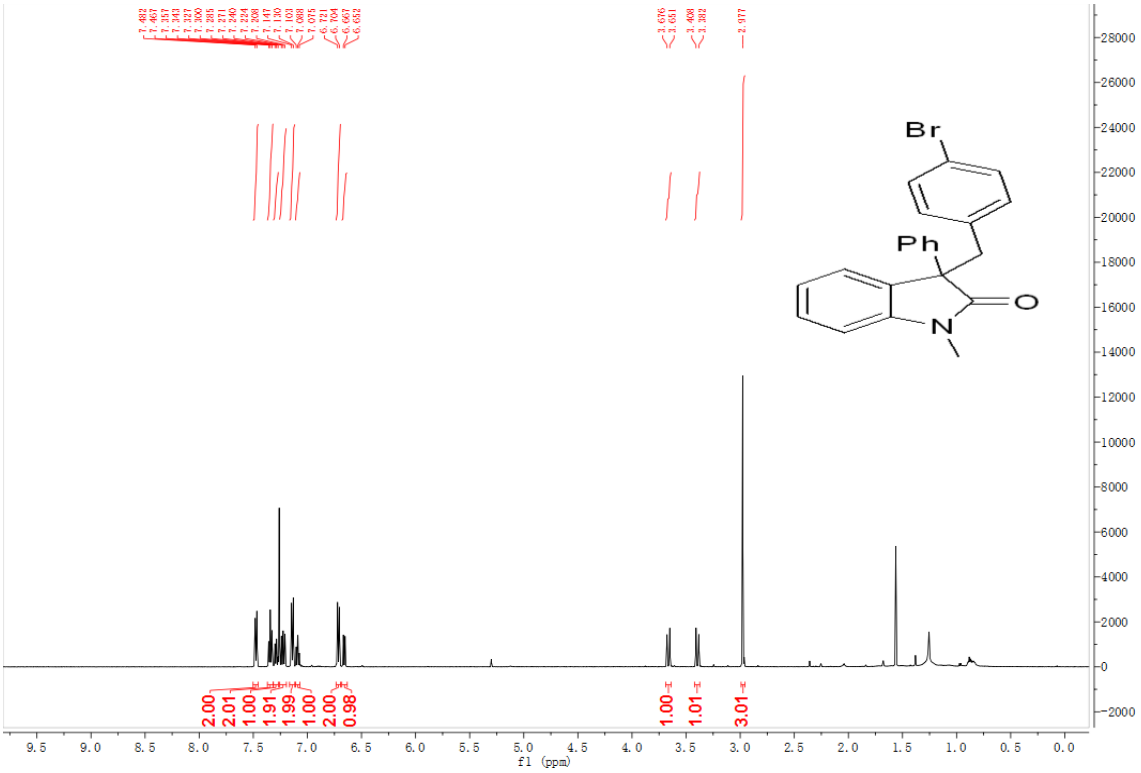


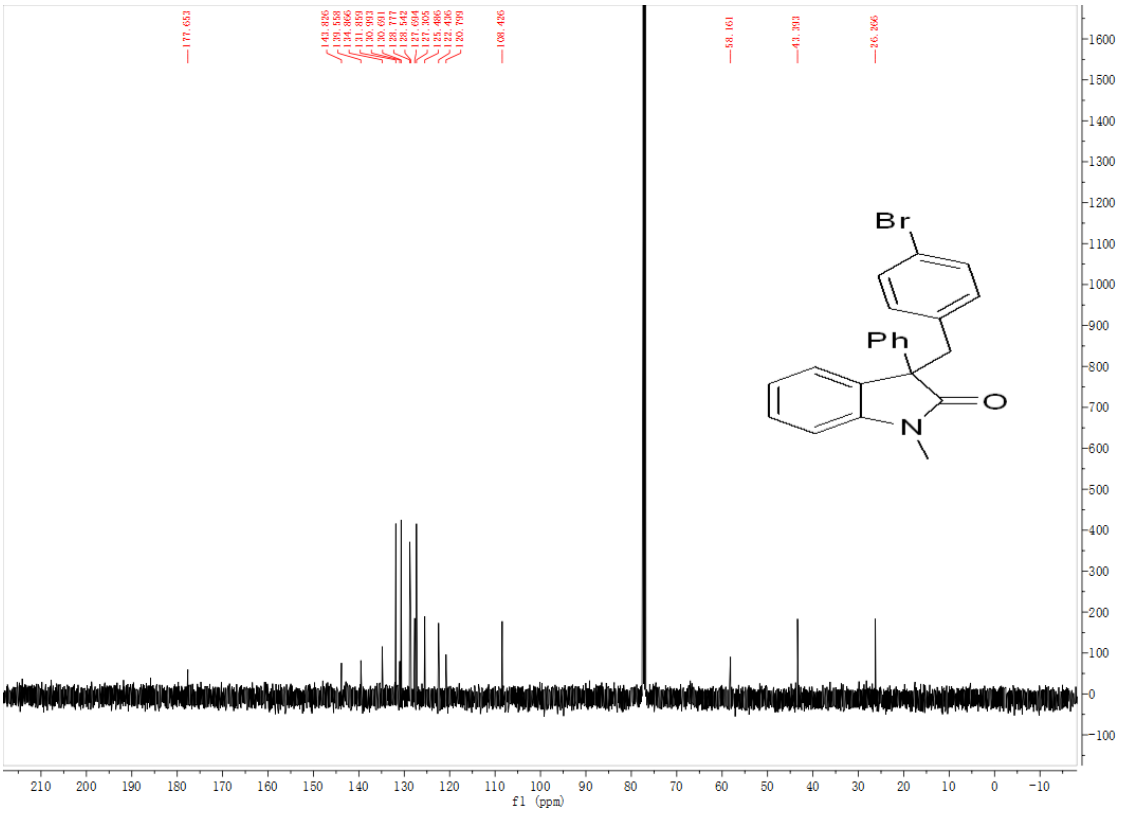
3ag



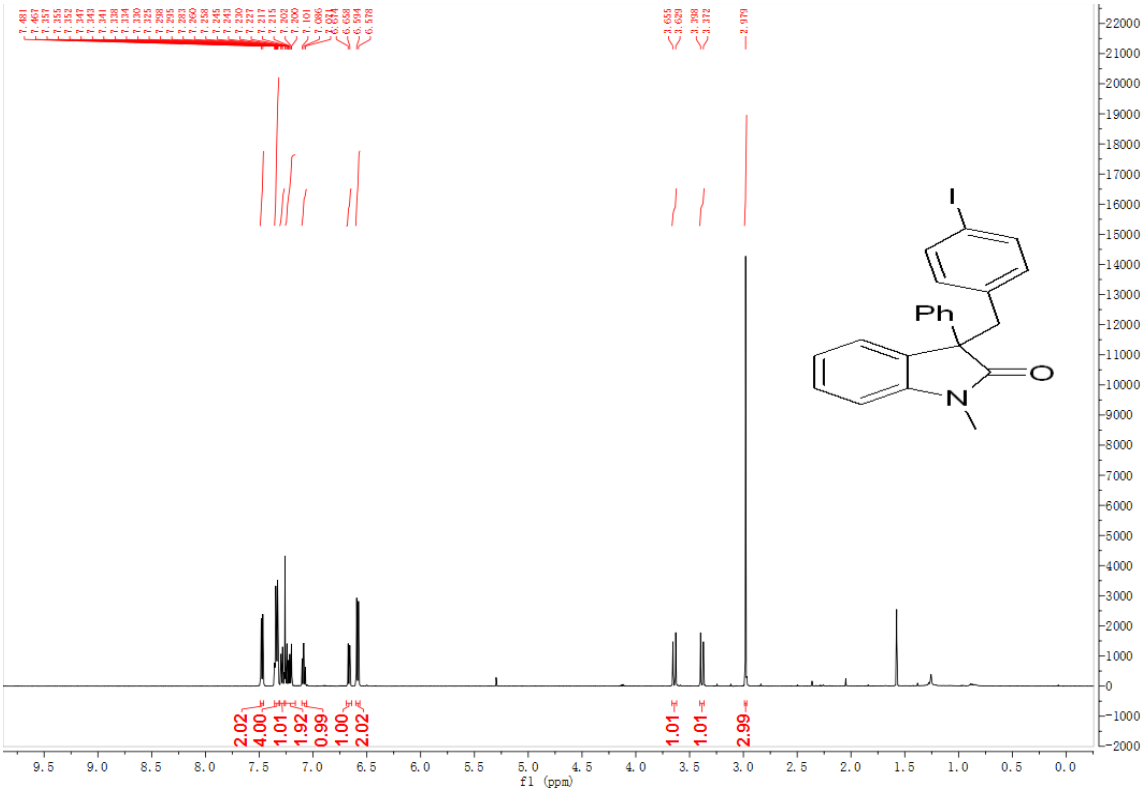


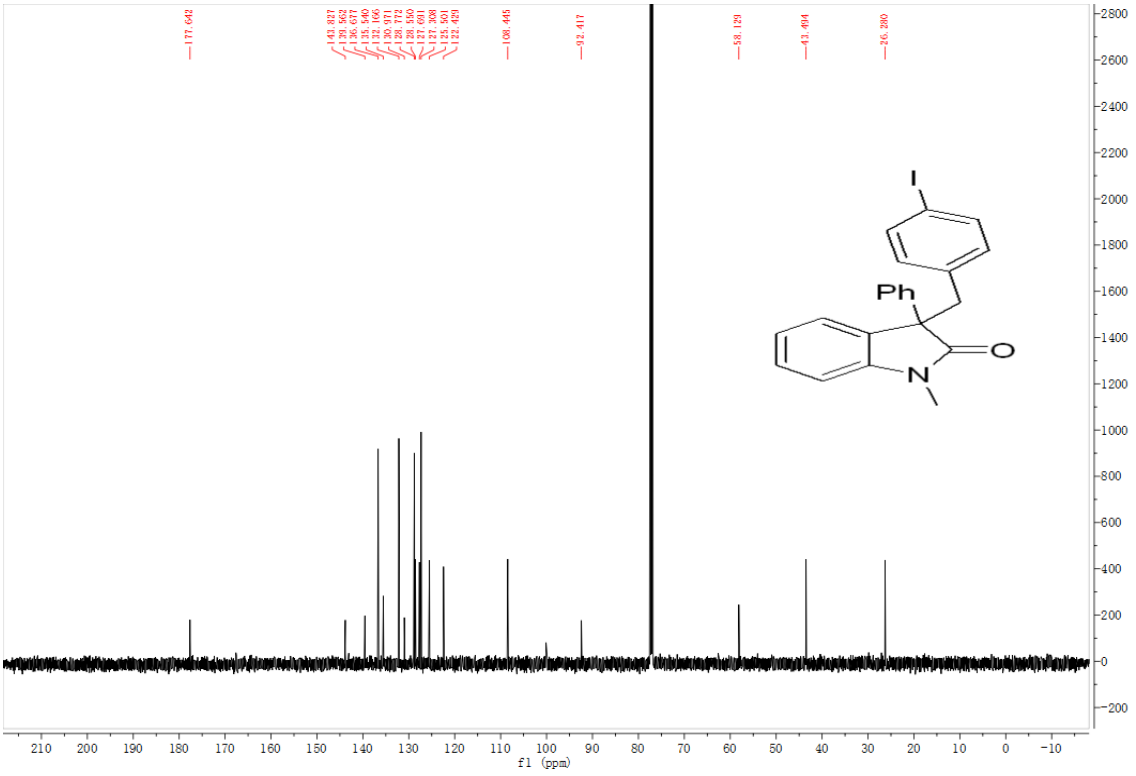
3ah





3ai





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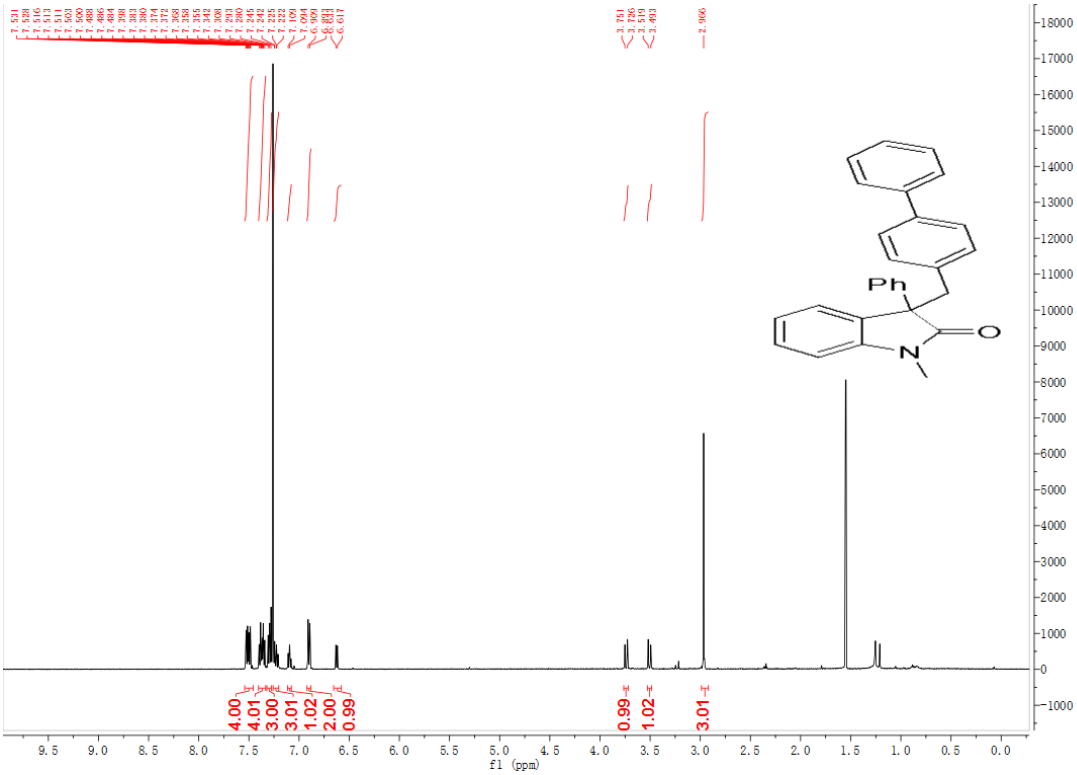

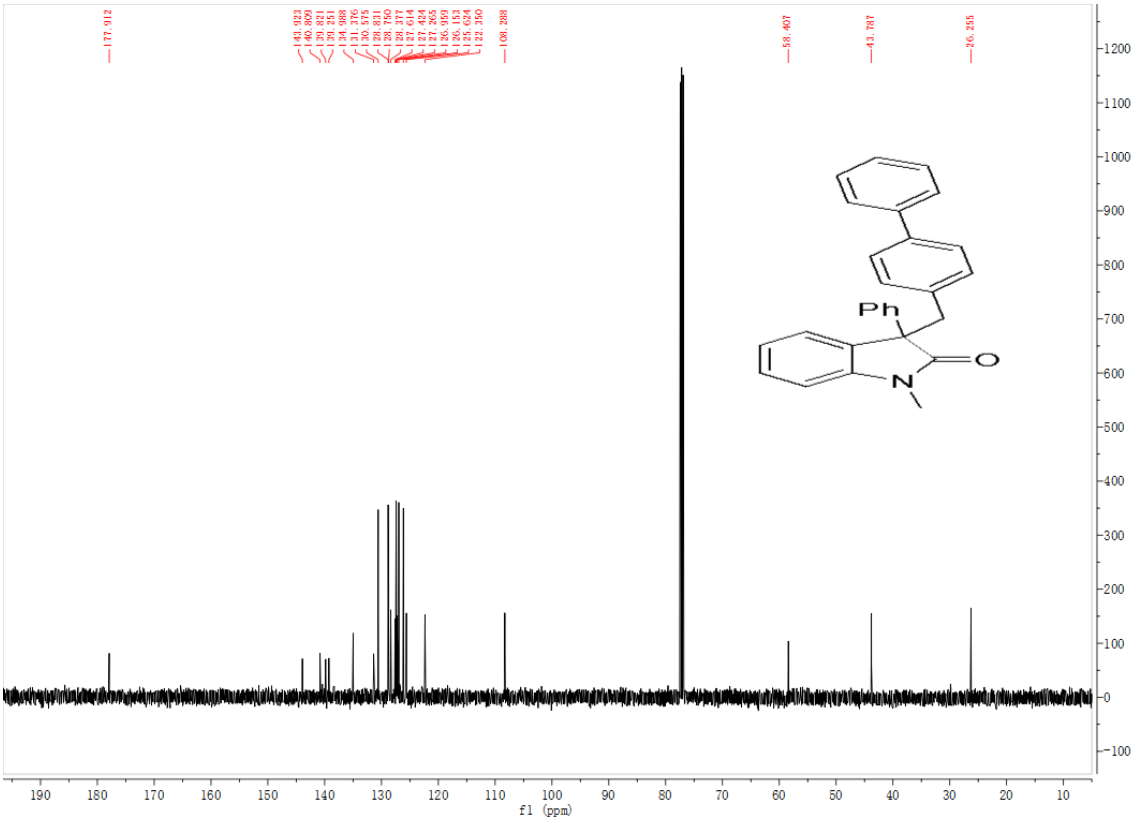

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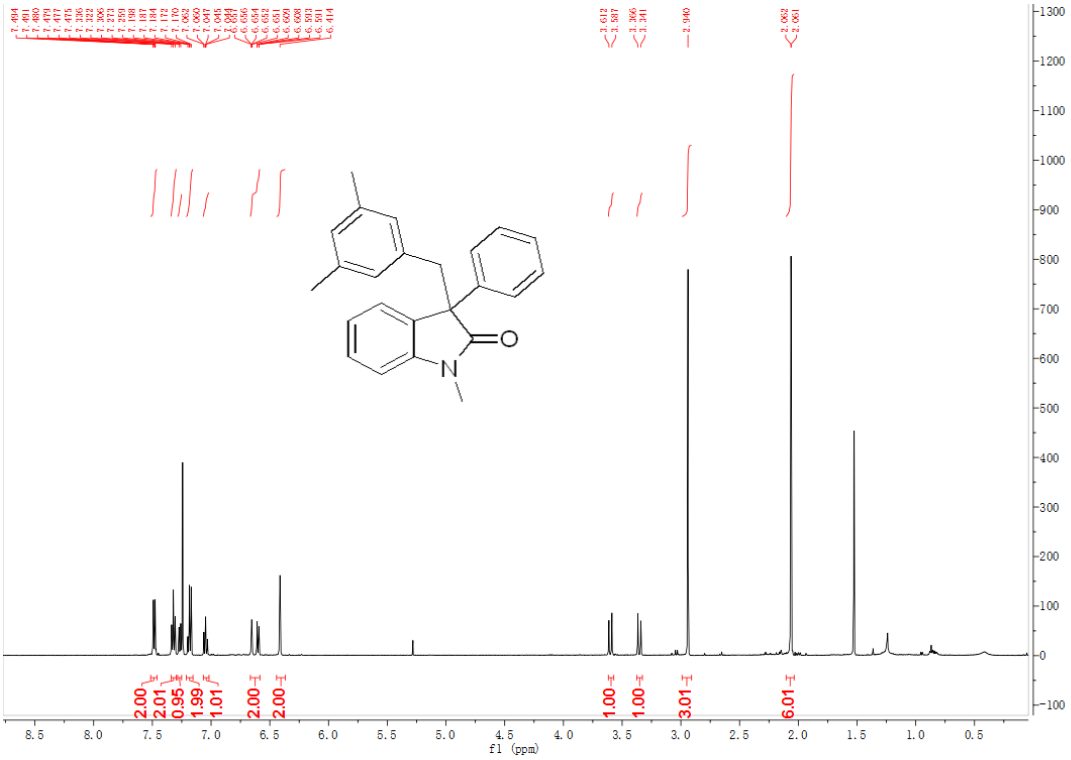
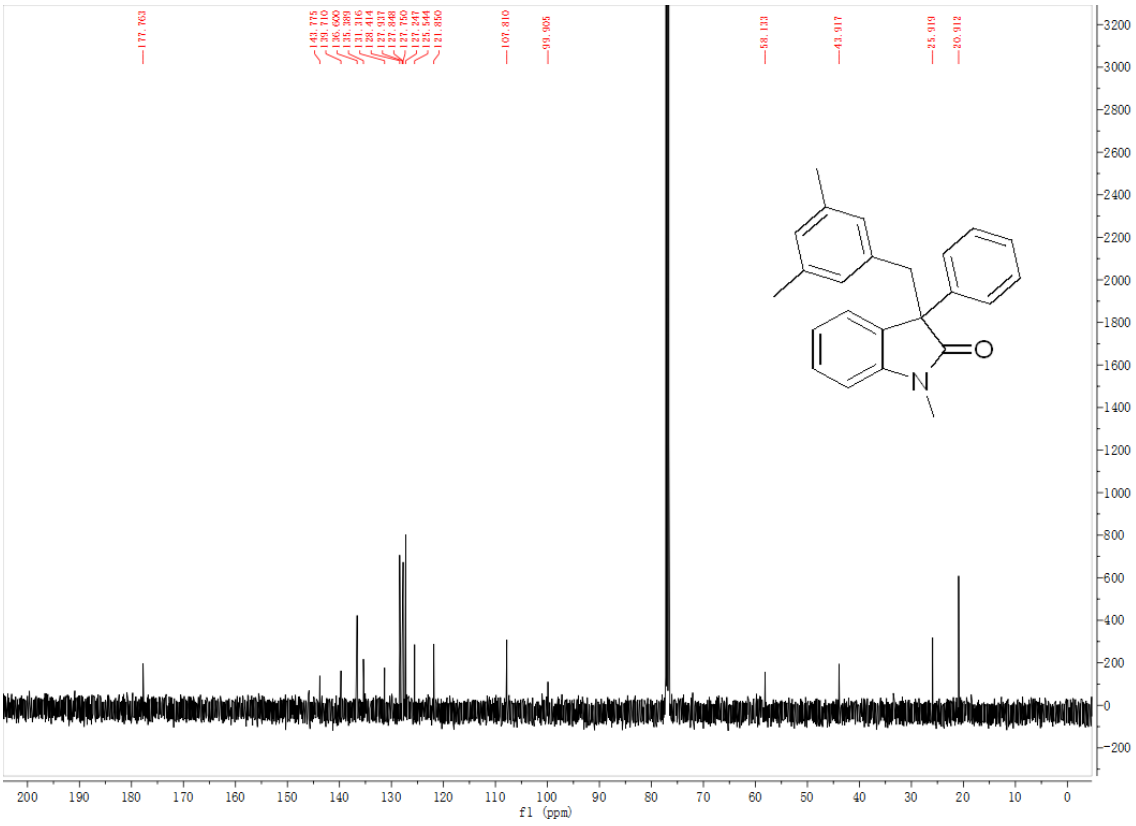
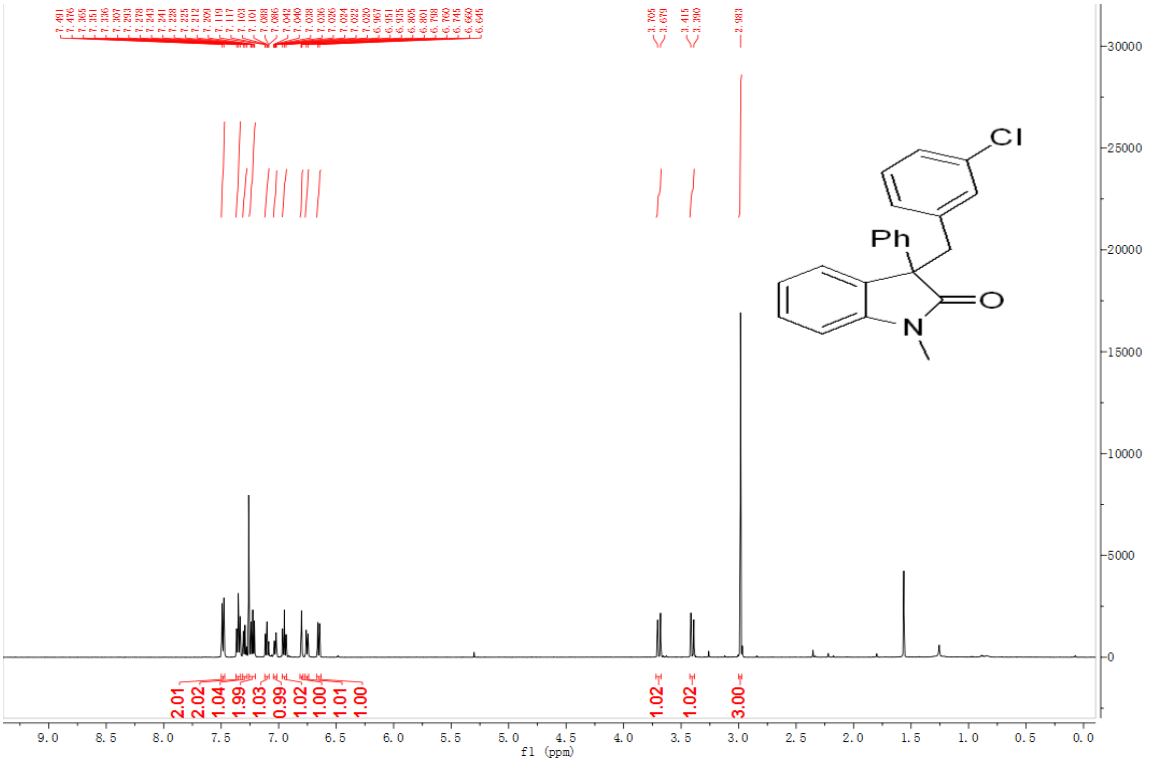
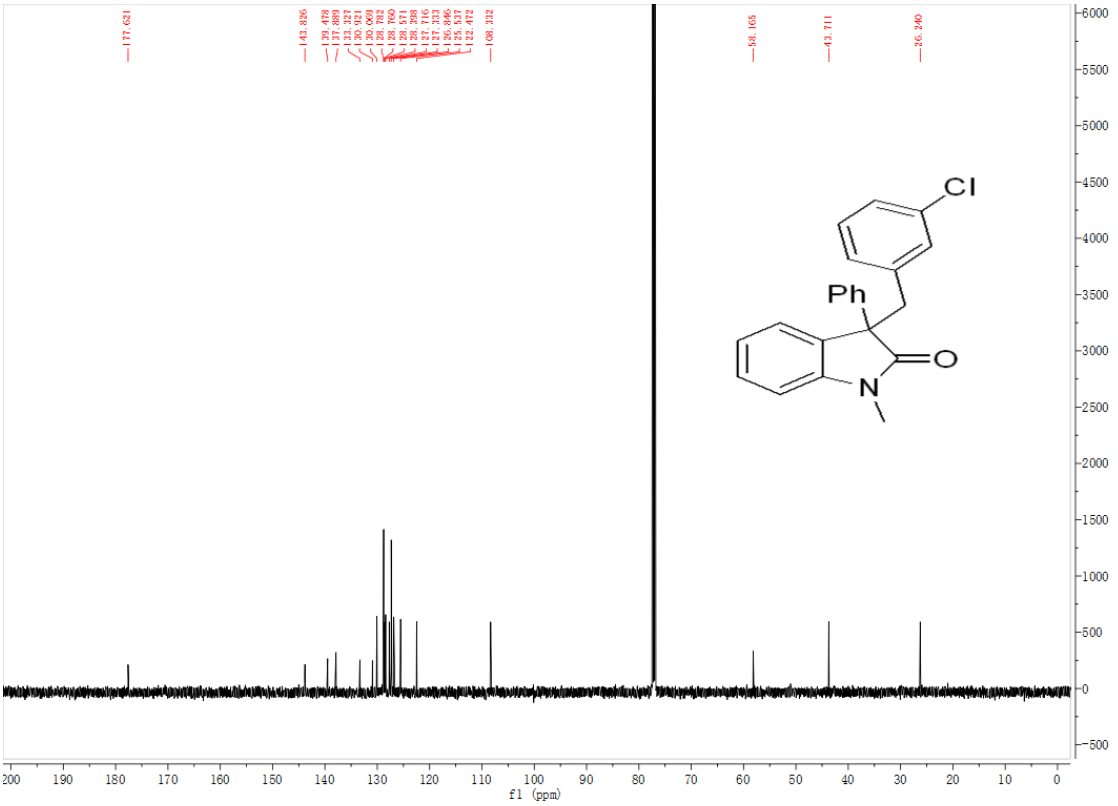


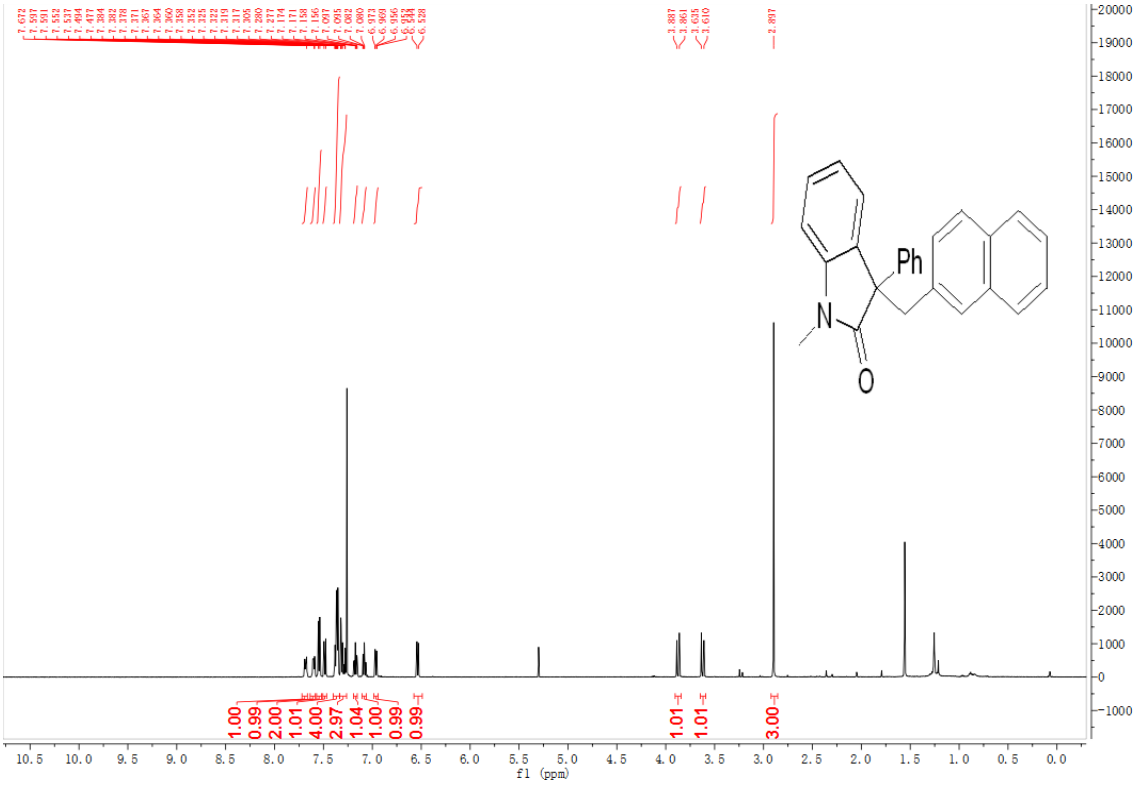


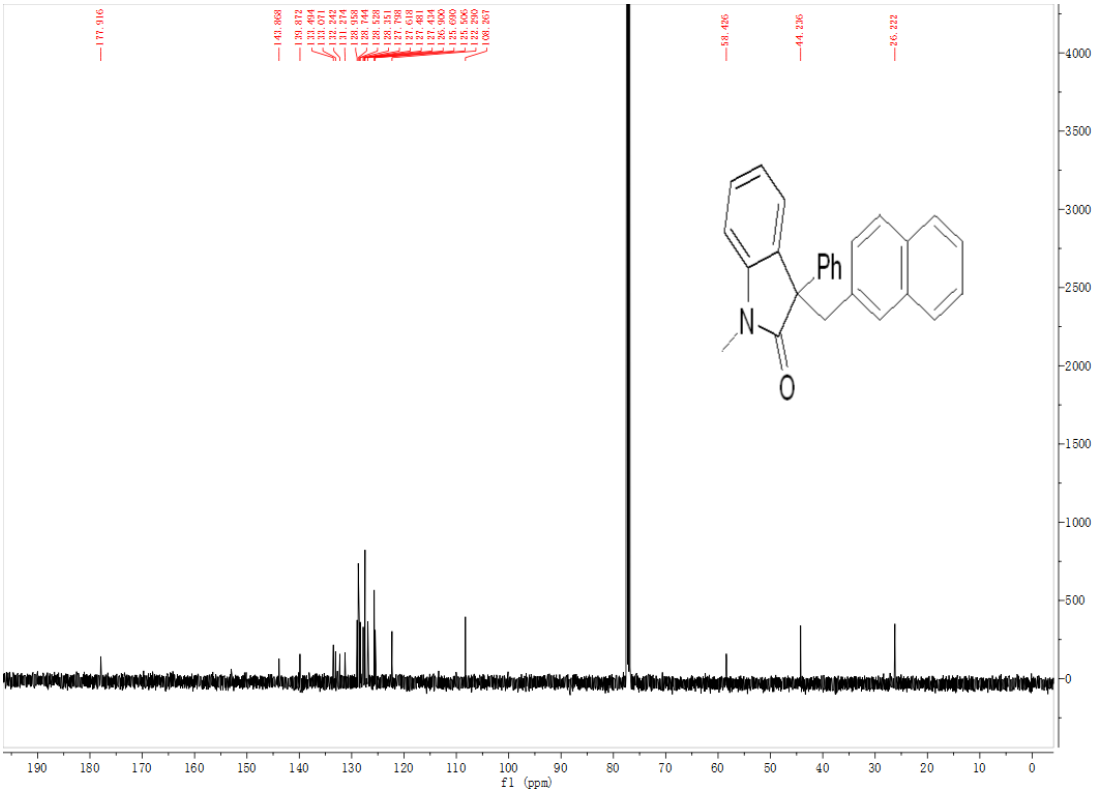
3al





3am





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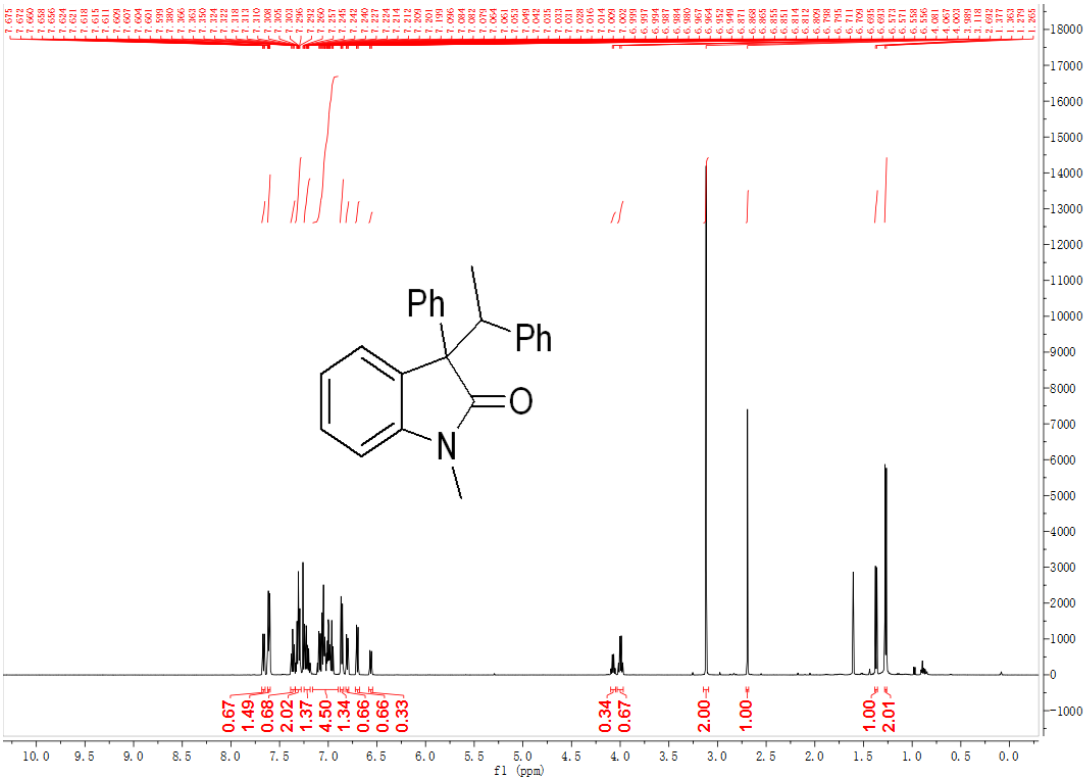
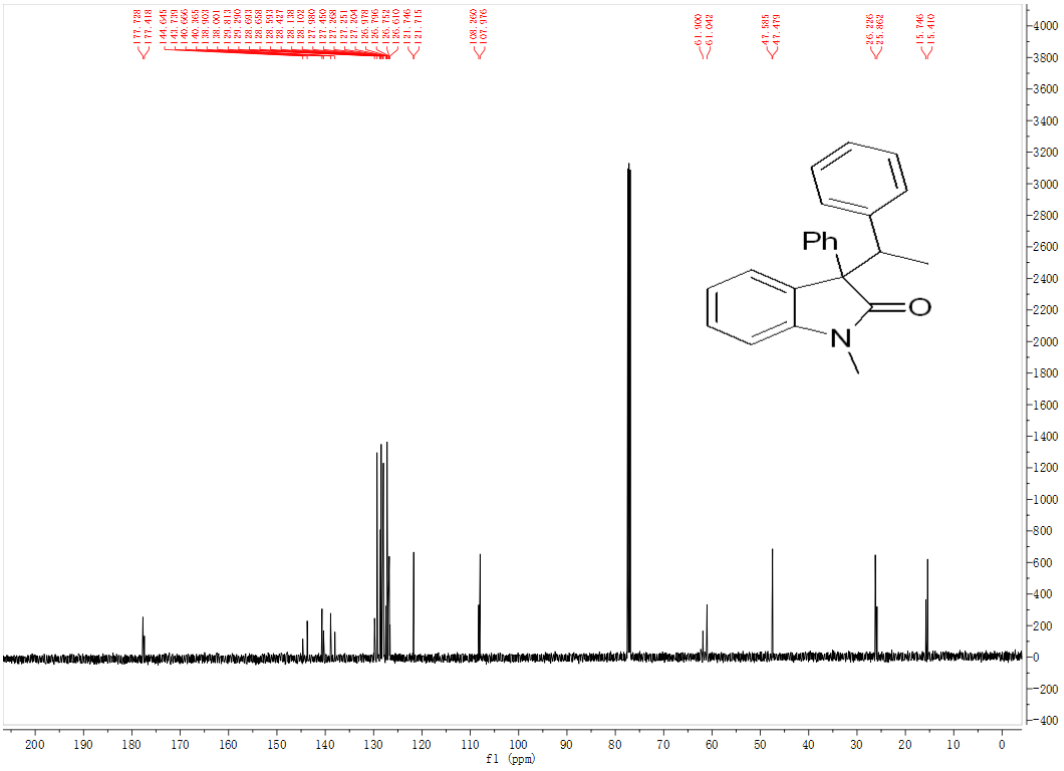
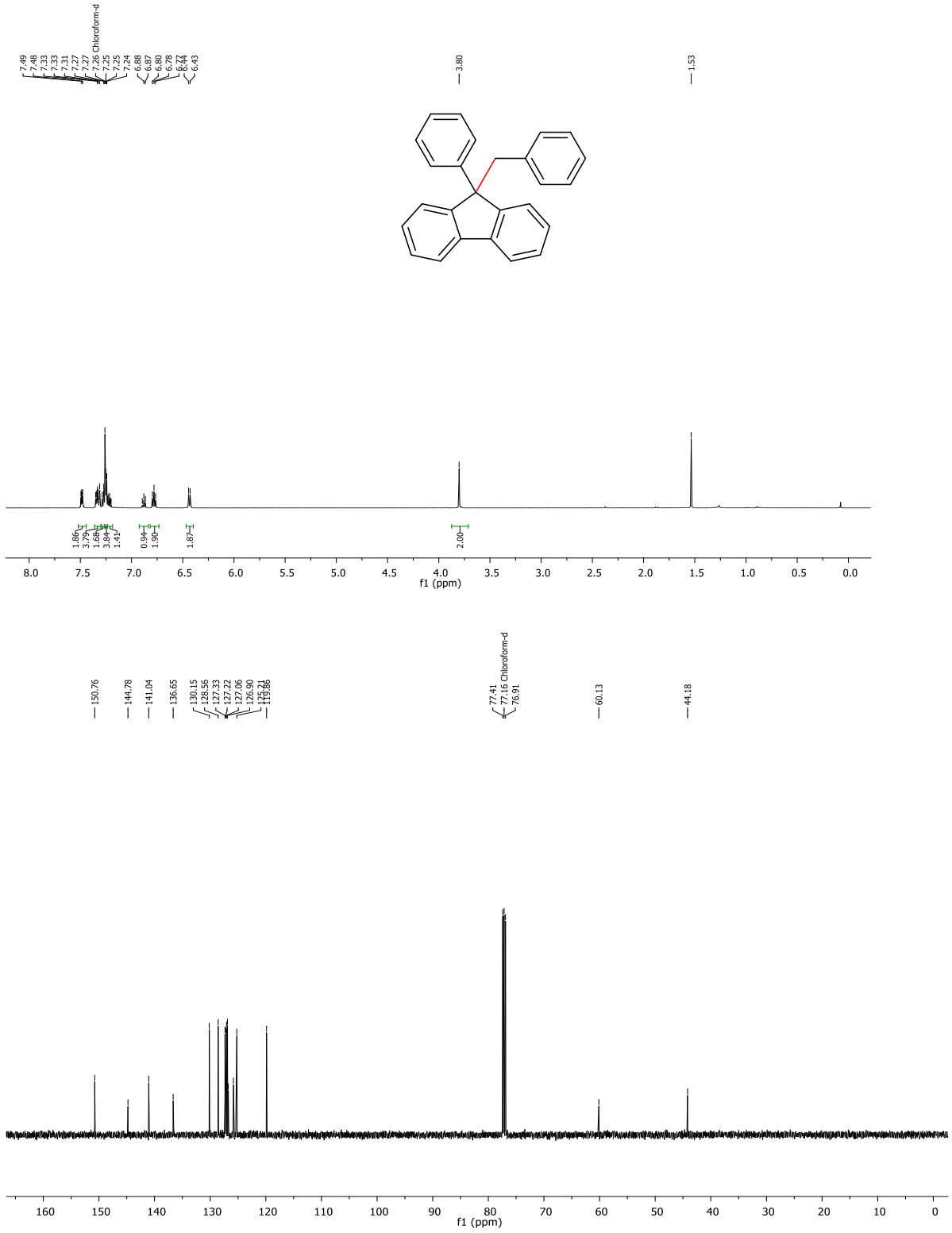
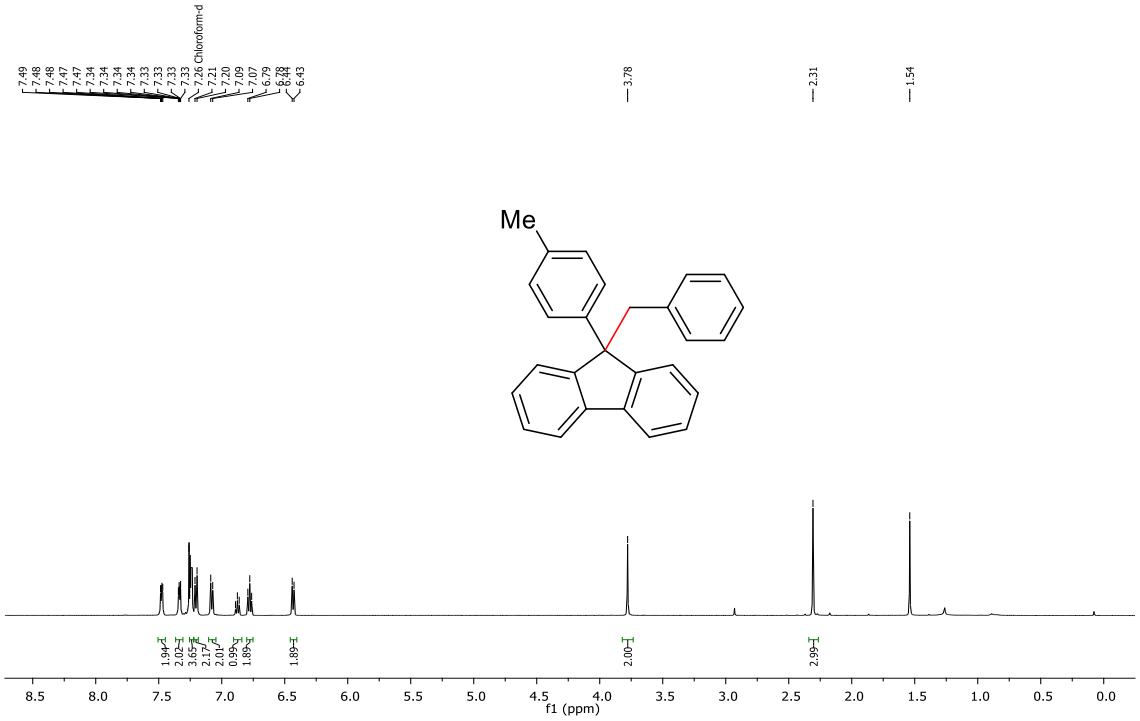

Ph
Ph
O
N
0.67
1.49
0.68
2.02
1.37
4.50
1.34
0.66
0.66
0.33
0.34
0.67
2.00
1.00
1.00
2.01
f1 (ppm)

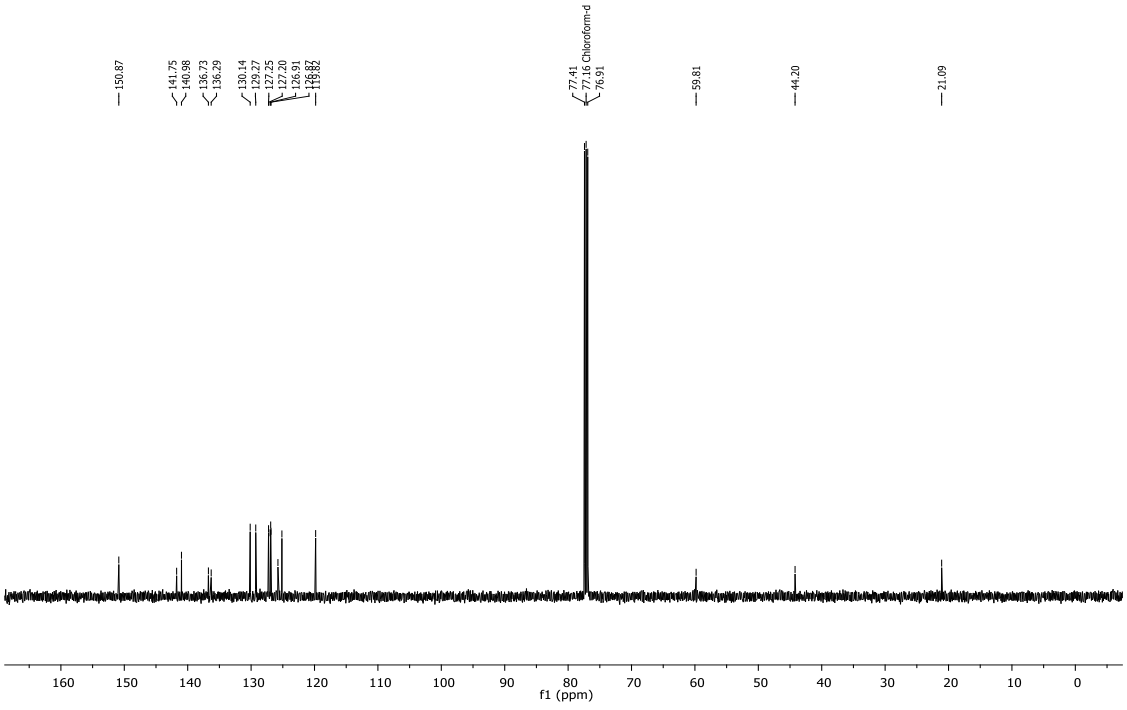

Ph
O
N
f1 (ppm)

5aa

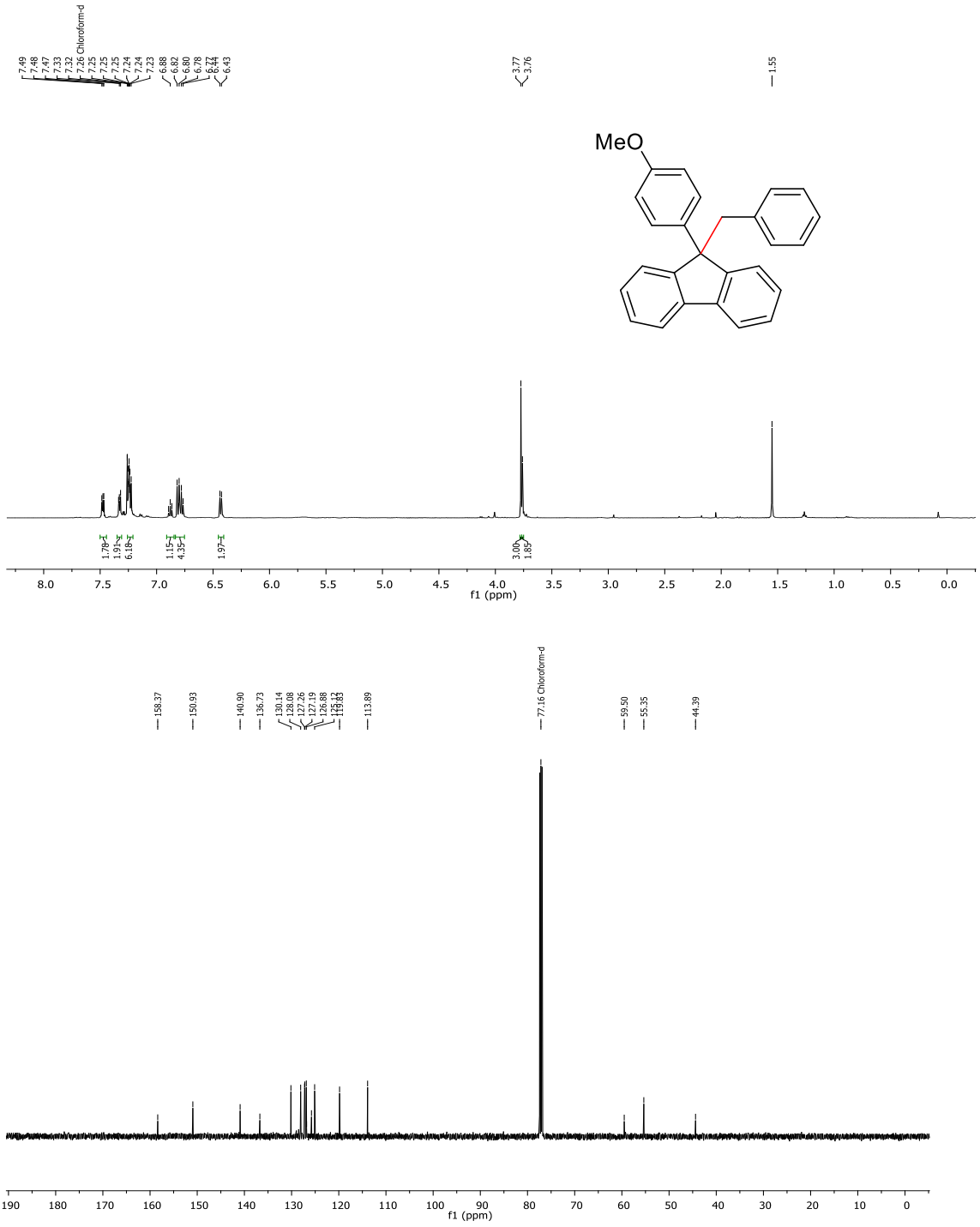

7.49
7.48
7.33
7.31
7.27
7.27
7.26 Chloroform-d
7.25
7.24
6.88
6.87
6.80
6.78
6.44
6.43
3.80
1.53
1.86
3.79
1.68
3.84
1.41
0.94
1.90
1.87
2.00
f1 (ppm)
150.76
144.78
141.04
136.65
130.15
128.56
127.33
127.22
127.06
126.90
125.21
119.86
77.41
77.16 Chloroform-d
76.91
60.13
44.18
f1 (ppm)

5ba

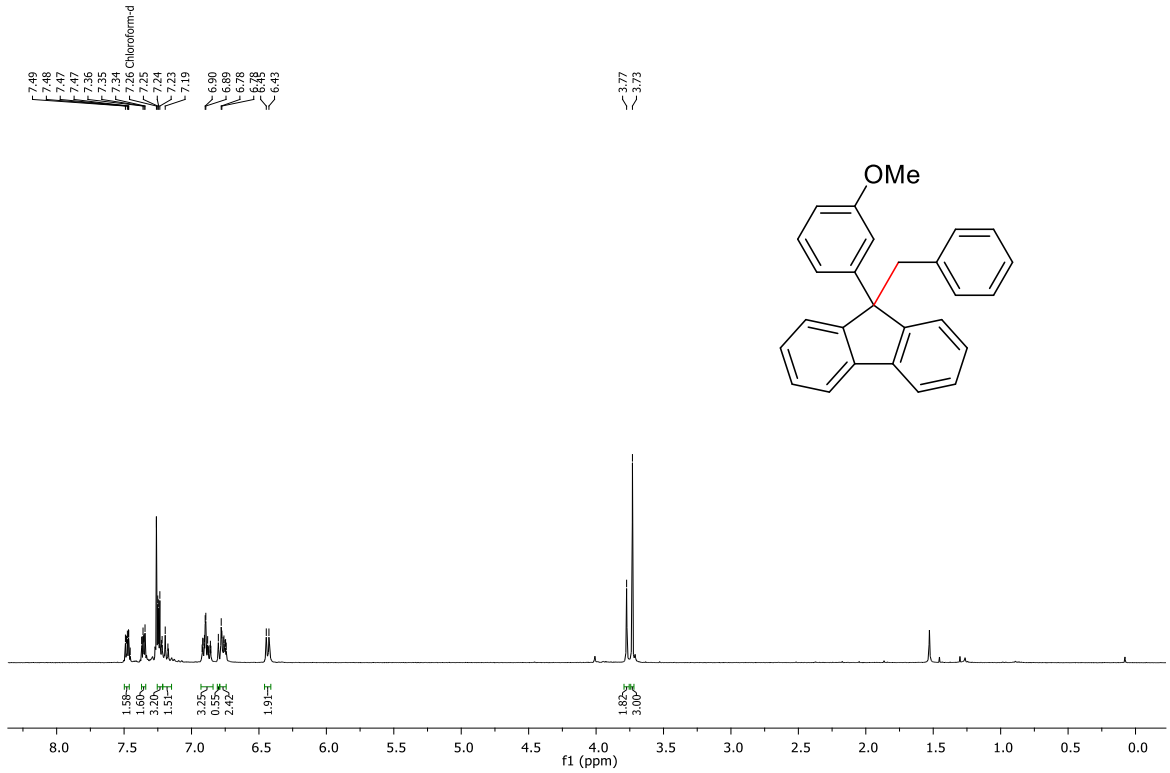

7.49
7.48
7.48
7.47
7.47
7.34
7.34
7.34
7.34
7.33
7.33
7.33
7.26 Chloroform-d
7.21
7.20
7.09
7.07
6.79
6.78
6.44
6.43
3.78
2.31
1.54
Me
1.94
2.03
3.65
2.17
2.01
0.99
1.89
1.89
2.00
2.99
f1 (ppm)


150.87
141.75
140.98
136.73
136.29
130.14
129.27
127.25
127.20
126.91
125.82
119.82
77.41
77.16 Chloroform-d
76.91
59.81
44.20
21.09
f1 (ppm)

5ca


7.49
7.48
7.47
7.33
7.32
7.26 Chloroform-d
7.25
7.25
7.25
7.24
7.24
7.23
6.88
6.82
6.80
6.78
6.44
6.43
3.77
3.76
1.55
MeO
1.78
1.91
6.18
1.15
4.35
1.97
3.00
1.85
f1 (ppm)
158.37
150.93
140.90
136.73
130.14
128.08
127.76
127.19
126.88
125.12
119.83
113.89
77.16 Chloroform-d
59.50
55.35
44.39
f1 (ppm)

5da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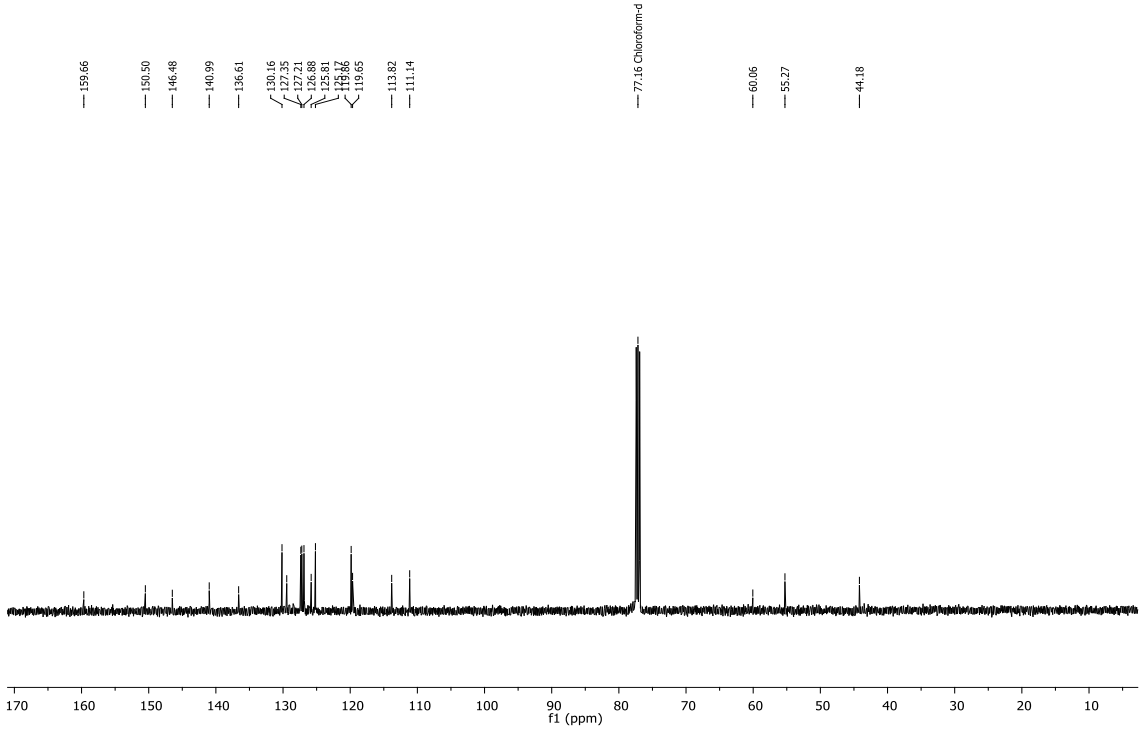
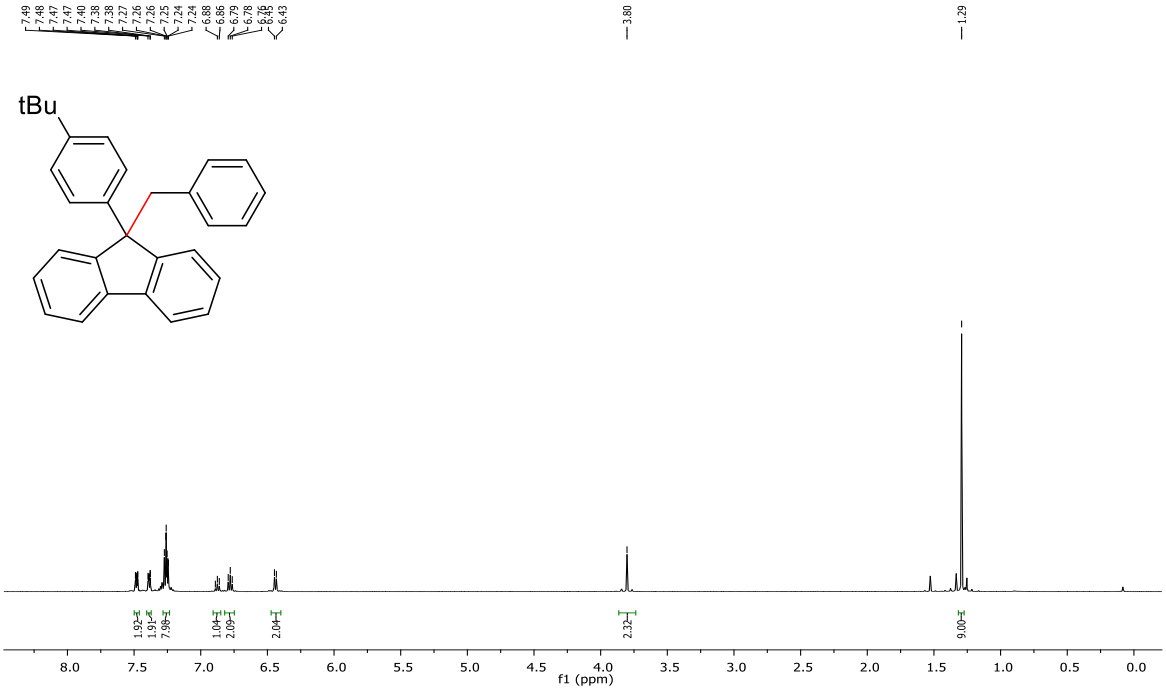
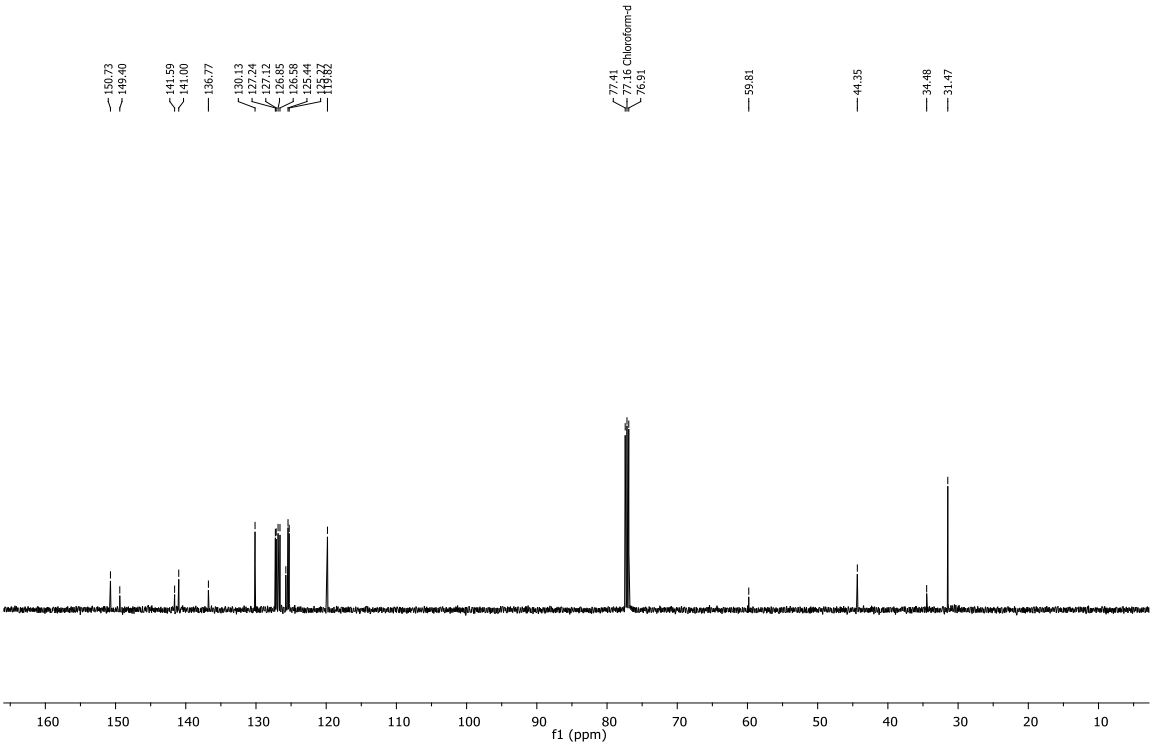
7.48
7.47
7.47
7.47
7.36
7.35
7.34
7.26 Chloroform-d
7.25
7.24
7.23
7.19
6.90
6.89
6.78
6.78
6.43
6.43
3.77
3.73
OMe
1.58
1.60
3.20
1.51
3.25
0.55
2.42
1.91
1.82
3.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


159.66
150.50
146.48
140.99
136.61
130.16
127.35
127.21
126.88
125.81
119.65
113.82
111.14
77.16 Chloroform-d
60.06
55.27
44.18
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

5ea


7.49
7.48
7.47
7.47
7.47
7.40
7.38
7.38
7.27
7.26
7.26
7.25
7.24
7.24
6.88
6.86
6.79
6.78
6.45
6.43
3.80
1.29
tBu
1.92
1.91
7.90
1.04
2.09
2.04
2.32
9.00
f1 (ppm)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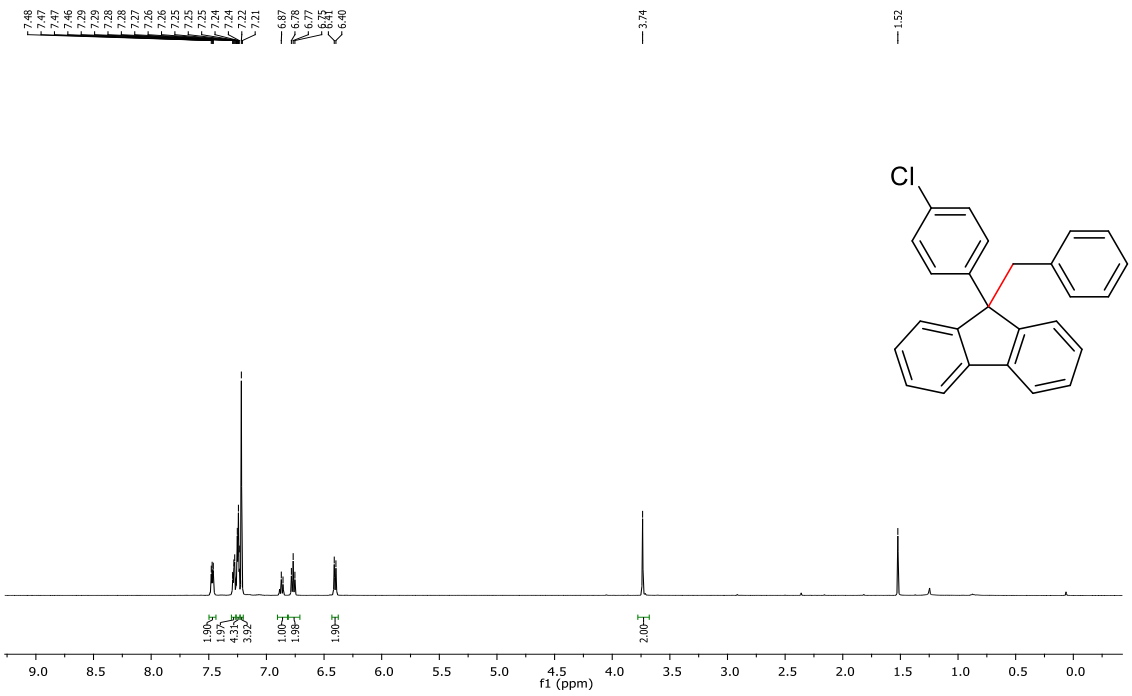
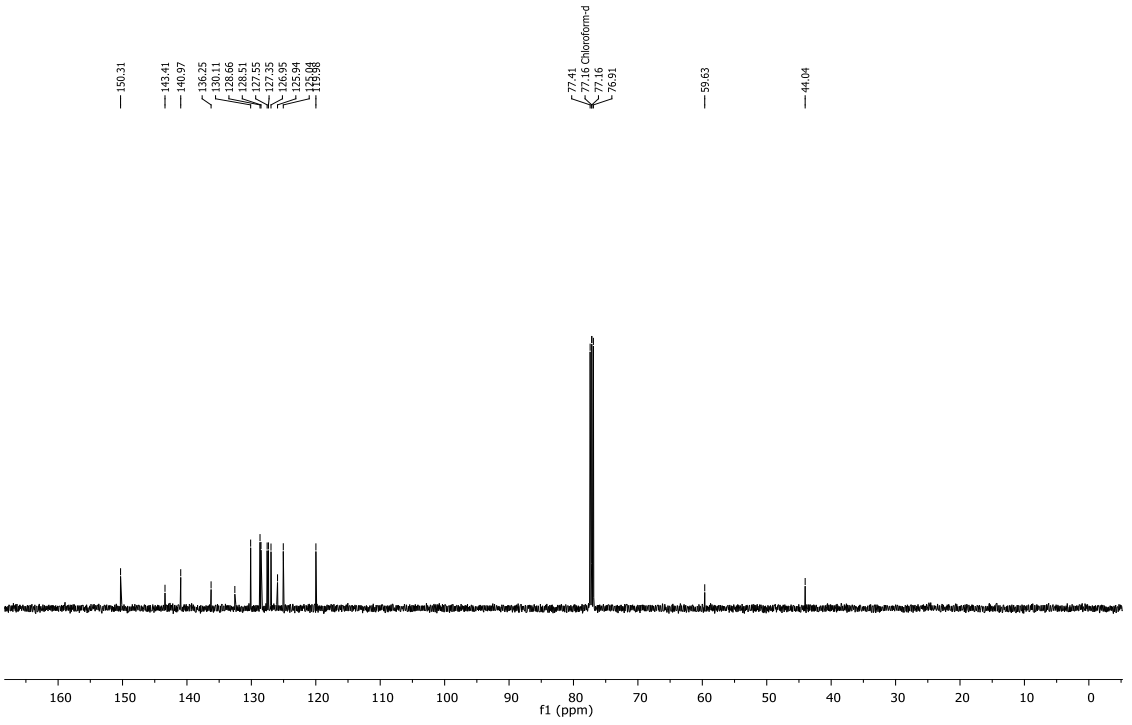
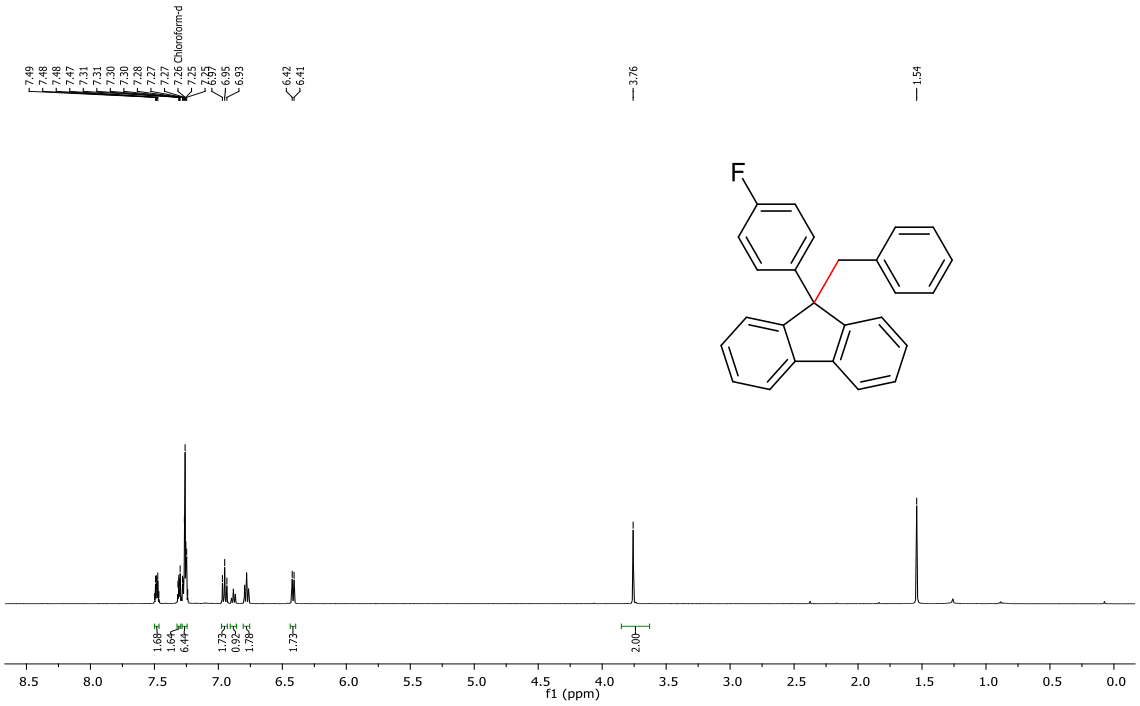
149.40
141.59
141.00
136.77
130.13
127.24
127.12
126.85
126.58
125.44
77.41
77.16 Chloroform-d
76.91
59.81
44.35
34.48
31.47
f1 (ppm)

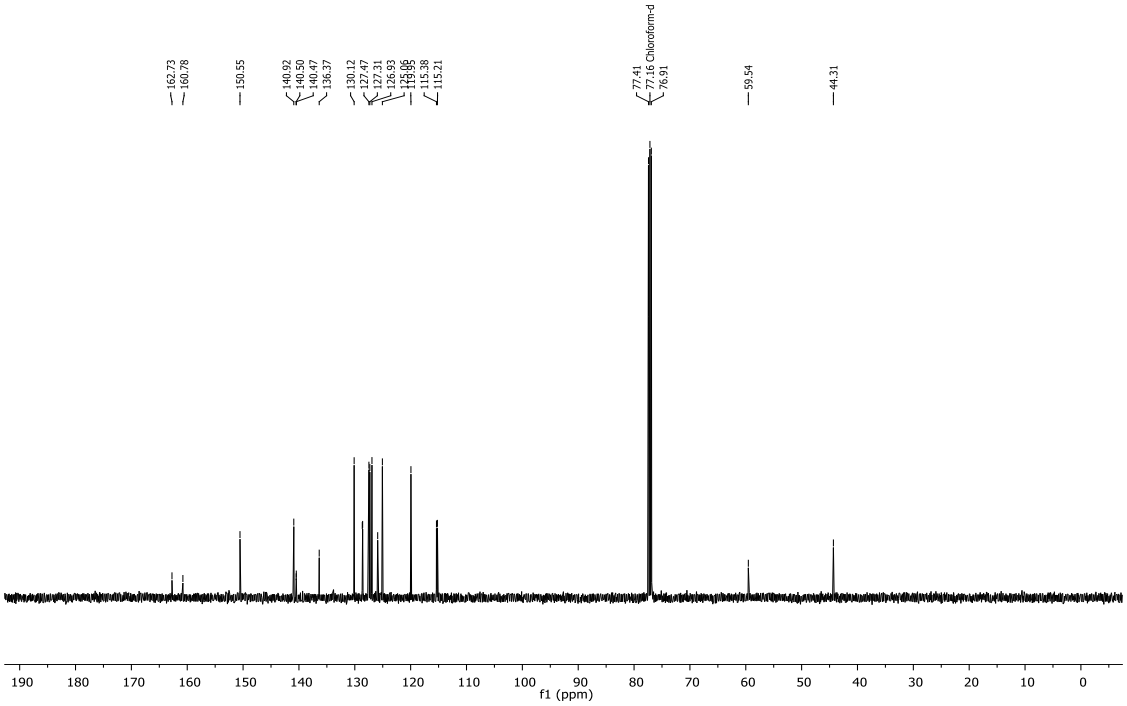
5fa


7.48
7.47
7.47
7.46
7.29
7.28
7.28
7.27
7.26
7.26
7.25
7.25
7.25
7.24
7.24
7.22
7.21
6.87
6.78
6.77
6.75
6.41
6.40
3.74
1.52
Cl
1.90
1.97
4.31
3.92
1.00
1.98
1.90
2.00
f1 (ppm)


150.31
143.41
140.97
136.25
130.11
128.66
128.51
127.55
127.35
126.95
125.94
120.08
119.98
77.41
77.16 Chloroform-d
77.16
76.91
59.63
44.04
f1 (ppm)

5ga


7.49
7.48
7.48
7.47
7.31
7.31
7.30
7.30
7.28
7.27
7.26 Chloroform-d
7.25
6.97
6.95
6.93
6.42
6.41
3.76
1.54
F
1.68
1.64
6.44
1.73
0.92
1.78
1.73
2.00
f1 (ppm)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160.78
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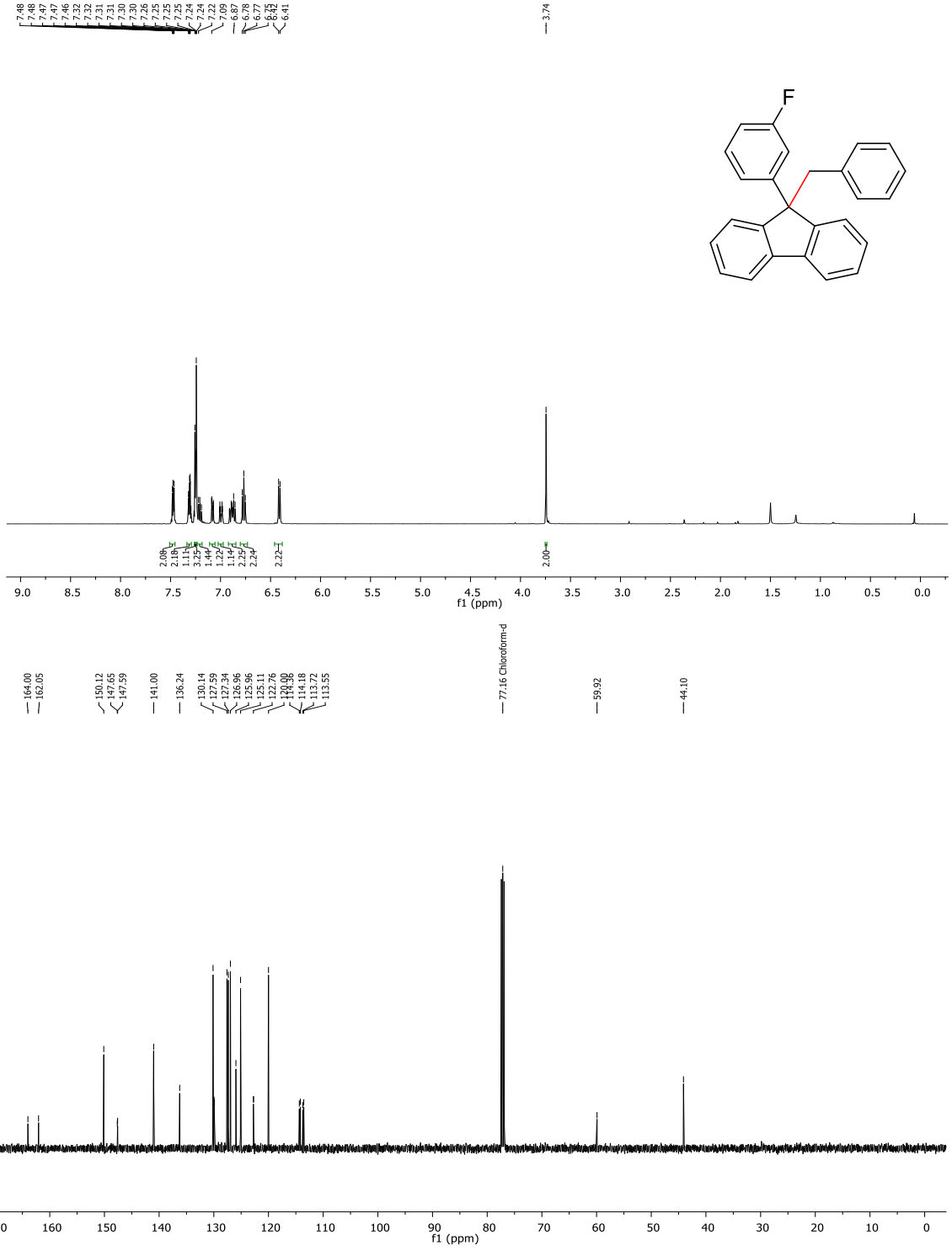
140.92
140.50
140.47
136.37
130.12
127.47
127.31
126.93
115.38
115.21
77.41
77.16 Chloroform-d
76.91
59.54
44.31
f1 (ppm)

5ha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7.48
7.47
7.47
7.46
7.32
7.32
7.31
7.31
7.30
7.30
7.26
7.25
7.25
7.25
7.24
7.24
7.22
7.09
6.87
6.78
6.77
6.75
6.42
6.41
3.74
F
2.08
2.18
1.11
3.25
1.44
1.22
1.14
2.25
2.24
2.22
2.00
f1 (ppm)
164.00
162.05
150.12
147.65
147.59
141.00
136.24
130.14
127.59
127.34
126.96
125.96
125.11
122.76
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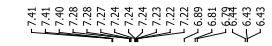
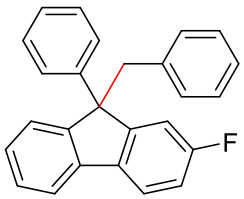
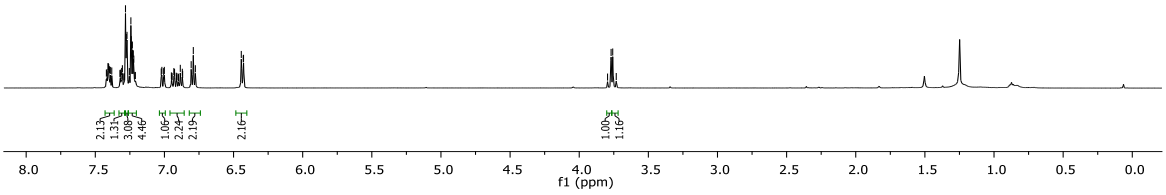
114.18
113.72
113.55
77.16 Chloroform-d
59.92
44.10
f1 (ppm)

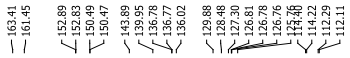
5ia


7.41
7.41
7.40
7.28
7.28
7.27
7.24
7.24
7.24
7.23
7.22
7.22
6.89
6.81
6.79
6.44
6.43
6.43


3.80
3.77
3.76
3.73

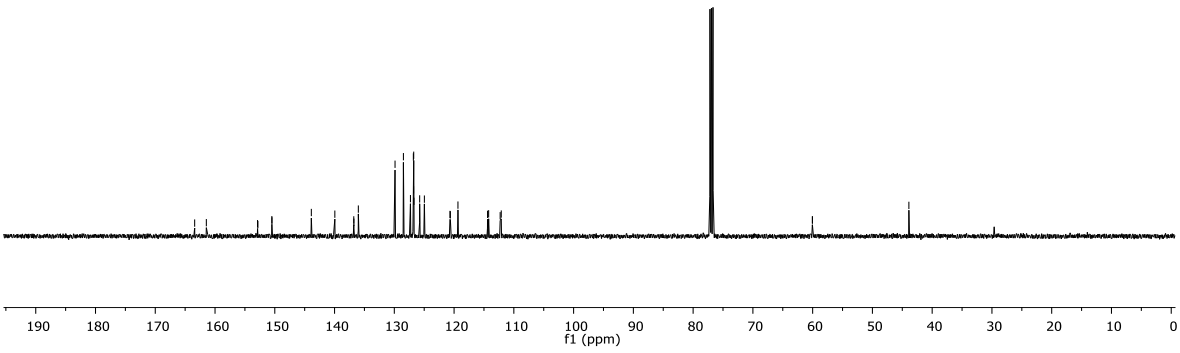

F


2.13
1.31
3.08
4.46
1.06
2.24
2.19
2.16
1.00
1.16
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


163.41
161.45
152.89
152.83
150.49
150.47
143.89
139.95
136.78
136.77
136.02
129.88
128.48
127.30
126.81
126.78
126.76
114.22
112.29
112.11


60.05
60.03

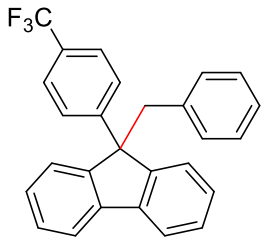
43.90

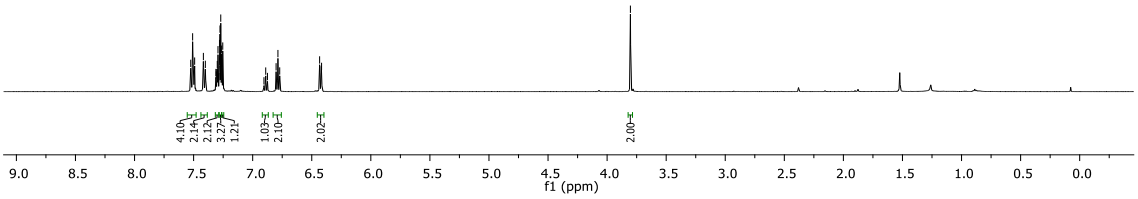

190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

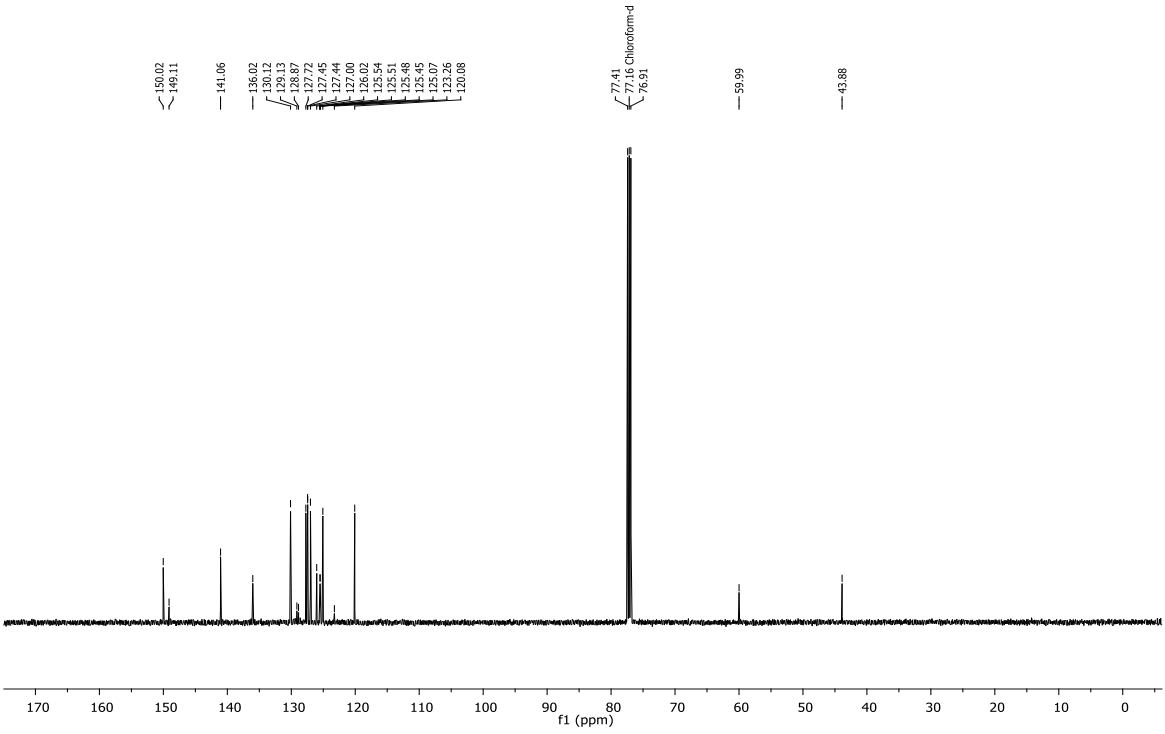
5ja


7.52
7.51
7.49
7.42
7.40
7.31
7.31
7.30
7.30
7.29
7.29
7.28
7.28
7.27
7.26
7.26
7.25
6.89
6.80
6.79
6.73
6.43
6.42

3.80


F3C


4.10
2.14
2.12
3.27
1.21
1.03
2.10
2.02
2.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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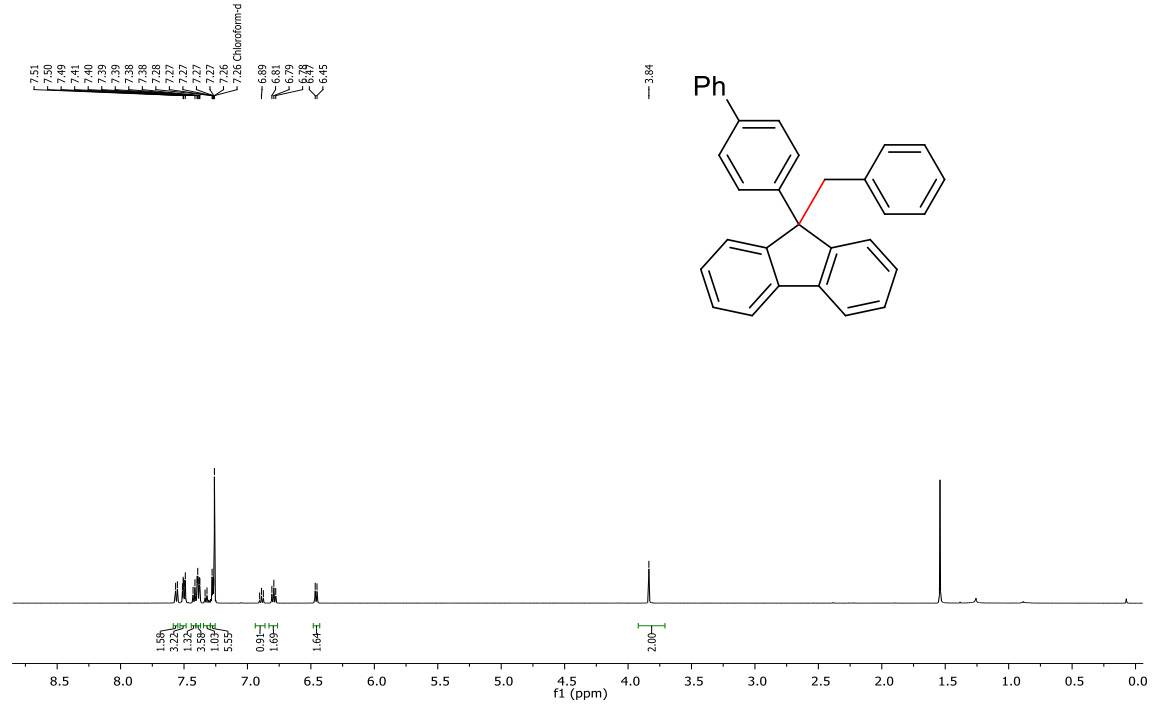
149.11
141.06
136.02
130.12
129.13
128.87
127.72
127.45
127.44
127.00
126.02
125.54
125.51
125.48
125.45
125.07
123.26
120.08
77.41
77.16 Chloroform-d
76.91
59.99
43.88
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

5ka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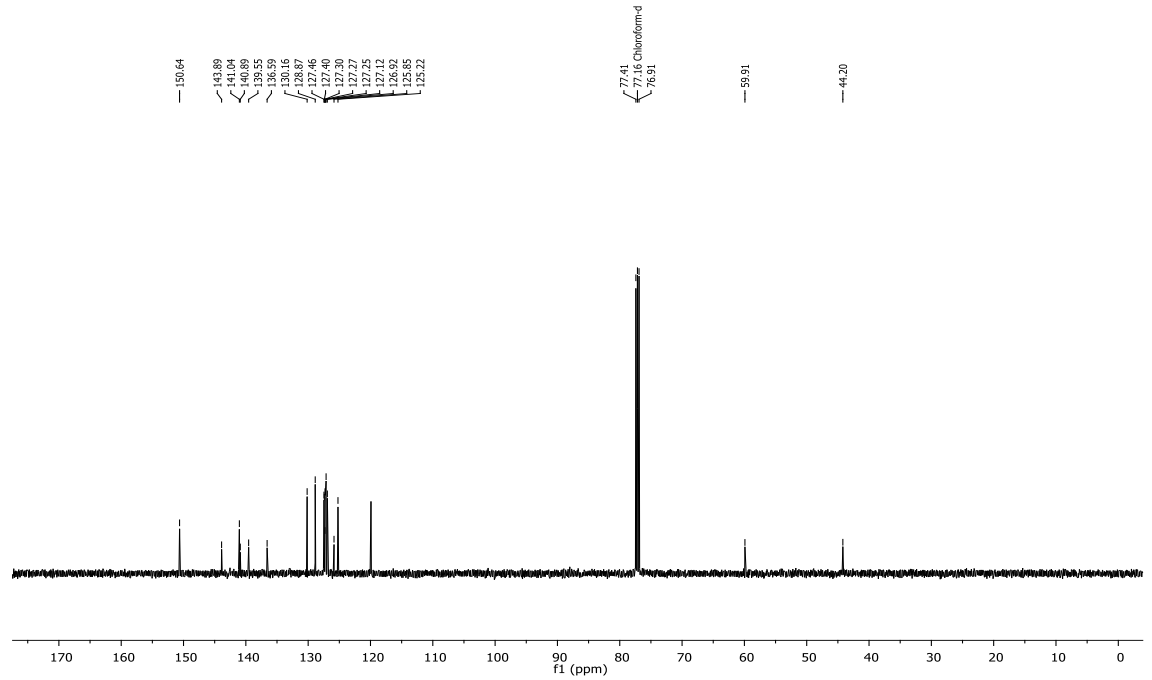
7.49
7.41
7.40
7.39
7.39
7.38
7.38
7.28
7.27
7.27
7.27
7.27
7.26
7.26 Chloroform-d
6.89
6.81
6.79
6.78
6.47
6.45
3.84
Ph
1.58
3.22
1.52
3.58
1.09
5.55
0.91
1.69
1.64
2.00
f1 (ppm)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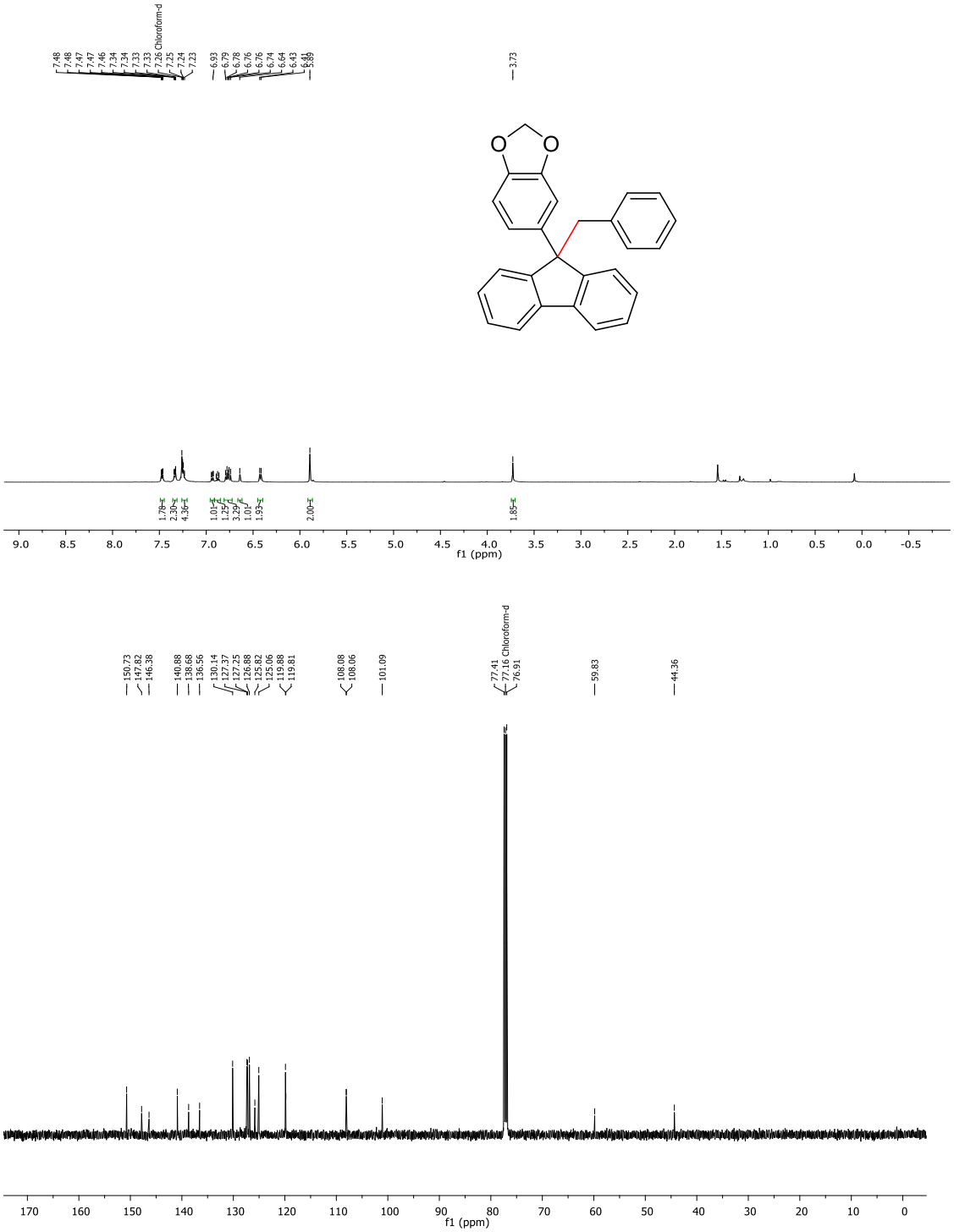
143.89
141.04
140.69
139.55
136.78
130.15
128.87
127.46
127.40
127.30
127.27
127.25
127.12
126.92
125.85
125.22
77.41
77.16 Chloroform-d
76.91
59.91
44.20
f1 (ppm)

5la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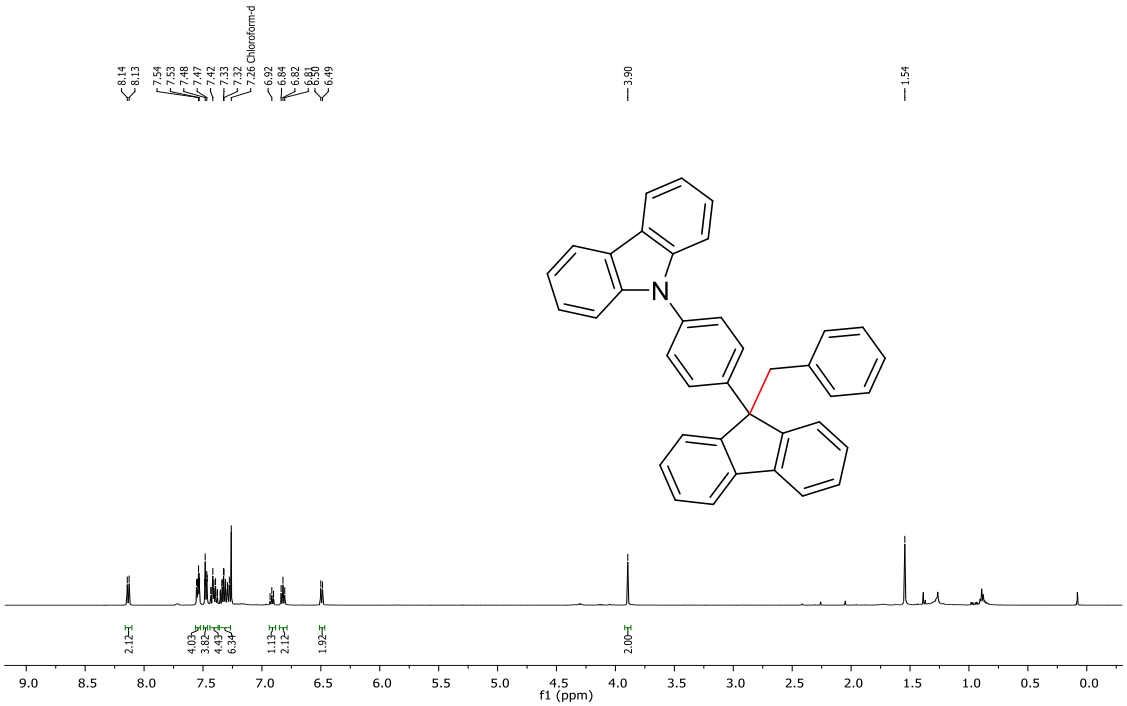
7.48
7.47
7.47
7.46
7.34
7.34
7.33
7.33
7.26 Chloroform-d
7.25
7.24
7.23
6.93
6.79
6.78
6.76
6.76
6.75
6.74
6.64
6.43
6.41
5.89
5.89
3.73
1.79
2.30
4.36
1.01
1.25
3.29
1.01
1.93
2.00
1.85
f1 (ppm)
150.73
147.82
146.38
140.88
138.68
136.56
130.14
127.37
127.25
125.88
125.82
125.06
119.88
119.81
108.08
108.06
101.09
77.41
77.16 Chloroform-d
76.91
59.83
44.36
f1 (ppm)

5ma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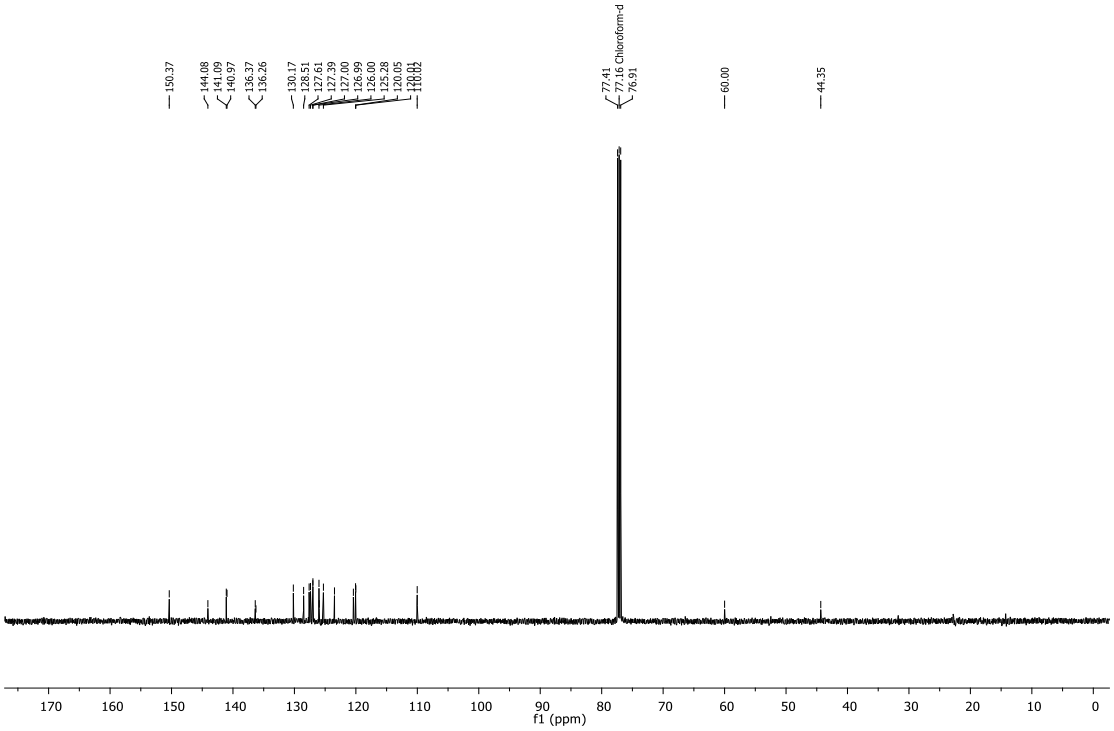
8.13
7.54
7.53
7.48
7.47
7.42
7.33
7.32
7.26 Chloroform-d
6.92
6.84
6.82
6.80
6.49
3.90
1.54
2.12
4.03
3.82
4.43
6.34
1.13
2.12
1.92
2.00
f1 (ppm)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136.26
130.17
128.51
127.61
127.39
127.00
126.99
126.00
125.28
120.05
77.41
77.16 Chloroform-d
76.91
60.00
44.35
f1 (ppm)

5na


7.64
7.62
7.50
7.50
7.50
7.50
7.44
7.43
7.35
7.34
7.34
7.32
7.32
7.29
7.29
7.28
7.27
7.26 Chloroform-d
7.05
7.00
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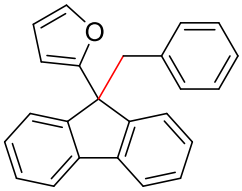
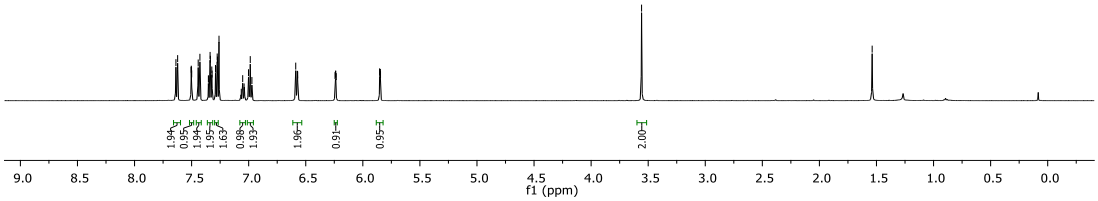
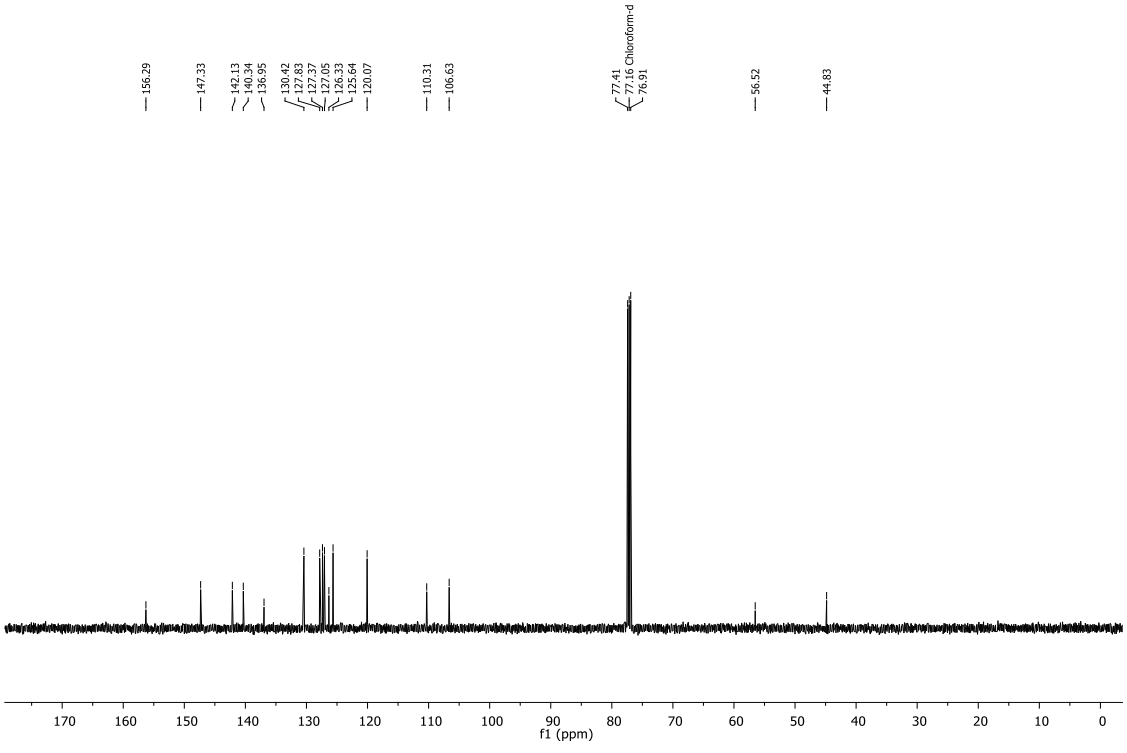
6.58
6.57
6.24
6.24
6.24
5.85
5.85
5.85
3.56
1.54


O


1.94
0.95
1.94
1.95
1.63
0.98
1.93
1.96
0.91
0.95
2.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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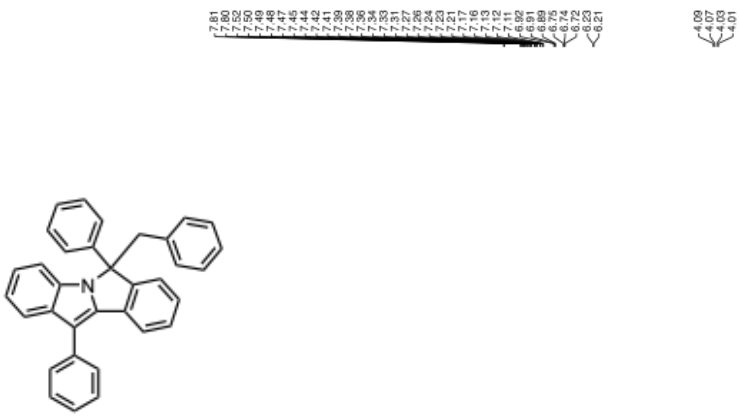
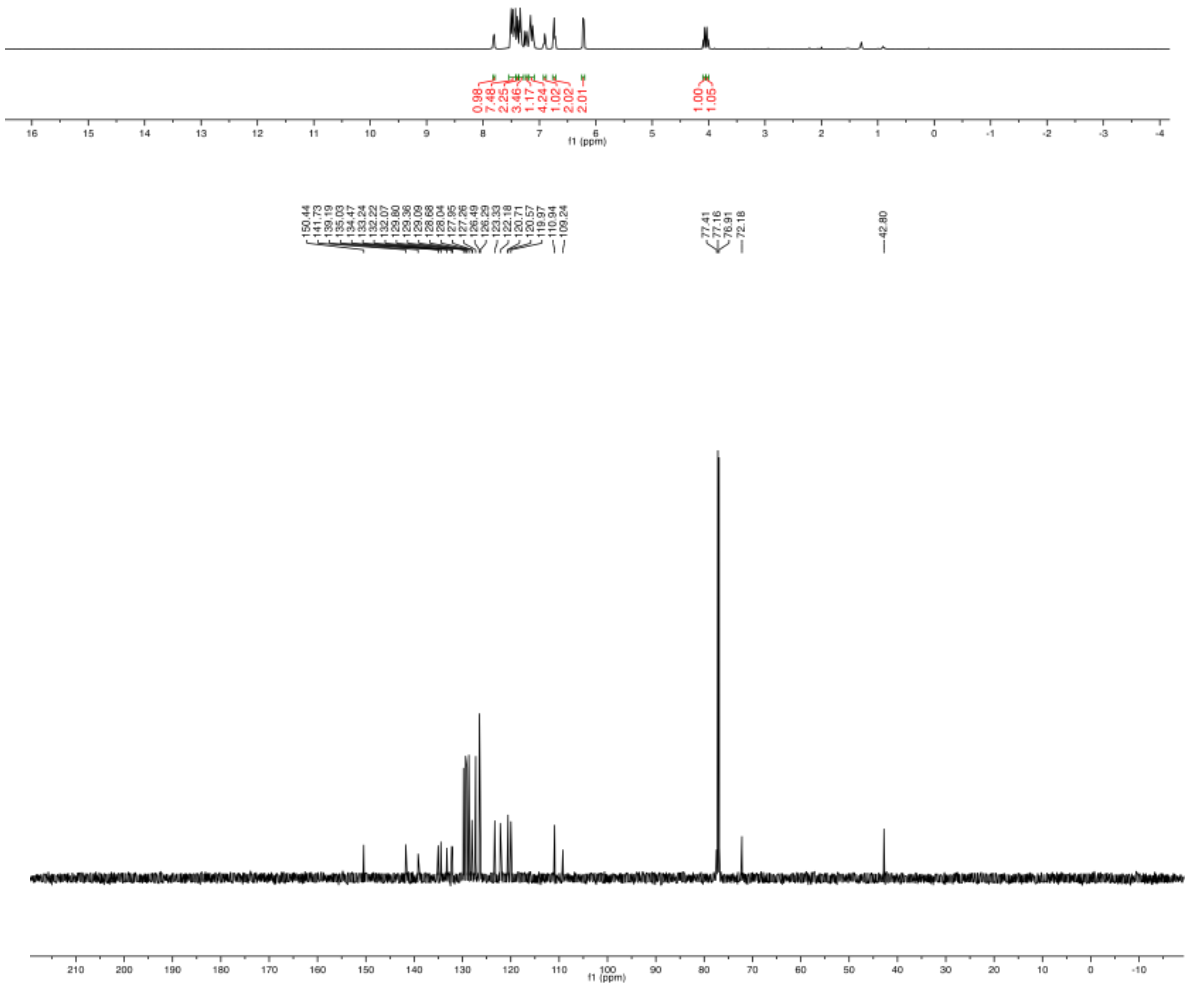
147.33
142.13
140.34
136.95
130.42
127.83
127.37
127.05
126.33
125.64
120.07
110.31
106.63
77.41
77.16 Chloroform-d
76.91
56.52
44.83
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

5oa





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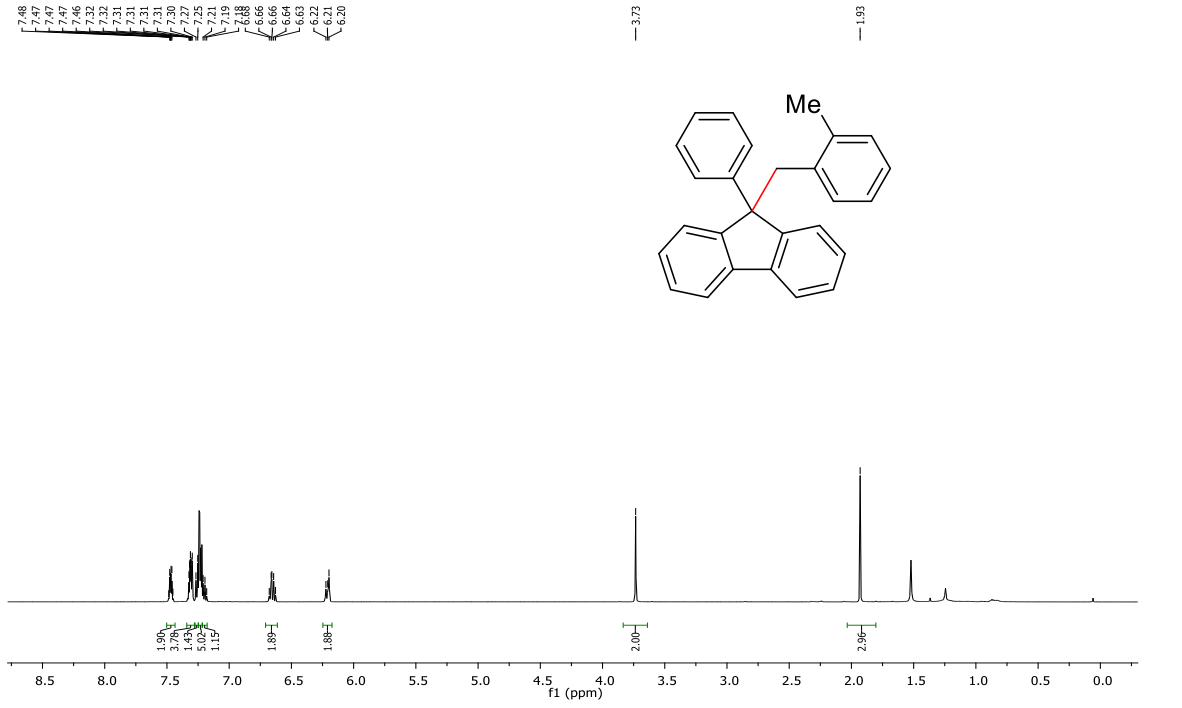
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7.47
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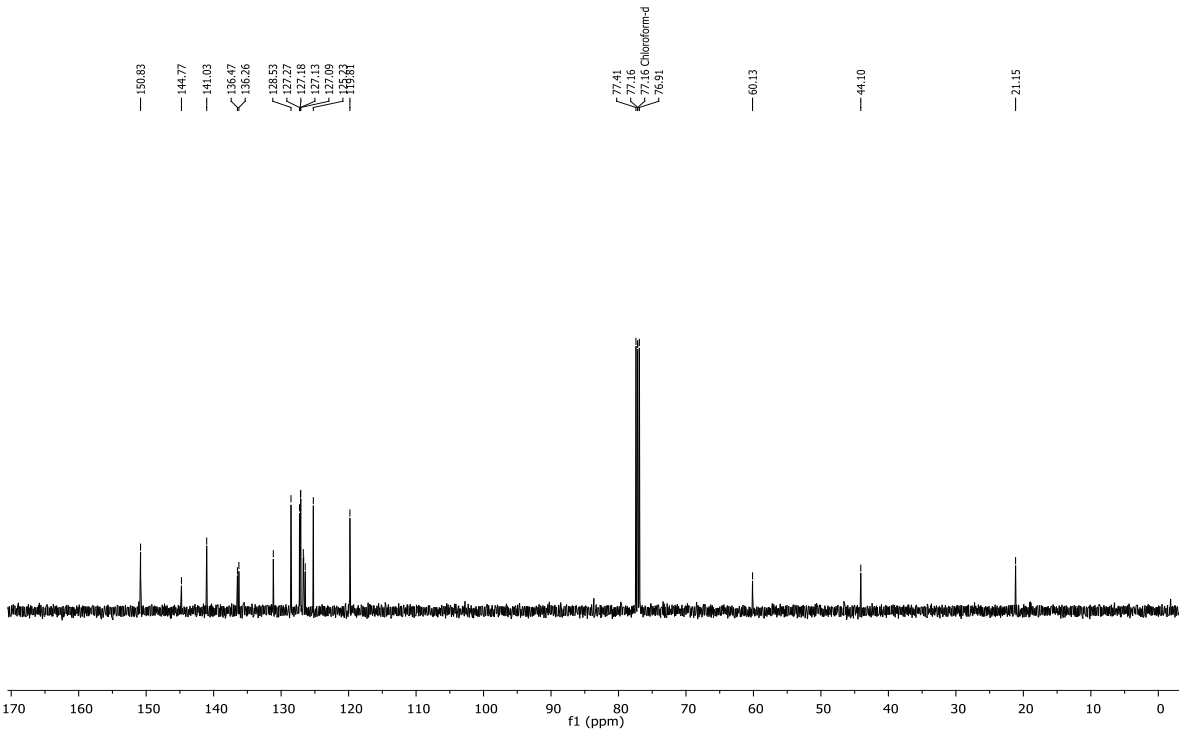
7.47
7.46
7.32
7.32
7.31
7.31
7.31
7.31
7.30
7.27
7.25
7.21
7.19
7.18
6.68
6.66
6.66
6.64
6.63
6.22
6.21
6.20
3.73
1.93
Me
1.90
3.78
1.43
5.02
1.15
1.89
1.88
2.00
2.96
f1 (ppm)


150.83
144.77
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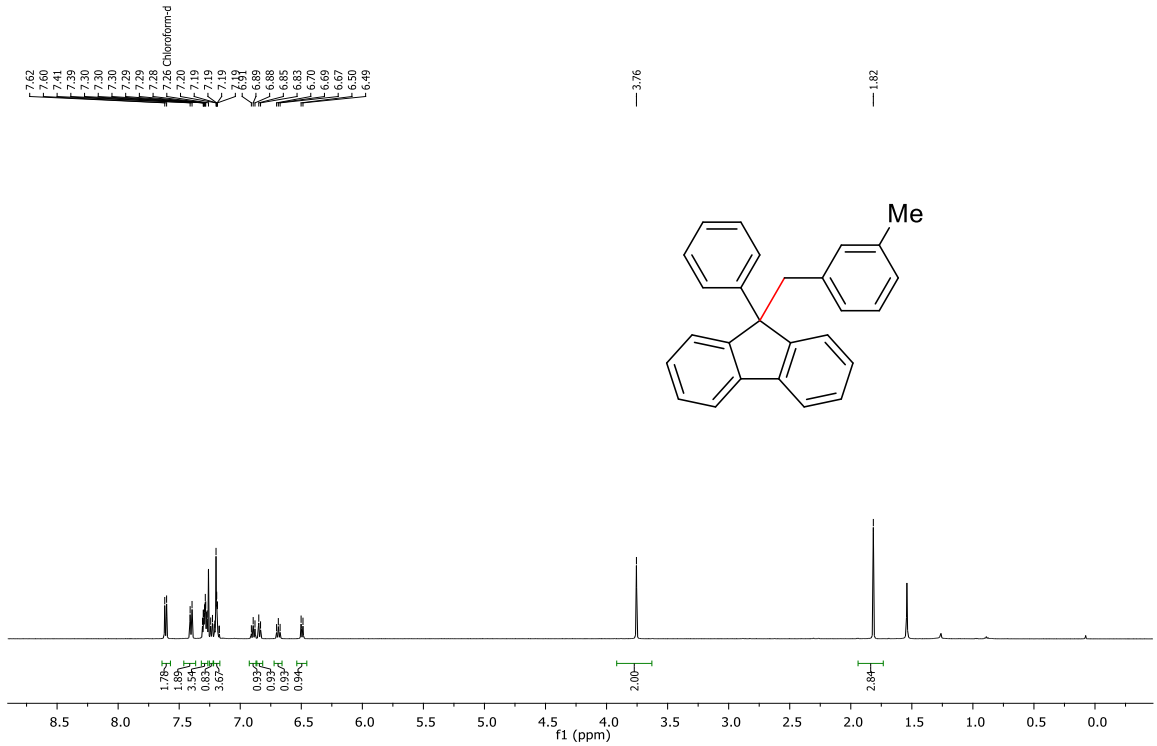
136.47
136.26
128.53
127.27
127.18
127.13
127.09
125.23
119.81
77.41
77.16
77.16 Chloroform-d
76.91
60.13
44.10
21.15
f1 (ppm)

5ac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7.41
7.39
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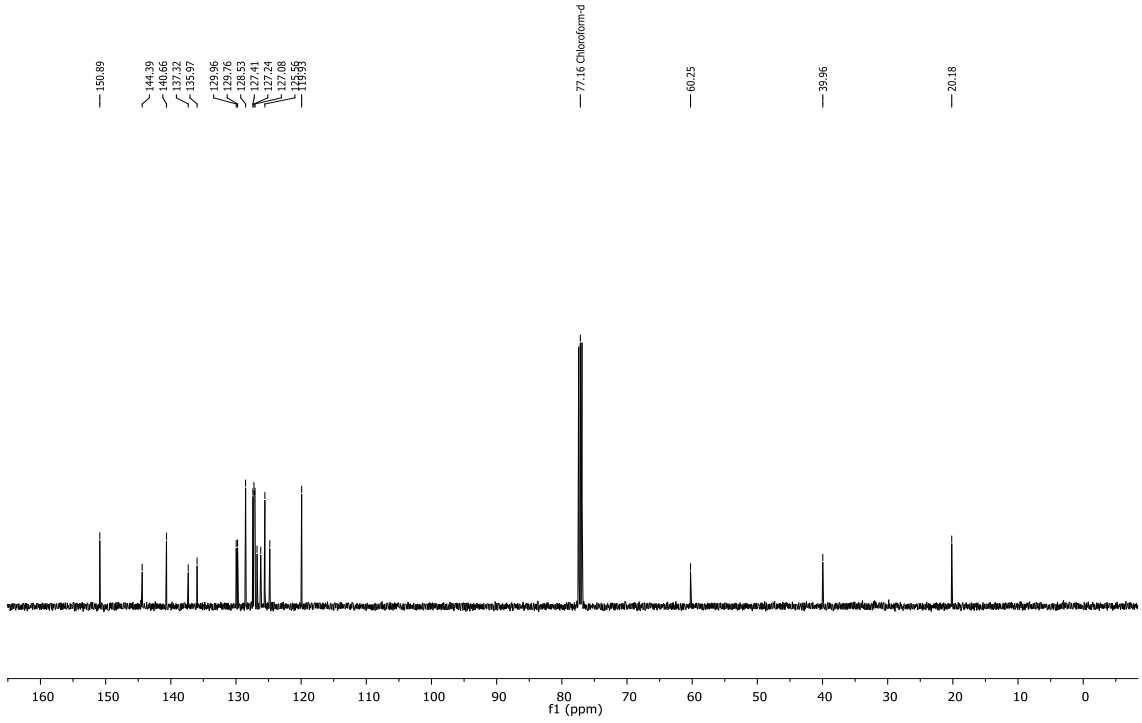
7.30
7.30
7.29
7.29
7.28
Chloroform-d
7.26
7.20
7.19
7.19
7.19
7.19
6.91
6.89
6.88
6.85
6.83
6.70
6.69
6.67
6.50
6.49
3.76
1.82
Me
1.78
1.89
3.54
0.83
3.67
0.93
0.93
0.92
0.94
2.00
2.84
f1 (ppm)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144.39
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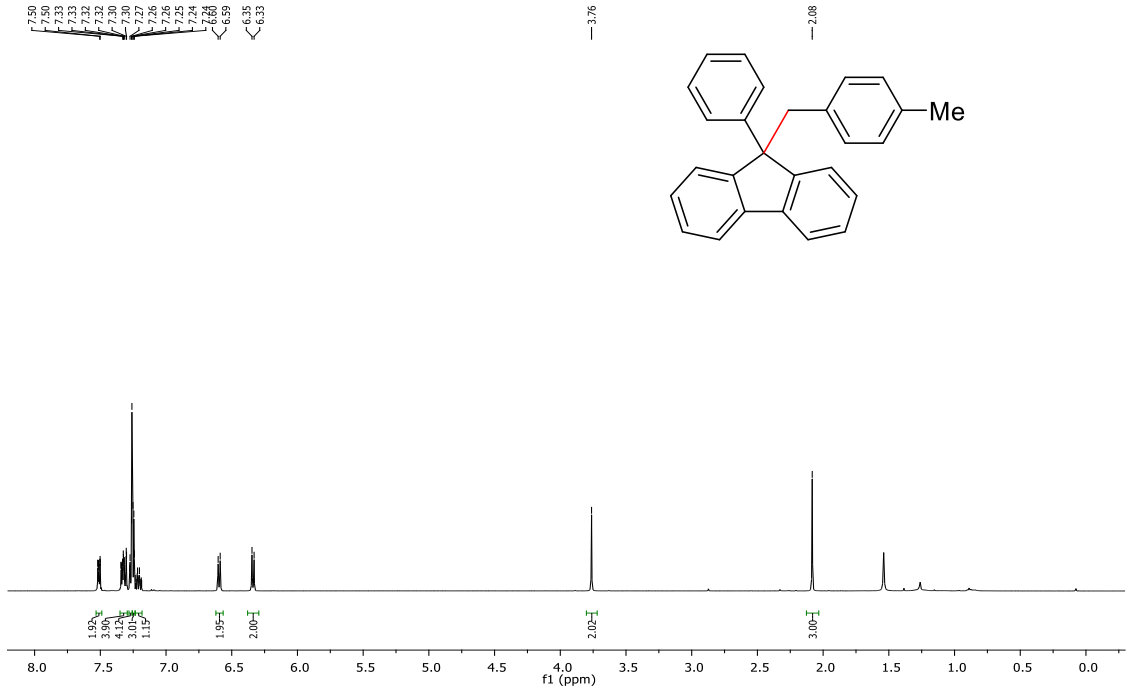
137.32
135.97
129.96
129.76
128.53
127.41
127.24
127.08
125.55
119.95
77.16 Chloroform-d
60.25
39.96
20.18
f1 (ppm)

5ad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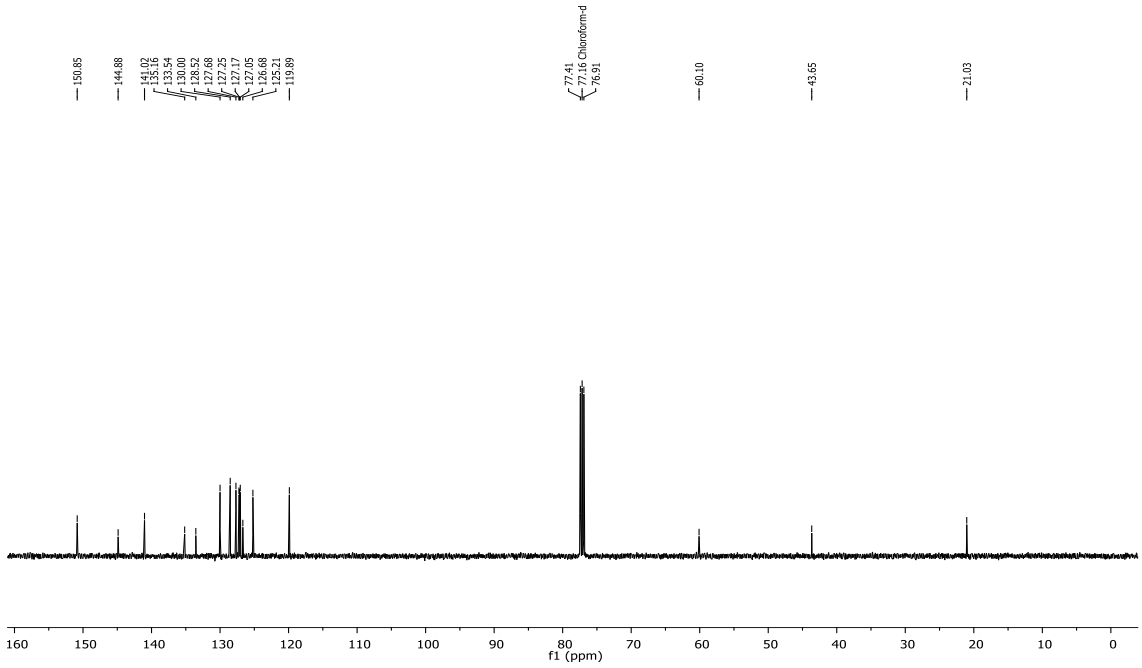
7.33
7.33
7.32
7.32
7.30
7.30
7.27
7.26
7.26
7.25
7.24
7.24
6.60
6.59
6.35
6.33
3.76
2.08
Me
1.92
3.90
4.15
3.01
1.15
1.95
2.00
2.02
3.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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127.68
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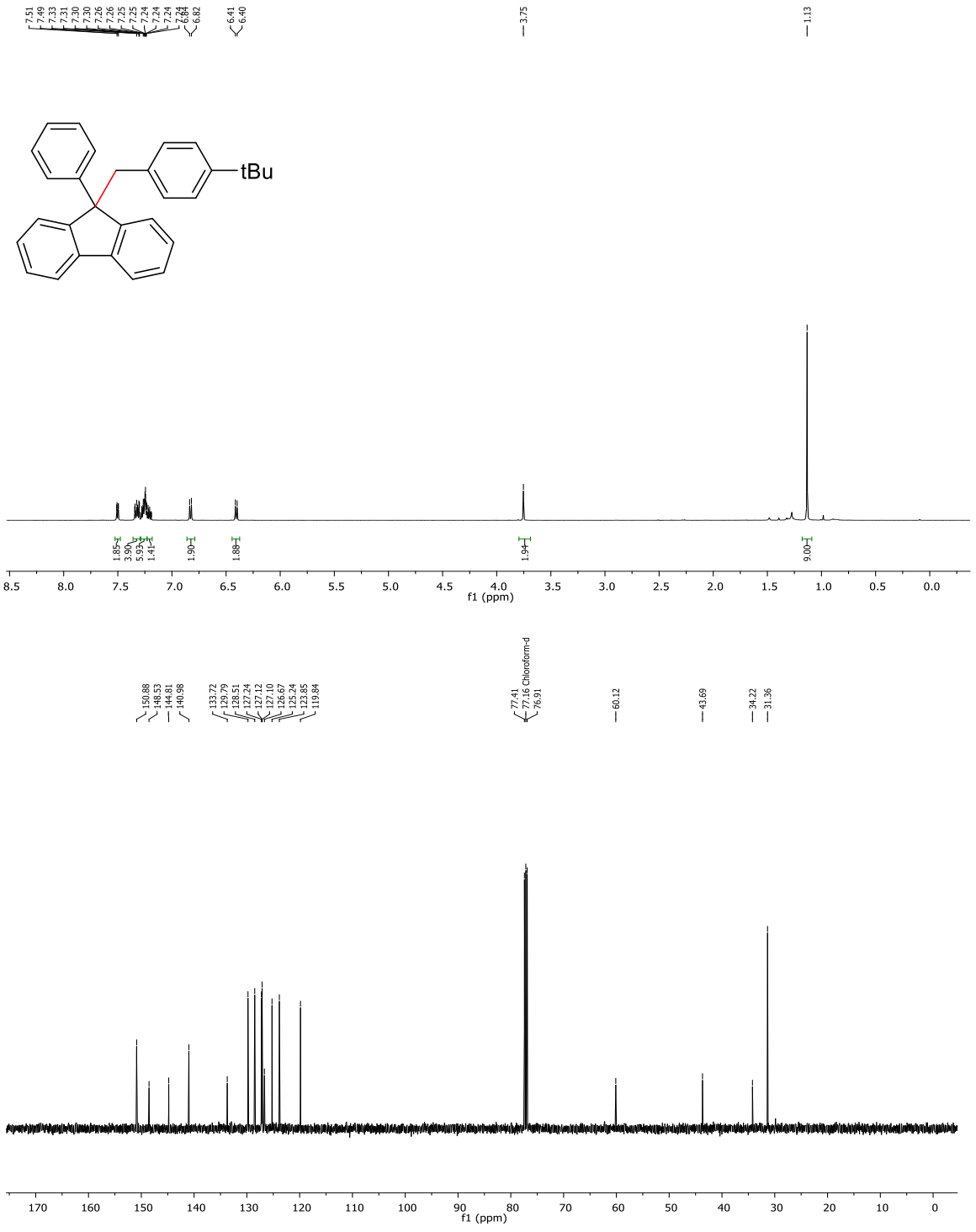
127.17
127.05
126.68
125.21
119.89
77.41
77.16 Chloroform-d
76.91
60.10
43.65
21.03
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

5ae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7.30
7.30
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7.26
7.25
7.25
7.24
7.24
7.24
6.84
6.82
6.41
6.40
3.75
1.13
tBu
1.85
3.90
5.93
1.41
1.90
1.88
1.94
9.00
f1 (ppm)
150.88
148.53
144.81
140.98
133.72
129.79
128.51
127.24
127.12
127.10
126.67
125.24
123.85
119.84
77.41
77.16 Chloroform-d
76.91
60.12
43.69
34.22
31.36
f1 (ppm)

5af


7.51
7.51
7.50
7.49
7.49
7.33
7.32
7.31
7.31
7.28
7.27
7.26
7.26
7.25
7.25
7.24
7.24
7.24
7.22
7.21
7.19
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6.38
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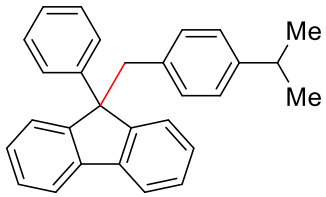
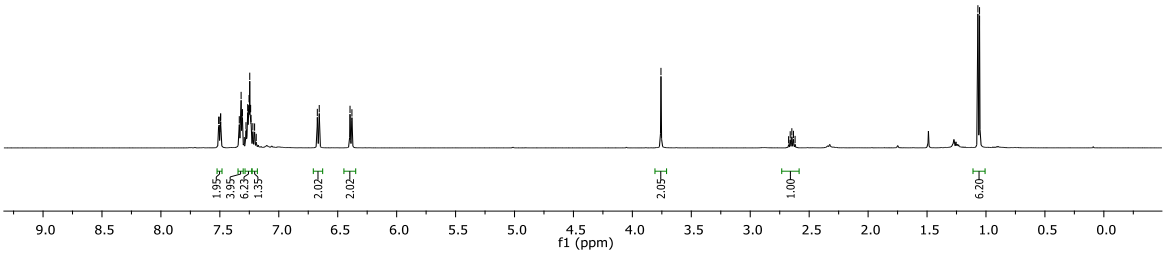
2.66
2.65
2.63
2.62
1.07
1.05


Me
Me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3.95
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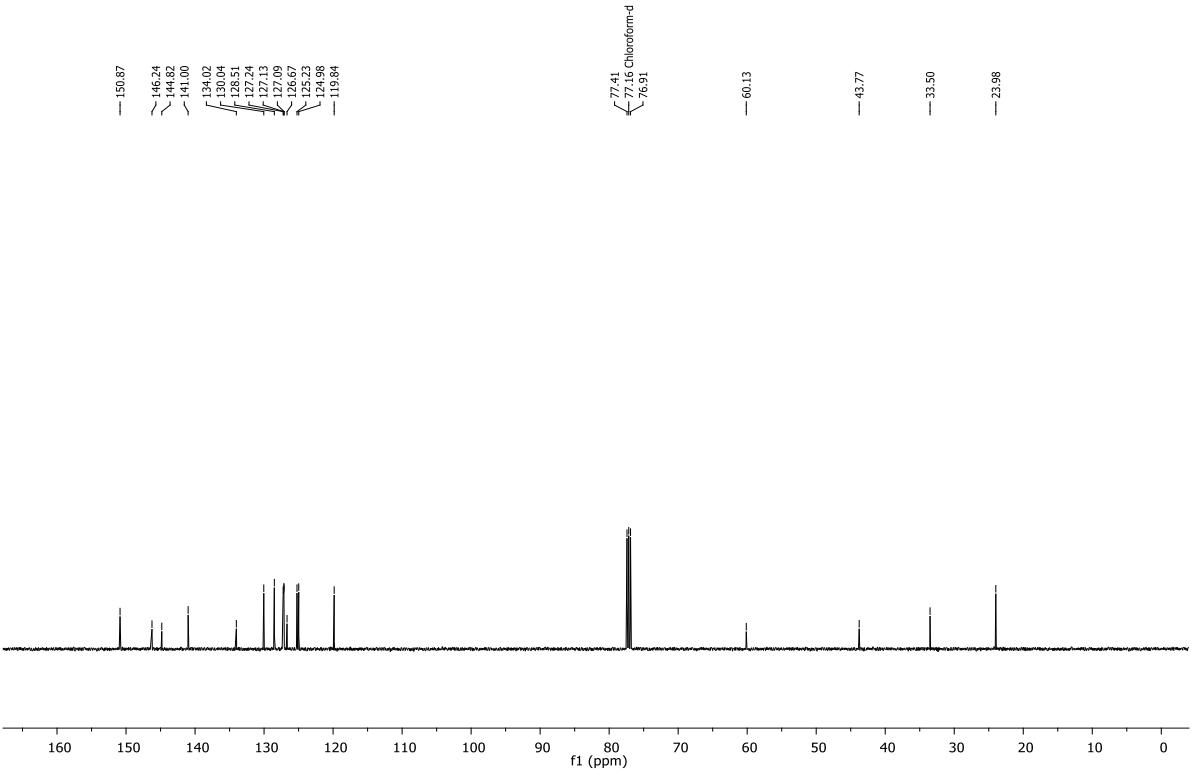
1.35
2.02
2.02
2.05
1.00
6.20
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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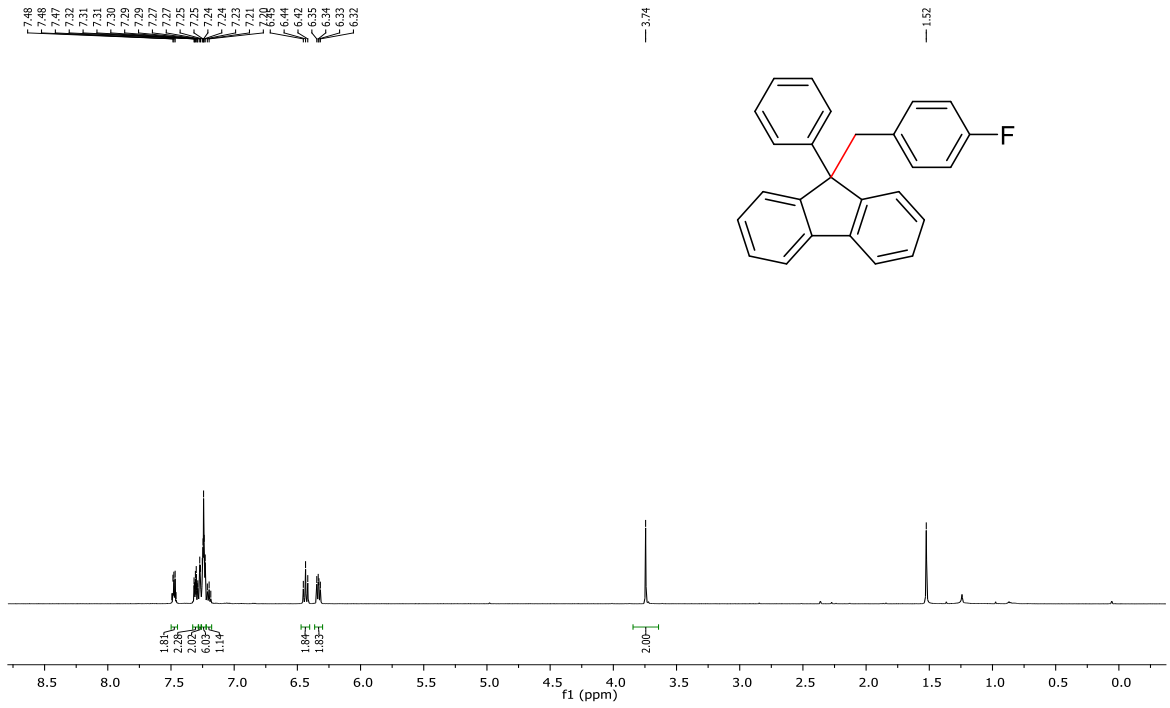
134.02
130.04
128.51
127.24
127.13
127.09
126.67
125.23
124.98
119.84
77.41
77.16 Chloroform-d
76.91
60.13
43.77
33.50
23.98
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

5ag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7.29
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7.27
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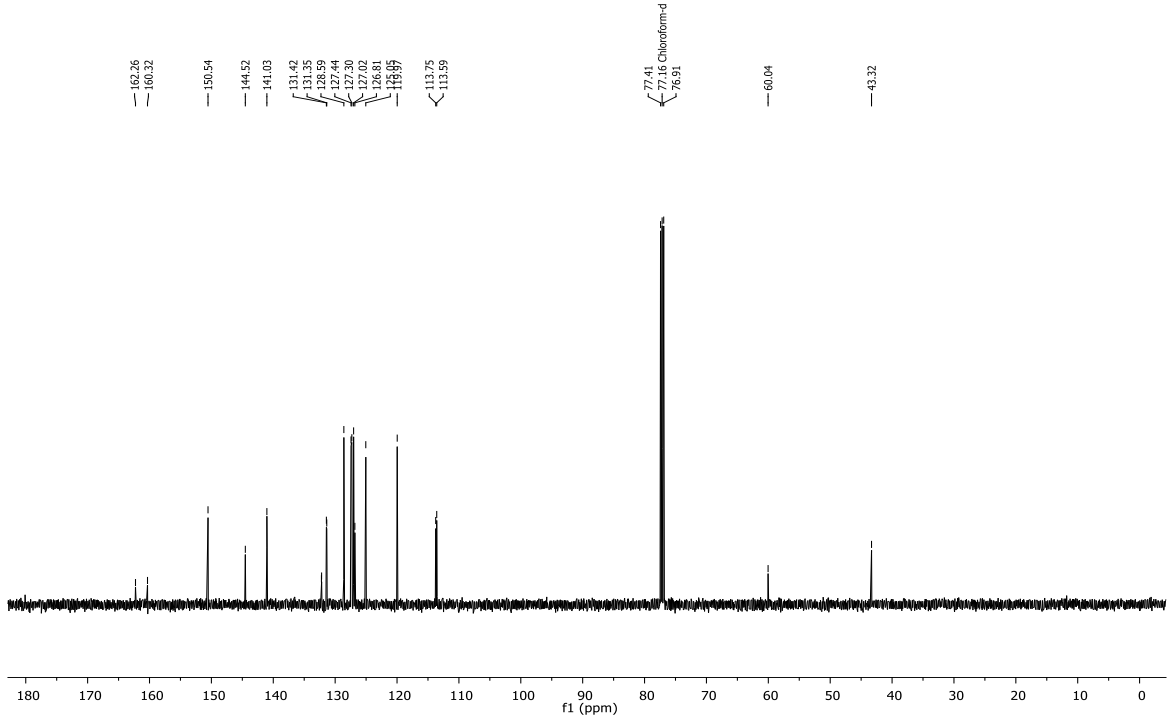
7.25
7.24
7.24
7.23
7.21
7.20
6.45
6.44
6.42
6.35
6.34
6.33
6.32
3.74
1.52
F
1.81
2.26
2.02
6.03
1.14
1.84
1.83
2.00
f1 (ppm)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127.02
126.81
125.05
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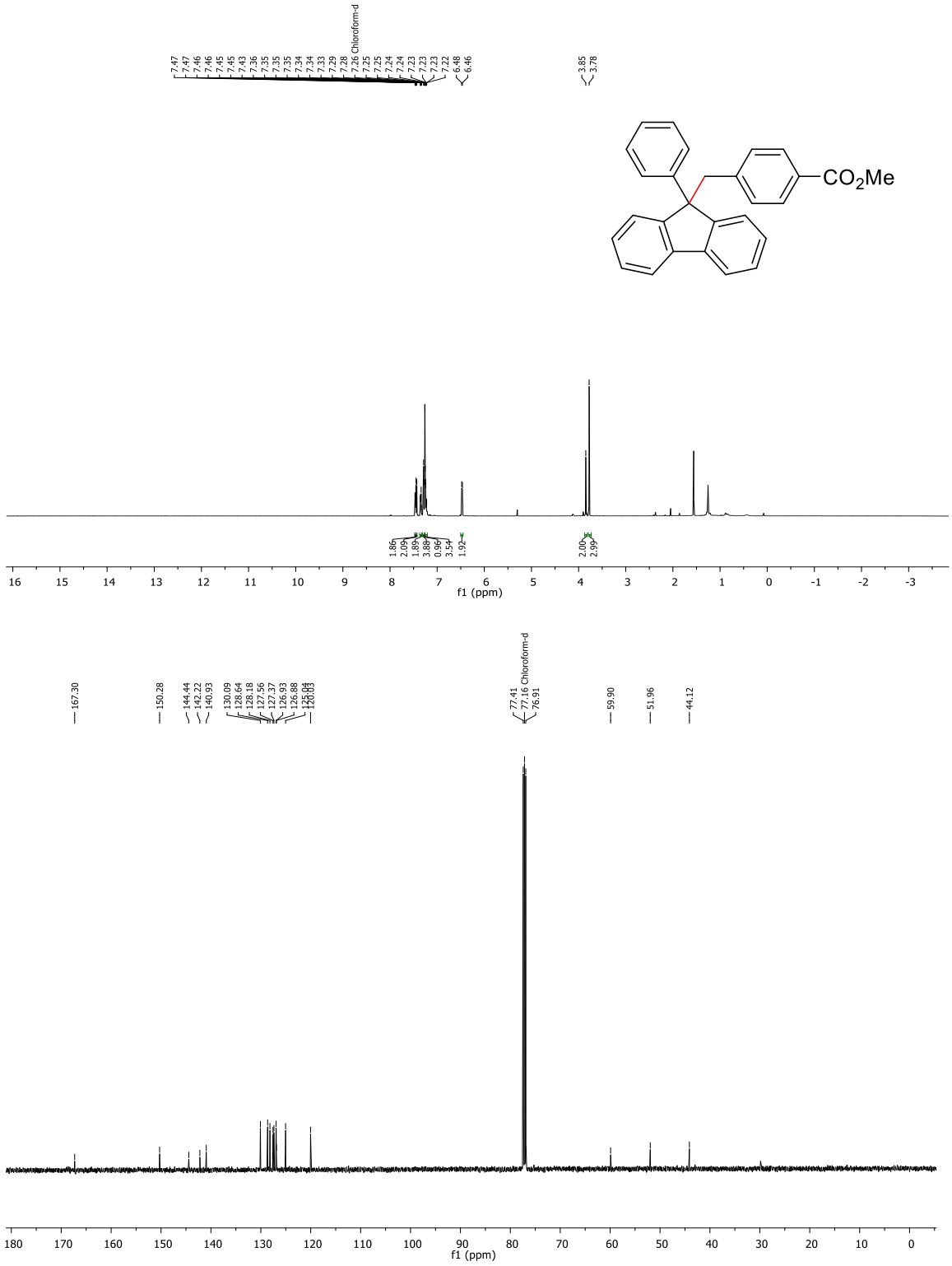
113.59
77.41
77.16 Chloroform-d
76.91
60.04
43.32
f1 (ppm)

5ah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7.35
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7.34
7.34
7.33
7.29
7.28
7.26 Chloroform-d
7.25
7.25
7.24
7.24
7.23
7.23
7.23
7.22
6.48
6.46
3.85
3.78
CO2Me
1.86
2.04
3.88
0.96
3.54
1.92
2.00
2.99
f1 (ppm)
167.30
150.28
144.44
142.22
140.93
130.09
128.64
128.18
127.56
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126.93
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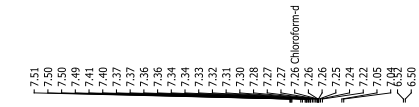
77.41
77.16 Chloroform-d
76.91
59.90
51.96
44.12
f1 (ppm)

5ai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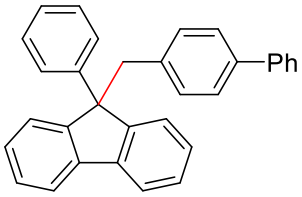
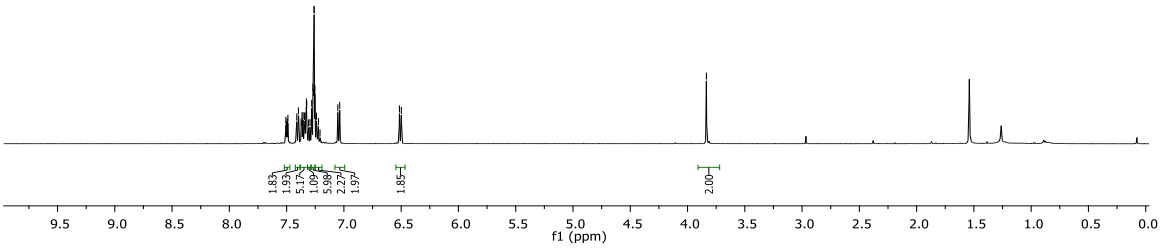
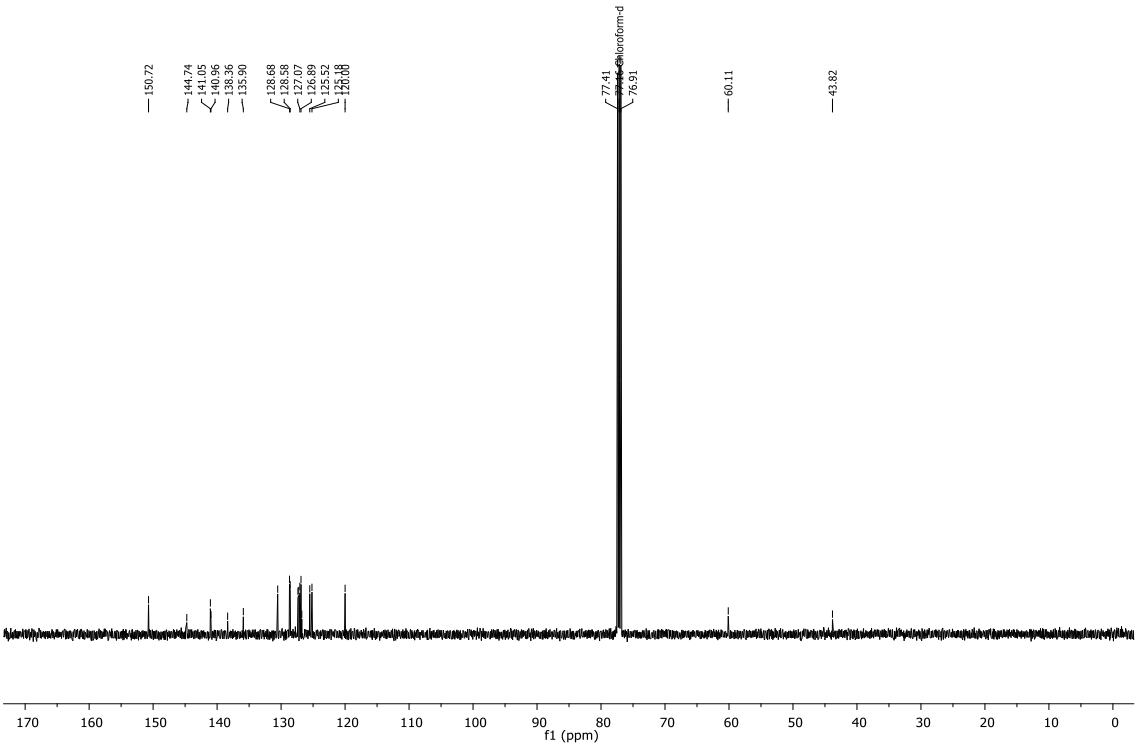
7.36
7.34
7.34
7.33
7.32
7.31
7.30
7.28
7.27
7.26 Chloroform-d
7.26
7.25
7.24
7.22
7.05
6.52
6.50

3.84


Ph


1.83
1.93
5.17
1.09
5.98
2.27
1.97
1.85
2.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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144.74
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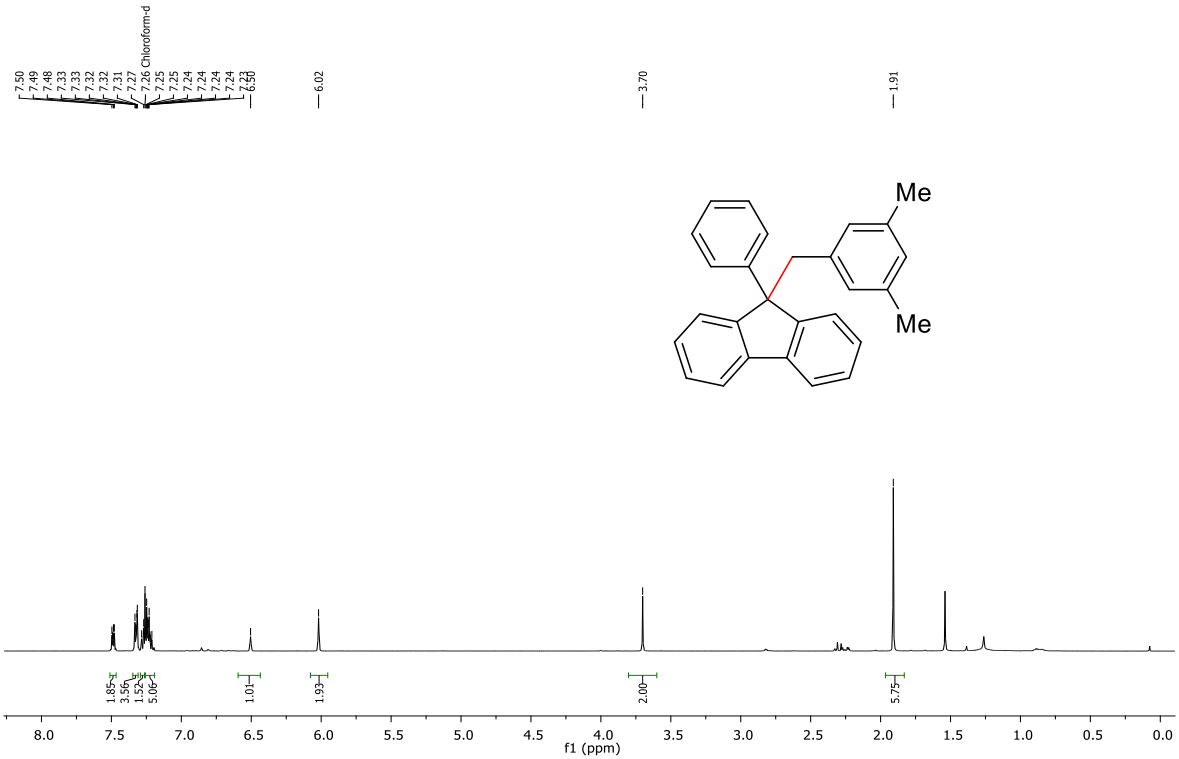
138.36
135.90
128.68
128.58
127.07
126.89
125.52
125.18
120.08
77.41
77.16 Chloroform-d
76.91
60.11
43.82
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

5aj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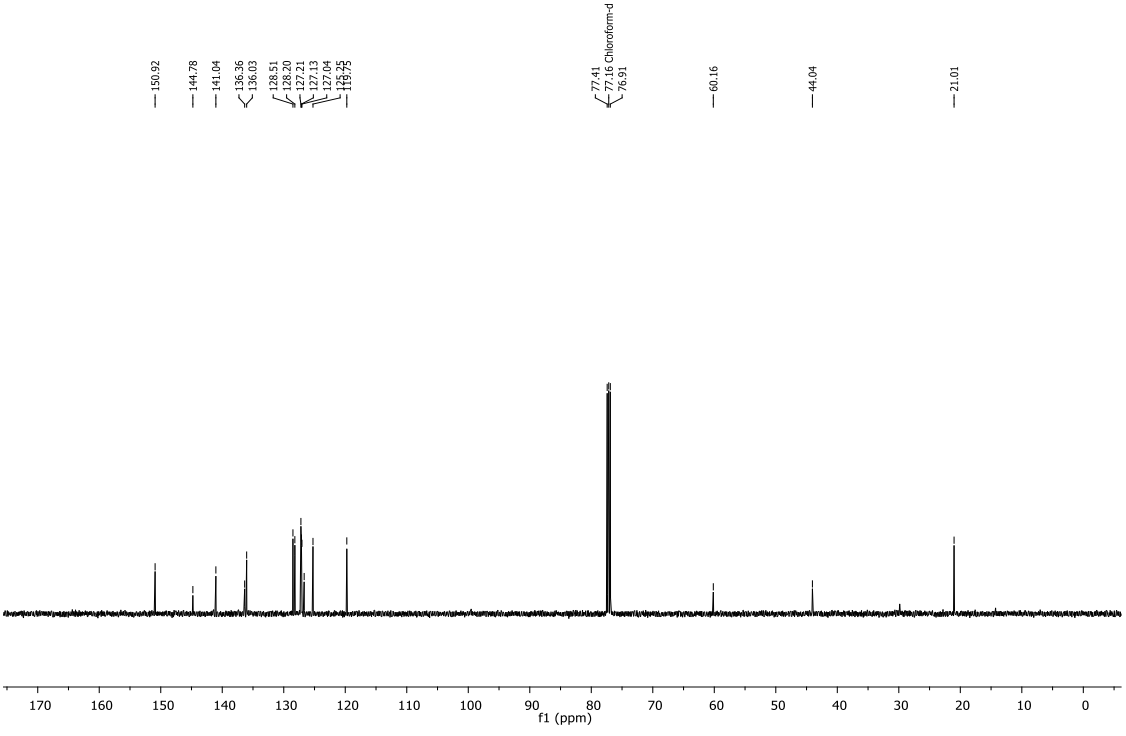
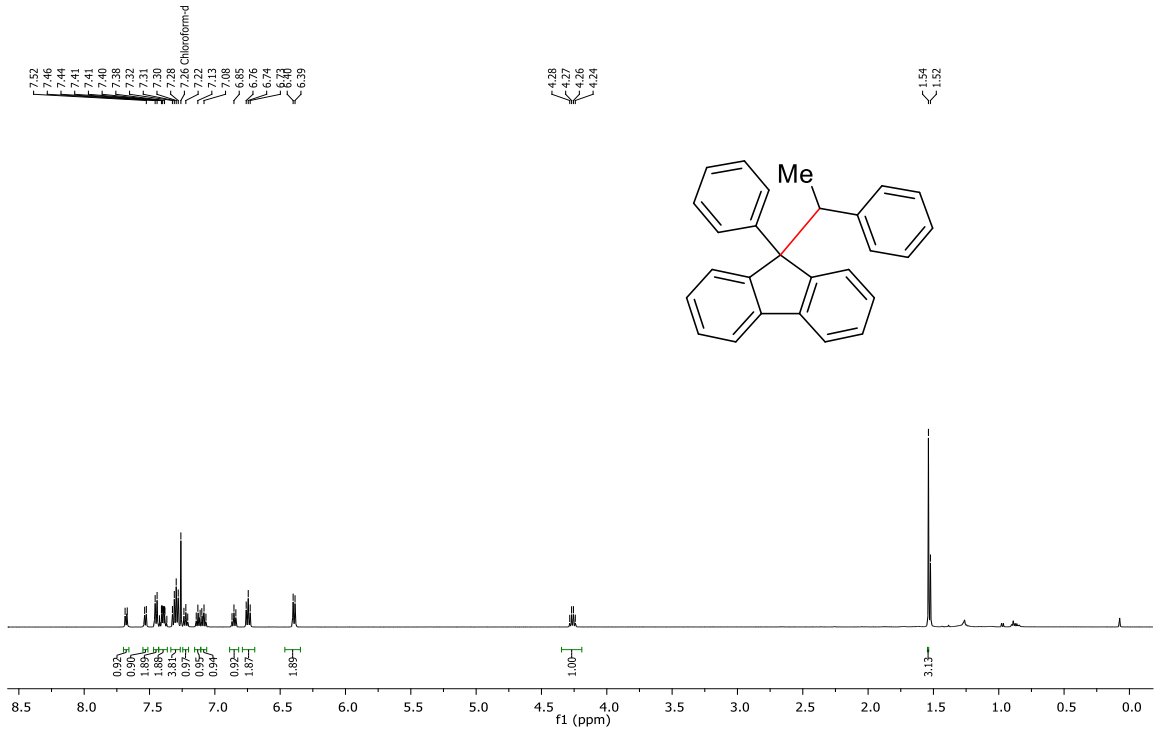
7.33
7.32
7.32
7.31
7.27
7.26 Chloroform-d
7.25
7.25
7.24
7.24
7.24
7.24
7.23
6.50
6.02
3.70
1.91
Me
Me
1.85
3.56
1.52
5.06
1.01
1.93
2.00
5.75
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


150.92
144.78
141.04
136.36
136.03
128.51
128.20
127.21
127.13
127.04
125.25
119.75
77.41
77.16 Chloroform-d
76.91
60.16
44.04
21.01
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

5ak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7.46
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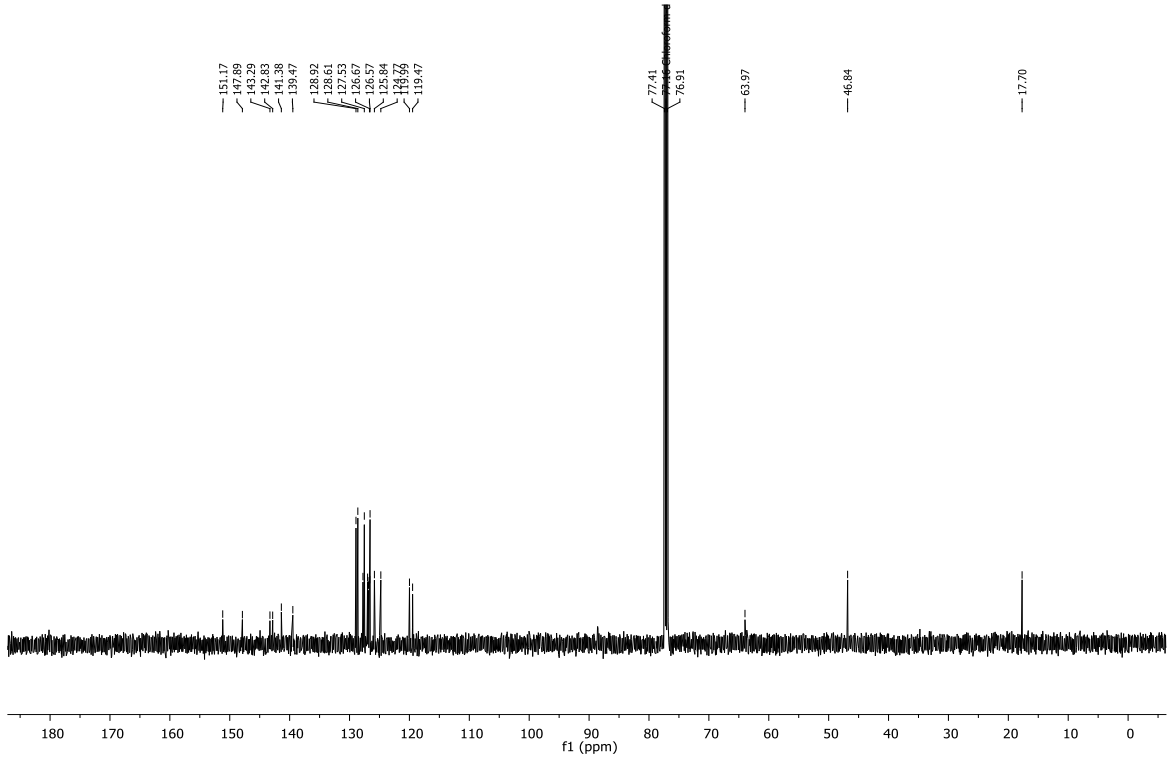
7.41
7.41
7.40
7.38
7.32
7.31
7.30
7.28
7.26 Chloroform-d
7.22
7.13
7.08
6.85
6.76
6.74
6.40
6.39
4.28
4.27
4.26
4.24
1.54
1.52
Me
0.92
0.90
1.89
1.86
3.81
0.97
0.95
0.94
0.92
1.87
1.89
1.00
3.13
f1 (ppm)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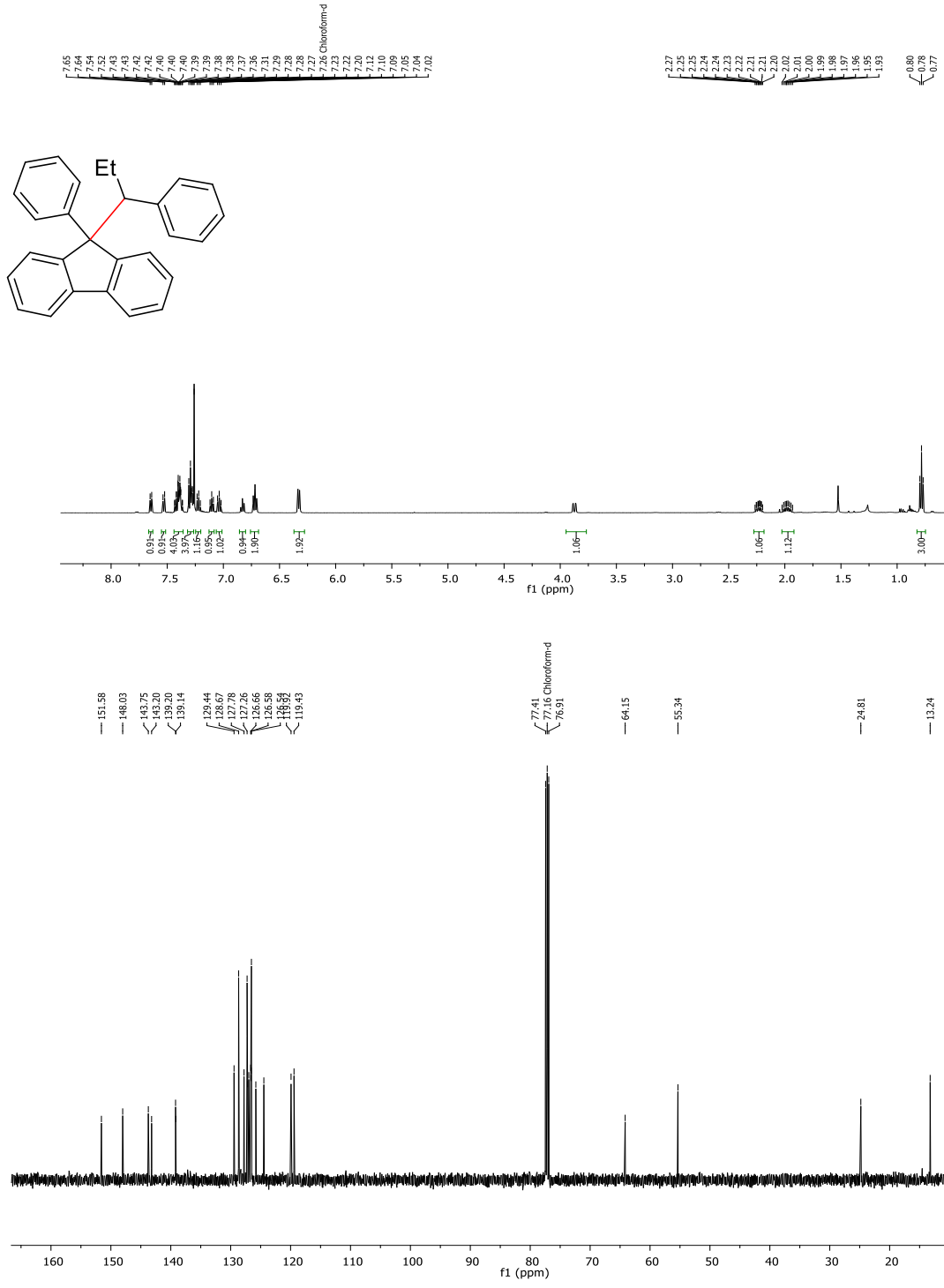
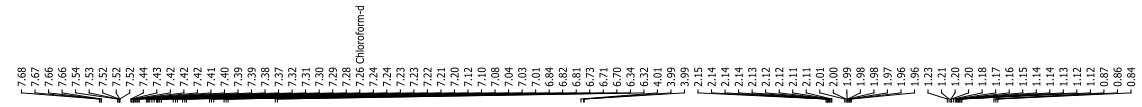
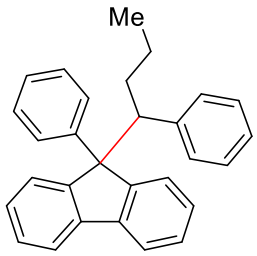
147.89
143.29
142.83
141.38
139.47
128.92
128.61
127.53
126.67
126.57
125.84
119.47
77.41
76.91
63.97
46.84
17.70
f1 (ppm)

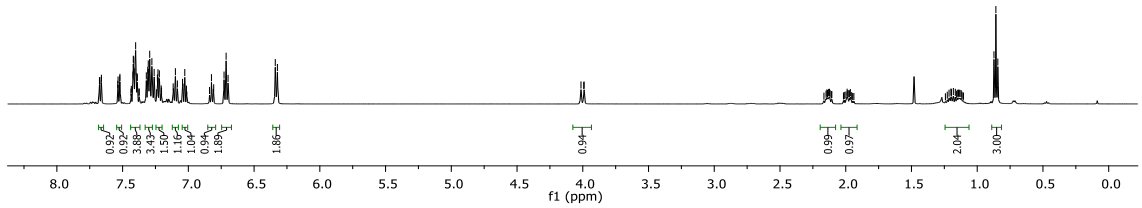
5al

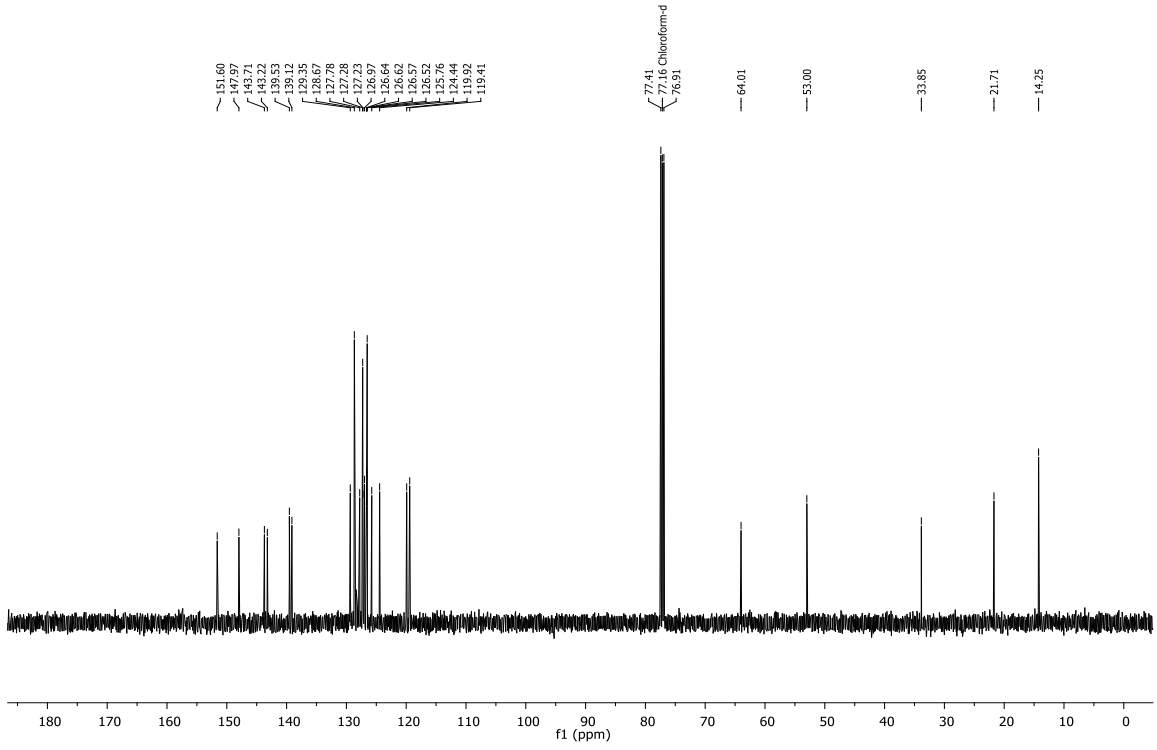


5am









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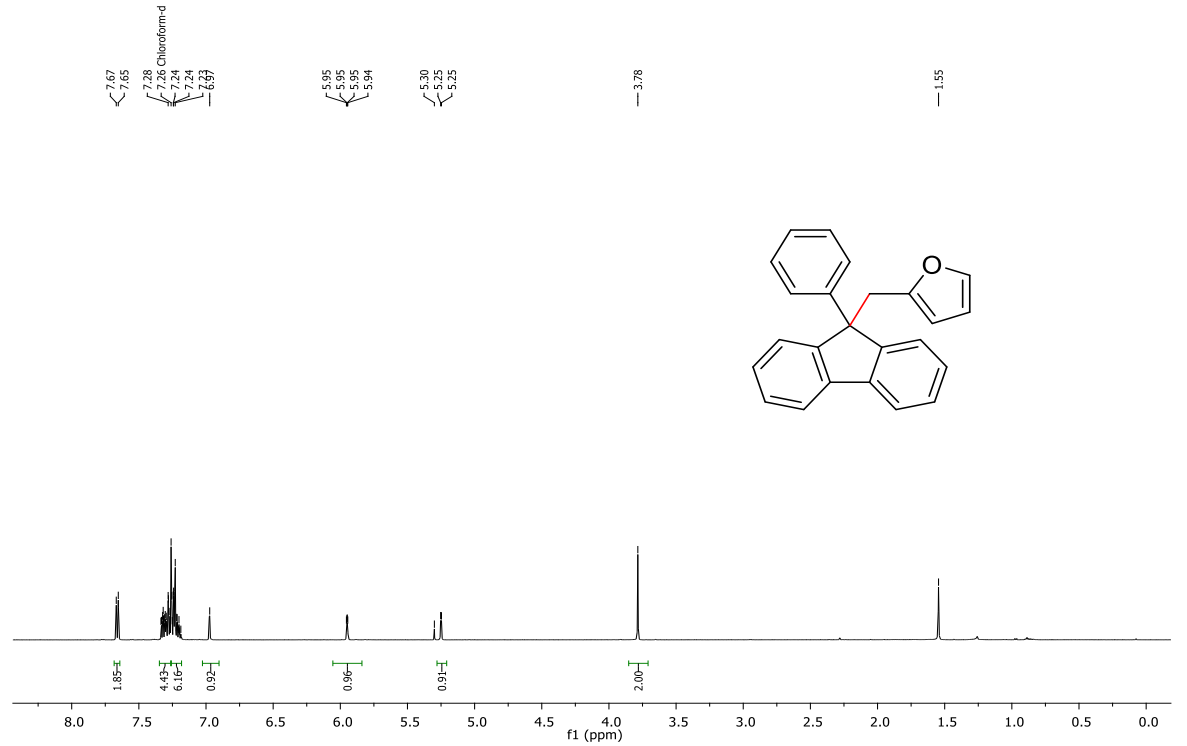
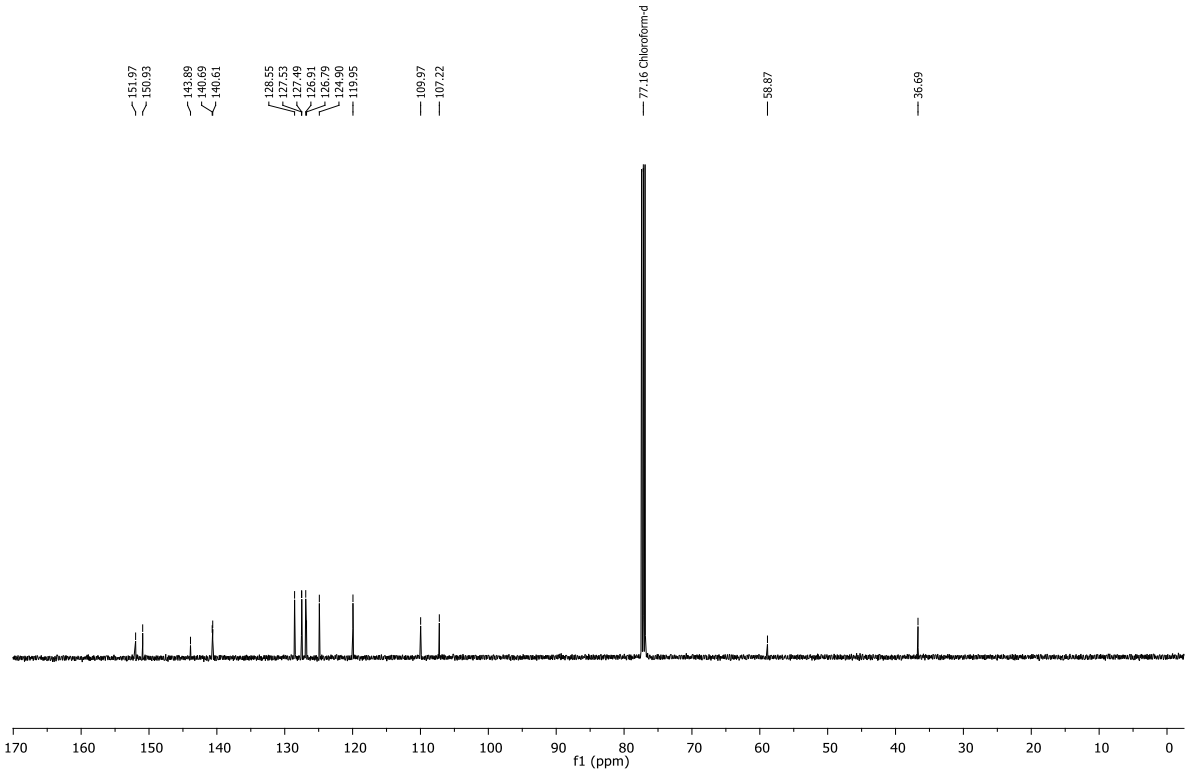

7.67
7.65
7.28
7.26 Chloroform-d
7.24
7.24
7.23
6.97
5.95
5.95
5.95
5.94
5.30
5.25
5.25
3.78
1.55
O
1.85
4.43
6.16
0.92
0.96
0.91
2.00
f1 (ppm)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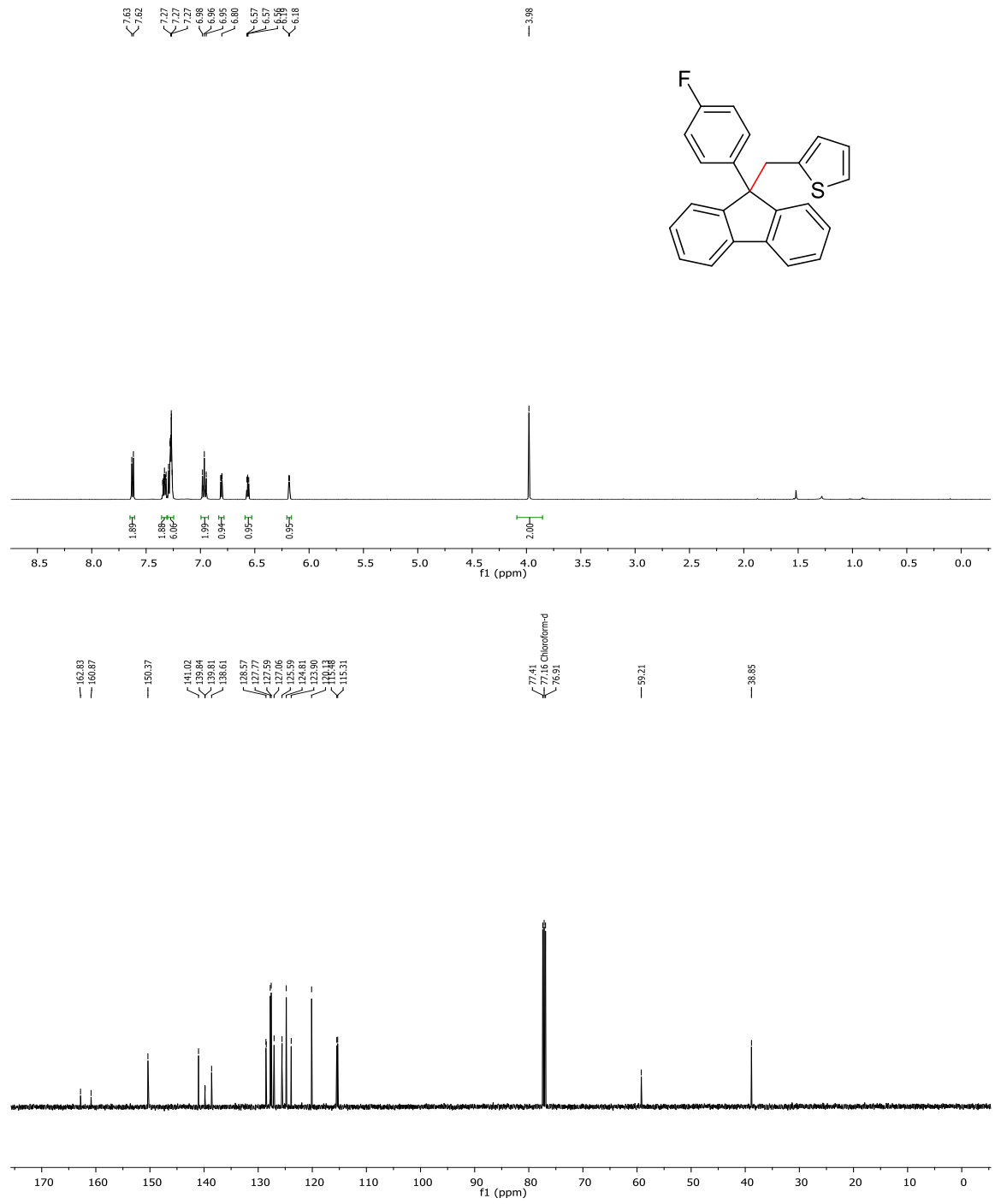
150.93
143.89
140.69
140.61
128.55
127.53
127.49
126.91
126.79
124.90
119.95
109.97
107.22
77.16 Chloroform-d
58.87
36.69
f1 (ppm)

5gq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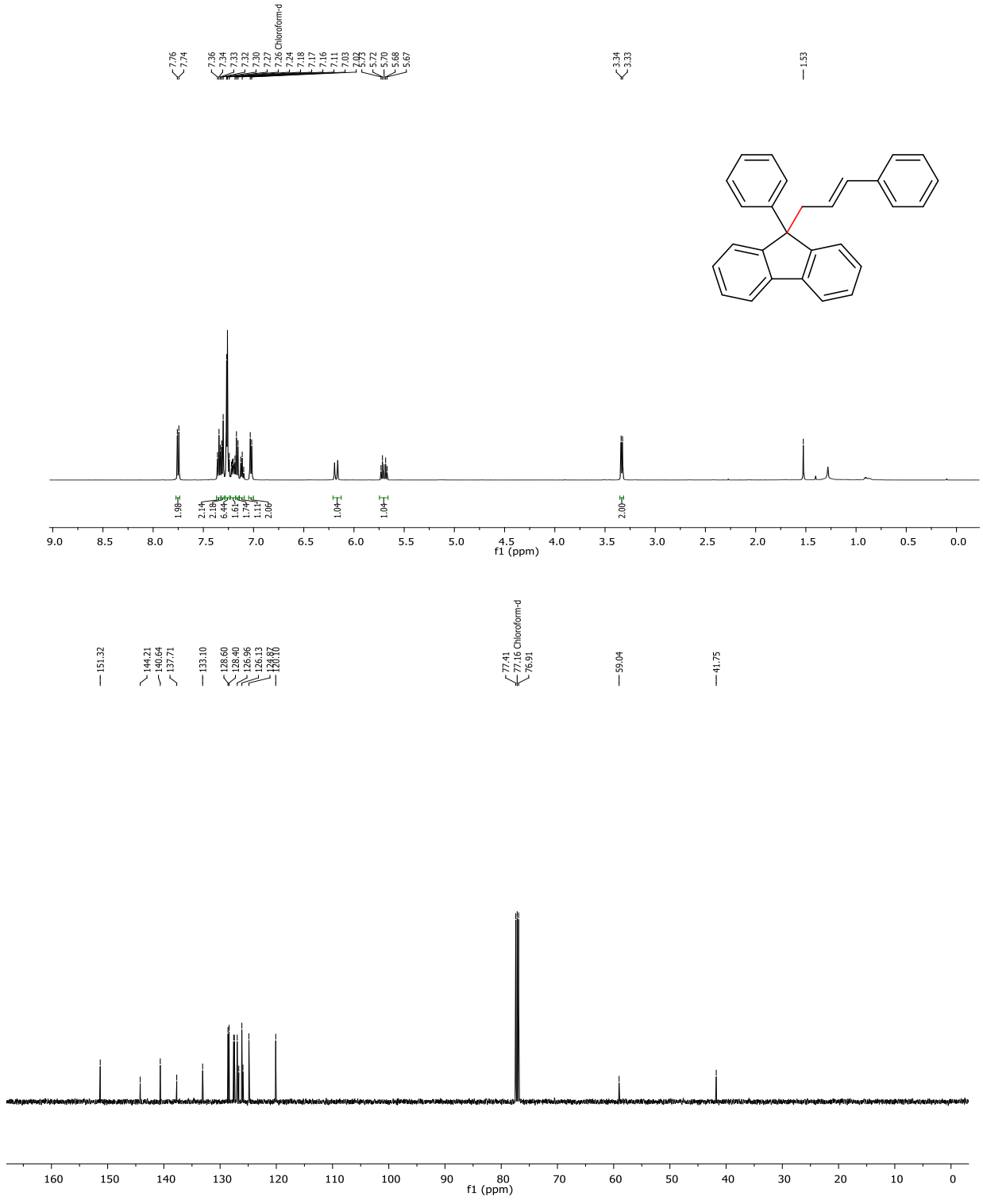
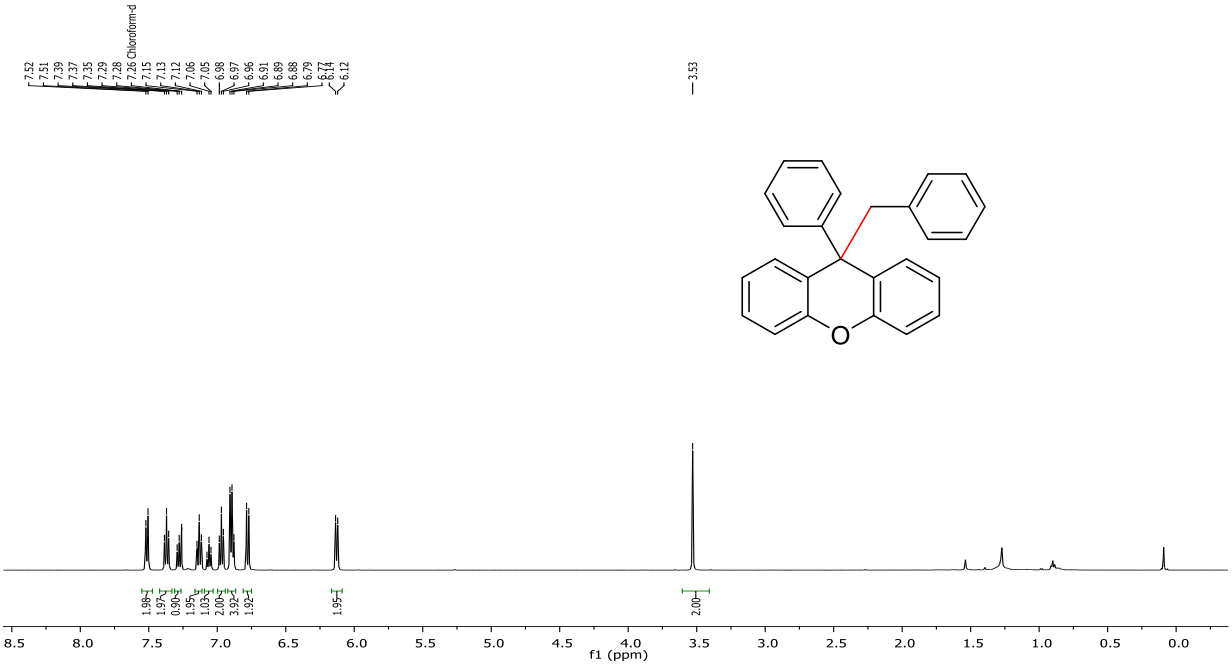
7.62
7.27
7.27
7.27
6.98
6.96
6.95
6.80
6.57
6.57
6.56
6.19
6.18
3.98
F
S
1.89
1.88
6.06
1.99
0.94
0.95
0.95
2.00
f1 (ppm)
162.83
160.87
150.37
141.02
139.84
139.81
138.61
128.57
127.77
127.59
127.06
125.59
124.81
123.90
120.13
115.48
115.31
77.41
77.16 Chloroform-d
76.91
59.21
38.85
f1 (ppm)

5ap


7.76
7.74
7.36
7.34
7.33
7.32
7.30
7.27
Chloroform-d
7.24
7.18
7.17
7.16
7.11
7.03
5.73
5.72
5.70
5.68
5.67
3.34
3.33
1.53
1.98
2.14
2.18
6.44
1.67
1.74
1.17
2.08
1.04
1.04
2.00
f1 (ppm)
151.32
144.21
140.64
137.71
133.10
128.60
128.40
126.96
126.13
77.41
77.16
Chloroform-d
76.91
59.04
41.75
f1 (ppm)

7aa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7.51
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7.28
7.26 Chloroform-d
7.15
7.13
7.12
7.06
7.05
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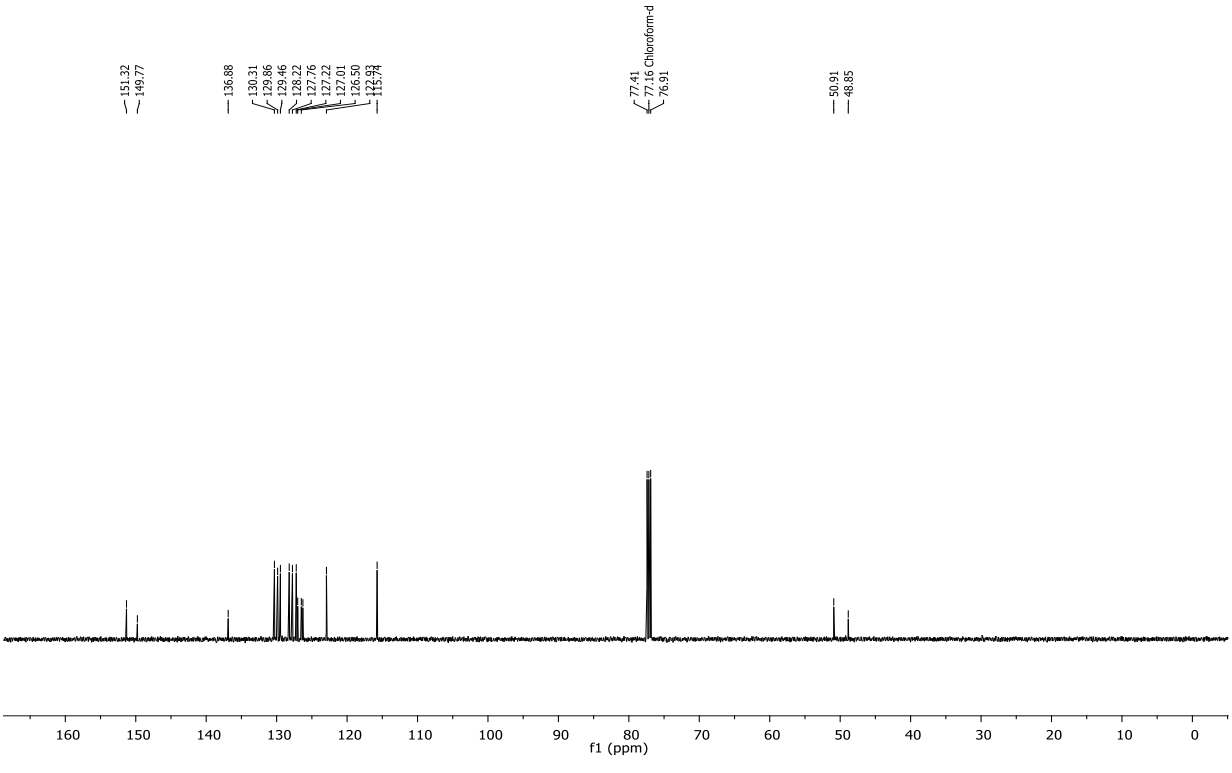
6.97
6.96
6.91
6.89
6.88
6.79
6.14
6.12
3.53
O
1.98
1.97
0.90
1.95
1.03
2.00
3.92
1.92
1.95
2.00
f1 (ppm)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129.46
128.22
127.76
127.22
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126.50
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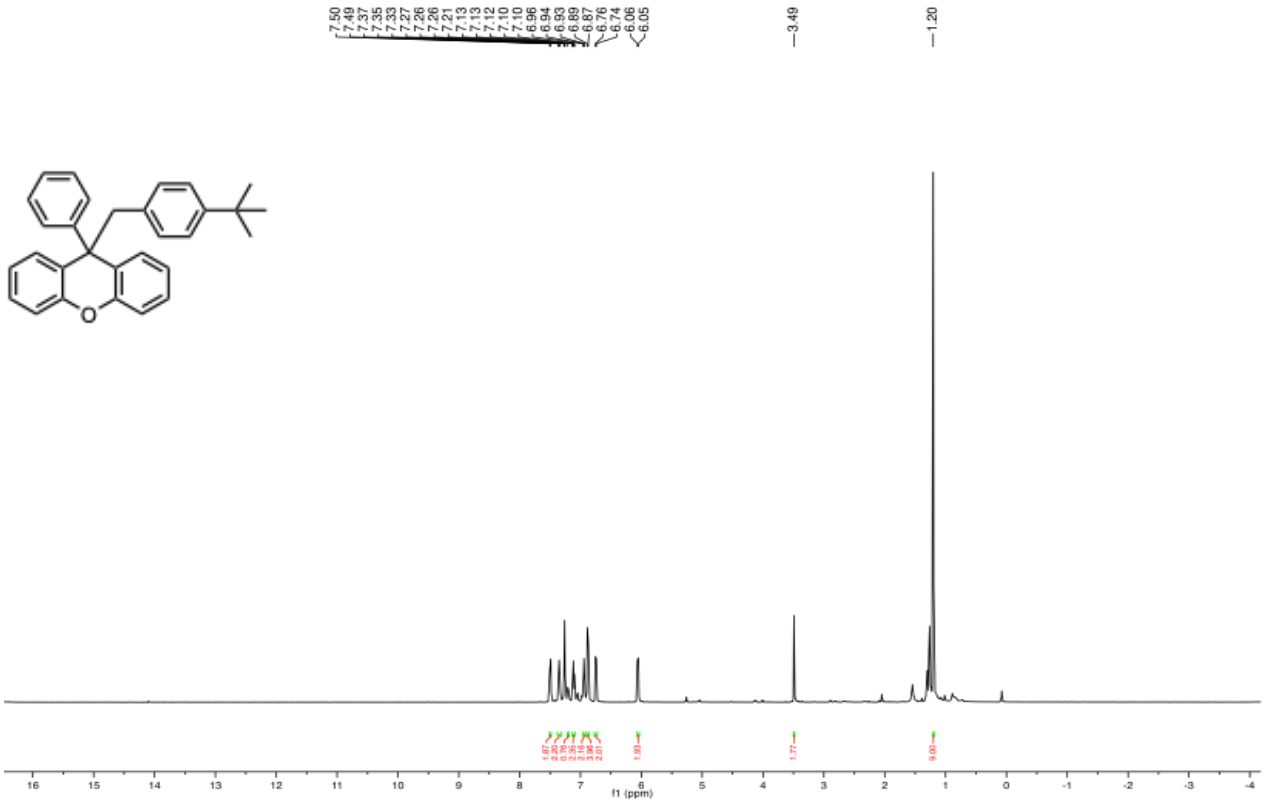
115.74
77.41
77.16 Chloroform-d
76.91
50.91
48.85
f1 (ppm)

7ab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7.37
7.35
7.33
7.27
7.26
7.26
7.21
7.13
7.13
7.12
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7.10
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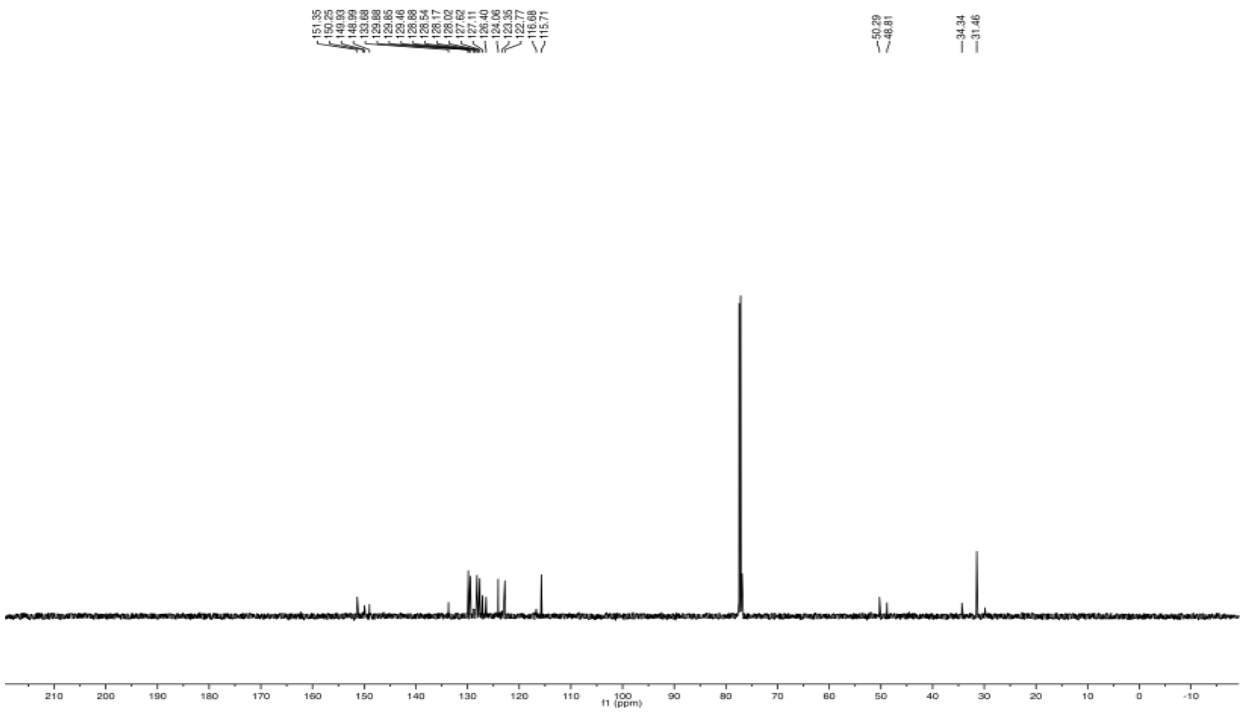
6.06
6.05
3.49
1.20
f1 (ppm)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148.99
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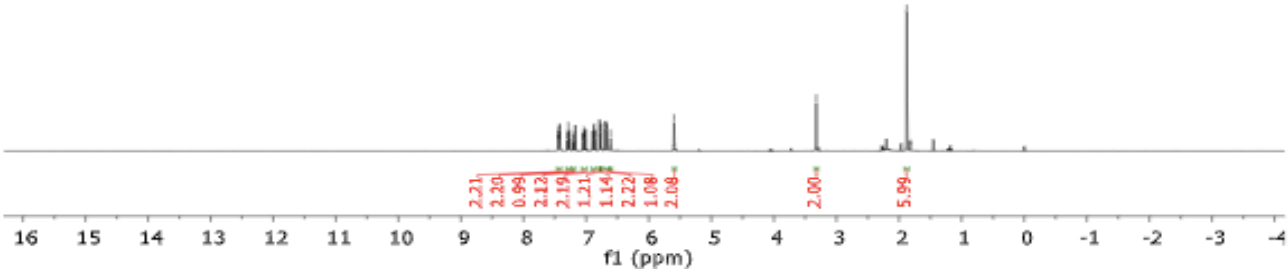
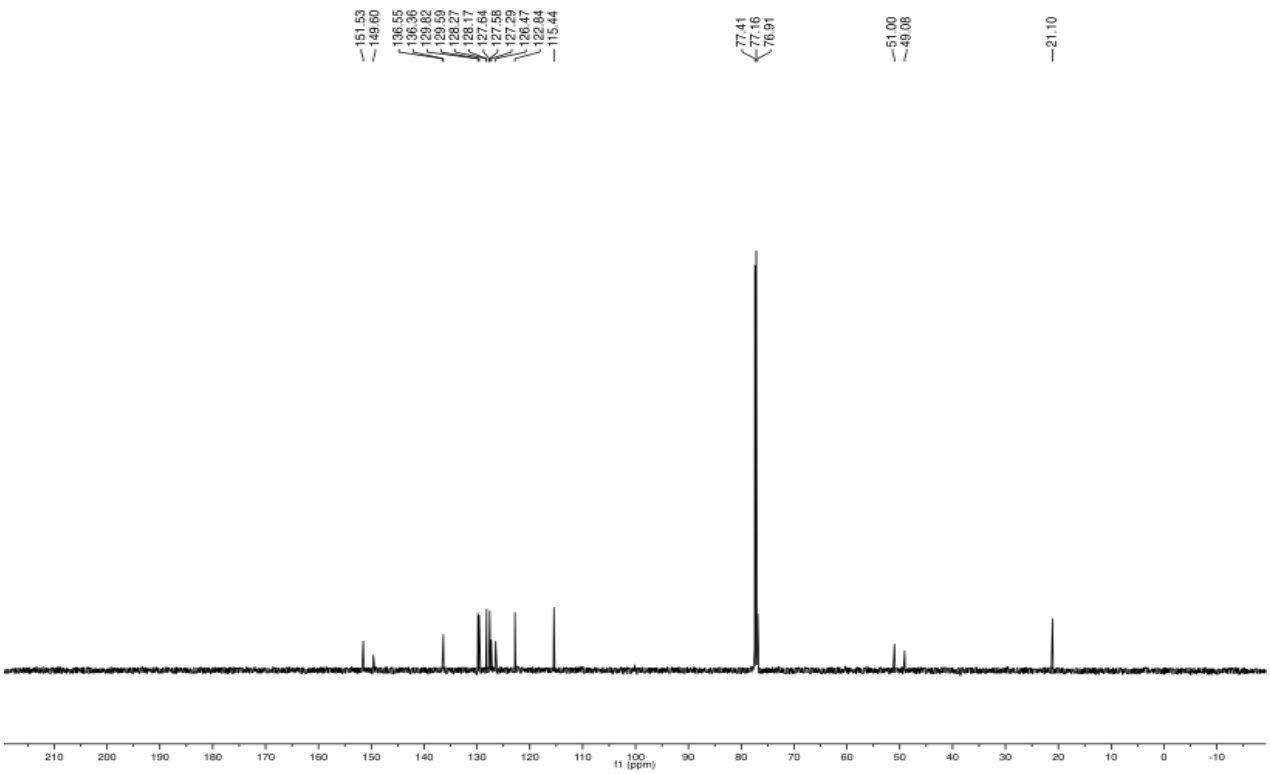
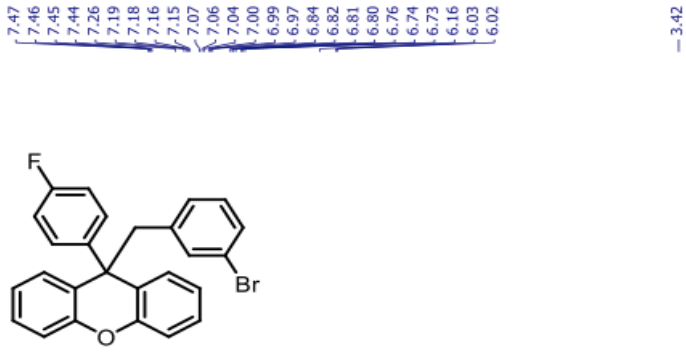
129.88
129.85
129.46
128.89
128.54
128.17
128.02
127.62
127.11
126.40
124.56
124.30
122.77
116.68
115.71
50.29
48.81
34.34
31.46
f1 (ppm)

7ac





7bd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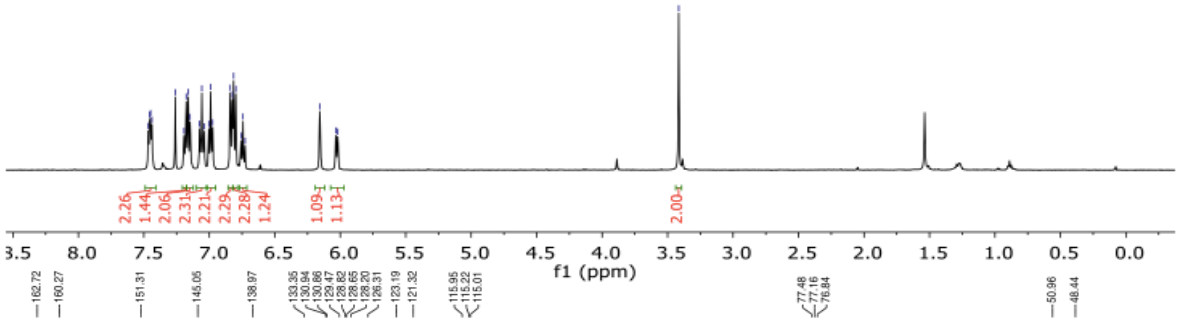
7.46
7.45
7.44
7.26
7.19
7.18
7.16
7.15
7.07
7.06
7.04
7.00
6.99
6.97
6.84
6.82
6.81
6.80
6.76
6.74
6.73
6.16
6.03
6.02
3.42

F
Br
O


2.25
1.44
2.06
2.31
2.21
2.29
2.28
1.24
1.09
1.13
2.00
f1 (ppm)
162.72
160.27
151.31
145.05
138.97
133.35
130.94
130.86
129.47
128.82
128.65
128.23
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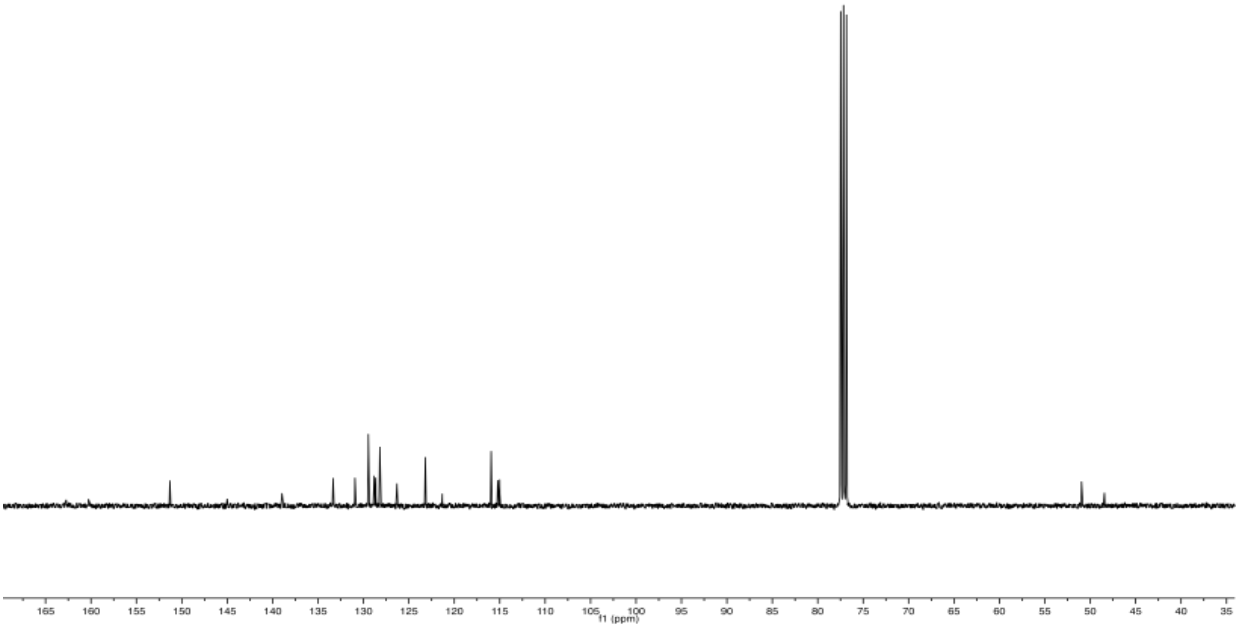
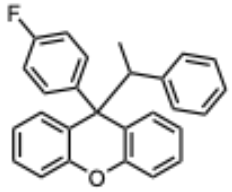
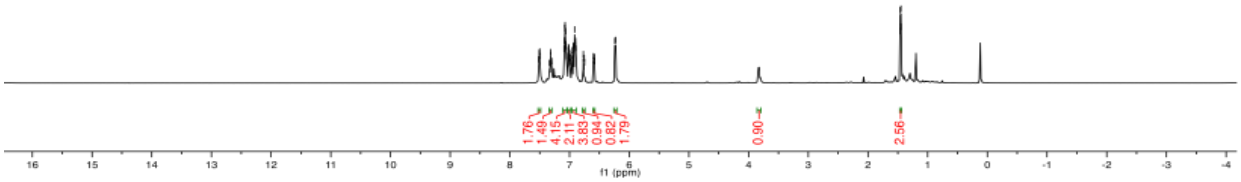
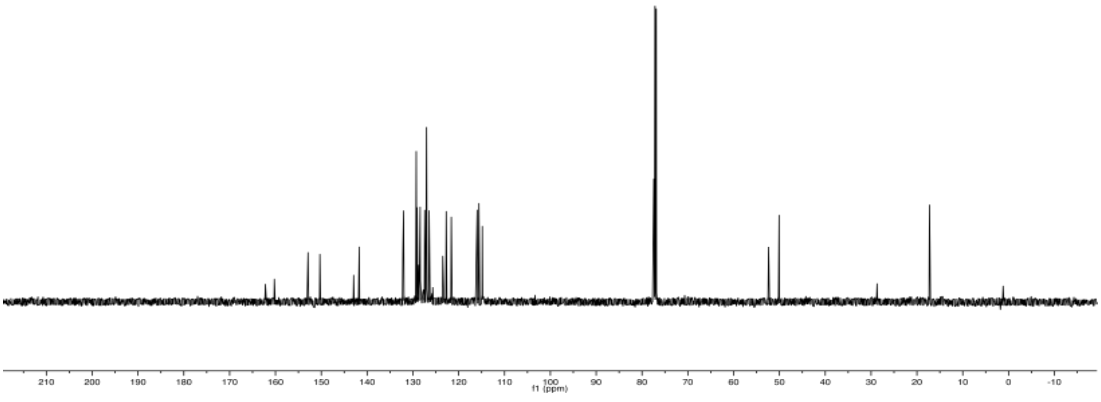
123.19
121.32
115.95
115.22
115.01
77.48
77.16
76.84
50.96
48.44


f1 (ppm)

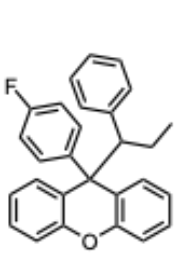
7be

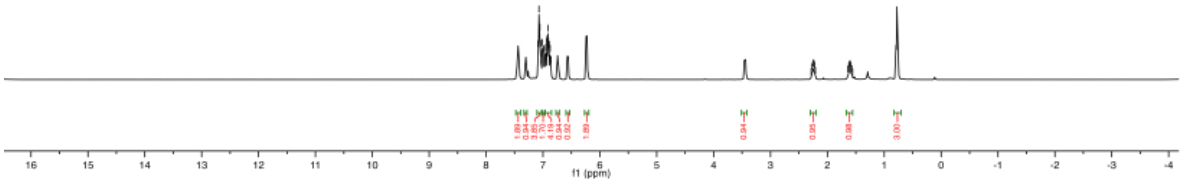


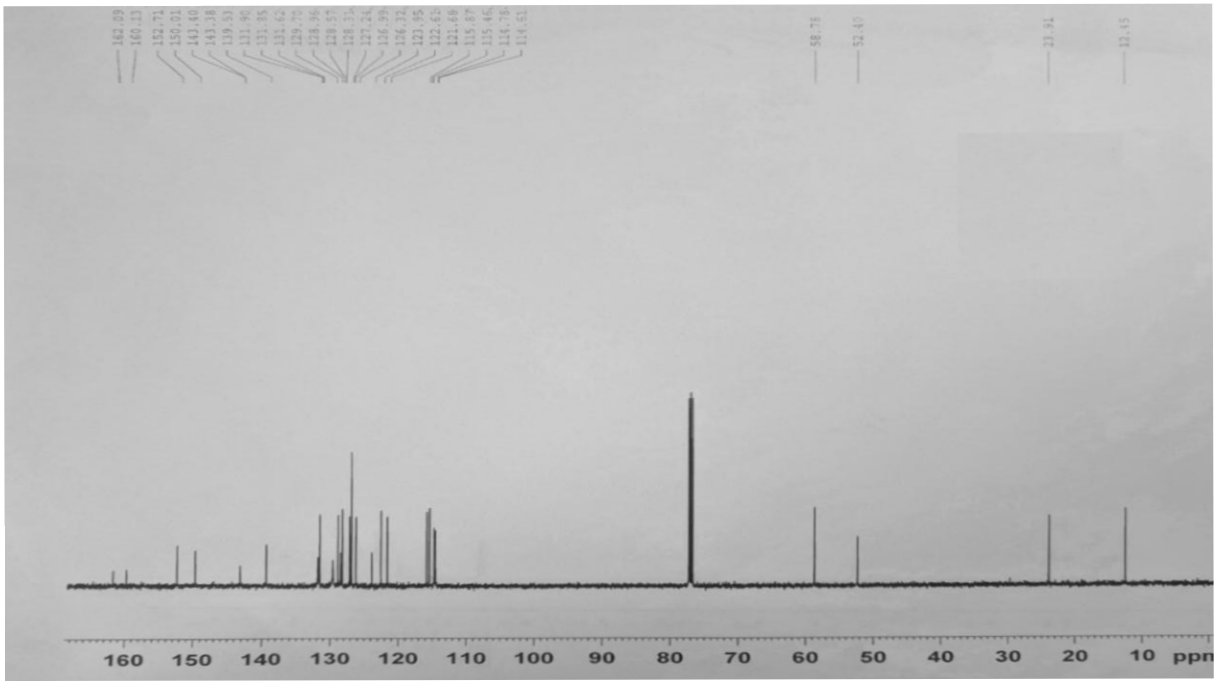




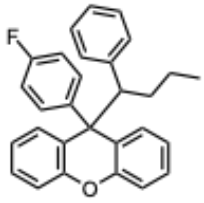
7bf

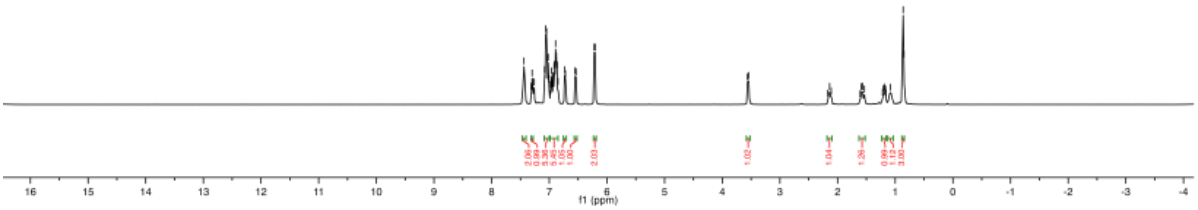


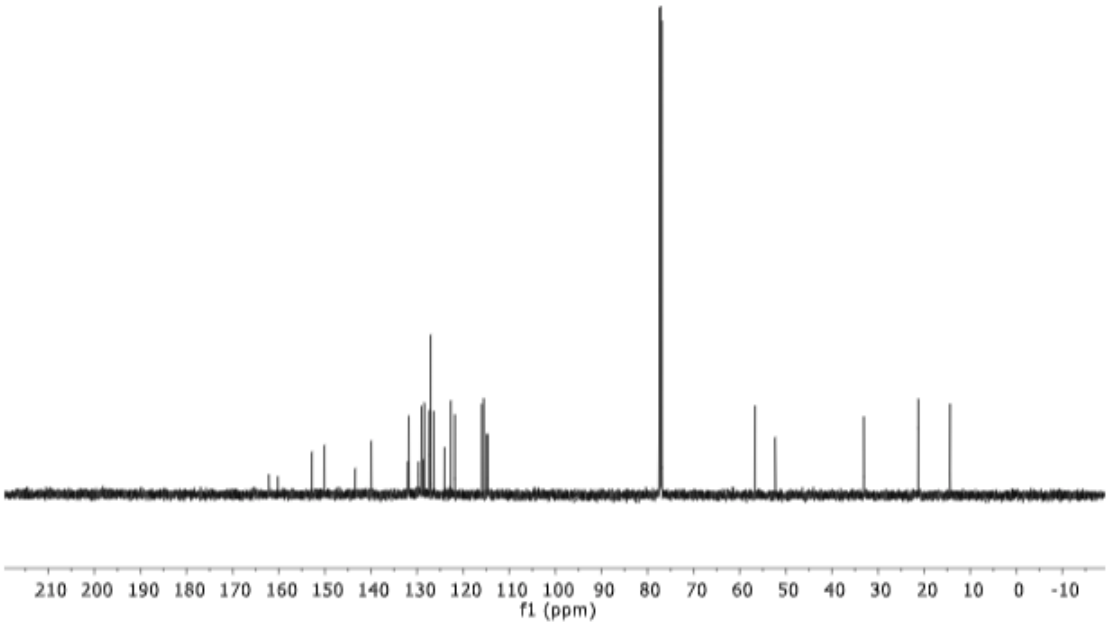




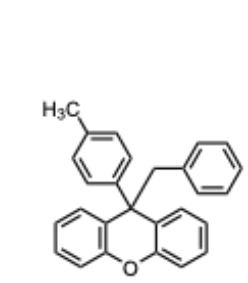
7bg



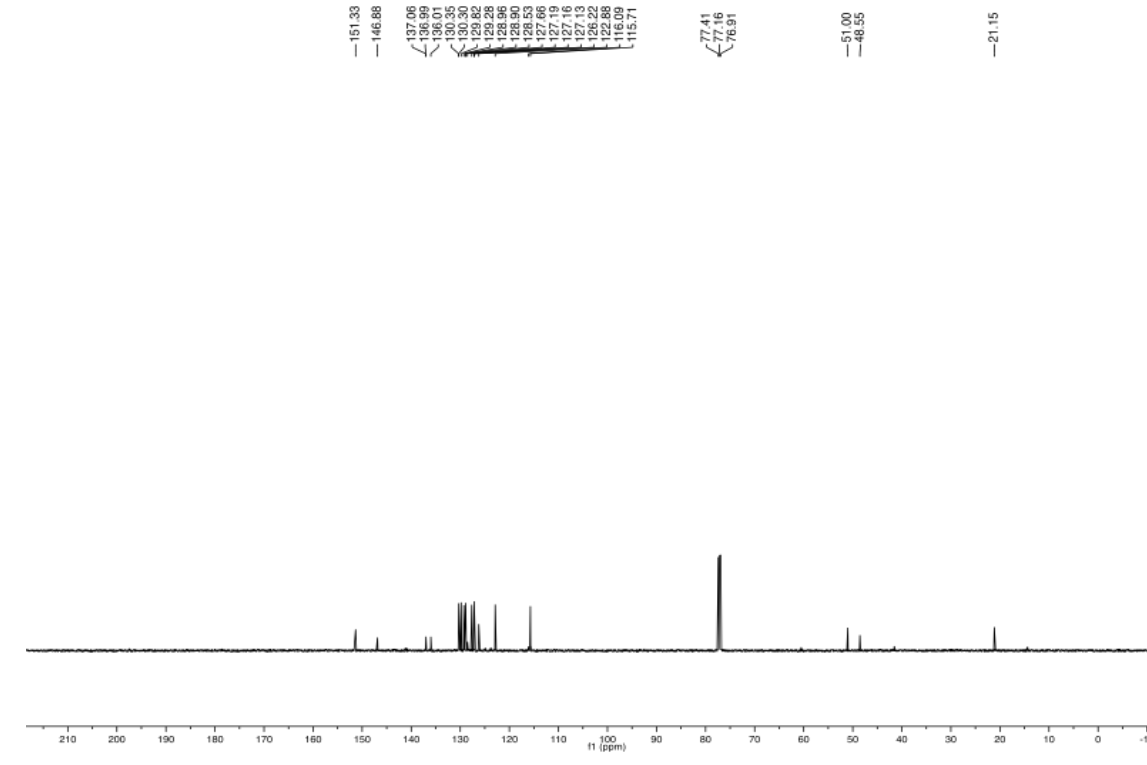




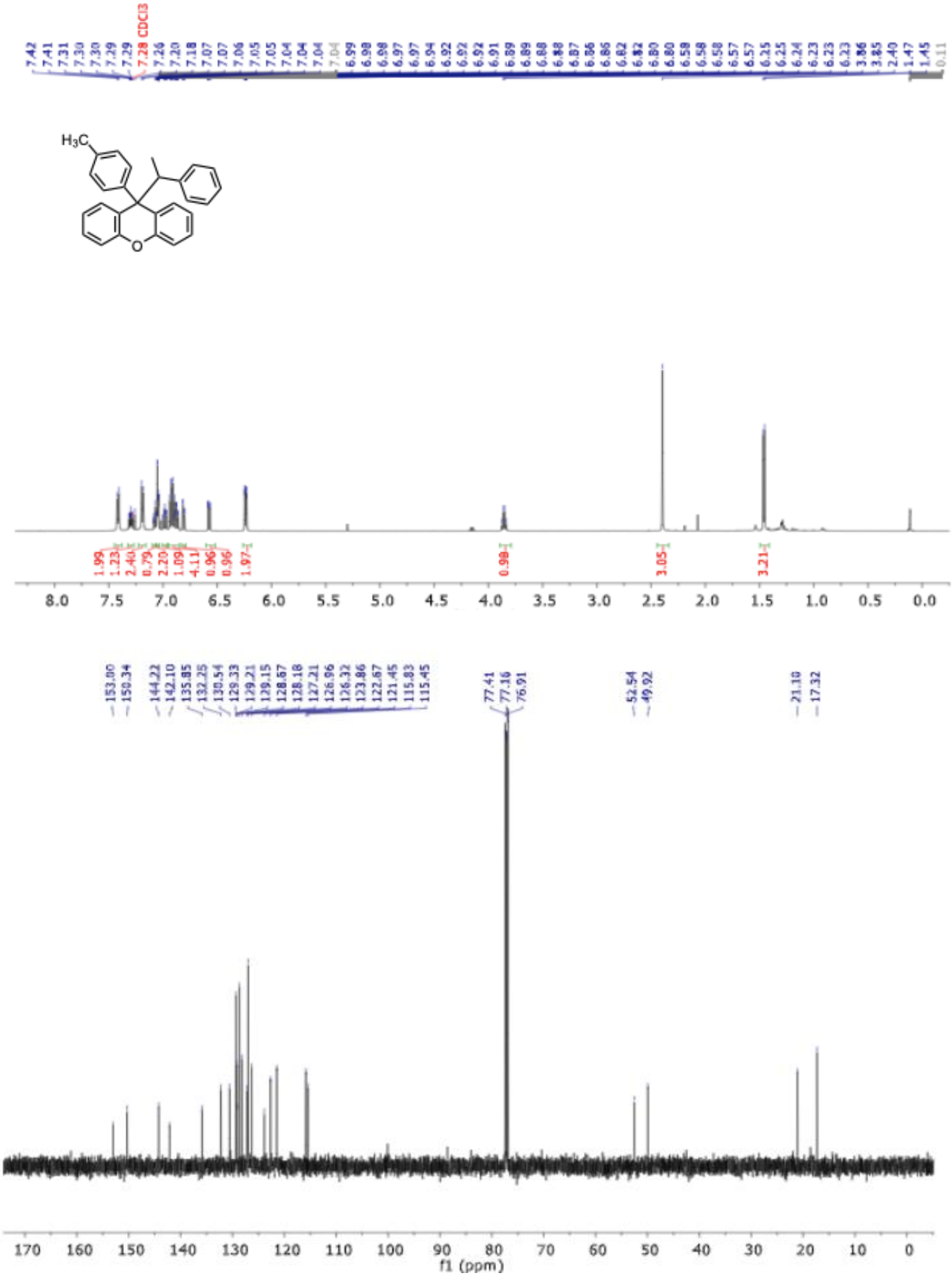
7ca


H3C
O

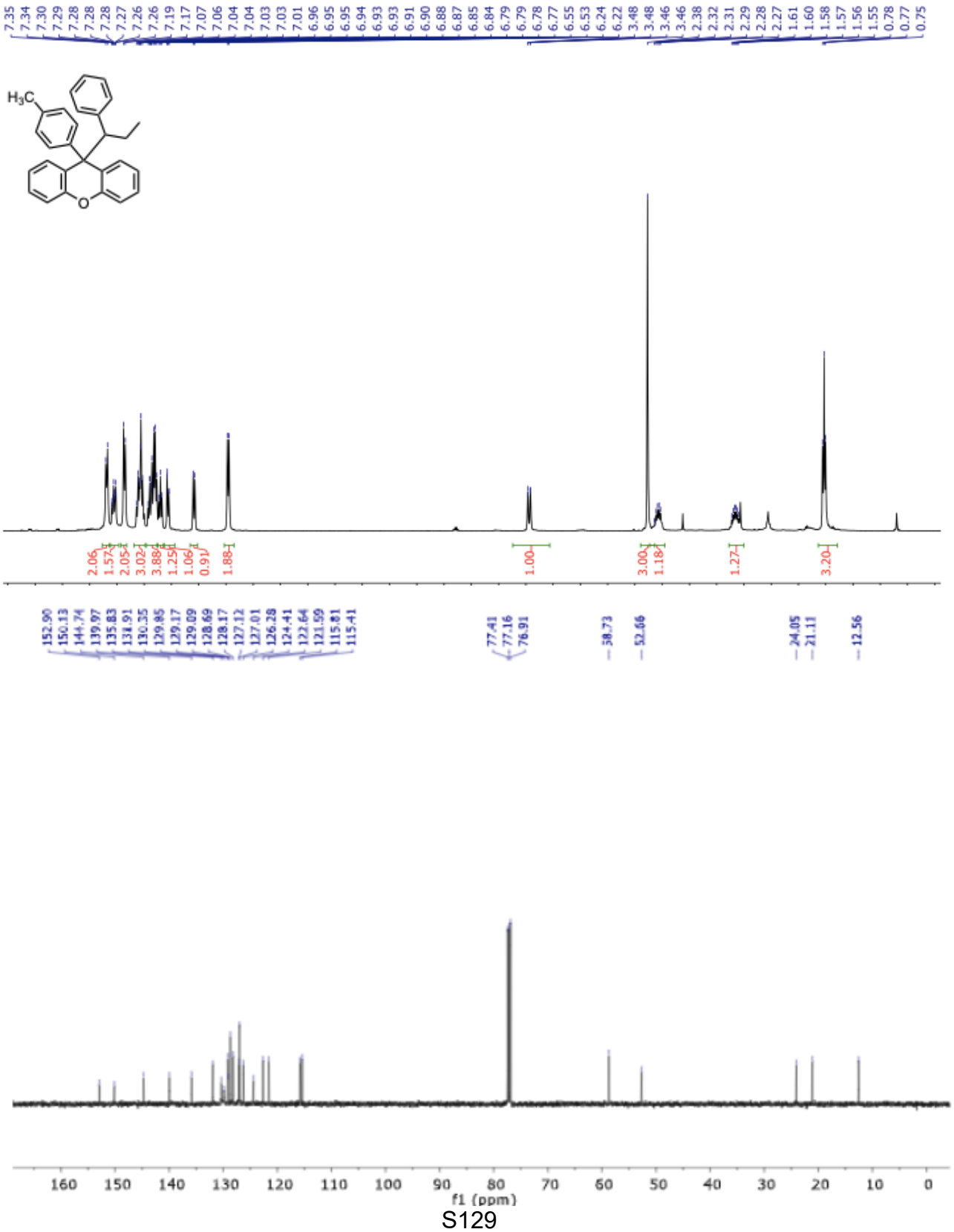
7.43
7.41
7.22
7.20
7.17
7.15
7.14
7.10
7.09
7.07
7.01
7.00
6.98
6.95
6.94
6.92
6.91
6.85
6.81
6.80
6.17
6.16
3.54
2.41
f1 (ppm)


151.33
146.88
137.06
136.99
136.01
130.35
130.30
129.82
129.28
128.96
128.90
128.53
127.66
127.19
127.16
127.13
126.22
122.88
116.09
115.71
77.41
77.16
76.91
51.00
48.55
21.15
f1 (ppm)

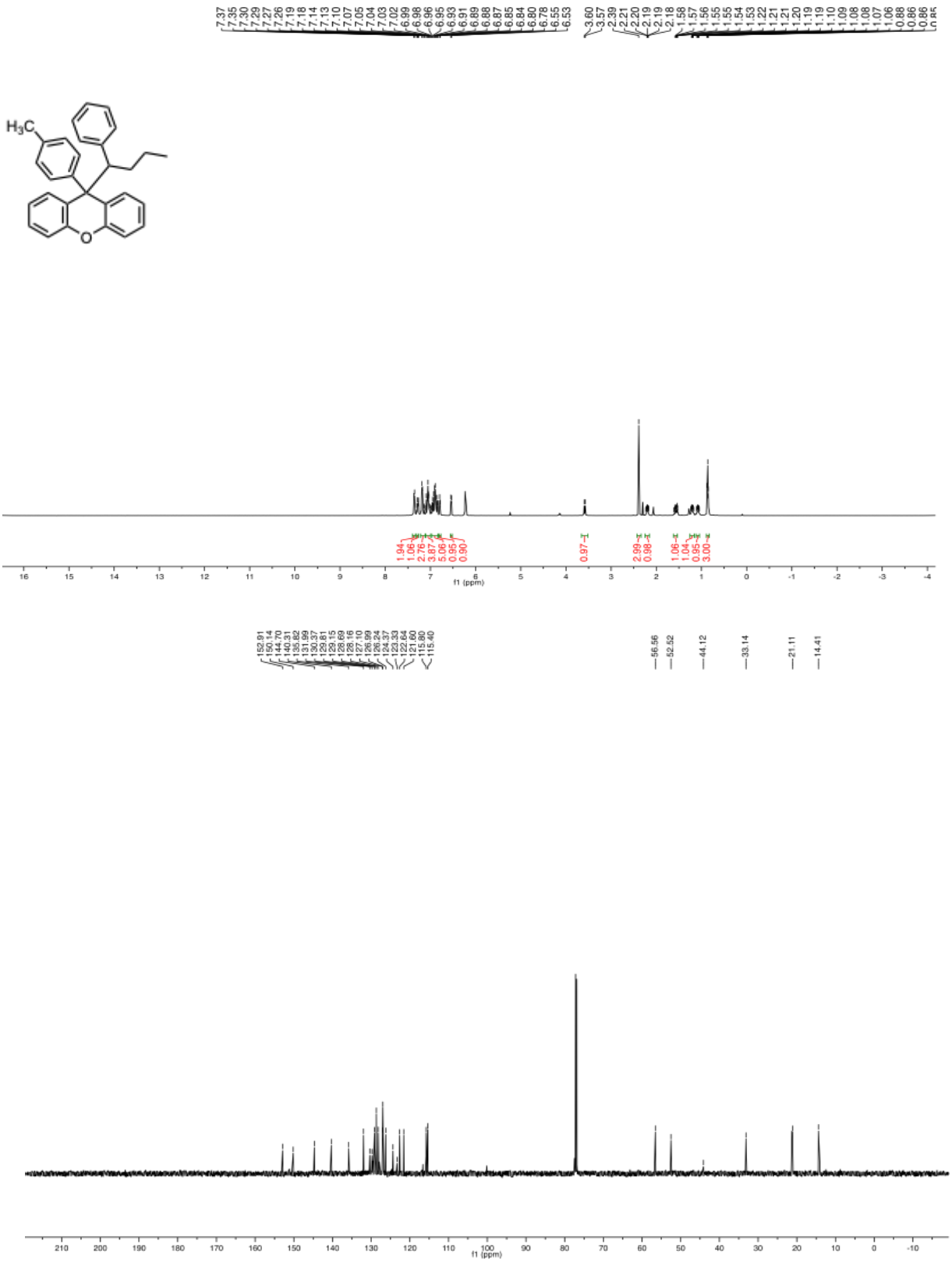
7ce



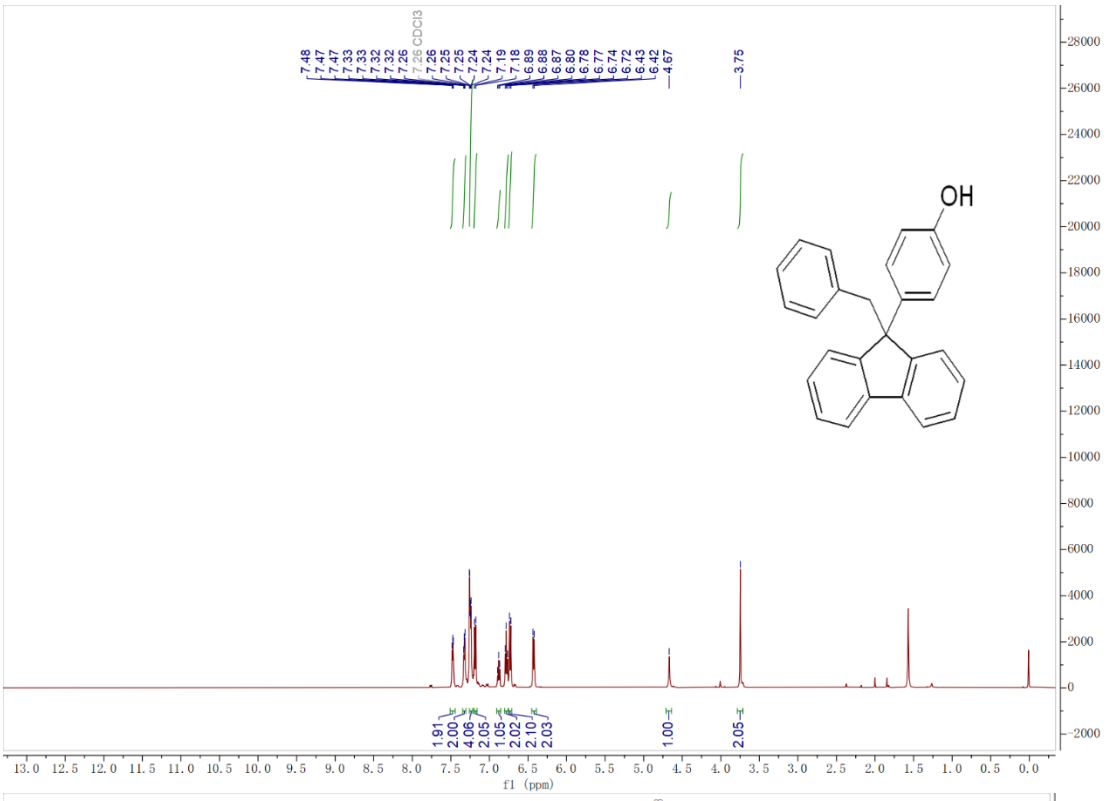
7cf


7.35 7.34 7.30 7.29 7.28 7.28 7.28 7.27 7.26 7.26 7.19 7.17 7.07 7.06 7.04 7.04 7.03 7.03 7.01 6.96 6.95 6.95 6.94 6.93 6.93 6.91 6.90 6.88 6.87 6.85 6.84 6.79 6.79 6.78 6.77 6.55 6.53 6.24 6.22 3.48 3.48 3.46 3.46 2.38 2.32 2.31 2.29 2.28 2.27 1.61 1.60 1.58 1.57 1.56 1.55 0.78 0.77 0.75
H3C
O
2.06 1.57 2.05 3.02 3.88 1.25 1.06 0.91 1.88 1.00 3.00 1.18 1.27 3.20
152.90 150.13 144.74 139.97 135.83 134.91 130.35 129.85 129.17 129.09 128.69 128.17 127.12 127.01 126.28 124.41 122.64 121.59 115.81 115.41 77.41 77.16 76.91 38.73 32.66 24.05 21.11 12.56
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

7cg



8


7.48
7.47
7.47
7.33
7.33
7.32
7.32
7.26 CDCl3
7.26
7.25
7.25
7.24
7.24
7.19
7.18
6.89
6.88
6.87
6.80
6.78
6.77
6.74
6.72
6.43
6.42
4.67
3.75
OH
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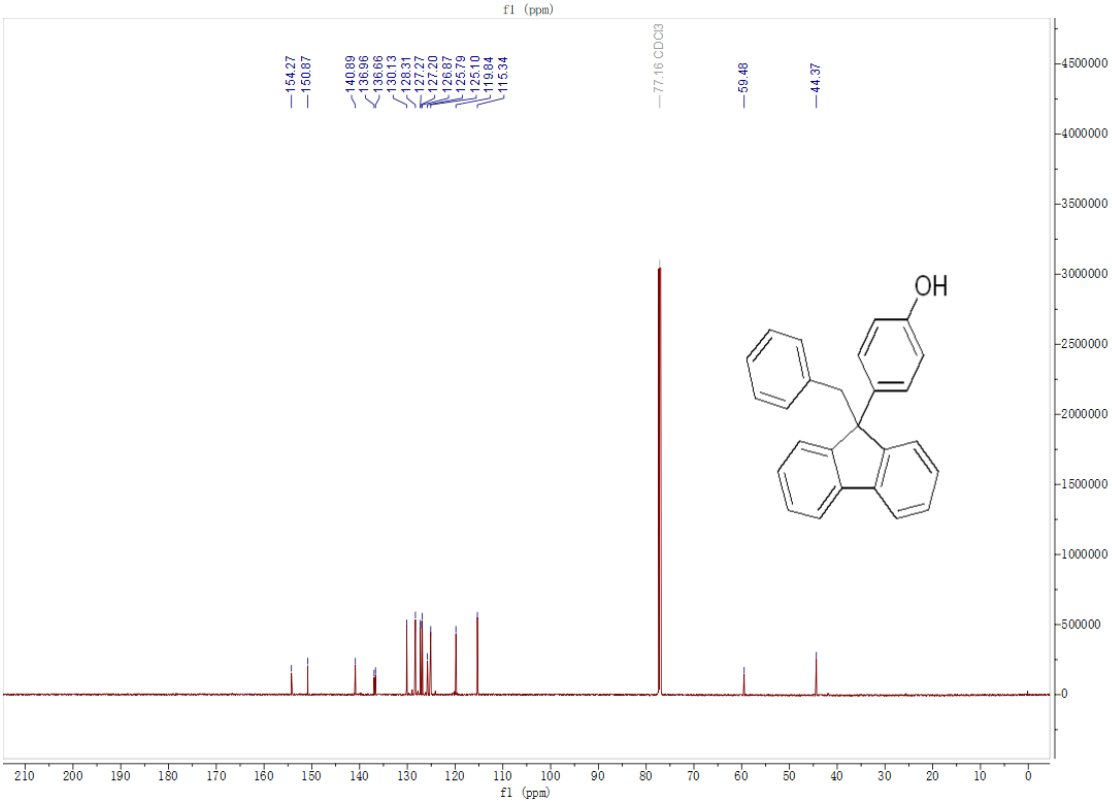
4.06
2.05
1.05
2.02
2.10
2.03
1.00
2.05
f1 (ppm)


154.27
150.87
140.89
136.96
136.66
130.13
128.31
127.27
127.20
126.87
125.79
125.10
119.84
115.34
77.16 CDCl3
59.48
44.37
OH
f1 (ppm)