Electronic Supplementary Information

Enynone-enabled migratory insertion and Schmittel cyclization cascade for the synthesis of furan-fused fluorenes

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1.Experimental procedures and spectroscopic data

1. 1 General information

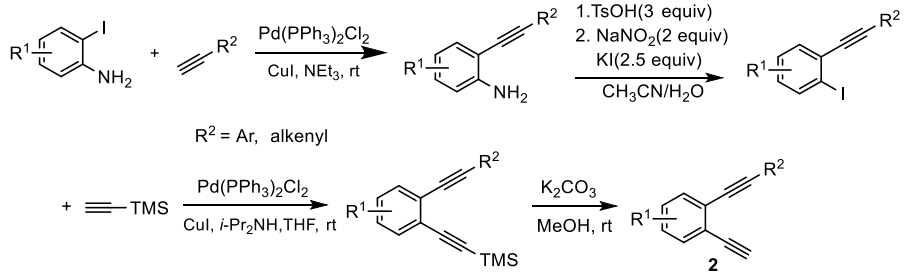
All reactions were carried out under an inert atmosphere of dry N_2 in Schlenk tube, solvents were purified by standard method. ^1H, ^{13}C, ^{19}F NMR spectra were recorded on a Bruker AVANCE 400 (400 MHz for ^1H; 100 MHz for ^{13}C; 376 MHz for ^{19}F), ^1H NMR and ^{13}C NMR chemical shifts were determined relative to internal standard TMS at δ 0.0 and ^{19}F NMR chemical shifts were determined relative to $CFCl_3$ as external standard. Chemical shifts (δ) are reported in ppm, and coupling constants (J) are in Hertz (Hz). The following abbreviations were used to explain the multiplicities: s = singlet, d =doublet, t = triplet, q = quartet, m = multiplet, br = broad. Infrared (IR) spectra are recorded on a Nicolet 210 spectrophotometer and were recorded in potassium bromide (KBr) pellet. Mass spectra (MS) were obtained using EI mass spectrometer. Melting points were determined using a hot stage apparatus. All reagents were used as received from commercial sources, unless specified otherwise, or prepared as described in the literature.

1.2 General procedure for the synthesis of enynones 1 and dialkynylbenzene 2

1.2. 1 General procedure for preparation of enynones 1a–1o

The typical procedure for the preparation of enynones **1a–1o** was according to literature.[1] The characterization data of **1a–1o** was consistent with literature.[1]

1.2.2 Typical experimental procedure for the synthesis of dialkynylbenzene 2[2]



To a solution of the corresponding 2-iodoaniline (1.0 eq.), $Pd(PPh_3)_2Cl_2$ (2.0 mol %), and CuI (1.0 mol %) in NEt_3 (0.25 M) was added the appropriate phenylacetylene (1.2 eq.). The resulting mixture was stirred under nitrogen atmosphere at room temperature overnight. After the reaction finished, the mixture was filtered by short silica, then the solvent was evaporated under reduced pressure and the residue was purified by flash chromatography on silica gel to afford the 2- phenylaniline in 80-90% yield**.**

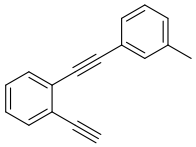
To a solution of *p*-TsOH H_2O (3.0 eq.) in MeCN (0.25 M) was added phenylaniline (1.0 eq.). The resulting suspension of ammonium salt was cooled to 0 ℃ and was added gradually a solution of $NaNO_2$ (2.0 eq.) and KI (2.5 eq.) in water (5 M). The reaction mixture was stirred for 10 min at 0 ℃. Saturated $NaHCO_3$ solution and $Na_2S_2O_3$ solution was added to the reaction mixture successively. The reaction suspension was extracted with diethyl ether and purified on a silica-gel column chromatography (petroleum ether) to provide 1-iodo-2-(phenylethynyl)benzene in 71-76%.

To a solution of the corresponding 2-iodoaniline (1.0 eq.), $Pd(PPh_3)_2Cl_2$ (2.0 mol %), i-Pr_2NH (0.1 eq.) and CuI (1.0 mol %) in THF (0.25 M) was added the appropriate trimethylsilylacetylene (1.2 eq.). The resulting mixture was stirred under nitrogen atmosphere at room temperature overnight. After the reaction finished, the mixture was filtered by short silica, then the solvent was evaporated under reduced pressure and the residue was purified by flash chromatography on silica gel to afford the trimethyl((2-(phenylethynyl)phenyl)ethynyl)silane in 78-92% yield.

To a solution of trimethyl((2-(phenylethynyl)phenyl)ethynyl)silane (1.0 eq.) in MeOH was added K_2CO_3 (2.0 eq.). The reaction mixture was stirred for 10 min at room temperature. The mixture was diluted with DCM, and the organic layer was washed with saturated NaCl solution, dried and concentrated to afford the desired product **2** in 90-96% yield.

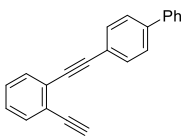
The characterization data of **2a–2h and 2j** was consistent with literature. [3,4,5]

1-Ethynyl-2-(m-tolylethynyl)benzene (2i)



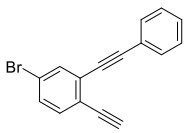
Colorless oil, **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.52 (d, J = 7.6 Hz, 2H), 7.37 (d, J = 8.2 Hz, 2H), 7.29 (d, J = 7.5 Hz, 1H), 7.26 – 7.19 (m, 2H), 7.14 (d, J = 7.6 Hz, 1H), 3.36 (s, 1H), 2.34 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 138.1, 132.6, 132.4, 131.8, 129.5, 128.9, 128.6, 128.3, 127.9, 126.5, 124.7, 123.0, 93.8, 87.6, 82.3, 81.2, 21.3. **IR** (KBr, cm^{-1}) 3448, 3293, 2921, 2207, 1641, 1483, 1441, 1250, 1087, 843, 755, 685, 624. **HRMS** (ESI) Calcd for $C_{17}H_{12}$ $(M+Na)^+$ 239.0831, found 239.0827.

4-((2-Ethynylphenyl)ethynyl)-1,1'-biphenyl (2k)



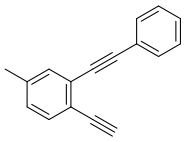
White solid, m. p. = 61-62 ℃ **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.64 (ddd, J = 15.8, 11.9, 7.8 Hz, 8H), 7.49 (t, J = 7.5 Hz, 2H), 7.43 – 7.32 (m, 3H), 3.43 (s, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 141.3, 140.4, 132.7, 132.3, 131.8, 128.9, 128.6, 128.0, 127.7, 127.1, 126.4, 124.7, 122.1, 93.6, 88.6, 82.3, 81.2. **IR** (KBr, cm^{-1}) 3289, 3062, 2216, 1917, 1593, 1484, 1442, 1398, 1265, 1101, 1006, 954, 839, 760, 694, 657, 559. **HRMS** (ESI) Calcd for $C_{20}H_{12}$ $(M+H)^+$ 253.1012, found 253.1019.

4-Bromo-1-ethynyl-2-(phenylethynyl)benzene (2l)



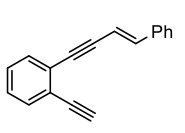
White solid, m. p. = 46-47 ℃ **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.73 (s, 1H), 7.61 (s, 2H), 7.44 – 7.37 (m, 5H), 3.45 (s, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 134.5, 133.7, 131.9, 131.2, 128.9, 128.5, 128.1, 123.6, 122.7, 122.5, 94.9, 86.6, 82.3, 81.4. **IR** (KBr, cm^{-1}) 3745, 3521, 3496, 3464, 3442, 2959, 1539, 1491, 1071, 1023, 819, 754, 687. **HRMS** (ESI) Calcd for $C_{16}H_9Br$ $(M-H)^-$ 278.9815, found 278.9820.

1-Ethynyl-4-methyl-2-(phenylethynyl)benzene (2m)



White solid, m. p. = 56-57 °C **^{1}H NMR** (400 MHz, $CDCl_3$) δ^1H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, J = 3.3 Hz, 2H), 7.51 (d, J = 7.9 Hz, 1H), 7.42 (d, J = 7.9 Hz, 4H), 7.14 (d, J = 7.8 Hz, 1H), 3.43 (s, 1H), 2.39 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 138.9, 132.6, 132.4, 131.9, 129.1, 128.6, 128.5, 126.2, 123.4, 121.8, 93.3, 88.3, 82.5, 80.6, 21.3. **IR** (KBr, cm^{-1}) 3817, 3744, 3520, 3497, 3442, 3287, 3028, 2921, 2213, 2105, 1911, 1599, 1492, 1443, 1376, 1237, 1098, 1068, 1027, 915, 888, 821, 755, 689, 652, 619, 583, 544, 515. **HRMS** (ESI) Calcd for $C_{17}H_{12}$ $(M+Na)^+$ 239.0831, found 239.0834.

(E)-1-Ethynyl-2-(4-phenylbut-3-en-1-yn-1-yl)benzene (2n)

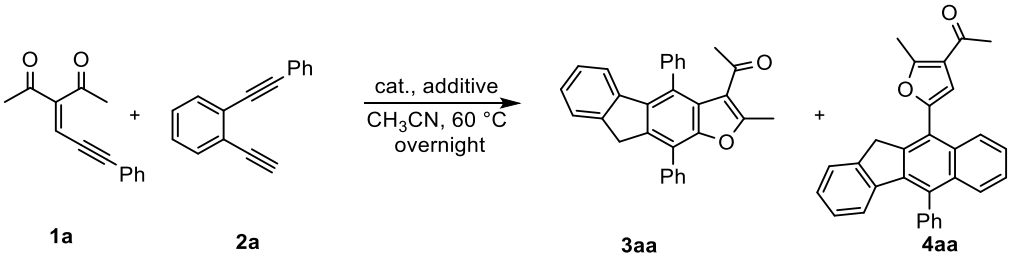


E/Z = 10:1, yellow oil, **^{1}H NMR** (400 MHz, $CDCl_3$) δ Isomer E δ 7.41 (dd, J = 13.2, 7.5 Hz, 2H), 7.33 (d, J = 7.4 Hz, 2H), 7.28 – 7.15 (m, 5H), 7.00 (d, J = 16.2 Hz, 1H), 6.35 (d, J = 16.2 Hz, 1H), 3.27 (s, 1H). Isomer Z δ 7.93 (d, J = 7.5 Hz, 2H), 6.62 (d, J = 12.0 Hz, 1H), 5.89 (d, J = 12.0 Hz, 1H), 3.22 (s, 1H) ppm (remaining peaks

could not be assigned) **^{13}C NMR** (100 MHz, $CDCl_3$) Isomer E δ 142.0, 136.3, 132.7, 131.9, 128.8, 128.6, 127.9, 126.5, 126.4, 124.4, 108.1, 107.2, 93.2, 90.2, 82.3, 81.2. Isomer Z δ 139.2, 132.9, 132.2, 129.1, 128.6, 128.3 ppm (the remaining signals could not be assigned) **IR** (KBr, cm^{-1}) 3703, 3521, 3498, 2922, 1475, 1266, 953, 750, 519. **HRMS** (ESI) Calcd for $C_{18}H_{12}$ $(M+H)^+$ 229.1012, found 229.1020.

1.3 Optimization of the reaction conditions for Synthesis of 3aa

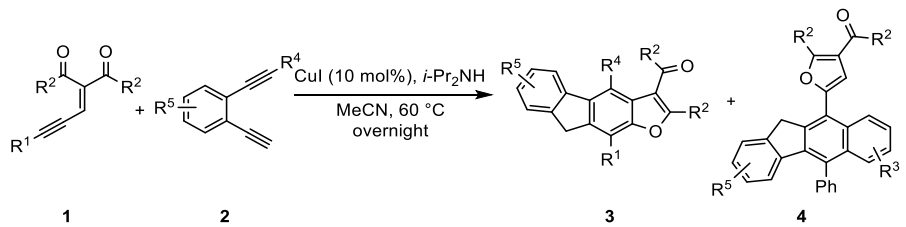
Table S1 Optimization of the Reaction Conditions for Synthesis of **3aa**[a]



Entry	Cat.	Base	**3aa**/**4aa**[b]	**3aa**[c] (%)
1	CuI	-	6:1	58
2	CuBr	-	-	trace
3	CuCl	-	-	trace
4	$Cu(MeCN)_4PF_4$	-	6:1	34
5	CuI	K_2CO_3	4:1	30
6	CuI	$NaHCO_3$	5:1	45
7	CuI	*i*-Pr_2NEt	8:1	69
8	**CuI**	***i*-Pr_2NH**	**8:1**	**75**[d]

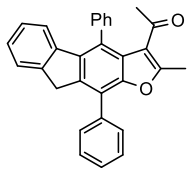
[a]The reaction was performed at 60 ℃ overnight. The molar ratio of **1a**:**2a** = 1:1. [**1a**] = 0.1 mmol, Cu(I) = 10 mol %, base (1.0 eq.) in MeCN (1 mL); [b]Isomeric ratio of **3aa** and **4aa** determined by ^{1}H NMR spectroscopy. [c]Yield of **3aa** determined by ^{1}H NMR spectroscopy. [d]Isolated yield of **3aa**.

1.4 General procedure for the synthesis of 3am-3bm



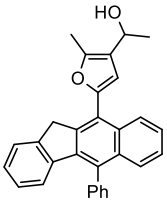
To an acetonitrile (MeCN, 1.0 mL) suspension of CuI (10 mol %) in Schlenk tube with a magnetic bar under nitrogen atmosphere, was added alkynyl (**2**, 0.1 mmol), i-Pr_2NH (1 eq.) and enynes (**1**, 0.1 mmol), The reaction mixture was then heated to a temperature of 60 ℃ and stirred. The reaction was monitored by TLC. The reaction mixture was purified by chromatography with petroleum/ethyl acetate, 20/1, and recrystallization to afford **3**. **4aa** was confirmed after further reduction with $NaBH_4$ to afford **7aa.**

1-(2-Methyl-4,10-diphenyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3aa)



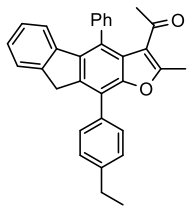
White solid, m. p. = 177-178 ℃, yield: 75%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 7.7 Hz, 2H), 7.63 – 7.50 (m, 8H), 7.47 (d, *J* = 7.4 Hz, 1H), 7.20 (t, *J* = 7.4 Hz, 1H), 7.05 (t, *J* = 7.6 Hz, 1H), 6.83 (d, *J* = 7.9 Hz, 1H), 4.01 (s, 2H), 2.46 (s, 3H), 1.59 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.2, 157.1, 150.5, 143.9, 141.5, 139.5, 139.2, 135.3, 135.0, 130.1, 129.6, 129.3, 128.6, 128.6,128.4, 128.0, 126.3, 126.1, 125.5, 124.6, 122.8, 122.2, 121.1, 36.3, 30.7, 13.5. **IR** (KBr, cm^{-1}) 3689, 3057, 2922, 1957, 1893, 1681, 1587, 1446, 1384, 1332, 1273, 1218, 1161, 1118, 1028, 941, 625, 496. **HRMS** (ESI) Calcd for $C_{30}H_{22}O_2$ $(M+H)^+$ 415.1693, found 415.1694.

1-(2-Methyl-5-(5-phenyl-11H-benzo[*b*]fluoren-10-yl)furan-3-yl)ethan-1-ol (7aa)



White solid, m. p. = 178-179 ℃, yield: 7%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.23 (d, *J* = 8.4 Hz, 1H), 7.59 (t, *J* = 9.3 Hz, 4H), 7.50 – 7.36 (m, 5H), 7.21 (d, *J* = 7.4 Hz, 1H), 7.01 (t, *J* = 7.4 Hz, 1H), 6.72 (s, 1H), 6.44 (d, *J* = 7.8 Hz, 1H), 5.01 (d, *J* = 6.2 Hz, 1H), 4.18 (s, 2H), 2.48 (s, 3H), 1.75 (s, 1H), 1.61 (d, *J* = 6.2 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 149.2, 147.6, 144.2, 141.1, 140.9, 139.0, 137.3, 134.1, 133.2, 130.8, 130.1, 129.2, 127.9, 127.2, 126.7, 126.5, 125.7, 125.6, 125.3, 125.0, 124.7, 124.4, 123.7, 109.7, 63.0, 37.3, 24.2, 12.2.**IR** (KBr, cm^{-1}) 3744, 3521, 3497, 2922, 1540, 761, 700. **HRMS** (ESI) Calcd for $C_{30}H_{24}O_2$ $(M+Na)^+$ 439.1669, found. 439.1667.

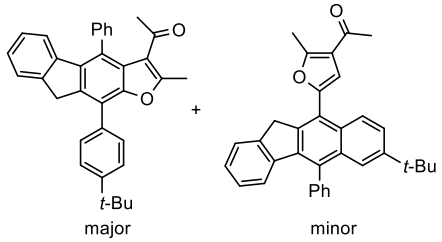
1-(10-(4-Ethylphenyl)-2-methyl-4-phenyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3ab)



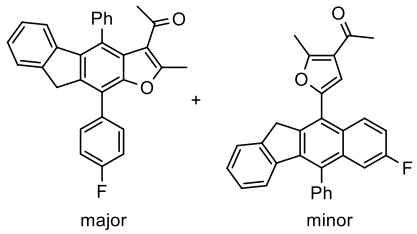
White solid, m. p. = 166-167 ℃, yield: 70%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.60 (dd, *J* = 20.5, 7.9 Hz, 7H), 7.45 (dd, *J* = 12.3, 7.7 Hz, 3H), 7.20 (t, *J* = 7.4 Hz, 1H), 7.04 (t, *J* = 7.6 Hz, 1H), 6.83 (d, *J* = 7.9 Hz, 1H), 4.02 (s, 2H), 2.82 (q, *J* = 7.6 Hz, 2H), 2.46 (s, 3H), 1.58 (s, 3H), 1.39 (t, *J* = 7.6 Hz, 3H).**^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.3, 157.1, 150.6, 145.1, 144.0, 143.9, 141.6, 139.6, 139.3, 135.3, 132.2, 130.2, 129.6, 129.3, 128.4, 128.2, 126.3, 126.1, 125.5, 124.6, 122.8, 122.2, 121.1, 36.4, 30.7, 28.8, 15.4, 13.5. **IR** (KBr, cm^{-1}) 3711, 3060, 2962, 2314, 1685, 1579, 1452, 1333, 1271, 1192, 1110, 1023, 940, 803, 756, 610, 518. **HRMS** (ESI) Calcd for $C_{32}H_{26}O_2$ $(M+H)^+$ 443.2006, found 443.2004.

1-(10-(4-(Tert-Butyl)phenyl)-2-methyl-4-phenyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3ac)

White solid, m. p. = 222-223 ℃, yield: 65%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ Isomer **3ac** δ 7.67 – 7.47 (m, 9H), 7.43 (d, *J* = 7.2 Hz, 1H), 7.16 (t, *J* = 7.4 Hz, 1H), 7.00 (t, *J* = 7.5 Hz, 1H), 6.78 (d, *J* = 7.9 Hz, 1H), 4.00 (s, 2H), 2.43 (s, 3H), 1.54 (s, 3H), 1.43 (s, 9H). Isomer **4ac** δ 8.08 (d, *J* = 8.9 Hz, 1H), 6.93 (s, 1H), 6.46 (d, *J* = 7.9 Hz, 1H), 4.14 (s, 2H), 2.78 (s, 3H), 2.55 (s, 3H), 1.27 (s, 9H) ppm (remaining peaks could not be assigned) **^{13}C NMR** (100 MHz, $CDCl_3$) mixtures **3ac** and **4ac** δ 199.3, 194.2, 158.2, 157.0, 150.8, 150.6, 149.5, 148.1, 144.0, 141.6, 141.2, 139.59, 139.30, 138.95, 135.31, 134.91, 131.93, 130.17, 129.98, 129.27, 129.13, 128.37, 127.90, 127.2, 126.58, 126.28, 126.1, 125.6, 125.5, 124.9, 124.8, 124.6, 123.7, 122.9, 122.8, 122.1, 122.0, 121.1, 111.0, 36.5, 34.9, 34.8, 31.5, 31.1, 30.7, 29.7, 29.3, 14.7, 13.5.**IR** (KBr, cm^{-1}) 3703, 3057, 2958, 1680, 1580, 1455, 1270, 1227, 1122, 1024, 945, 811, 732, 616, 556. **HRMS** (ESI) Calcd for $C_{34}H_{30}O_2$ $(M+Na)^+$ 493.2138, found 493.2135.

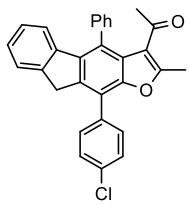


1-(10-(4-Fluorophenyl)-2-methyl-4-phenyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3ad)



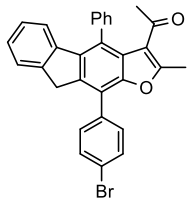
White solid, m. p. = 172-174 ℃, yield: 82%. **^{1}H NMR** (400 MHz, $CDCl_3$) Isomer **3ad** δ 7.66 (dd, *J* = 8.4, 5.5 Hz, 2H), 7.56 (d, *J* = 7.0 Hz, 5H), 7.47 (d, *J* = 7.4 Hz, 1H), 7.29 (s, 2H), 7.20 (t, *J* = 7.4 Hz, 1H), 7.05 (t, *J* = 7.6 Hz, 1H), 6.82 (d, *J* = 7.9 Hz, 1H), 3.97 (s, 2H), 2.46 (s, 3H), 1.58 (s, 3H). Isomer **4ad** δ 8.15 – 8.08 (m, 1H), 6.94 (s, 1H), 6.46 (d, *J* = 8.0 Hz, 1H), 4.13 (s, 2H), 2.78 (s, 3H), 2.55 (s, 3H) ppm (remaining peaks could not be assigned) **^{13}C NMR** (101 MHz, $CDCl_3$) mixtures **3ad** and **4ad** δ 199.1, 194.1, 161.3, 158.5, 157.0, 150.5, 148.9, 143.7, 141.4, 140.6, 139.5, 139.1, 138.4, 138.3, 135.4, 131.4, 131.3, 130.1, 129.9, 129.4, 129.3, 128.7, 128.5, 128.3, 127.7, 126.7, 126.4, 126.2, 125.6, 124.7, 123.9, 122.8, 121.2, 115.8, 115.6, 111.3, 37.0, 36.2, 30.7, 29.7, 14.7, 13.4. **^{19}F NMR** (376 MHz, $CDCl_3$) Isomer **3ad** δ -113.8 Isomer **4ad** δ-114.7 **IR** (KBr, cm^{-1}) 3711, 3062, 2922, 2855, 1680, 1510, 1453, 1226, 1157, 1110, 1022, 948, 808, 757, 613. **HRMS** (ESI) Calcd for $C_{30}H_{21}FO_2$ $(M+H)^+$ 433.1598, found 443.1597.

1-(10-(4-Chlorophenyl)-2-methyl-4-phenyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3ae)



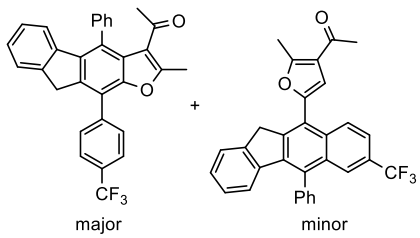
White solid, m. p. = 217-218 ℃, yield: 62%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.53 (d, *J* = 8.3 Hz, 2H), 7.46 (dd, *J* = 8.9, 3.2 Hz, 7H), 7.36 (d, *J* = 7.4 Hz, 1H), 7.10 (t, *J* = 7.4 Hz, 1H), 6.94 (t, *J* = 7.6 Hz, 1H), 6.71 (d, *J* = 7.9 Hz, 1H), 3.87 (s, 2H), 2.35 (s, 3H), 1.47 (s, 3H).**^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.1, 157.1, 150.3, 143.7, 141.4, 139.4, 139.0, 135.4, 134.0, 133.4, 131.0, 130.1, 129.3, 128.9, 128.9, 128.5, 126.4, 126.2, 125.6, 124.7, 122.8, 121.2, 120.9, 36.2, 30.7, 13.4. **IR** (KBr, cm^{-1})3710, ,3060, 2925, 1582, 1487, 1267,1225, 1154, 1112,1021, 934, 790,754, 701, 480.. **HRMS** (ESI) Calcd for $C_{30}H_{21}ClO_2$ $(M+H)^+$ 449.1303, found 449.1302.

1-(10-(4-Bromophenyl)-2-methyl-4-phenyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3af)



White solid, m. p. = 135-136 °C, yield: 65%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.66 (d, *J* = 7.6 Hz, 2H), 7.58 – 7.51 (m, 7H), 7.48 (d, *J* = 7.5 Hz, 1H), 7.42 (d, *J* = 7.4 Hz, 1H), 7.15 (t, *J* = 7.3 Hz, 1H), 7.00 (t, *J* = 7.6 Hz, 1H), 6.79 (d, *J* = 7.9 Hz, 1H), 3.96 (s, 2H), 2.42 (s, 3H), 1.55 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.2, 157.1, 150.5, 143.9, 141.5, 139.6, 139.2, 135.3, 135.0, 130.2, 129.7, 129.3, 128.7, 128.6, 128.4, 128.0, 126.4, 126.1, 125.5, 124.7, 122.8, 122.2, 121.2, 36.3, 30.7, 13.5. **IR** (KBr, cm^{-1}) 3711, 3058, 2922, 1679, 1582, 1445, 1385, 1335, 1272, 1224, 1159, 1116, 1025, 944, 802, 760, 704, 625, 497. **HRMS** (ESI) Calcd for $C_{30}H_{21}BrO_2$ $(M+Na)^+$ 515.0617, found 515.0616.

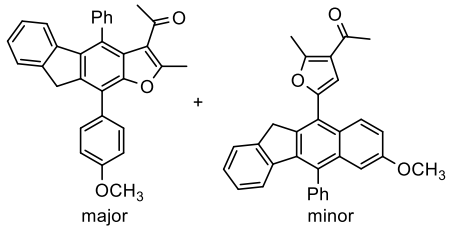
1-(2-Methyl-4-phenyl-10-(4-(trifluoromethyl)phenyl)-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3ag)



White solid, m. p. = 187-189 ℃, yield: 66%. **^{1}H NMR** (400 MHz, $CDCl_3$) Isomer **3ag** δ 7.80 (dd, *J* = 17.1, 8.1 Hz, 4H), 7.52 (dd, *J* = 17.4, 6.6 Hz, 5H), 7.42 (d, *J* = 7.5 Hz, 1H), 7.17 (t, *J* = 7.4 Hz, 1H), 7.01 (t, *J* = 7.6 Hz, 1H), 6.79 (d, *J* = 7.9 Hz, 1H), 3.94 (s, 2H), 2.42 (s, 3H), 1.56 (s, 3H). Isomer **4ag** δ 8.25 (d, *J* = 8.9 Hz, 1H), 7.89 (s, 1H), 7.63 (d, *J* = 4.5 Hz, 1H), 6.96 (s, 1H), 6.45 (d, *J* = 7.9 Hz, 1H), 4.17 (s, 1H), 2.79 (s, 1H), 2.56 (s, 1H) ppm (remaining peaks could not be assigned) **^{13}C NMR** (100 MHz, $CDCl_3$)

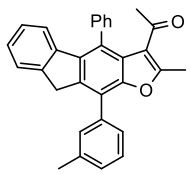
Isomer **3ag** δ 199.0, 157.1, 150.2, 143.6, 141.3, 139.4, 138.9, 135.6, 130.0, 130.0, 129.8, 129.5, 129.3, 128.6, 126.5, 126.3, 125.7, 125.7, 125.6, 124.7, 122.8, 121.2, 120.7, 36.2, 30.7, 13.4. Isomer **4ag** δ 194.0, 138.8, 29.73 ppm (the remaining signals could not be assigned) **^{19}F NMR** (376 MHz, $CDCl_3$) Isomer **3ag** δ -62.5. **IR** (KBr, cm^{-1}) 3624, 3061, 2923, 2855, 1679, 1580, 1448, 1398, 1322, 1275, 1228, 1166, 1122, 1068, 1022, 946, 845, 758, 618. **HRMS** (ESI) Calcd for $C_{31}H_21F_3O_2$ $(M+H)^+$ 483.1566, found 483.1566.

1-(10-(4-Methoxyphenyl)-2-methyl-4-phenyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3ah)



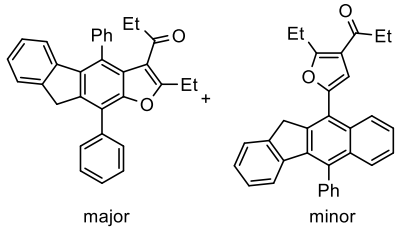
Colorless oil, yield: 46%. **^{1}H NMR** (400 MHz, $CDCl_3$) Isomer **3ah** δ 7.60 (dd, *J* = 7.1, 3.9 Hz, 3H), 7.52 (d, *J* = 2.8 Hz, 4H), 7.42 (d, *J* = 7.2 Hz, 1H), 7.16 (dd, *J* = 8.5, 5.2 Hz, 1H), 7.10 (d, *J* = 8.5 Hz, 2H), 7.00 (dd, *J* = 11.7, 7.3 Hz, 1H), 6.79 (d, *J* = 7.9 Hz, 1H), 3.96 (s, 2H), 3.90 (s, 3H), 2.43 (s, 3H), 1.54 (s, 3H). Isomer **4ah** δ 8.05 (d, *J* = 9.2 Hz, 1H), 6.92 (s, 1H), 6.88 (s, 1H), 6.45 (d, *J* = 7.9 Hz, 1H), 4.11(s, 1H), 3.69 (s, 3H), 2.78 (s, 2H), 2.56 (s, 2H) ppm (remaining peaks could not be assigned) **^{13}C NMR** (100MHz, $CDCl_3$) mixtures **3ah** and **4ah** δ 199.3, 194.2, 159.3, 158.3, 157.3, 157.0, 150.6, 149.3, 144.1, 143.9, 141.6, 141.1, 139.5, 139.3, 139.3, 139.0, 137.9, 135.3, 134.6, 133.7, 130.8, 130.1, 129.9, 129.5, 129.3, 129.3, 128.4, 128.2, 128.0, 127.3, 127.1, 126.7, 126.6, 126.3, 126.1, 125.5, 124.8, 124.6, 123.7, 123.1, 122.9, 122.8, 121.9, 121.1, 118.0, 114.1, 111.0, 105.7, 55.4, 55.1, 36.9, 36.4, 30.7, 29.7, 29.4, 14.7, 13.5. **IR** (KBr, cm^{-1}) 3057, 2922, 2846, 1676, 1611, 1508, 1455, 1349, 1283, 1235, 1177, 1121, 1032, 949, 832, 732, 620, 514. **HRMS** (ESI) Calcd for $C_{31}H_{24}O_3$ $(M+H)^+$ 445.1798, found 445.1797.

1-(2-Methyl-4-phenyl-10-(m-tolyl)-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3ai)



White solid, m. p. = 131-132 ℃, yield: 65%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.58 – 7.49 (m, 5H), 7.44 (t, *J* = 7.4 Hz, 4H), 7.29 (d, *J* = 4.0 Hz, 1H), 7.16 (t, *J* = 7.4 Hz, 1H), 7.01 (t, *J* = 7.6 Hz, 1H), 6.79 (d, *J* = 7.9 Hz, 1H), 3.96 (s, 2H), 2.48 (s, 3H), 2.42 (s, 3H), 1.55 (s, 3H).**^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.2, 157.1, 150.6, 144.0, 141.6, 139.6, 139.3, 138.3, 135.3, 135.0, 130.3, 130.2, 129.3, 128.8, 128.6, 128.5, 128.4, 126.8, 126.4, 126.1, 125.5, 124.7, 122.8, 122.4, 121.2, 36.3, 30.7, 21.7, 13.5. **IR** (KBr, cm^{-1}) 3690, 3052, 2921, 1680, 1587, 1447, 1382, 1336, 1276, 1233, 1161, 1115, 1031, 948, 903, 628. **HRMS** (ESI) Calcd for $C_{31}H_{24}O_2$ $(M+Na)^+$ 451.1669, found 451.1670.

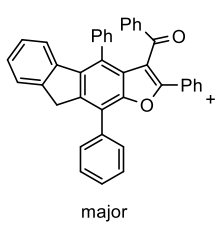
1-(2-Ethyl-4,10-diphenyl-9H-fluoreno[2,3-*b*]furan-3-yl)propan-1-one (3aj)



Colorless oil, yield: 84%. **^{1}H NMR** (400 MHz, $CDCl_3$) Isomer **3aj** δ 7.56 (d, *J* = 7.3 Hz, 2H), 7.50 – 7.31 (m, 8H), 7.28 (d, *J* = 7.2 Hz, 1H), 7.01 (t, *J* = 7.3 Hz, 1H), 6.86 (dd, *J* = 14.9, 7.4 Hz, 1H), 6.63 (d, *J* = 7.9 Hz, 1H), 3.84 (s, 2H), 2.60 (q, *J* = 7.5 Hz, 2H), 1.78 (q, *J* = 7.2 Hz, 2H), 1.16 – 1.07 (m, 3H), 0.55 (t, *J* = 7.2 Hz, 3H). Isomer **4aj** δ 8.05 (d, *J* = 8.4 Hz, 1H), 7.08 (s, 2H), 6.34 (d, *J* = 7.9 Hz, 1H), 4.03 (s, 2H), 3.11 (q, *J* = 7.5 Hz, 2H), 2.78 (q, *J* = 7.2 Hz, 2H), 1.28 (dd, *J* = 15.5, 8.0 Hz, 3H) ppm (remaining peaks could not be assigned) **^{13}C NMR** (100 MHz, $CDCl_3$) mixtures **3aj** and **4aj** δ 203.2, 197.2, 163.1, 160.2, 150.5, 149.2, 143.9, 141.6, 141.0, 139.4, 138.8, 135.2, 135.2, 134.8, 133.3, 130.9, 130.0, 129.7, 129.3, 128.6, 128.6, 128.4, 128.0, 127.9, 127.4, 126.9, 126.7, 126.3, 126.1, 125.8, 125.6, 125.2, 124.8, 124.7, 123.8, 122.7, 122.2, 121.4, 119.5, 110.8, 37.8, 37.1, 36.4, 34.7, 29.8, 22.0, 20.9, 13.0, 12.3, 8.3, 8.1. **IR** (KBr, cm^{-1}) 3692, 3058, 2976, 2932, 1955, 1685, 1588, 1452,

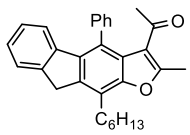
1379, 1329, 1245, 1116, 1019, 919, 758, 706, 601, 496. **HRMS** (ESI) Calcd for $C_{32}H_{26}O_2$ $(M+H)^+$ 443.2006, found 443.2008.

Phenyl(2,4,10-triphenyl-9H-fluoreno[2,3-*b*]furan-3-yl)methanone (3ak)



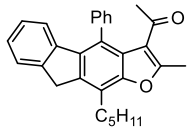
White solid, m. p. = 150-151 ℃, yield: 63%. **^{1}H NMR** (400 MHz, $CDCl_3$) Isomer **3ak** δ 7.69 (d, J = 7.8 Hz, 2H), 7.52 – 7.44 (m, 5H), 7.44 – 7.34 (m, 4H),7.34 – 7.27 (m, 2H), 7.21-7.16 (m, 1H), 7.13 – 7.05 (m, 5H), 6.93 (m, 4H), 6.78 (t, J = 7.6 Hz, 1H), 3.90 (s, 2H). Isomer **4ak** δ 8.20 (d, J = 8.3 Hz, 1H), 7.89 (d, J = 7.5 Hz, 1H), 7.74 (d, J = 7.2 Hz, 1H), 6.35 (d, J = 7.7 Hz, 3H), 4.14 (s, 2H) ppm (remaining peaks could not be assigned) **^{13}C NMR** (100 MHz, $CDCl_3$) mixtures **3ak** and **4ak** δ 193.9, 191.9, 155.6, 153.0, 150.6, 150.3, 143.9, 143.7, 141.8, 141.4, 141.0, 140.2, 138.9, 138.2, 137.6, 137.0, 135.8, 135.2, 135.1, 133.4, 133.3, 133.1, 130.8, 130.1, 130.0, 129.9, 129.8, 129.7, 129.6, 129.5, 129.4, 129.3, 129.2, 129.1, 128.8, 128.7, 128.6, 128.6, 128.2, 128.2, 128.1, 128.0, 127.8, 127.6, 127.5, 127.0, 126.7, 126.4, 126.3, 126.2, 125.7, 125.2, 124.9, 124.6, 123.8, 123.1, 122.8, 122.3, 117.2, 114.7, 37.4, 36.5.**IR** (KBr, cm^{-1}) 3728, 3059, 2922, 1957, 1815, 1662, 1593, 1486, 1450, 1373, 1326, 1276, 1168, 1067, 1025, 891, 838, 755, 605, 508. **HRMS** (ESI) Calcd for $C_{40}H_{26}O_2$ $(M+H)^+$ 539.2006, found 539.2009.

1-(10-Hexyl-2-methyl-4-phenyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3al)



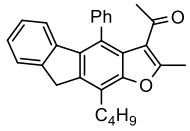
White solid, m. p. = 100-101 ^{o}C, yield: 95%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.50 (d, J = 6.6 Hz, 4H), 7.46 (d, J = 6.9 Hz, 2H), 7.17 (t, J = 7.2 Hz, 1H), 7.00 (t, J = 7.6 Hz, 1H), 6.77 (d, J = 7.9 Hz, 1H), 3.95 (s, 2H), 3.02 (t, J = 7.7 Hz, 2H), 2.48 (s, 3H), 1.82 – 1.76 (m, 2H), 1.51 (s, 3H), 1.47 (s, 2H), 1.36 (s, 4H), 0.91 (t, J = 6.4 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.4, 156.5, 151.7, 143.6, 142.0, 139.5, 134.7, 130.2, 129.1, 128.2, 127.1, 126.3, 125.9, 124.9, 124.7, 122.7, 121.9, 121.2, 35.2, 31.8, 30.6, 29.6, 29.2, 27.6, 22.7, 14.2, 13.5. **IR** (KBr, cm^{-1}) 3058, 2926, 2859, 1682, 1584, 1452, 1387, 1342, 1265, 1160, 1032, 953, 730, 622. **HRMS** (ESI) Calcd for $C_{30}H_{30}O_2$ $(M+H)^+$ 423.2319, found 423.2318.

1-(2-Methyl-10-pentyl-4-phenyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3am)



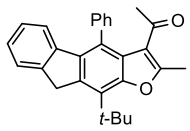
White solid, m. p. = 118-119 ^{o}C, yield: 88%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.52 – 7.41 (m, 6H), 7.15 (t, J = 7.3 Hz, 1H), 6.99 (t, J = 7.6 Hz, 1H), 6.77 (d, J = 7.9 Hz, 1H), 3.93 (s, 2H), 3.04 – 2.94 (m, 2H), 2.48 (s, 3H), 1.86 – 1.76 (m, 2H), 1.51 (s, 3H), 1.44 (dd, J = 8.3, 4.9 Hz, 4H), 0.93 (t, J = 6.9 Hz, 3H).**^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.4, 156.5, 151.7, 143.6, 142.0, 139.5, 134.8, 130.2, 129.2, 128.2, 127.1, 126.3, 125.9, 124.9, 124.7, 123.3, 122.7, 121.9, 121.2, 35.2, 32.0, 30.6, 29.0, 27.6, 22.6, 14.1, 13.5. **IR** (KBr, cm^{-1}) 3718, 3059, 2928, 2861, 2315, 1681, 1582, 1452, 1388, 1339, 1263, 1157, 1092, 1023, 952, 802, 756,624. **HRMS** (ESI) Calcd for $C_{29}H_{28}O_2$ $(M+H)^+$ 409.2162, found 409.2161.

1-(10-Butyl-2-methyl-4-phenyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3an)



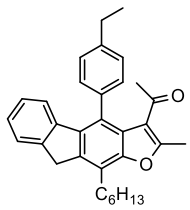
White solid, m. p. = 139-149 ^{o}C, yield: 86%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.54 (d, J = 5.6 Hz, 4H), 7.49 (d, J = 7.4 Hz, 2H), 7.20 (t, J = 7.4 Hz, 1H), 7.04 (t, J = 7.6 Hz, 1H), 6.81 (d, J = 7.9 Hz, 1H), 3.99 (s, 2H), 3.06 (t, J = 7.7 Hz, 2H), 2.52 (s, 3H), 1.86 – 1.78 (m, 2H), 1.55 (s, 3H), 1.54 – 1.47 (m, 2H), 1.04 (t, J = 7.3 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.4, 156.5, 151.7, 143.6, 142.0, 139.5, 134.8, 130.2, 129.3, 129.2, 128.2, 127.1, 126.3, 125.9, 124.9, 124.7, 122.7, 121.8, 121.2, 35.2, 31.5, 30.6, 27.3, 23.0, 14.1, 13.5. **IR** (KBr, cm^{-1}) 3728, 3058, 2939, 2865, 1681, 1584, 1452, 1386, 1267, 1159, 1069, 1023, 953, 755, 626. **HRMS** (ESI) Calcd for $C_{28}H_{26}O_2$ $(M+Na)^+$ 417.1825, found 417.1830.

1-(10-(Tert-butyl)-2-methyl-4-phenyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3ao)



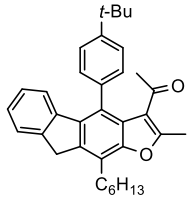
White solid, m. p. = 177-178 °C, yield: 94%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.46 (dt, *J* = 8.5, 3.9 Hz, 6H), 7.14 (t, *J* = 7.4 Hz, 1H), 6.95 (t, *J* = 7.6 Hz, 1H), 6.62 (d, *J* = 7.9 Hz, 1H), 4.26 (s, 2H), 2.47 (s, 3H), 1.73 (s, 9H), 1.52 (s, 3H).**^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.7, 155.2, 151.8, 143.9, 140.7, 139.5, 137.6, 136.1, 130.2, 130.0, 129.2, 128.3, 127.6, 126.2, 126.1, 125.9, 124.1, 122.7, 120.6, 39.0, 37.3, 31.7, 30.7, 13.4. **IR** (KBr, cm^{-1}) 3713, 3046, 2920, 2851, 1680, 1591, 1451, 1369, 1232, 1139, 1232, 1139, 1027, 953, 807, 757, 696, 626. **HRMS** (ESI) Calcd for $C_{28}H_{26}O_2$ $(M+H)^+$ 395.2006, found 395.2005.

1-(4-(4-Ethylphenyl)-10-hexyl-2-methyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3ba)



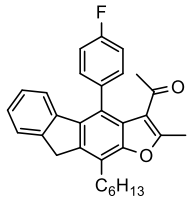
Colorless oil, yield: 56%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.50 (d, *J* = 7.4 Hz, 1H), 7.35 (q, *J* = 8.0 Hz, 4H), 7.16 (t, *J* = 7.4 Hz, 1H), 7.01 (t, *J* = 7.6 Hz, 1H), 6.85 (d, *J* = 7.9 Hz, 1H), 3.94 (s, 2H), 3.01 (t, *J* = 7.7 Hz, 2H), 2.77 (q, *J* = 7.6 Hz, 2H), 2.47 (s, 3H), 1.83 – 1.74 (m, 2H), 1.47 (s, 5H), 1.34 (dd, *J* = 13.6, 5.9 Hz, 7H), 0.91 (t, *J* = 6.6 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.8, 156.5, 151.7, 144.4, 143.6, 142.1, 139.5, 136.7, 134.7, 130.1, 128.6, 127.2, 126.3, 125.8, 125.1, 124.7, 122.7, 121.7, 121.3, 35.2, 31.8, 30.5, 29.6, 29.3, 28.8, 27.6, 22.7, 15.8, 14.2, 13.4. **IR** (KBr, cm^{-1}) 3729, 2927, 2861, 1680, 1583, 1454, 1388, 1264, 1157, 1025, 953, 836, 625. **HRMS** (ESI) Calcd for $C_{32}H_{34}O_2$ $(M+Na)^+$ 473.2451, found 473.2449.

1-(4-(4-(Tert-butyl)phenyl)-10-hexyl-2-methyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3bb)



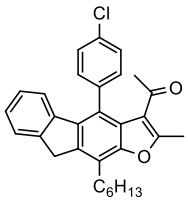
Colorless oil, yield: 60%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.42 (t, *J* = 8.3 Hz, 3H), 7.29 (d, *J* = 7.9 Hz, 2H), 7.08 (t, *J* = 7.4 Hz, 1H), 6.93 (t, *J* = 7.6 Hz, 1H), 6.77 (d, *J* = 7.9 Hz, 1H), 3.85 (s, 2H), 2.92 (t, *J* = 7.7 Hz, 2H), 2.39 (s, 3H), 1.71 (dd, *J* = 14.9, 7.4 Hz, 2H), 1.38 (d, *J* = 8.5 Hz, 2H), 1.34 (s, 12H), 1.31 – 1.24 (m, 4H), 0.83 (t, *J* = 6.6 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 199.6, 156.6, 151.7, 151.4, 143.6, 142.2, 139.5, 136.5, 134.8, 129.9, 127.1, 126.3, 126.0, 125.8, 125.1, 124.7, 122.8, 121.7, 121.4, 35.2, 34.8, 31.8, 31.5, 30.4, 29.6, 29.3, 27.6, 22.7, 14.2, 13.4. **IR** (KBr, cm^{-1}) 3710, 3051, 2955, 2862, 1681, 1582, 1456, 1389, 1268, 1194, 1159, 1109, 1023, 952, 837, 758, 622, 561. **HRMS** (ESI) Calcd for $C_{34}H_{38}O_2$ $(M+H)^+$ 479.2945, found 479.2946.

1-(4-(4-Fluorophenyl)-10-hexyl-2-methyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3bc)



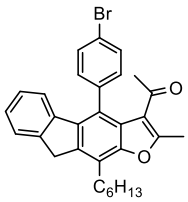
White solid, m. p. = 130-131 °C, yield: 74%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.50 (d, *J* = 7.4 Hz, 1H), 7.45 – 7.37 (m, 2H), 7.21 (dd, *J* = 15.4, 7.8 Hz, 3H),7.03 (t, *J* = 7.6 Hz, 1H), 6.72 (d, *J* = 7.9 Hz, 1H), 3.94 (s, 2H), 3.01 (t, *J* = 7.7 Hz, 2H), 2.49 (s, 3H), 1.83 – 1.75 (m, 2H), 1.63 (s, 3H), 1.50 – 1.42 (m, 2H), 1.40 – 1.28 (m, 4H), 0.91 (t, *J* = 6.7 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.0, 162.7 (d, *J* = 247.9 Hz), 156.5, 151.7, 143.7, 141.9, 139.5, 135.5 (d, *J* = 3.3 Hz),135.0, 131.9, 131.8, 131.3, 128.3, 126.4, 126.0, 125.8, 125.0, 124.8, 122.5, 122.1, 121.0, 116.16 (d, *J* = 21.3 Hz), 35.2, 31.8, 30.9, 29.6, 29.2, 27.6, 22.7, 14.2, 13.5.**^{19}F NMR** (376 MHz, $CDCl_3$) δ -113.4. **IR** (KBr, cm^{-1}) 3713, 3063, 2929, 2860, 2315, 1682, 1589, 1508, 1455, 1389, 1340, 1226, 1155, 1088, 1022, 951, 839, 728, 626, 517. **HRMS** (ESI) Calcd for $C_{30}H_{29}FO_2$ $(M+H)^+$ 441.2224, found 441.2230.

1-(4-(4-Chlorophenyl)-10-hexyl-2-methyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3bd)



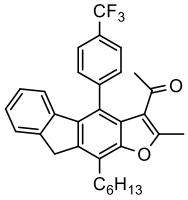
White solid, m. p. = 103-104 °C, yield: 98%. **^{1}H NMR** (400 MHz, DMSO) δ 7.49 (d, *J* = 7.8 Hz, 3H), 7.38 (d, *J* = 7.6 Hz, 2H), 7.18 (t, *J* = 7.4 Hz, 1H), 7.03 (t, *J* = 7.6 Hz, 1H), 6.76 (d, *J* = 7.9 Hz, 1H), 3.92 (s, 2H), 3.00 (t, *J* = 7.6 Hz, 2H), 2.49 (s, 3H), 1.82 – 1.74 (m, 2H), 1.63 (s, 3H), 1.45 (d, *J* = 7.3 Hz, 2H), 1.36 (s, 4H), 0.91 (t, *J* = 6.4 Hz, 3H).**^{13}C NMR** (100 MHz, DMSO) δ 198.9, 156.6, 151.7, 143.7, 141.8, 139.6, 137.9, 134.8, 134.2, 131.6, 129.4, 126.4, 126.1, 125.6, 124.9, 124.8, 122.5, 122.3, 121.0, 35.2, 31.8, 30.9, 29.6, 29.2, 27.6, 22.7, 14.2, 13.6. **IR** (KBr, cm^{-1}) 3710, 2926, 2859, 1682, 1583, 1453, 1389, 1342, 1262, 1160, 1090, 1019, 952, 830, 727, 625, 502. **HRMS** (ESI) Calcd for $C_{30}H_{29}ClO_2$ $(M+H)^+$ 457.1929, found 457.1930.

1-(4-(4-Bromophenyl)-10-hexyl-2-methyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3be)



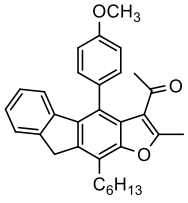
White solid, m. p. = 109-110 °C, yield: 78%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8.2 Hz, 2H), 7.49 (d, *J* = 7.4 Hz, 1H), 7.32 (d, *J* = 8.2 Hz, 2H), 7.18 (t, *J* = 7.4 Hz, 1H), 7.04 (t, *J* = 7.6 Hz, 1H), 6.77 (d, *J* = 7.9 Hz, 1H), 3.92 (s, 2H), 3.06 – 2.92 (m, 2H), 2.49 (s, 3H), 1.82 – 1.73 (m, 2H), 1.62 (s, 3H), 1.49 – 1.42 (m, 2H), 1.35 (dd, *J* = 9.2, 5.9 Hz, 4H), 0.91 (t, *J* = 6.7 Hz, 3H).**^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.9, 156.6, 151.7, 143.7, 141.7, 139.6, 138.4, 134.7, 132.3, 131.9, 131.0, 126.4, 126.1, 125.5, 124.9, 124.7, 122.5, 122.3, 121.0, 35.2, 31.8, 30.9, 29.6, 29.2, 27.6, 22.7, 14.2, 13.6. **IR** (KBr, cm^{-1}) 2926, 2860, 1680, 1583, 1453, 1391, 1230, 1071, 1014, 956, 896, 827, 726, 627, 498. **HRMS** (ESI) Calcd for $C_{30}H_{29}BrO_2$ $(M+H)^+$ 501.1424, found 501.1425.

1-(10-Hexyl-2-methyl-4-(4-(trifluoromethyl)phenyl)-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3bf)



White solid, m. p. = 145-146 °C, yield: 75%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.72 (d, *J* = 7.8 Hz, 2H), 7.52 (d, *J* = 7.8 Hz, 2H), 7.45 (d, *J* = 7.4 Hz, 1H), 7.12 (t, *J* = 7.4 Hz, 1H), 6.95 (t, *J* = 7.6 Hz, 1H), 6.58 (d, *J* = 7.9 Hz, 1H), 3.88 (s, 2H), 2.95 (t, *J* = 7.7 Hz, 2H), 2.43 (s, 3H), 1.76 – 1.68 (m, 2H), 1.50 (s, 3H), 1.39 (d, *J* = 7.4 Hz, 2H), 1.28 (d, *J* = 11.8 Hz, 4H), 0.84 (t, *J* = 6.6 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.5, 156.8, 151.7, 143.7, 143.4, 141.5, 139.7, 134.7, 130.7, 130.4 (q, *J* = 32.6 Hz), 126.5, 126.2, 126.0 (q, *J* = 3.6 Hz), 125.3, 124.9, 124.6, 122.9, 122.6, 122.4, 120.9, 117.7, 35.2, 31.8, 30.7, 29.6, 29.2, 27.6, 22.7, 14.1, 13.6. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -62.3. **IR** (KBr, cm^{-1}) 3711, 2929, 2861, 1685, 1580, 1456, 1395, 1323, 1264, 1165, 1125, 1067, 1020, 952, 846, 759, 725, 619. **HRMS** (ESI) Calcd for $C_{31}H_{29}F_3O_2$ $(M+H)^+$ 491.2192, found 491.2193.

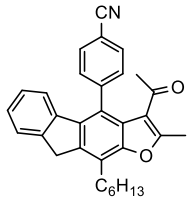
1-(10-Hexyl-4-(4-methoxyphenyl)-2-methyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3bg)



White solid, m. p. = 117-118 °C, yield: 61%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 7.4 Hz, 1H), 7.40 (d, *J* = 8.2 Hz, 2H), 7.21 (t, *J* = 7.4 Hz, 1H), 7.07 (t, *J* = 9.0 Hz, 3H), 6.89 (d, *J* = 7.8 Hz, 1H), 3.96 (d, *J* = 7.5 Hz, 5H), 3.04 (t, *J* = 7.7 Hz, 2H), 2.52 (s, 3H), 1.87 – 1.79 (m, 2H), 1.62 (s, 3H), 1.50 (d, *J* = 7.3 Hz, 2H), 1.44 – 1.35 (m, 4H), 0.96 (t, *J* = 6.7 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.6, 159.5, 156.3, 151.7, 143.6, 142.2, 139.5, 135.1, 131.8, 131.3, 126.8, 126.3, 125.8,

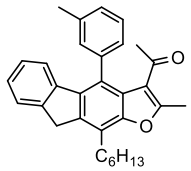
125.3, 124.7, 122.7, 121.7, 121.3, 114.5, 55.4, 35.2, 31.8, 30.8, 29.6, 29.3, 27.6, 22.7, 14.2, 13.4. **IR** (KBr, cm^{-1}) 3714, 2929, 2859, 2314, 1682, 1597, 1513, 1454, 1389, 1342, 1284, 1246, 1173, 1105, 1031, 951, 834, 758, 728, 624. **HRMS** (ESI) Calcd for $C_{31}H_{32}O_3$ $(M+H)^+$ 453.2424, found 453.2426.

4-(3-Acetyl-10-hexyl-2-methyl-9H-fluoreno[2,3-*b*]furan-4-yl)benzonitrile (3bh)



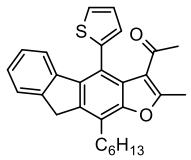
White solid, m. p. = 133-134 °C, yield: 58%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.85 (d, J = 7.9 Hz, 2H), 7.59 (d, J = 8.0 Hz, 2H), 7.55 (d, J = 7.4 Hz, 1H), 7.23 (t, J = 7.4 Hz, 1H), 7.06 (t, J = 7.6 Hz, 1H), 6.59 (d, J = 7.9 Hz, 1H), 3.98 (s, 2H), 3.05 (t, J = 7.7 Hz, 2H), 2.57 (s, 3H), 1.85 – 1.80 (m, 2H), 1.79 (s, 3H), 1.53 – 1.46 (m, 2H), 1.43 – 1.35 (m, 4H), 0.95 (t, J = 6.7 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 197.6, 157.2, 151.7, 144.6, 143.7, 141.4, 139.7, 134.7, 132.7, 131.1, 126.5, 126.3, 125.0, 125.0, 124.2, 122.8, 122.3, 120.6, 118.8, 111.9, 35.2, 31.8, 31.0, 29.5, 29.2, 27.6, 22.7, 14.2, 14.0. **IR** (KBr, cm^{-1}) 3714, 3060, 2928, 2860, 2314, 2227, 1686, 1593, 1454, 1394, 1340, 1265, 1193, 1103, 1023, 952, 841, 758, 613, 553. **HRMS** (ESI) Calcd for $C_{31}H_{29}NO_2$ $(M+H)^+$ 448.2271, found 448.2276.

1-(10-Hexyl-2-methyl-4-(m-tolyl)-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3bi)



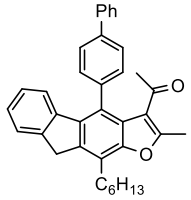
Colorless oil, m. p. = 177-178 °C, yield: 67%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.42 (d, J = 7.4 Hz, 1H), 7.31 (d, J = 7.6 Hz, 1H), 7.20 – 7.16 (m, 3H), 7.09 (t, J = 7.3 Hz, 1H), 6.94 (t, J = 7.6 Hz, 1H), 6.78 (d, J = 7.8 Hz, 1H), 3.86 (s, 2H), 2.93 (t, J = 7.7 Hz, 2H), 2.40 (s, 3H), 2.32 (s, 3H), 1.74 – 1.67 (m, 2H), 1.43 (s, 3H), 1.37 (d, J = 7.2 Hz, 2H), 1.28 (d, J = 3.1 Hz, 4H), 0.83 (t, J = 6.7 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.5, 156.3, 151.7, 143.6, 142.1, 139.5, 139.3, 138.9, 134.6, 130.8, 129.0, 128.8, 127.3, 126.3, 125.8, 124.9, 124.7, 123.3, 122.8, 121.7, 121.3, 35.2, 31.8, 30.6, 29.6, 29.3, 27.6, 22.7, 21.5, 14.2, 13.5. **IR** (KBr, cm^{-1}) 3692, 3045, 2926, 2860, 1683, 1588, 1453, 1386, 1343, 1271, 1207, 1155, 1034, 954, 882, 625. **HRMS** (ESI) Calcd for $C_{31}H_{32}O_2$ $(M+Na)^+$ 459.2295, found 459.2297.

1-(10-Hexyl-2-methyl-4-(thiophen-2-yl)-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3bj)



White solid, m. p. = 105-106 °C, yield: 63%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.56 – 7.46 (m, 2H), 7.27 (d, J = 2.0 Hz, 1H), 7.19 (dd, J = 13.3, 6.1 Hz, 2H), 7.07 (t, J = 7.6 Hz, 1H), 6.87 (d, J = 7.8 Hz, 1H), 3.93 (s, 2H), 3.00 (t, J = 7.7 Hz, 2H), 2.48 (s, 3H), 1.83 – 1.74 (m, 2H), 1.68 (s, 3H), 1.49 – 1.42 (m, 2H), 1.40 – 1.30 (m, 4H), 0.91 (t, J = 6.8 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.4,156.4, 151.7, 143.6, 141.9, 139.7, 139.4, 135.6, 129.9, 126.6, 126.5, 126.0, 125.6, 124.7, 124.3, 122.5, 122.2, 121.4, 121.2, 35.2, 31.8, 30.2, 29.6, 29.2, 27.6, 22.7, 14.2, 13.5. **IR** (KBr, cm^{-1}) 3443, 3101, 2925, 2859, 1680, 1585, 1454, 1385, 1260, 1201, 1154, 1038, 955, 841, 758, 726, 640. **HRMS** (ESI) Calcd for $C_{31}H_{32}O_2$ $(M+Na)^+$ 459.2295, found 459.2297.

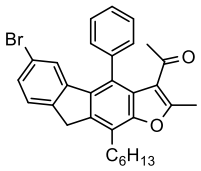
1-(4-([1,1'-Biphenyl]-4-yl)-10-hexyl-2-methyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3bk)



White solid, m. p. = 148-149 °C, yield: 83%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 (dd, J = 11.4, 7.8 Hz, 4H), 7.64 – 7.54 (m, 5H), 7.46 (t, J = 7.3 Hz, 1H), 7.25 (t, J = 7.4 Hz, 1H), 7.10 (t, J = 7.5 Hz, 1H), 7.02 (d, J = 7.9 Hz, 1H), 4.02 (s, 2H), 3.09 (t, J = 7.6 Hz, 2H), 2.57 (s, 3H), 1.94 – 1.82 (m, 2H), 1.63 (s, 3H), 1.56 (s, 2H), 1.45 (d, J = 3.1 Hz, 4H), 1.01 (d, J = 7.0 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.4, 156.6, 151.8, 143.7, 142.0, 140.8, 140.4, 139.6, 138.5, 134.8, 130.7, 129.0, 127.7,

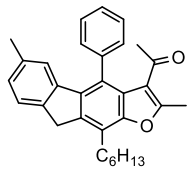
127.1, 126.7, 126.4, 126.0, 125.0, 124.8, 122.8, 122.0, 121.3, 35.2, 31.8, 30.8, 29.6, 29.3, 27.7, 22.8, 14.2, 13.5. **IR** (KBr, cm^{-1}) 3714, 3054, 2926, 2859, 2315, 1683, 1585, 1456, 1342, 1265, 1018, 952, 842, 755, 624. **HRMS** (ESI) Calcd for $C_{34}H_{32}O_2$ $(M+Na)^+$ 495.2295, found 495.2283.

1-(10-Hexyl-2-methyl-4-(naphthalen-2-yl)-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3bl)



White solid, m. p. = 117-118 °C, yield: 68%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.56 (s, 3H), 7.46 (s, 2H), 7.36 (s, 1H), 7.31 (s, 1H), 6.85 (s, 1H), 3.91 (s, 2H), 3.02 (s, 2H), 2.52 (s, 3H), 1.80 (d, J = 6.7 Hz, 2H), 1.55 (s, 3H), 1.49 (s, 2H), 1.38 (s, 4H), 0.94 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.2, 156.9, 151.9, 144.1, 142.2, 139.7, 138.8, 133.6, 129.9, 129.3, 128.5, 127.5, 125.9, 125.8, 124.9, 122.0, 121.1, 120.3, 34.8, 31.8, 30.7, 29.6, 29.2, 27.6, 22.7, 14.2, 13.5. **IR** (KBr, cm^{-1}). 3849, 3704, 3522, 3498, 2925,1682, 1588, 1448, 655. **HRMS** (ESI) Calcd for $C_{30}H_{29}BrO_2$ $(M+H)^+$ 501.1424, found 501.1421.

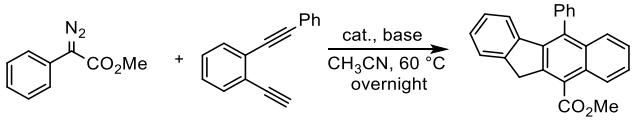
1-(10-Hexyl-2,6-dimethyl-4-phenyl-9H-fluoreno[2,3-*b*]furan-3-yl)ethan-1-one (3bm)



White solid, m. p. = 116-117 °C, yield: 63%. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.51 (d, J = 14.1 Hz, 5H), 7.41 (d, J = 7.1 Hz, 1H), 7.02 (d, J = 7.2 Hz, 1H), 6.58 (s, 1H), 3.93 (s, 2H), 3.03 (s, 2H), 2.51 (s, 3H), 2.15 (s, 3H), 1.81 (s, 2H), 1.55 (s, 3H), 1.49 (s, 2H), 1.39 (s, 4H), 0.94 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.5, 156.5, 151.6, 142.1, 140.7, 139.9, 139.5, 135.7, 134.8, 130.2, 129.1, 128.1, 127.0, 126.8, 124.7, 124.4, 123.5, 121.8, 121.2, 34.8, 31.8, 30.7, 29.6, 29.26, 27.6, 22.7, 21.7, 14.2, 13.5. **IR** (KBr, cm^{-1}) 3925, 3817, 3742, 3565, 3524, 3481, 3456, 3425, 2927, 1680, 1581, 1460, 1387, 1284, 1264, 1208, 1111, 1072, 1029, 952, 805, 724, 702, 627. **HRMS** (ESI) Calcd for $C_{31}H_{32}O_2$ $(M+Na)^+$ 459.2295, found 459.2290.

1.5 Optimization of the reaction conditions for synthesis of 6a

Table S2. Optimization of the reaction conditions for synthesis of **6a**[a]

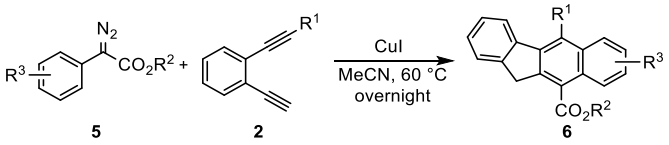


5a **2a** **6a**

Entry	Cat. (5 mol %)	Base	Yield (%)[b]
1	CuBr	-	12
2	CuCl	-	41
3	$Cu(MeCN)_4PF_4$	-	45
4	**CuI**	**-**	**68[c]**
5	CuI	i-Pr_2NH	59
6[d]	CuI	-	51

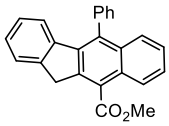
[a]The reaction was performed at 60 ℃ overnight. The molar ratio of **5a**:**2a** = 1.5:1. [**2a**] = 0.1M. [b]Yield of **6a** determined by ^{1}H NMR spectroscopy. [c]Isolated yield of **6a.** [d]**5a**:**2a** = 1:1.

1.6 General procedure for the synthesis of 6a-6j



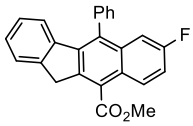
To an acetonitrile (MeCN, 1.0 mL) suspension of CuI (10 mol %) in Schlenk tube with a magnetic bar under nitrogen atmosphere, was added alkynyl (**2**, 0.1 mmol) and diazonium (**5**, 0.15 mmol). The reaction was stirred at 60 ℃ unless being noted and monitored by TLC. After accomplished, the reaction mixture was purified by chromatography with petroleum/ethyl acetate(v/v: 20/1) to obtain **6**.

Methyl 5-phenyl-11H-benzo[*b*]fluorene-10-carboxylate (6a)



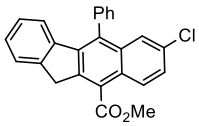
White solid, m. p. = 145-146 °C, yield = 68%; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.42 (d, J = 8.5 Hz, 1H), 7.54 (dt, J = 16.7, 7.3 Hz, 6H), 7.38 (t, J = 8.0 Hz, 3H), 7.22 (t, J = 7.4 Hz, 1H), 7.01 (t, J = 7.6 Hz, 1H), 6.40 (d, J = 7.9 Hz, 1H), 4.01 (s, 2H), 4.29 (s, 2H), 4.11 (s, 3H). **^{13}C NMR** (100MHz, $CDCl_3$) δ 168.9, 143.9, 142.8, 140.4, 138.6, 137.4, 136.8, 133.2, 129.8, 129.7, 129.3, 128.1, 127.5, 126.8, 126.6,126.6, 125.7, 125.3, 124.9, 124.7, 123.7, 52.2, 37.5. **IR** (KBr, cm^{-1}) 3777, 3437, 3061, 2955, 1719, 1633, 1441, 1392, 1254, 1210, 1037, 969, 752, 598. **HRMS** (ESI) Calcd for $C_{25}H_{18}O_2$ $(M+H)^+$ 351.1380, found 351.1381.

Methyl 7-fluoro-5-phenyl-11H-benzo[*b*]fluorene-10-carboxylate (6b)



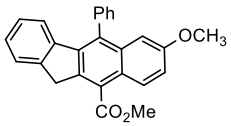
White solid, m. p. = 126-127 °C, yield = 56%; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.42 – 8.29 (m, 1H), 7.47 (d, J = 3.8 Hz, 3H), 7.38 (d, J = 7.5 Hz, 1H), 7.24 – 7.15 (m, 3H), 7.12 (t, J = 7.3 Hz, 1H), 7.05 (d, J = 11.0 Hz, 1H), 6.90 (t, J = 7.6 Hz, 1H), 6.29 (d, J = 7.9 Hz, 1H), 4.15 (s, 2H), 3.99 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 168.6, 160.6 (d, J = 245.9 Hz), 144.1, 142.4, 140.1, 138.5, 138.1, 136.2, 136.2, 134.6, 134.6, 129.6, 129.4, 128.4, 127.9, 126.7, 124.8, 123.8, 116.7, 116.4, 110.4, 110.2, 52.2, 37.6. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -114.2. **IR** (KBr, cm^{-1}) 3714, 3061, 2952, 1719, 1619, 1508, 1437, 1210, 1124, 1038, 966, 864, 825, 751, 587, 453. **HRMS** (ESI) Calcd for $C_{25}H_{17}FO_2$ $(M+H)^+$ 369.1285, found 369.1289.

Methyl 7-chloro-5-phenyl-11H-benzo[*b*]fluorene-10-carboxylate (6c)



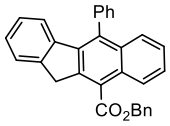
White solid, m. p. = 173-174 °C, yield = 55%; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.41 (d, J = 9.1 Hz, 1H), 7.62 (d, J = 5.6 Hz, 3H), 7.51 (d, J = 6.2 Hz, 2H), 7.47 (d, J = 9.2 Hz, 1H), 7.36 (d, J = 7.2 Hz, 2H), 7.25 (s, 1H), 7.02 (t, J = 7.6 Hz, 1H), 6.37 (d, J = 7.9 Hz, 1H), 4.29 (s, 2H), 4.13 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 168.5, 144.0, 143.3, 140.0, 138.6, 137.8, 136.0, 134.2, 131.9, 129.7, 129.4, 128.4, 128.1, 127.9, 127.3, 127.1, 126.7, 125.5, 124.7, 123.8, 52.3, 37.7. **IR** (KBr, cm^{-1}) 3731, 3061, 2952, 1720, 1600, 1489, 1443, 1396, 1247, 1148, 1090, 1039, 969, 883, 821, 756, 711, 599. **HRMS** (ESI) Calcd for $C_{25}H_{17}ClO_2$ $(M+H)^+$ 385.0990, found 385.0983.

Methyl 7-methoxy-5-phenyl-11H-benzo[*b*]fluorene-10-carboxylate (6d)



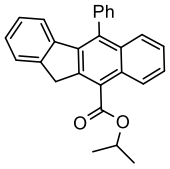
White solid, m. p. = 192-193 °C, yield =46%; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.60 (d, J = 8.0 Hz, 2H), 7.56 – 7.49 (m, 7H), 7.43 (d, J = 7.4 Hz, 1H), 7.17 (t, J = 7.3 Hz, 1H), 7.01 (t, J = 7.6 Hz, 1H), 6.78 (d, J = 7.9 Hz, 1H), 3.94 (s, 2H), 2.42 (s, 3H), 1.55 (s, 3H). **^{13}C NMR** (100MHz, $CDCl_3$) δ 169.0, 157.2, 144.2, 140.6, 140.5, 138.8, 137.9, 135.8, 134.6, 129.7, 129.3, 128.1, 127.4, 126.9, 126.5, 125.3, 124.7, 124.6, 123.6, 118.5, 105.8, 55.1, 52.1, 37.5. **IR** (KBr, cm^{-1}) 3460, 2918, 1733, 1624, 1509, 1428, 1242, 1149, 1030, 813. **HRMS** (ESI) Calcd for $C_{26}H_{20}O_3$ $(M+H)^+$ 381.1485, found 381.1485.

Benzyl 5-phenyl-11H-benzo[*b*]fluorene-10-carboxylate (6e)



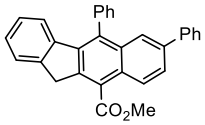
White solid, m. p. = 118-119 °C, yield = 61%; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.41 (d, *J* = 8.6 Hz, 1H), 7.58 (dd, *J* = 15.0, 6.9 Hz, 6H), 7.42 (ddd, *J* = 19.9, 15.1, 7.4 Hz, 8H), 7.21 (d, *J* = 7.4 Hz, 1H), 7.00 (t, *J* = 7.6 Hz, 1H), 6.39 (d, *J* = 7.9 Hz, 1H), 5.60 (s, 2H), 4.24 (s, 2H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 168.4, 143.9, 142.7, 140.4, 138.6, 137.4, 136.9, 135.9, 133.2, 129.8, 129.8, 129.3, 128.8, 128.7, 128.5, 128.1, 127.5, 126.9, 126.7, 126.6, 125.7, 125.3, 124.9, 124.8, 123.7, 67.2, 37.5. **IR** (KBr, cm^{-1}) 3458, 3063, 2955, 1454, 1393, 1248, 1207, 1137, 1036, 967, 756, 697, 594. **HRMS** (ESI) Calcd for $C_{31}H_{22}O_2$ $(M+Na)^+$ 449.1512, found 449.1516.

Isopropyl 5-phenyl-11H-benzo[*b*]fluorene-10-carboxylate (6f)



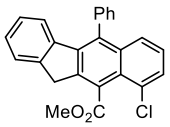
White solid, m. p. = 160-161 °C, yield = 85%; **^{1}H NMR** (400 MHz, $CDCl_3$) δ8.39 (d, *J* = 8.5 Hz, 1H), 7.62 – 7.49 (m, 6H), 7.38 (t, *J* = 7.0 Hz, 3H), 7.21 (d, *J* = 6.5 Hz, 1H), 7.02 (d, *J* = 7.6 Hz, 1H), 6.41 (d, *J* = 7.8 Hz, 1H), 5.60 – 5.47 (m, 1H), 4.29 (s, 2H), 1.53 (d, *J* = 6.1 Hz, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 168.1, 143.9, 141.9, 140.5, 138.7, 137.4, 136.5, 133.2, 129.8, 129.7, 129.3, 128.1, 127.5, 126.9, 126.7, 126.5, 125.8, 125.7, 125.2, 124.8, 123.7, 69.1, 37.3, 22.3. **IR** (KBr, cm^{-1}) 3716, 3062, 2975, 2314, 1716, 1596, 1456, 1383, 1251, 1213, 1103, 1035, 963, 757, 700. **HRMS** (ESI) Calcd for $C_{27}H_{22}O_2$ $(M+H)^+$ 379.1693, found 379.1696.

Methyl 5,7-diphenyl-11H-benzo[*b*]fluorene-10-carboxylate (6g)



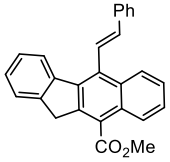
White solid, m. p. = 163-164 °C, yield = 64%; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.53 (d, *J* = 8.8 Hz, 1H), 7.81 – 7.75 (m, 2H), 7.58 (q, *J* = 5.7 Hz, 3H), 7.51 (t, *J* = 8.6 Hz, 3H), 7.41 – 7.34 (m, 4H), 7.29 (t, *J* = 7.3 Hz, 1H), 7.23 – 7.17 (m, 1H), 7.01 (t, *J* = 7.6 Hz, 1H), 6.39 (d, *J* = 7.9 Hz, 1H), 4.30 (s, 2H), 4.12 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 168.86, 144.04, 143.11, 140.97, 140.43, 138.49, 138.28, 137.92, 137.22, 133.55, 129.80, 129.38, 129.14, 128.88, 128.25, 127.62, 127.43, 126.70, 126.28, 125.99, 124.77, 124.67, 123.76, 52.22, 37.73. **IR** (KBr, cm^{-1}) 3713, 3047, 2926, 2858, 2314, 1734, 1594, 1482, 1445, 1251, 1164, 1089, 1013, 958, 832, 755, 696, 617, 501. **HRMS** (ESI) Calcd for $C_{31}H_{22}O_2$ $(M+Na)^+$ 449.1512, found 449.1512.

Methyl 9-chloro-5-phenyl-11H-benzo[*b*]fluorene-10-carboxylate (6h)



Yellow oil, yield = 66%; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.63 (t, *J* = 6.6 Hz, 4H), 7.55 (t, *J* = 6.9 Hz, 2H), 7.39 (d, *J* = 6.9 Hz, 2H), 7.30 (d, *J* = 7.6 Hz, 2H), 7.06 (t, *J* = 7.6 Hz, 1H), 6.41 (d, *J* = 7.9 Hz, 1H), 4.15 (d, *J* = 31.8 Hz, 5H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 170.5, 143.7, 141.8, 140.1, 138.2, 137.9, 135.4, 135.0, 129.9, 129.8, 129.3, 128.3, 128.2, 128.0, 126.8, 126.4, 126.1, 125.9, 125.5, 124.9, 123.9, 52.8, 36.0.**IR** (KBr, cm^{-1}) 3726, 3062, 2937, 2314, 1730, 1446, 1251, 1183, 1144, 880, 814, 733, 513. **HRMS** (ESI) Calcd for $C_{25}H_{17}ClO_2$ $(M+H)^+$ 385.0990, found 385.0989.

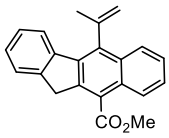
Methyl (E)-5-styryl-11H-benzo[*b*]fluorene-10-carboxylate (6i)



Yellow oil, yield = 70%; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.44 (d, *J* = 8.3 Hz, 1H), 8.36 (d, *J* = 8.3 Hz, 1H), 8.09 (d, *J* = 7.4 Hz, 1H), 7.76 – 7.68 (m, 3H), 7.59 (d, *J* = 6.6 Hz, 2H), 7.53 (dd, *J* = 14.6, 7.4 Hz, 3H), 7.43 (t, *J* = 6.9 Hz, 1H), 7.36 (dd, *J* = 14.2, 6.9 Hz, 2H), 6.93 (d, *J* = 16.7 Hz, 1H), 4.30 (s, 2H), 4.15 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 168.9, 144.0, 142.8, 140.9, 137.1, 136.9, 136.8, 133.7, 132.4,

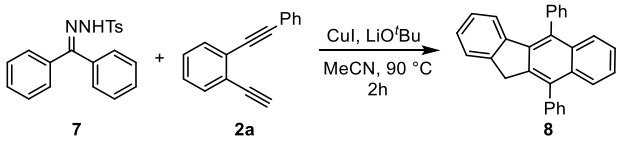
130.0, 129.0, 128.7, 128.3, 128.2, 127.5, 126.9, 126.7, 126.2, 125.7, 125.6, 125.0, 124.9, 124.5, 52.1, 37.6. **IR** (KBr, cm^{-1}) 3441, 2919, 1713, 1643, 1441, 1391, 1213, 1043, 974, 798, 753. **HRMS** (ESI) Calcd for $C_{27}H_{20}O_2$ $(M+H)^+$ 377.1536, found 377.1543.

Methyl 5-(2-methylprop-1-en-1-yl)-11H-benzo[*b*]fluorene-10-carboxylate (6j)



Yellow solid, yield = 70%; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.43 (d, J = 8.2 Hz, 1H), 8.19 (t, J = 6.7 Hz, 2H), 7.59 (dd, J = 15.3, 7.3 Hz, 3H), 7.40 (d, J = 4.1 Hz, 2H), 5.76 (s, 1H), 5.22 (s, 1H), 4.30 (s, 2H), 4.14 (s, 3H), 2.30 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 168.9, 143.9, 143.1, 142.6, 140.1, 138.6, 135.0, 131.4, 129.9, 129.3, 127.5, 126.9, 126.6, 125.9, 125.8, 125.5, 124.8, 123.9, 117.5, 52.1, 37.4, 24.1. **IR** (KBr, cm^{-1}) 3443, 2954, 1714, 1639, 1438, 1212, 1042, 759. **HRMS** (ESI) Calcd for $C_{22}H_{18}O_2$ $(M+H)^+$ 315.1380, found 315.1376.

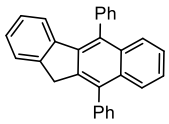
1.7 General procedure for the synthesis of 8



To an acetonitrile (MeCN, 1.0 mL) suspension of CuI (10 mol %) and LiO^{t}Bu (2eq.) in Schlenk tube with a magnetic bar under nitrogen atmosphere, was added alkynyl (**2a**, 0.1 mmol) and N-tosylhydrazones (**7**, 0.15 mmol). The reaction was stirred at 90 ℃ unless being noted and monitored by TLC. After accomplished, the reaction mixture was purified by chromatography with petroleum/ethyl acetate(v/v: 20/1) to obtain **8**.

The characterization data of **8** was consistent with literature. [6]

5,10-Diphenyl-11H-benzo[b]fluorene (8)



White solid, yield = 53%; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.68 – 7.54 (m, 7H), 7.50 (d, J = 9.2 Hz, 5H), 7.42 – 7.33 (m, 3H), 7.19 (s, 1H), 7.02 (t, J = 7.5 Hz, 1H), 6.50 (d, J = 7.9 Hz, 1H), 3.87 (s, 2H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 144.3, 141.5, 139.5, 139.3, 139.2, 137.0, 135.3, 133.2, 133.0, 131.6, 130.2, 130.0, 129.2, 128.7, 127.8, 127.4, 127.1, 126.5, 126.5, 125.8, 125.3, 125.1, 124.8, 123.8, 36.6.

2. References

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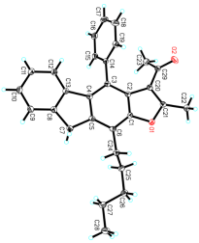
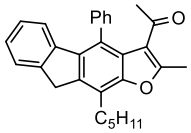
[6] K. Wang, H. Zhang and J. L. Petersen, *J. Org. Chem.*, 1999, **64**,1650.

3. X-Ray diffraction analysis

3.1 Crystal data and structure refinement for 3am

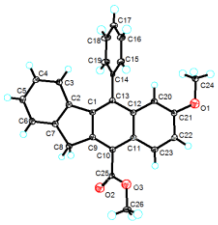


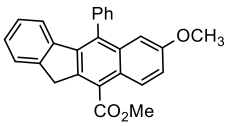


CCDC number	1888277
Identification code	**3am**
Empirical formula	$C_{29}H_{28}O_2$
Formula weight	408.51
Temperature/K	100.00(10)
Crystal system	triclinic
Space group	P-*1*
a/Å	10.2239(5)
b/Å	11.0090(6)
c/Å	11.0538(6)
α/°	73.729(5)
β/°	86.050(5)
γ/°	65.798(5)
Volume/Å^3	1087.85(11)
Z	2
ρ_{calc}g/cm^3	1.247
μ/mm^{-1}	0.076
F(000)	436.0
Crystal size/mm^3	0.13 × 0.12 × 0.11
Radiation	MoKα (λ = 0.71073)
2θ range for data collection/°	4.222 to 49.99
Index ranges	-12 ≤ h ≤ 12, -13 ≤ k ≤ 12, -13 ≤ l ≤ 12
Reflections collected	11241
Independent reflections	3818 [R_{int} = 0.0404, R_{sigma} = 0.0473]
Data/restraints/parameters	3818/0/292
Goodness-of-fit on F^2	1.043
Final R indexes [I>=2σ (I)]	R_1 = 0.0458, wR_2 = 0.1096
Final R indexes [all data]	R_1 = 0.0577, wR_2 = 0.1198

Largest diff. peak/hole / e $Å^{-3}$ 0.23/-0.18

3.2 Crystal data and structure refinement for 6d

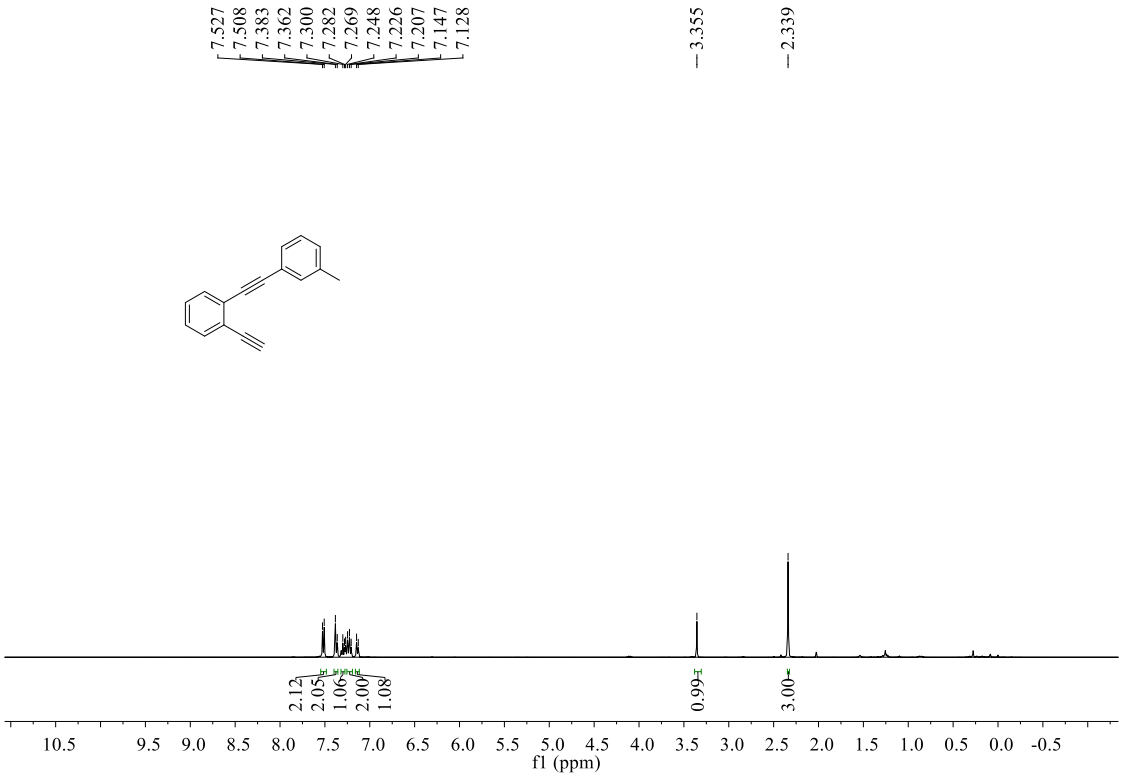


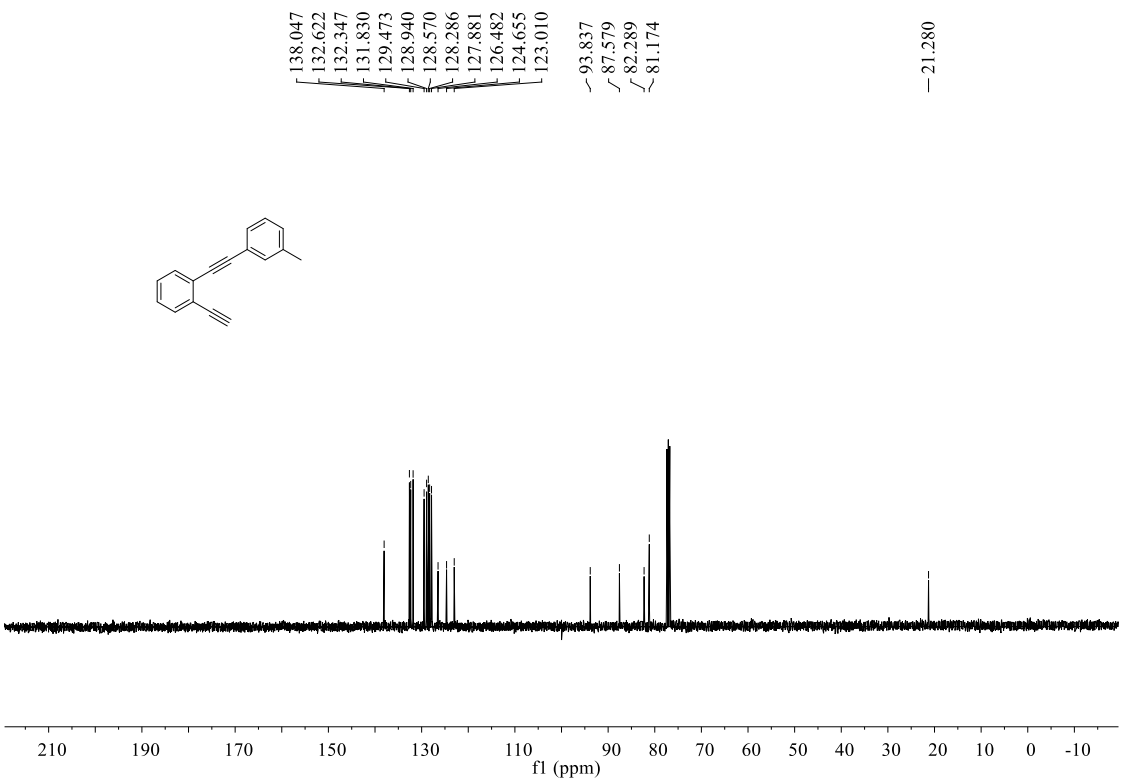


CCDC number	1888278
Identification code	**6d**
Empirical formula	$C_{26}H_{20}O_3$
Formula weight	380.42
Temperature/K	100.01(10)
Crystal system	Monoclinic
Space group	$P2_1/n$
a/Å	11.5269(6)
b/Å	6.9766(4)
c/Å	23.8120(12)
α/°	90
β/°	98.369(5)
γ/°	90
Volume/$Å^3$	1894.54(18)
Z	4
$\rho_{calc}g/cm^3$	1.334
μ/mm^{-1}	0.086
F(000)	800.0
Crystal size/mm^3	0.13 × 0.12 × 0.11
Radiation	Mo Kα (λ = 0.71073)
2θ range for data collection/ °	4.188 to 50
Index ranges	$-13 \le h \le 13$, $-6 \le k \le 8$, $-26 \le l \le 28$
Reflections collected	11699
Independent reflections	3333 [R_{int} = 0.0287, R_{sigma} = 0.0290]
Data/restraints/parameters	3333/0/273
Goodness-of-fit on F^2	1.084
Final R indexes [I>=2σ (I)]	R_1 = 0.0398, wR_2 = 0.0945
Final R indexes [all data]	R_1 = 0.0474, wR_2 = 0.0991
Largest diff. peak/hole / e $Å^{-3}$	0.20/-0.17

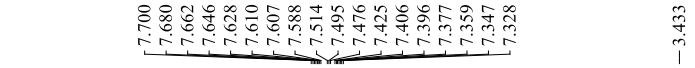
4. Copies of NMR spectra

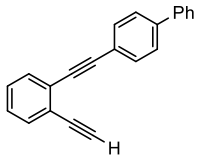
2i

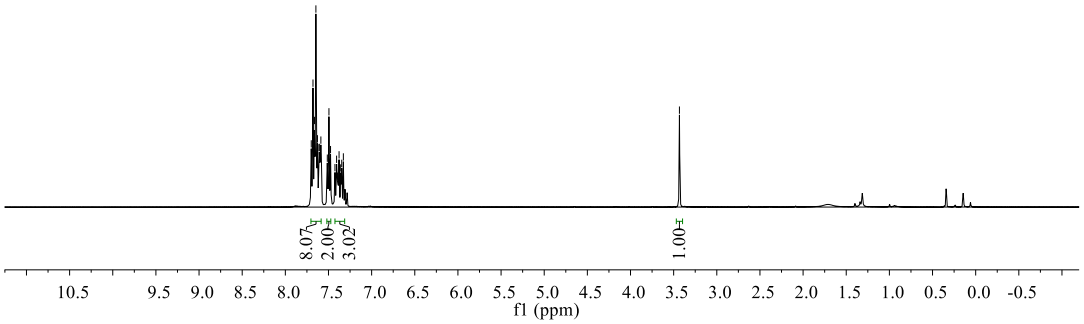




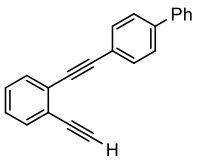
2k

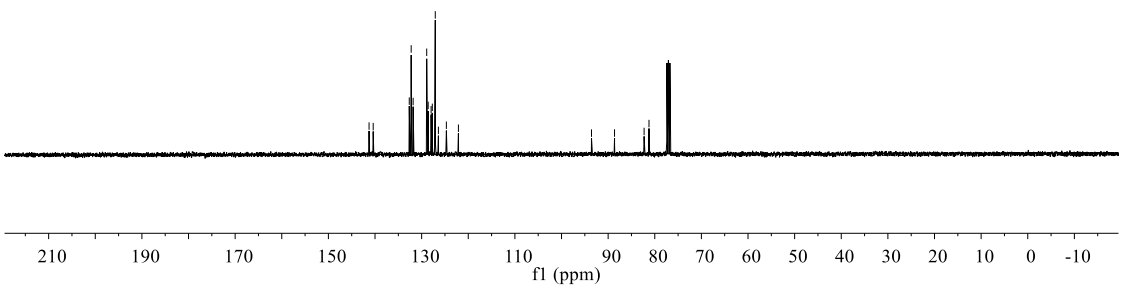

7.700
7.680
7.662
7.646
7.628
7.610
7.607
7.588
7.514
7.495
7.476
7.425
7.406
7.396
7.377
7.359
7.347
7.328
3.433


Ph
H

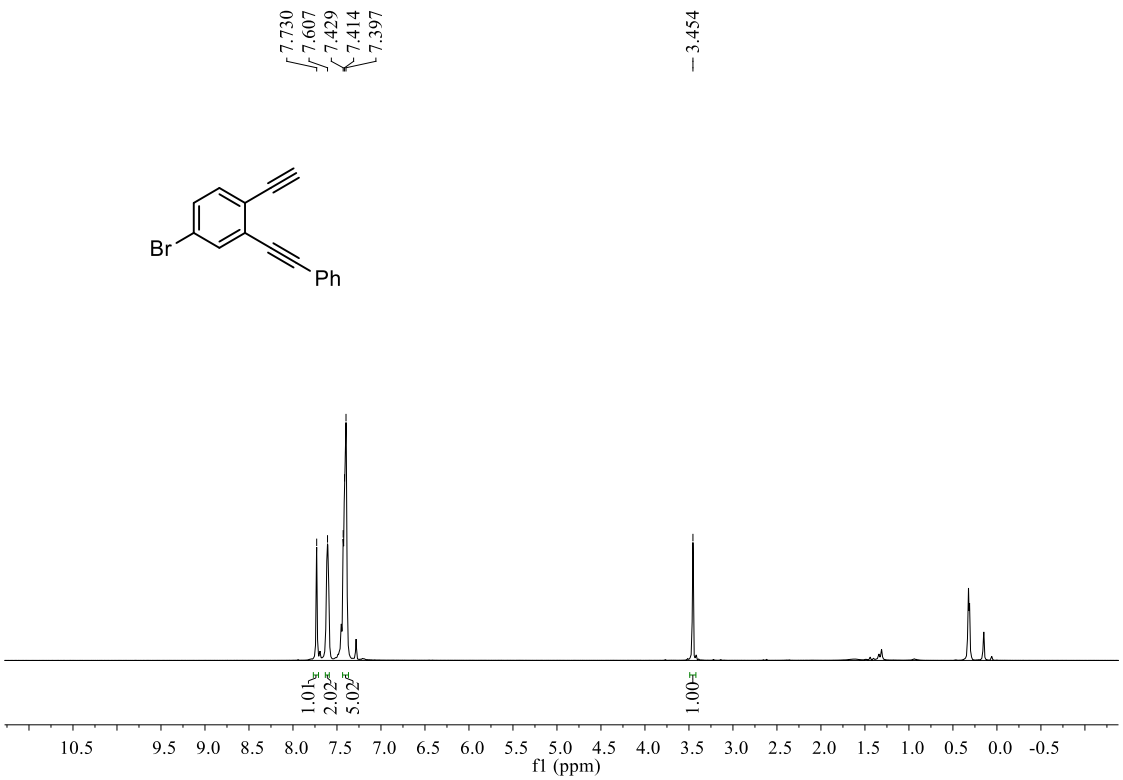

8.07
2.00
3.02
1.00
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

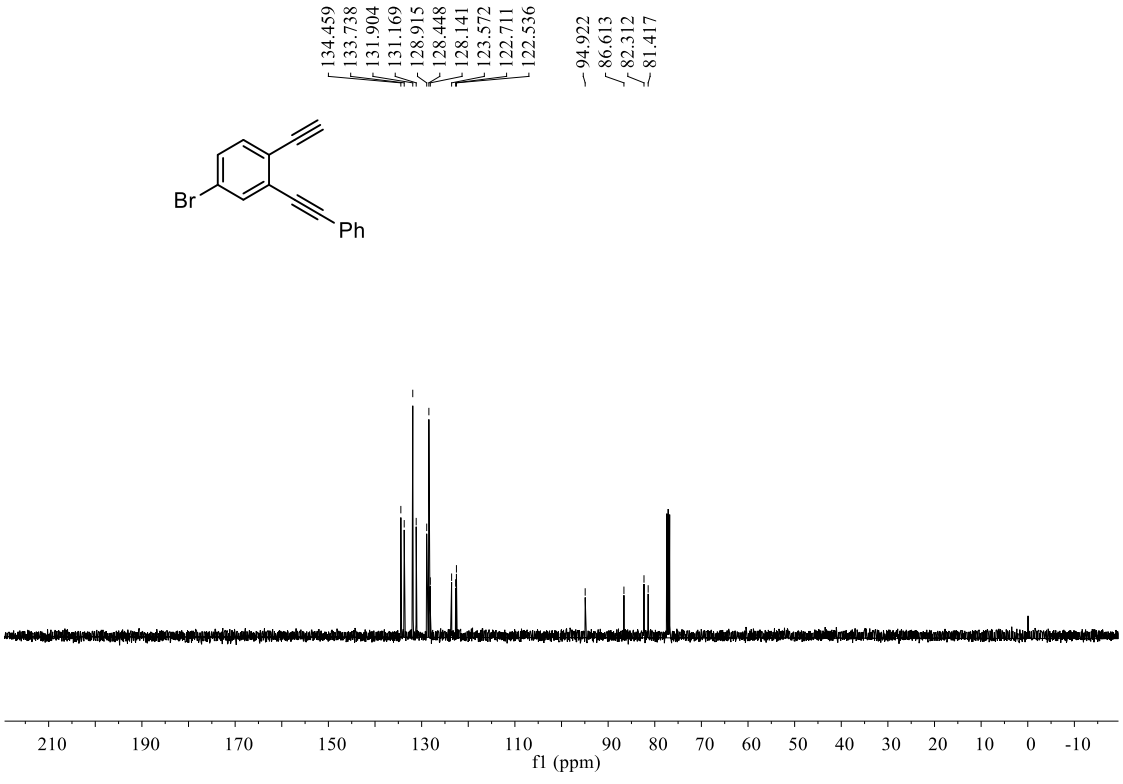

141.278
140.389
132.653
132.243
131.823
128.914
128.597
127.968
127.715
127.075
126.406
124.696
122.111
93.567
88.630
82.288
81.238


Ph
H

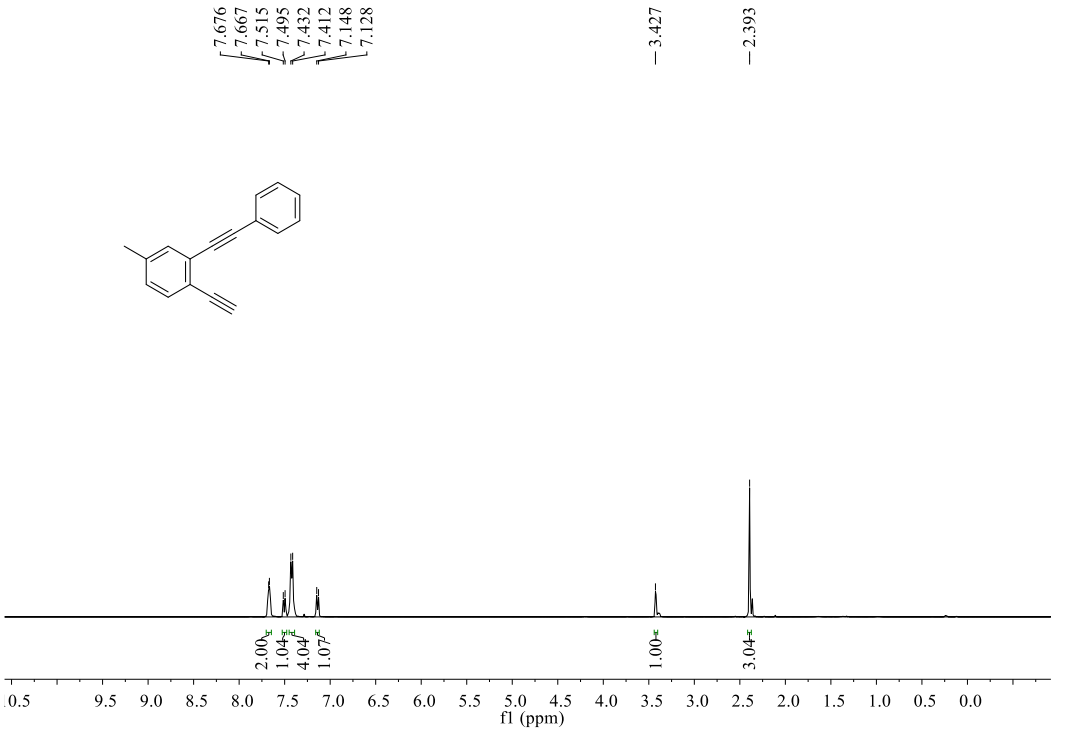

210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

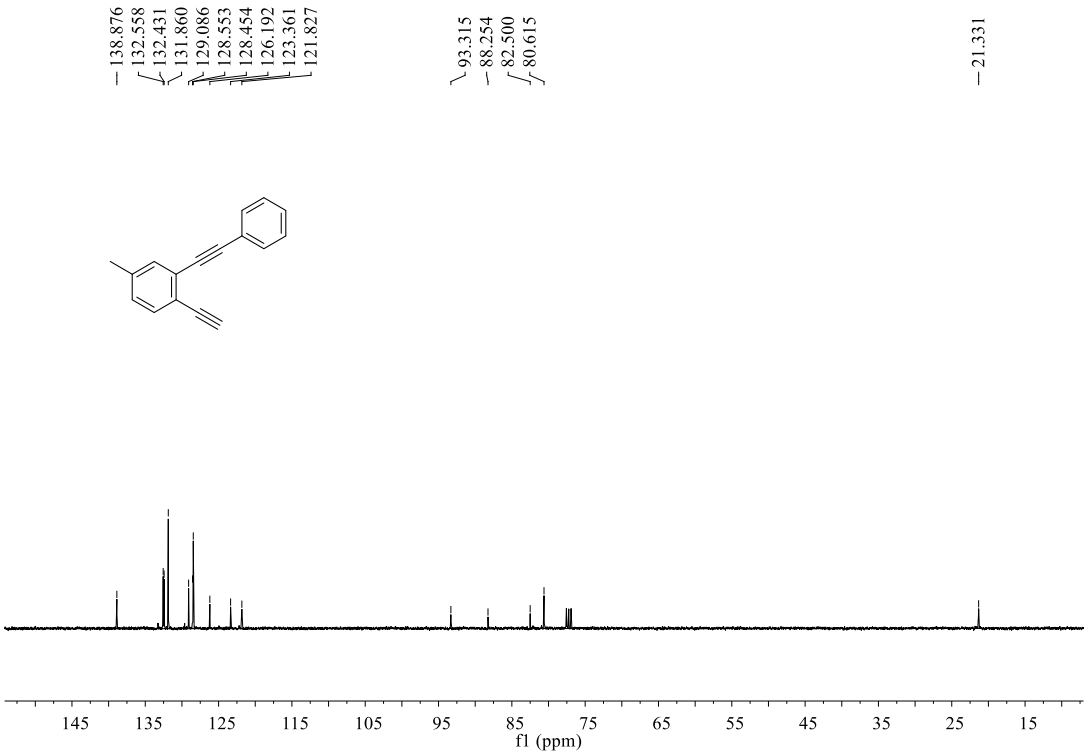
2l


7.730
7.607
7.429
7.414
7.397
3.454
Br
Ph
1.01
2.02
5.02
1.00
10.5 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 -0.5
f1 (ppm)

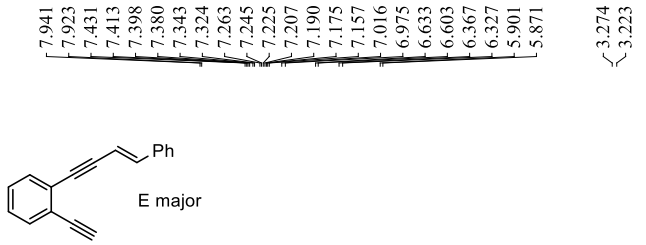

134.459
133.738
131.904
131.169
128.915
128.448
128.141
123.572
122.711
122.536
94.922
86.613
82.312
81.417
Br
Ph
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

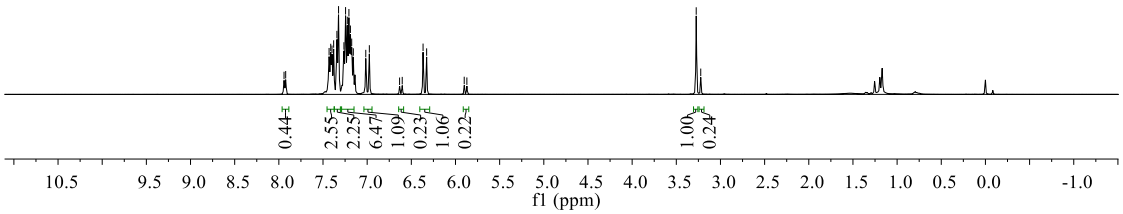
2m


7.676
7.667
7.515
7.495
7.432
7.412
7.148
7.128
3.427
2.393
2.00
1.04
4.04
1.07
1.00
3.04
f1 (ppm)

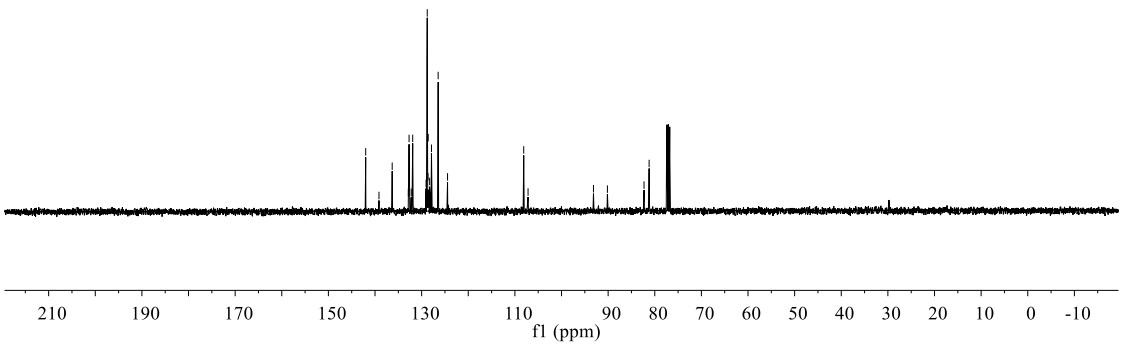

138.876
132.558
132.431
131.860
129.086
128.553
128.454
126.192
123.361
121.827
93.315
88.254
82.500
80.615
21.331
f1 (ppm)

2n(E/Z = 5:1**)**

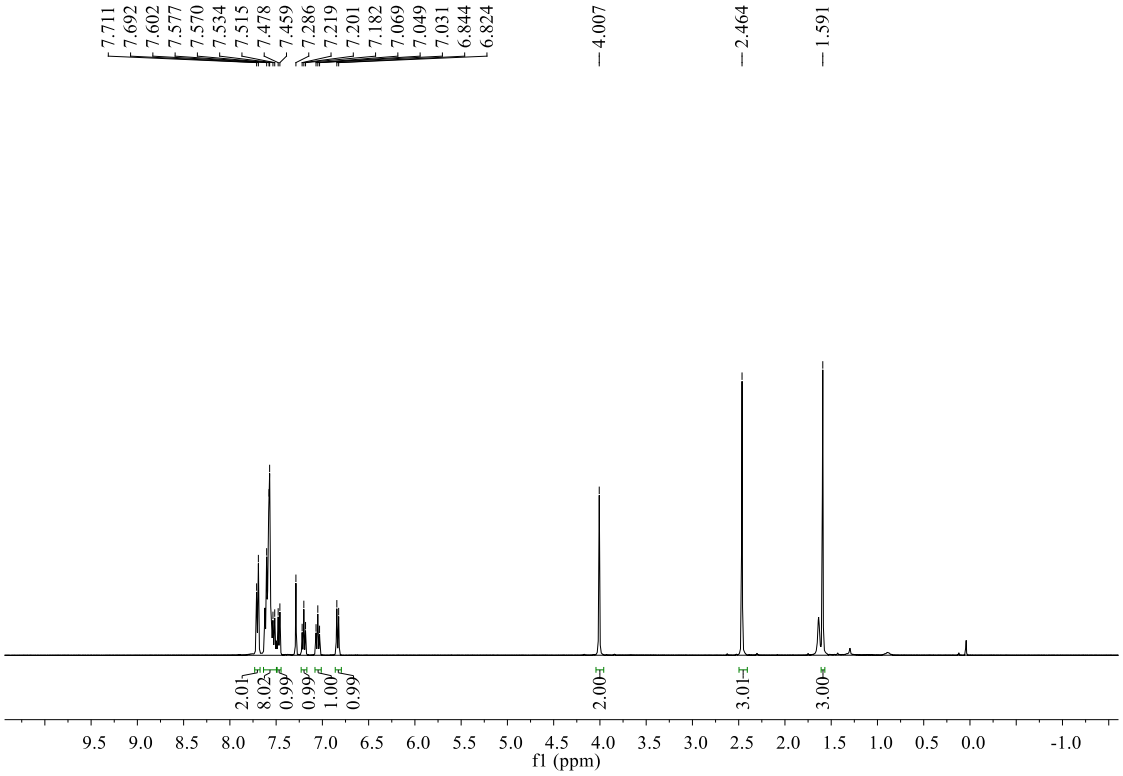

7.941
7.923
7.431
7.413
7.398
7.380
7.343
7.324
7.263
7.245
7.225
7.207
7.190
7.175
7.157
7.016
6.975
6.633
6.603
6.367
6.327
5.901
5.871
3.274
3.223
Ph
E major

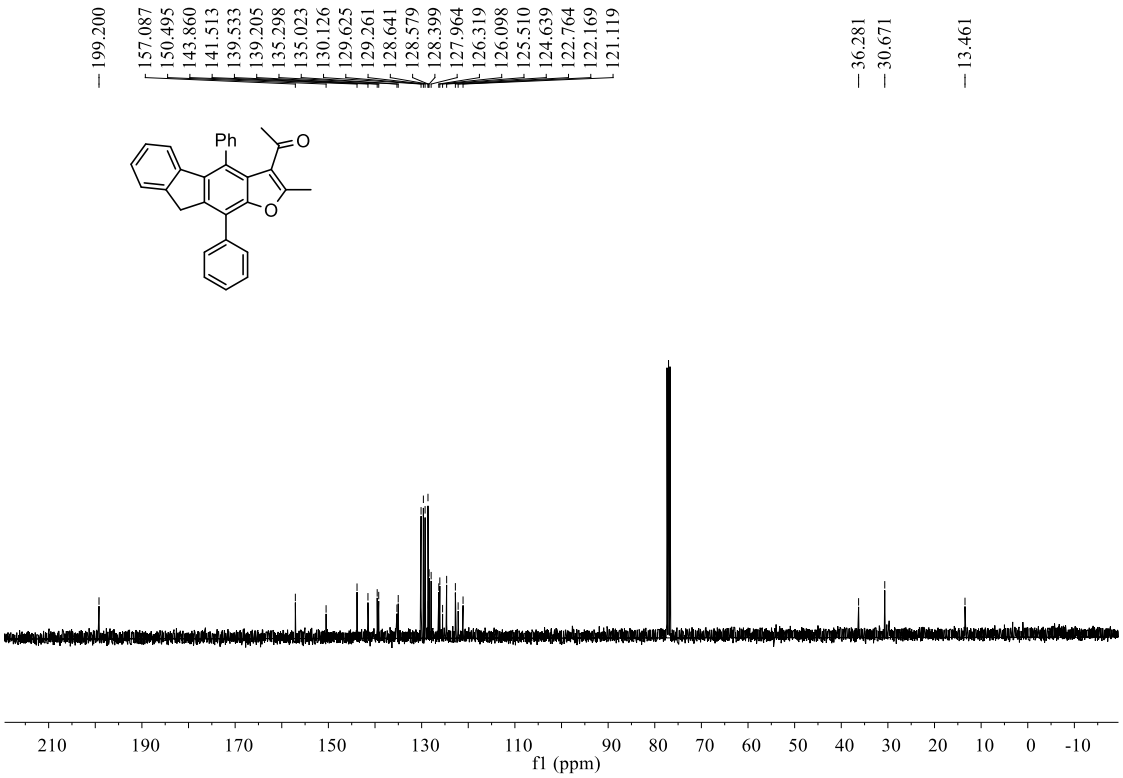

0.44
2.55
2.25
6.47
1.09
0.23
1.06
0.22
1.00
0.24
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-1.0
f1 (ppm)


141.999
139.151
136.317
132.850
132.699
132.236
131.916
129.049
128.799
128.635
128.592
128.287
127.892
126.457
124.445
108.105
107.176
93.146
90.157
82.298
81.212
Ph
E major

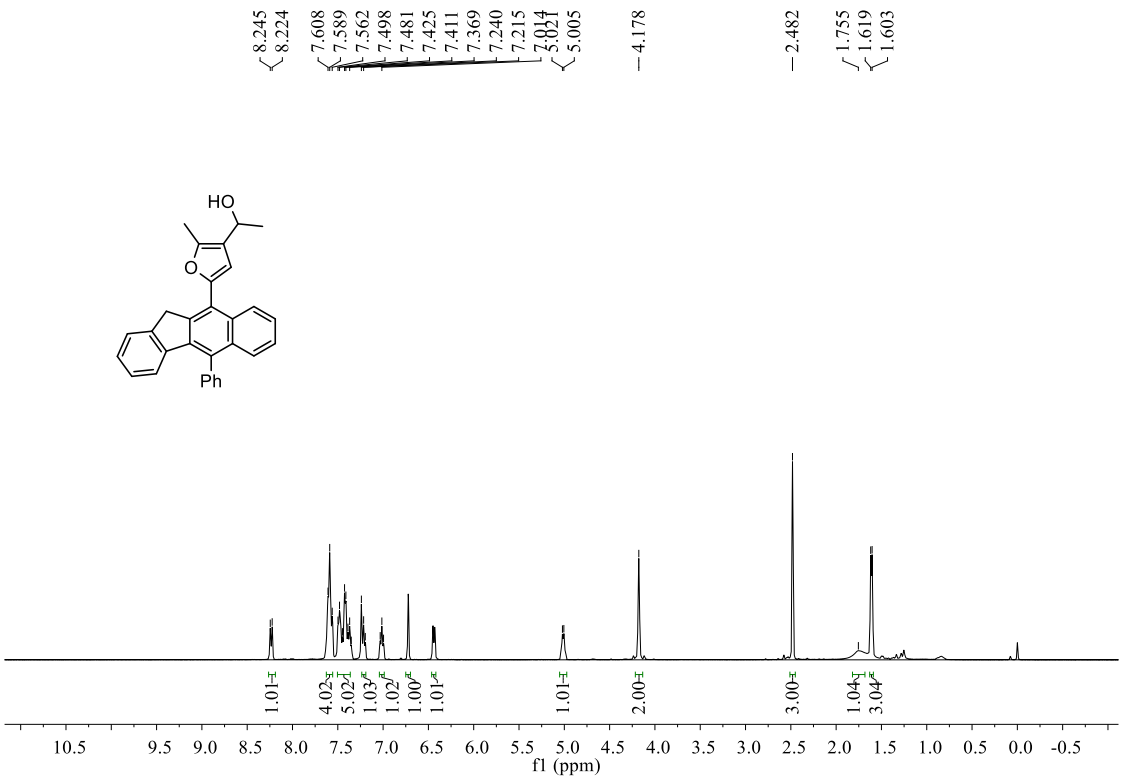

210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

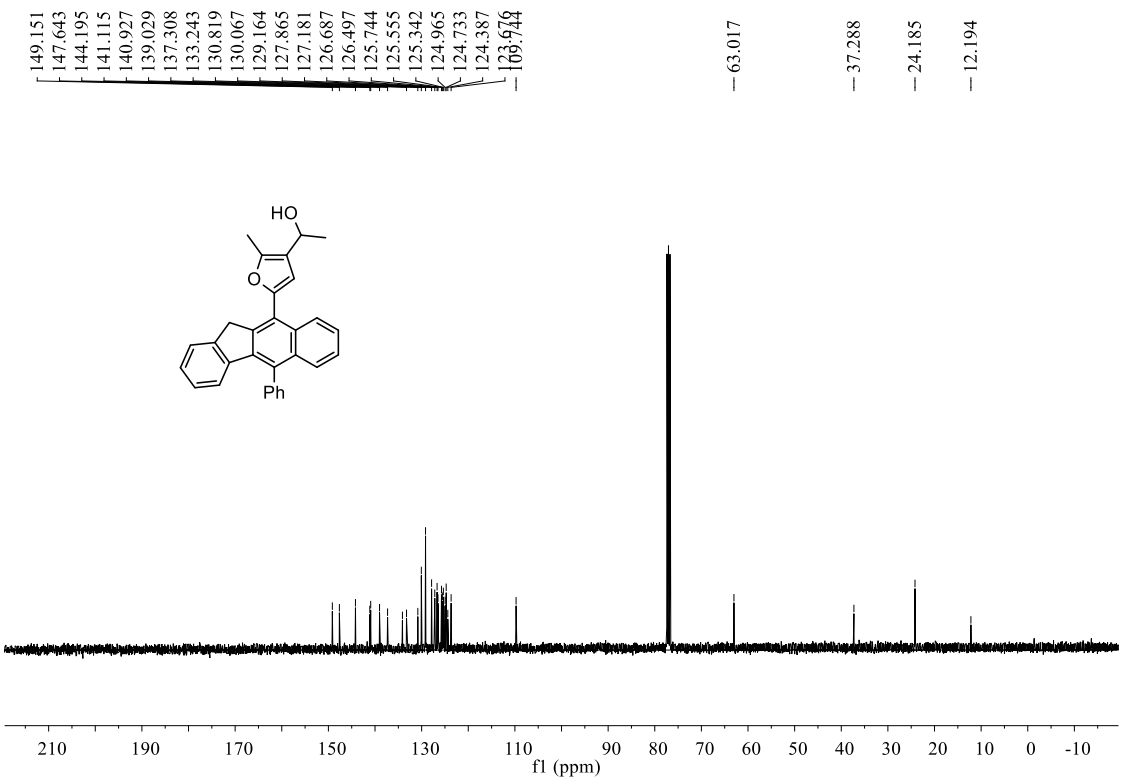
3aa


7.711
7.692
7.602
7.577
7.570
7.534
7.515
7.478
7.459
7.286
7.219
7.201
7.182
7.069
7.049
7.031
6.844
6.824
4.007
2.464
1.591
2.01
8.02
0.99
0.99
1.00
0.99
2.00
3.01
3.00
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 -1.0
f1 (ppm)

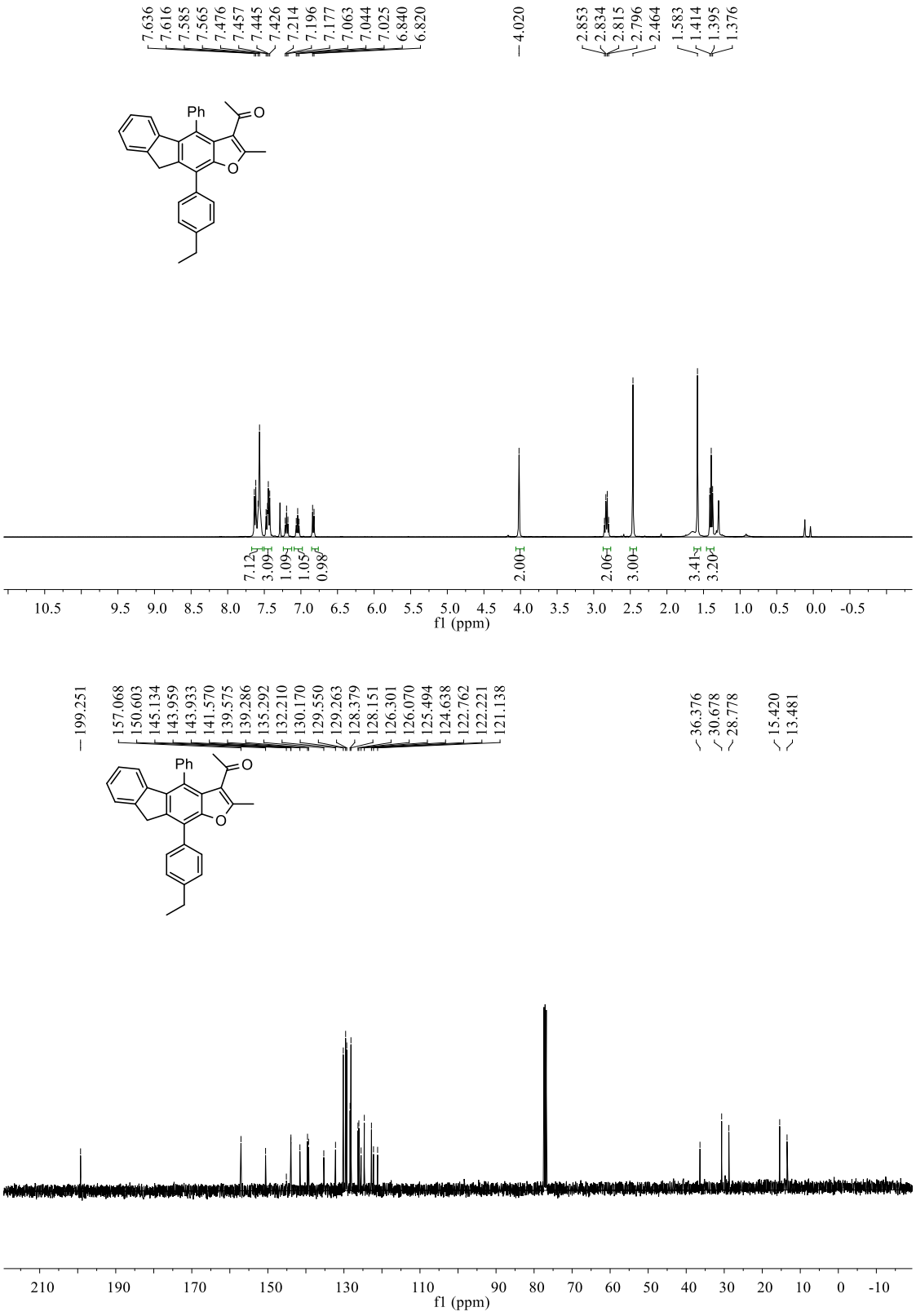

199.200
157.087
150.495
143.860
141.513
139.533
139.205
135.298
135.023
130.126
129.625
129.261
128.641
128.579
128.399
127.964
126.319
126.098
125.510
124.639
122.764
122.169
121.119
36.281
30.671
13.461
Ph
O
O
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

7aa

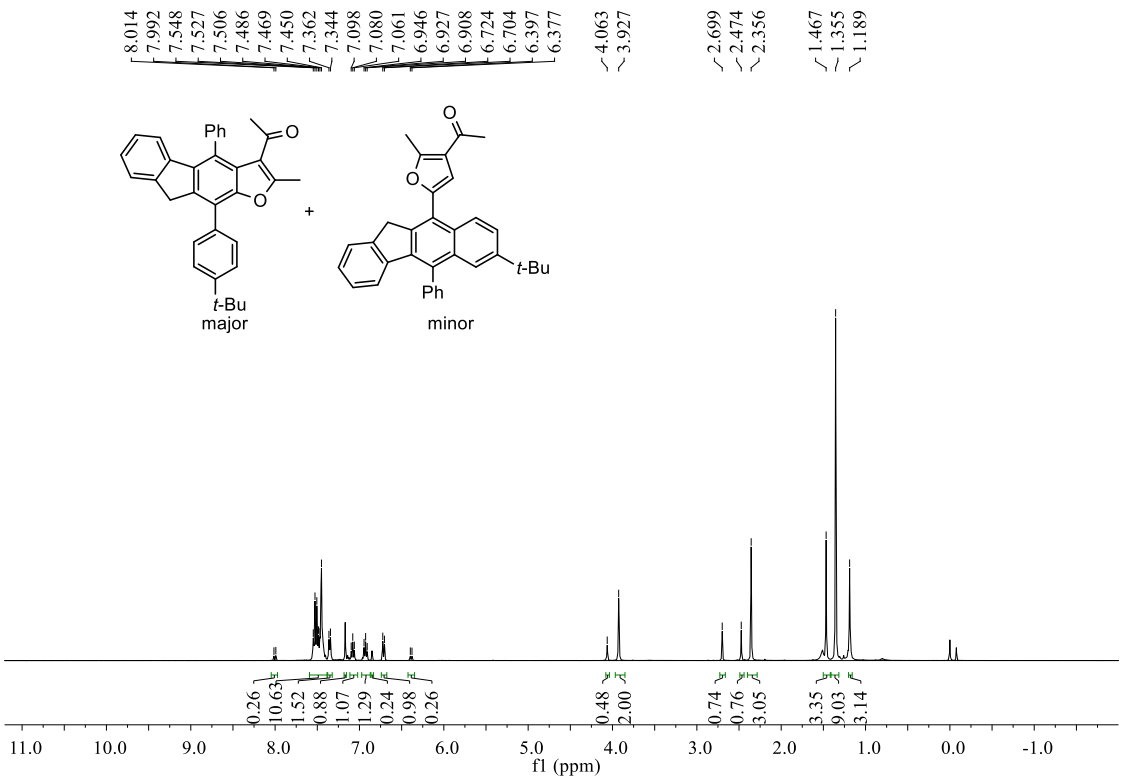

8.245
8.224
7.608
7.589
7.562
7.498
7.481
7.425
7.411
7.369
7.240
7.215
7.014
5.021
5.005
4.178
2.482
1.755
1.619
1.603
HO
O
Ph
1.01
4.02
5.02
1.03
1.02
1.00
1.01
1.01
2.00
3.00
1.04
3.04
10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

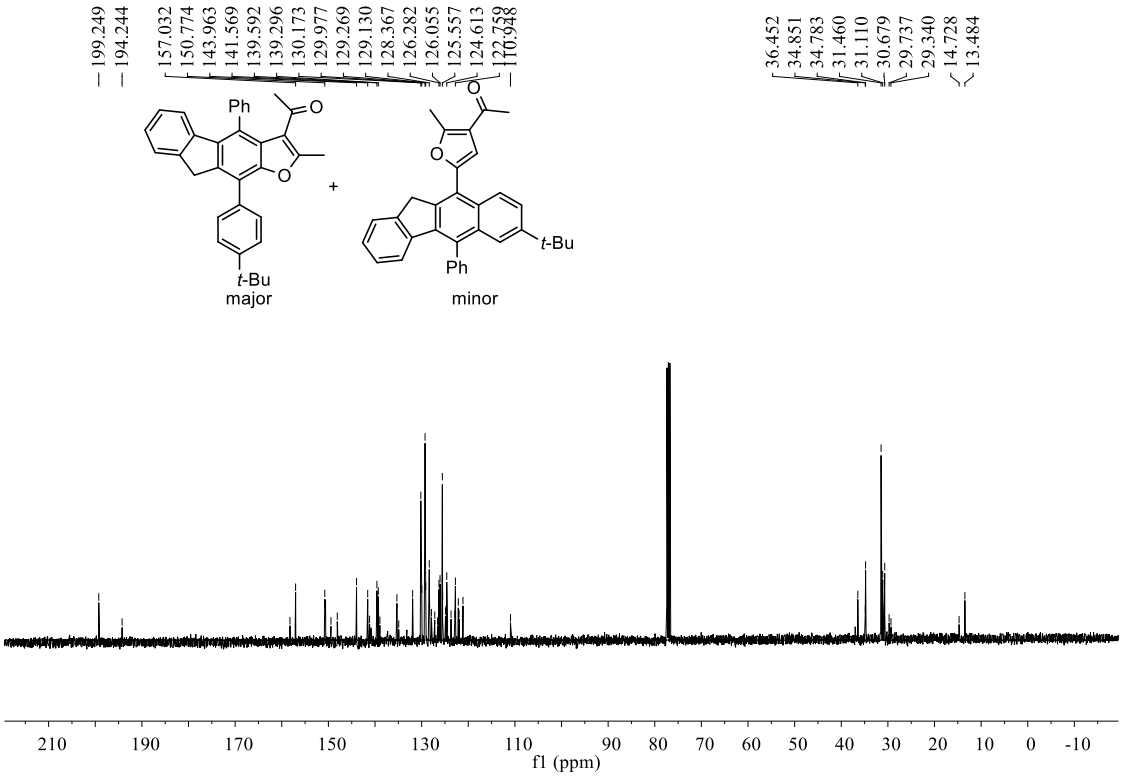

149.151
147.643
144.195
141.115
140.927
139.029
137.308
133.243
130.819
130.067
129.164
127.865
127.181
126.687
126.497
125.744
125.555
125.342
124.965
124.733
124.387
123.676
63.017
37.288
24.185
12.194
HO
O
Ph
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

3ab

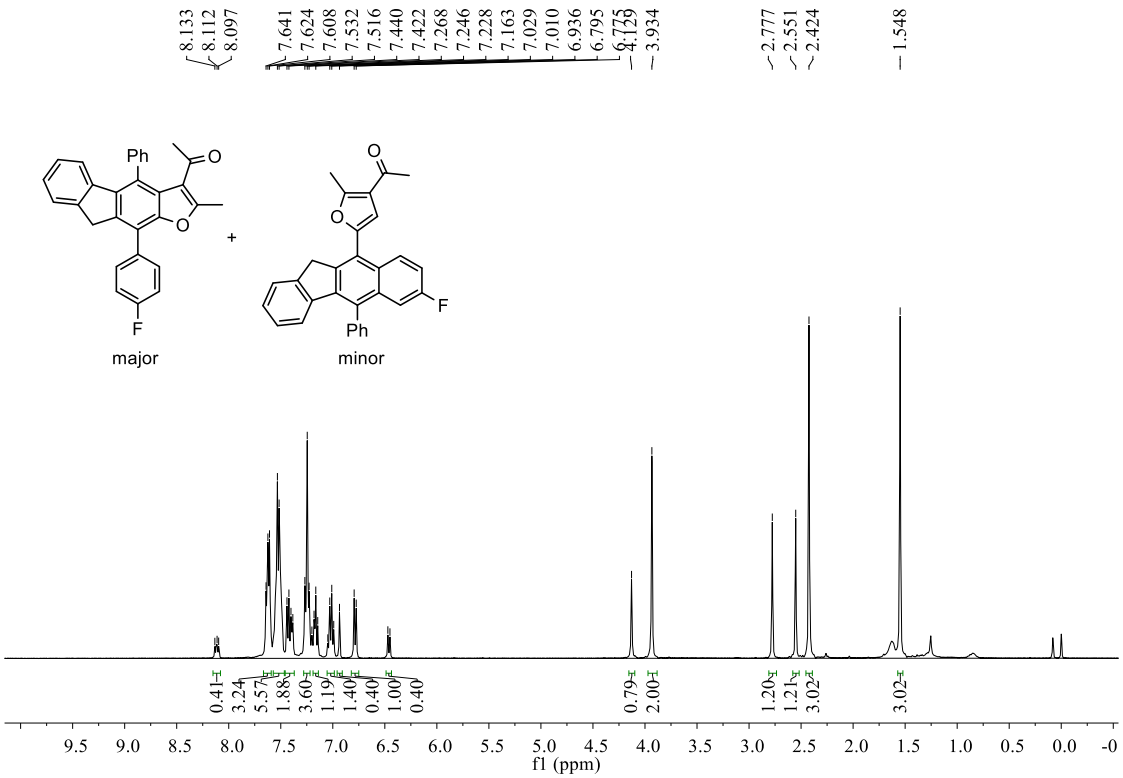

7.636
7.616
7.585
7.565
7.476
7.457
7.445
7.426
7.214
7.196
7.177
7.063
7.044
7.025
6.840
6.820
4.020
2.853
2.834
2.815
2.796
2.464
1.583
1.414
1.395
1.376
Ph
O
O
7.12
3.09
1.09
1.05
0.98
2.00
2.06
3.00
3.41
3.20
fl (ppm)
199.251
157.068
150.603
145.134
143.959
143.933
141.570
139.575
139.286
135.292
132.210
130.170
129.550
129.263
128.379
128.151
126.301
126.070
125.494
124.638
122.762
122.221
121.138
36.376
30.678
28.778
15.420
13.481
Ph
O
O
fl (ppm)

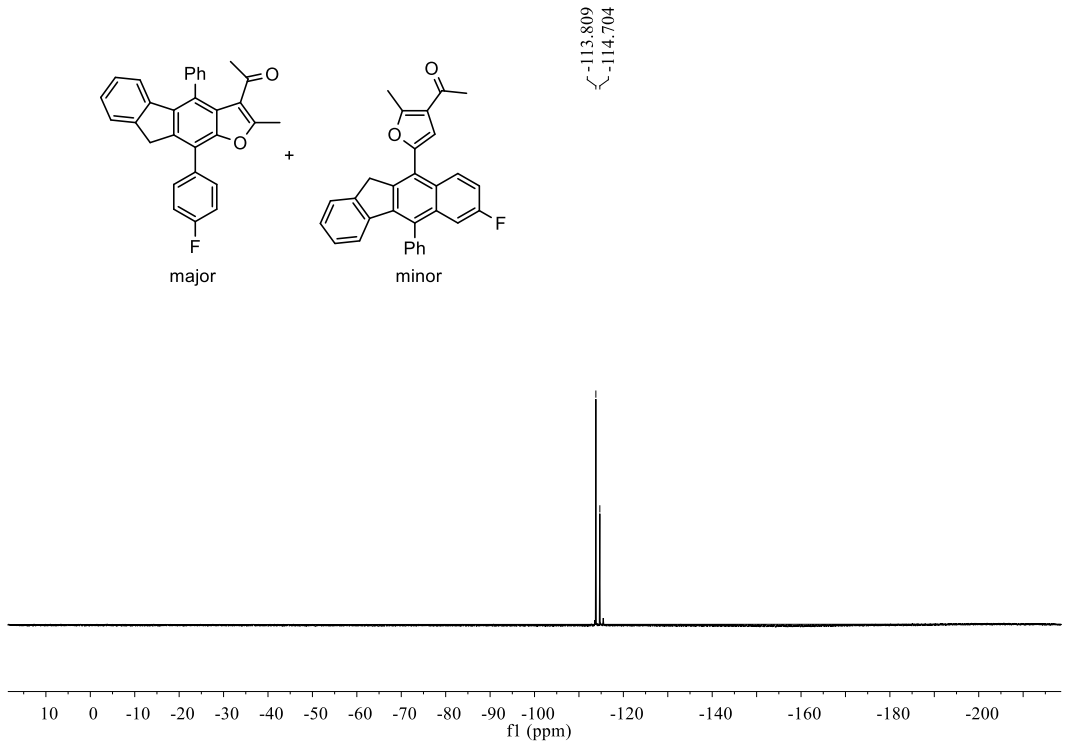
3ac

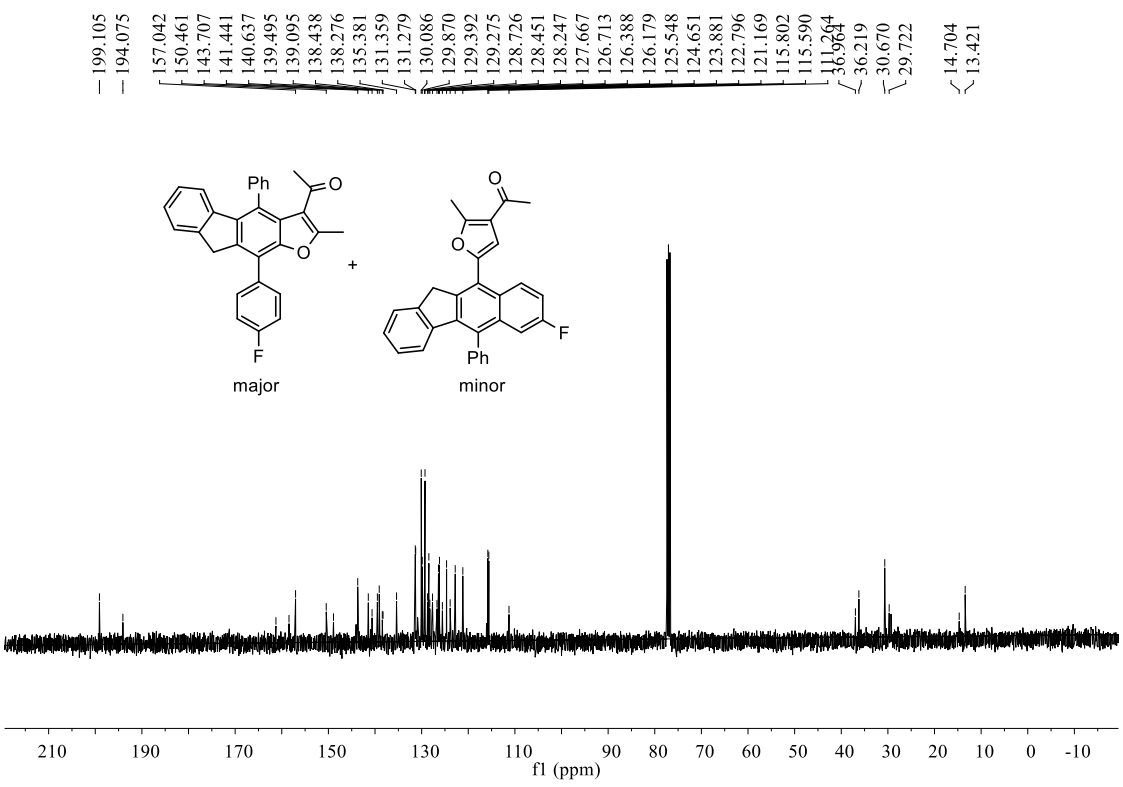

8.014
7.992
7.548
7.527
7.506
7.486
7.469
7.450
7.362
7.344
7.098
7.080
7.061
6.946
6.927
6.908
6.724
6.704
6.397
6.377
4.063
3.927
2.699
2.474
2.356
1.467
1.355
1.189
Ph
O
O
t-Bu
major
+
O
O
t-Bu
Ph
minor
0.26
10.63
1.52
0.88
1.07
1.29
0.24
0.98
0.26
0.48
2.00
0.74
0.76
3.05
3.35
9.03
3.14
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)


199.249
194.244
157.032
150.774
143.963
141.569
139.592
139.296
130.173
129.977
129.269
129.130
128.367
126.282
126.055
125.557
124.613
122.758
110.948
36.452
34.851
34.783
31.460
31.110
30.679
29.737
29.340
14.728
13.484
Ph
O
O
t-Bu
major
+
O
O
t-Bu
Ph
minor
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

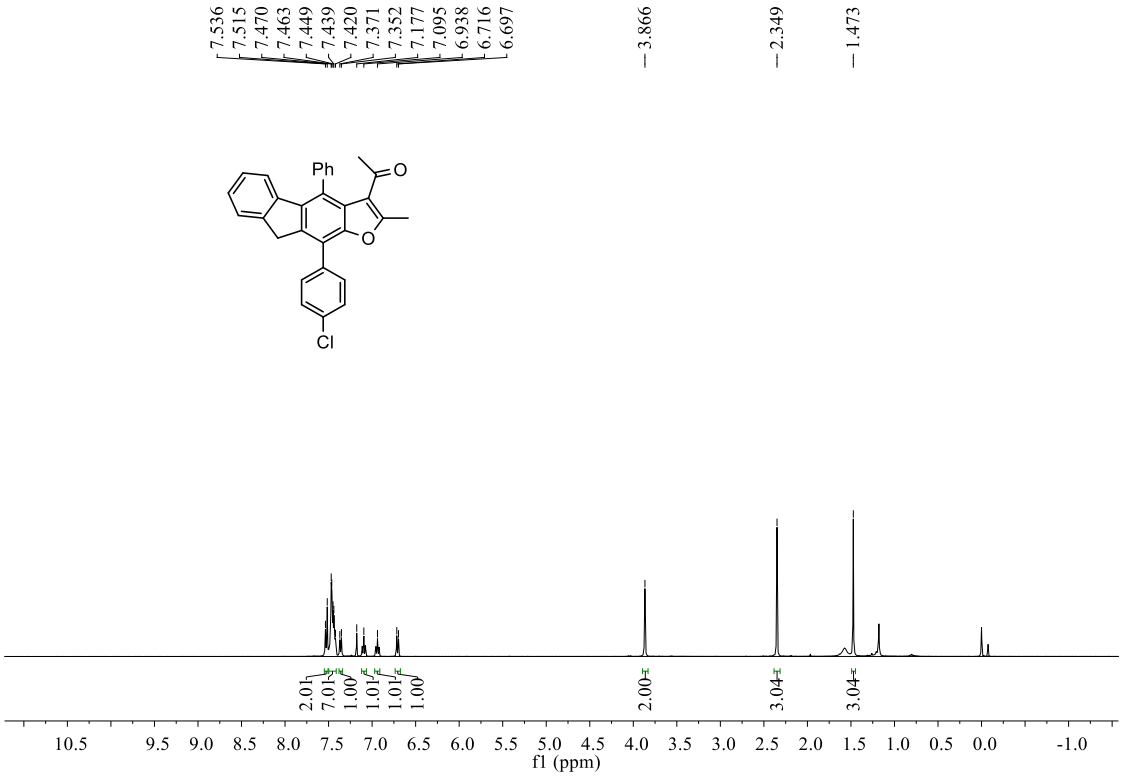
3ad

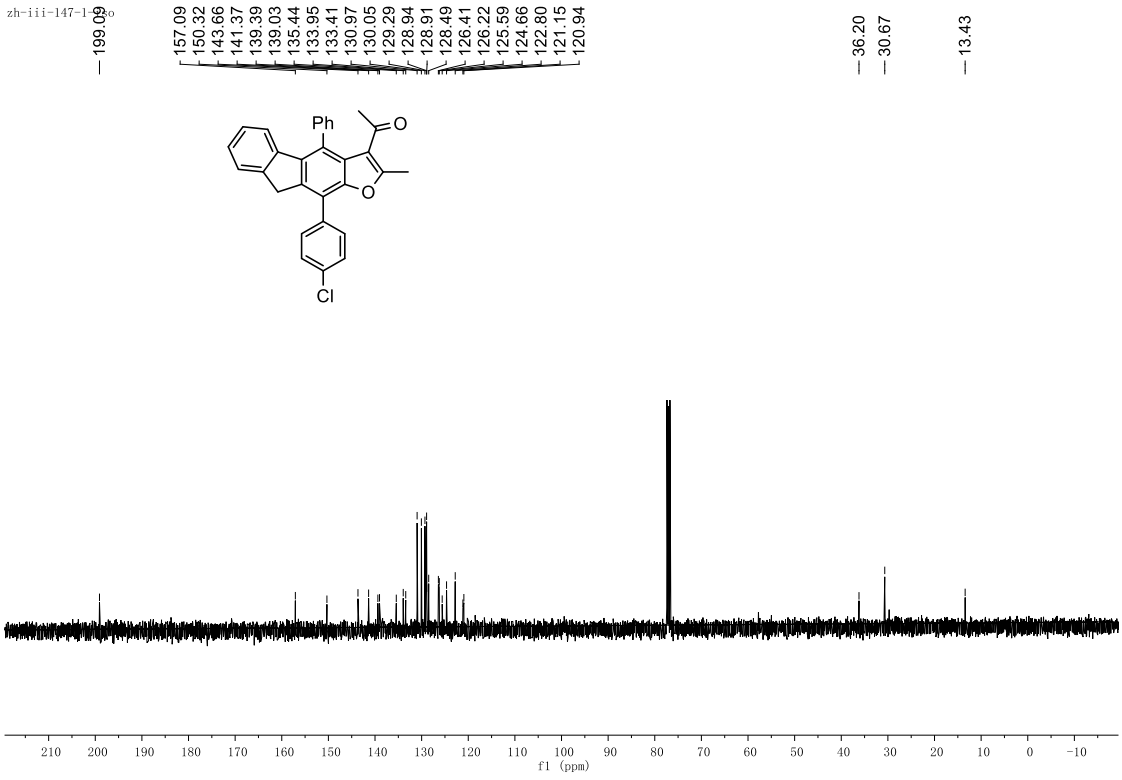

8.133
8.112
8.097
7.641
7.624
7.608
7.532
7.516
7.440
7.422
7.268
7.246
7.228
7.163
7.029
7.010
6.936
6.795
6.775
4.129
3.934
2.777
2.551
2.424
1.548
Ph
O
O
F
major
+
O
O
F
Ph
minor
0.41
3.24
5.57
1.88
3.60
1.19
1.40
0.40
1.00
0.40
0.79
2.00
1.20
1.21
3.02
3.02
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0
f1 (ppm)


-113.809
-114.704
Ph
O
O
F
major
+
O
O
F
Ph
minor
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

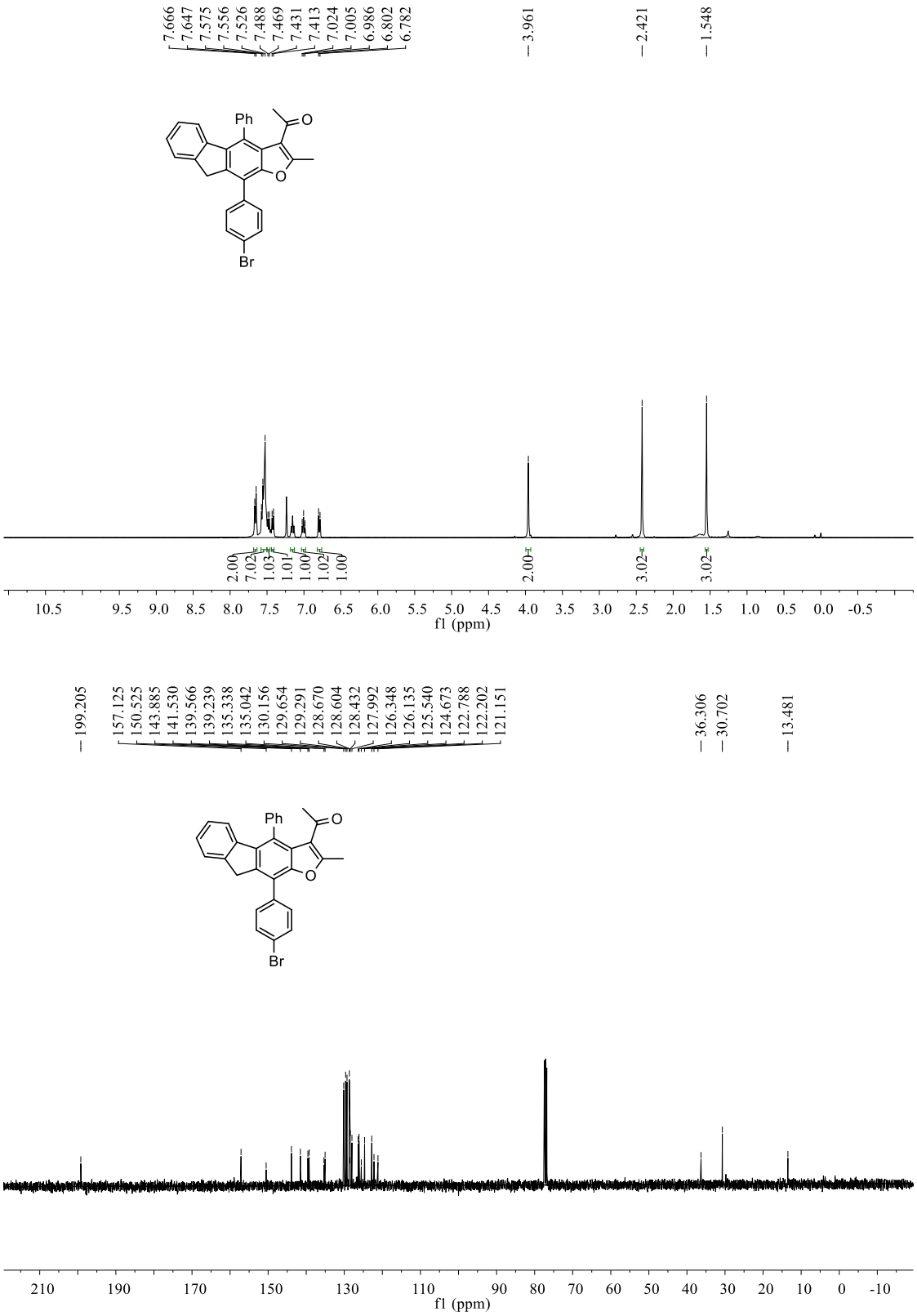

199.105
194.075
157.042
150.461
143.707
141.441
140.637
139.495
139.095
138.438
138.276
135.381
131.359
131.279
130.086
129.870
129.392
129.275
128.726
128.451
128.247
127.667
126.713
126.388
126.179
125.548
124.651
123.881
122.796
121.169
115.802
115.590
111.264
36.964
36.219
30.670
29.722
14.704
13.421
Ph
O
O
F
major
+
O
O
F
Ph
minor
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

3ae


7.536
7.515
7.470
7.463
7.449
7.439
7.420
7.371
7.352
7.177
7.095
6.938
6.716
6.697
3.866
2.349
1.473
Ph
O
O
Cl
2.01
1.00
1.01
1.01
1.00
2.00
3.04
3.04
f1 (ppm)


199.09
157.09
150.32
143.66
141.37
139.39
139.03
135.44
133.95
133.41
130.97
130.05
129.29
128.94
128.91
128.49
126.41
126.22
125.59
124.66
122.80
121.15
120.94
36.20
30.67
13.43
Ph
O
O
Cl
f1 (ppm)

3af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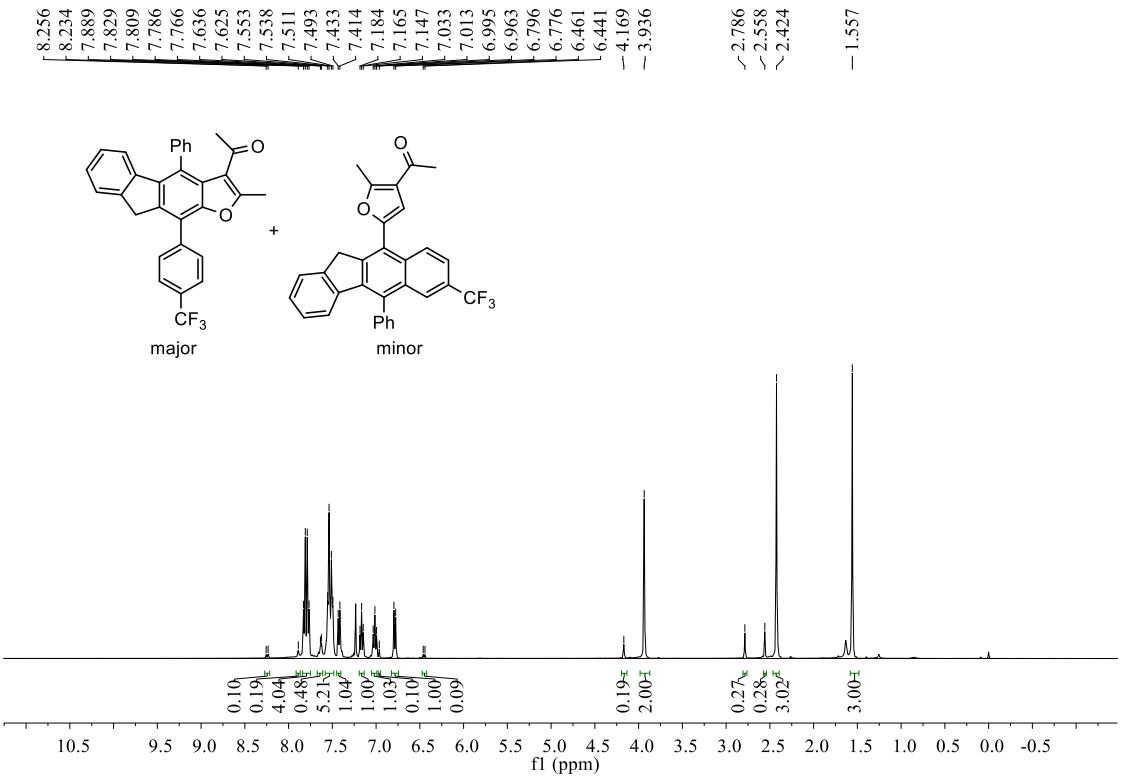
7.647
7.575
7.556
7.526
7.488
7.469
7.431
7.413
7.024
7.005
6.986
6.802
6.782
3.961
2.421
1.548
Ph
O
O
Br
2.00
7.02
1.03
1.01
1.00
1.02
1.00
2.00
3.02
3.02
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)
199.205
157.125
150.525
143.885
141.530
139.566
139.239
135.338
135.042
130.156
129.654
129.291
128.670
128.604
128.432
127.992
126.348
126.135
125.540
124.673
122.788
122.202
121.151
36.306
30.702
13.481
Ph
O
O
Br
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

3ag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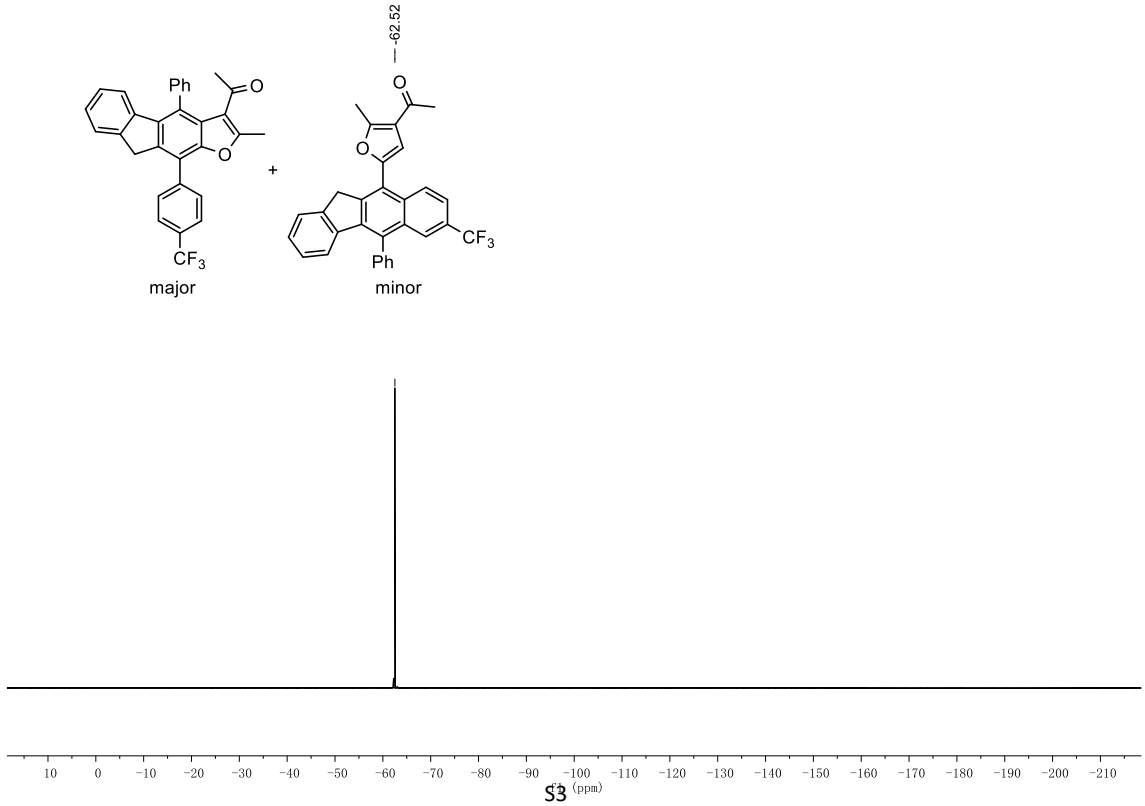
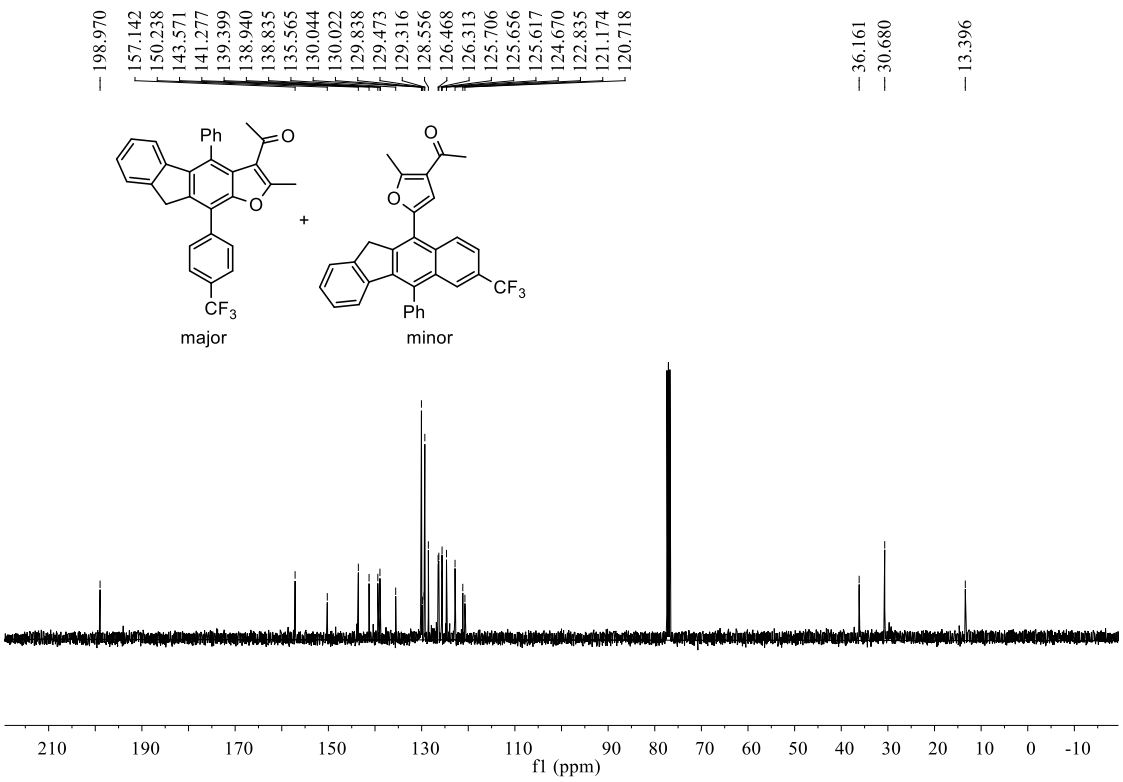
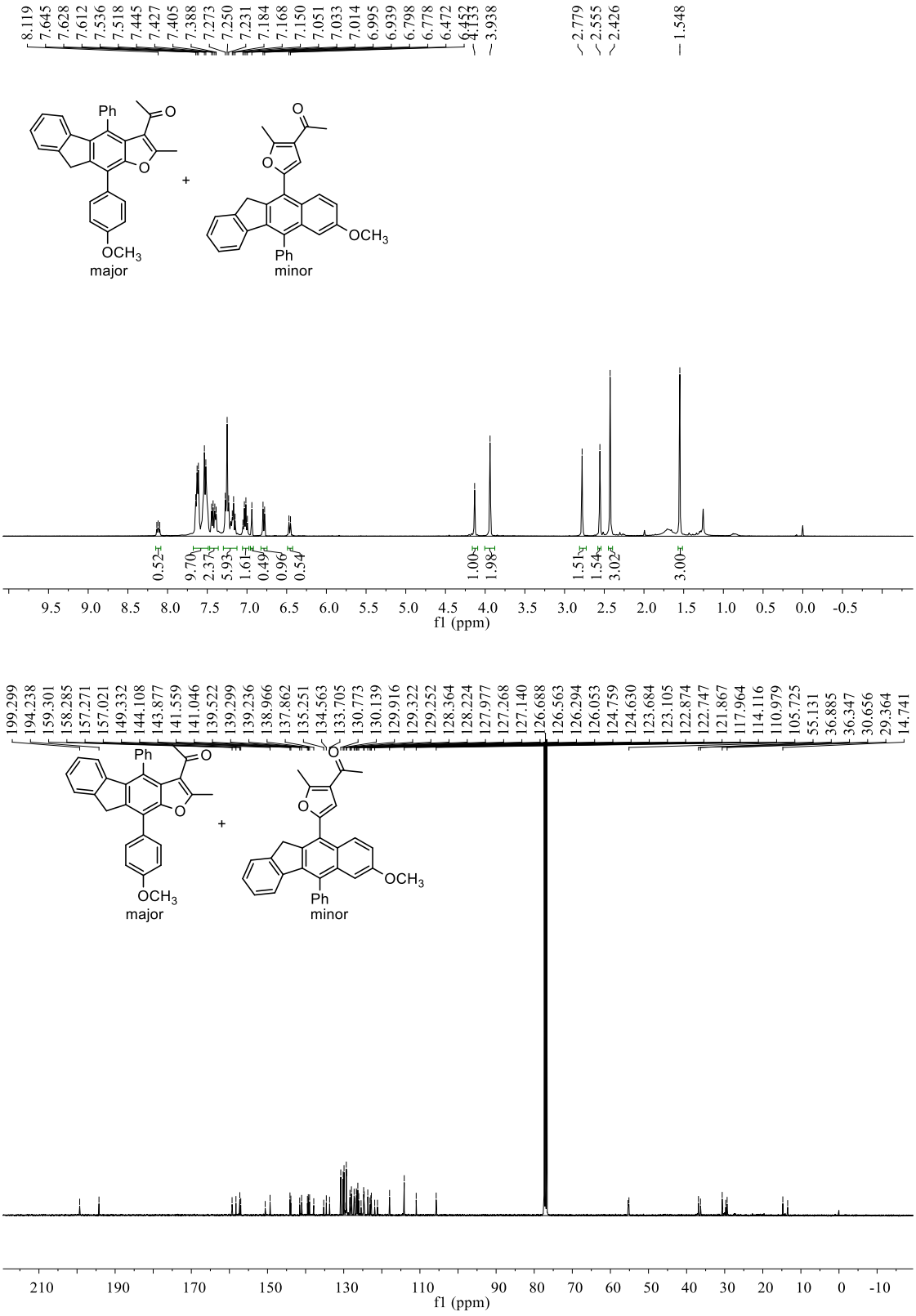
8.234
7.889
7.829
7.809
7.786
7.766
7.636
7.625
7.553
7.538
7.511
7.493
7.433
7.414
7.184
7.165
7.147
7.033
7.013
6.995
6.963
6.796
6.776
6.461
6.441
4.169
3.936
2.786
2.558
2.424
1.557
Ph
O
O
CF3
major
O
O
CF3
Ph
minor
0.10
0.19
4.04
0.48
5.21
1.04
1.00
1.03
0.10
1.00
0.09
0.19
2.00
0.27
0.28
3.02
3.00
10.5 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 -0.5
f1 (ppm)

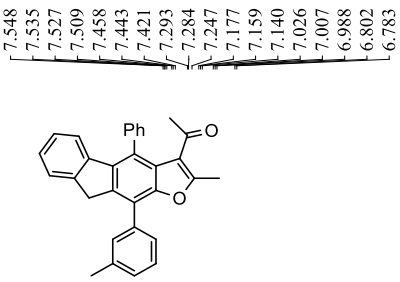

-62.52
Ph
O
O
CF3
major
O
O
CF3
Ph
minor
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

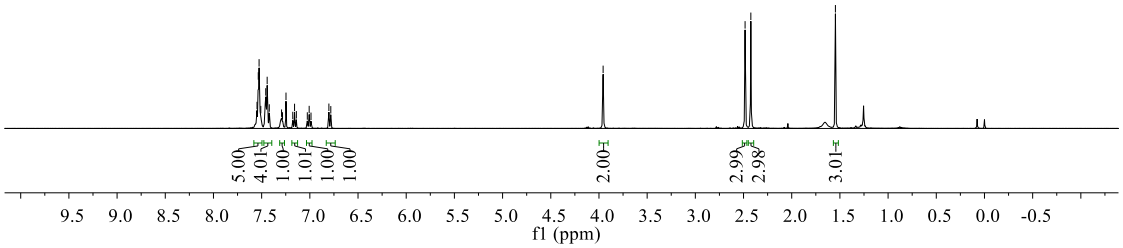

198.970
157.142
150.238
143.571
141.277
139.399
138.940
138.835
135.565
130.044
130.022
129.838
129.473
129.316
128.556
126.468
126.313
125.706
125.656
125.617
124.670
122.835
121.174
120.718
36.161
30.680
13.396
Ph
O
O
CF3
major
+
O
O
CF3
Ph
minor
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

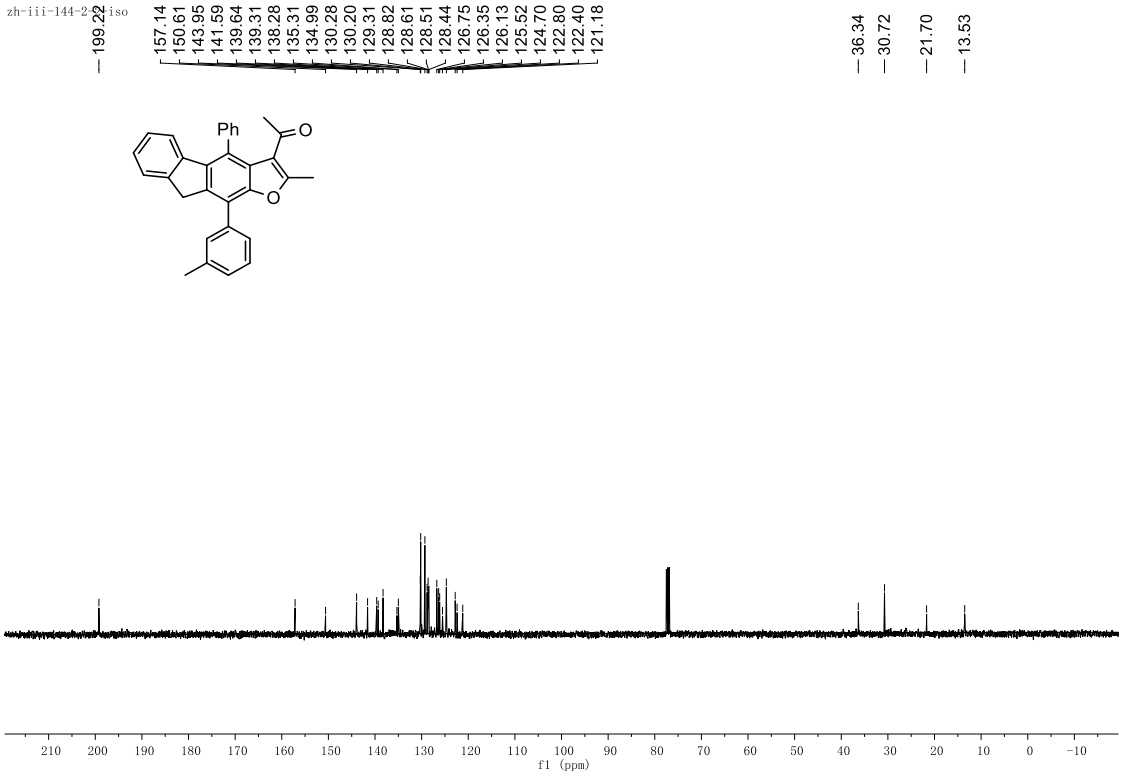
3ah


8.119
7.645
7.628
7.612
7.536
7.518
7.445
7.427
7.405
7.388
7.273
7.250
7.231
7.184
7.168
7.150
7.051
7.033
7.014
6.995
6.939
6.798
6.778
6.472
6.452
4.133
3.938
2.779
2.555
2.426
1.548
Ph
O
O
OCH3
major
+
O
O
OCH3
Ph
minor
0.52
9.70
2.37
5.93
1.61
0.49
0.96
0.54
1.00
1.98
1.51
1.54
3.02
3.00
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 -0.5
f1 (ppm)
199.299
194.238
159.301
158.285
157.271
157.021
149.332
144.108
143.877
141.559
141.046
139.522
139.299
139.236
138.966
137.862
135.251
134.563
133.705
130.773
130.139
129.916
129.322
129.252
128.364
128.224
127.977
127.268
127.140
126.688
126.563
126.294
126.053
124.759
124.630
123.684
123.105
122.874
122.747
121.867
117.964
114.116
110.979
105.725
55.131
36.885
36.347
30.656
29.364
14.741
Ph
O
O
OCH3
major
+
O
O
OCH3
Ph
minor
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

3ai

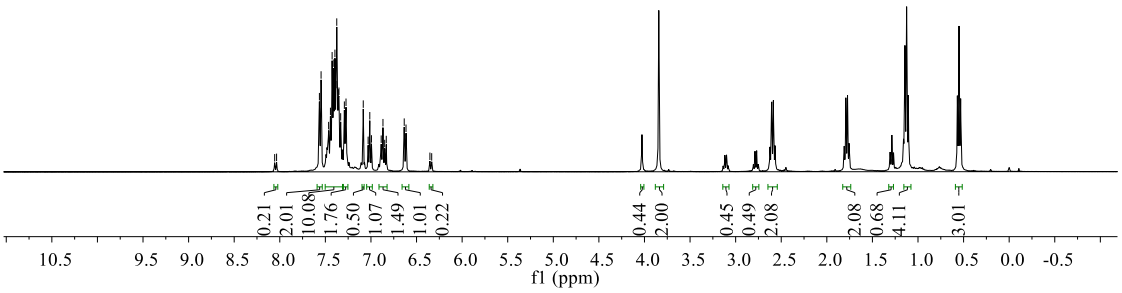

7.548
7.535
7.527
7.509
7.458
7.443
7.421
7.293
7.284
7.247
7.177
7.159
7.140
7.026
7.007
6.988
6.802
6.783
3.957
2.484
2.424
1.547
Ph
O
O

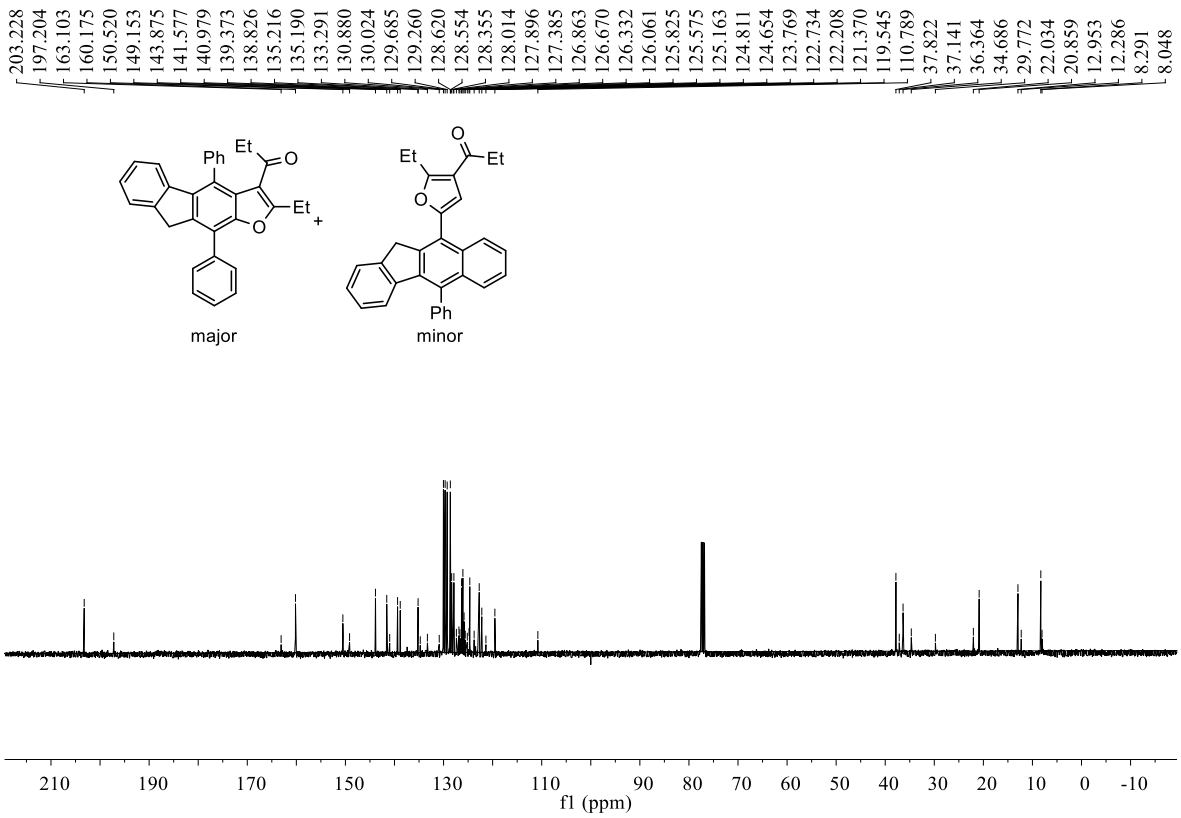

5.00
4.01
1.00
1.01
1.00
1.00
2.00
2.99
2.98
3.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


zh-iii-144-2 iso
199.22
157.14
150.61
143.95
141.59
139.64
139.31
138.28
135.31
134.99
130.28
130.20
129.31
128.82
128.61
128.51
128.44
126.75
126.35
126.13
125.52
124.70
122.80
122.40
121.18
36.34
30.72
21.70
13.53
Ph
O
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

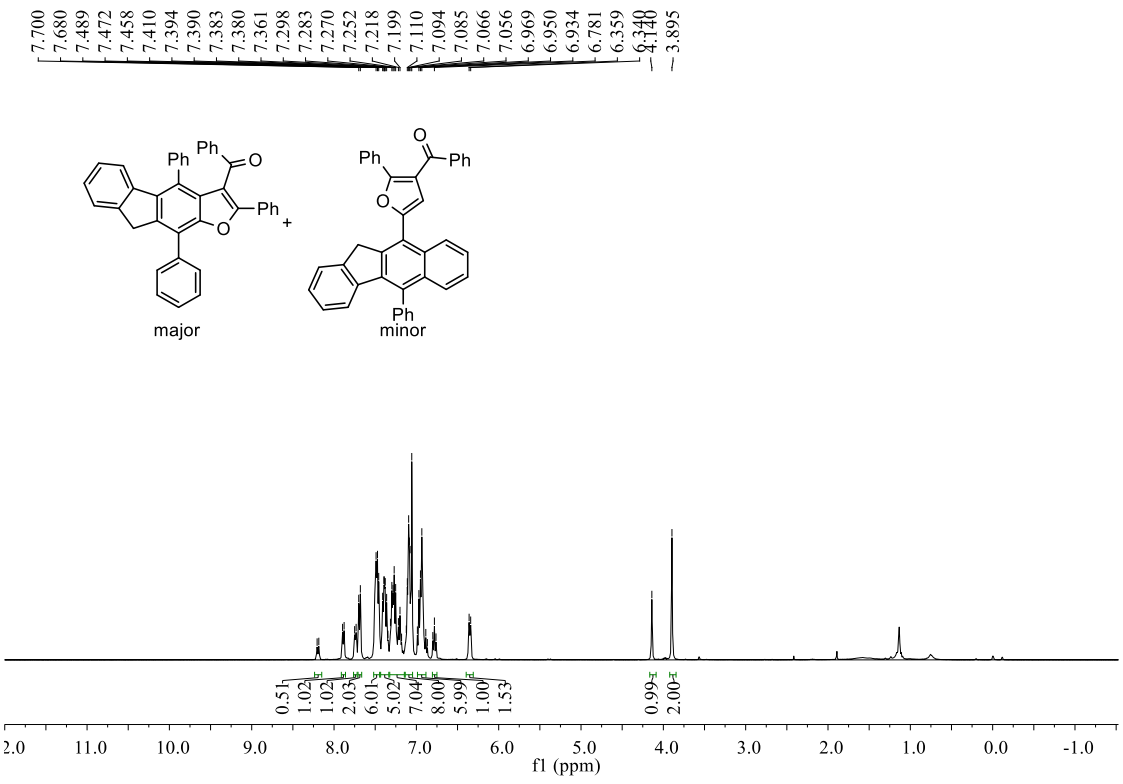
3aj

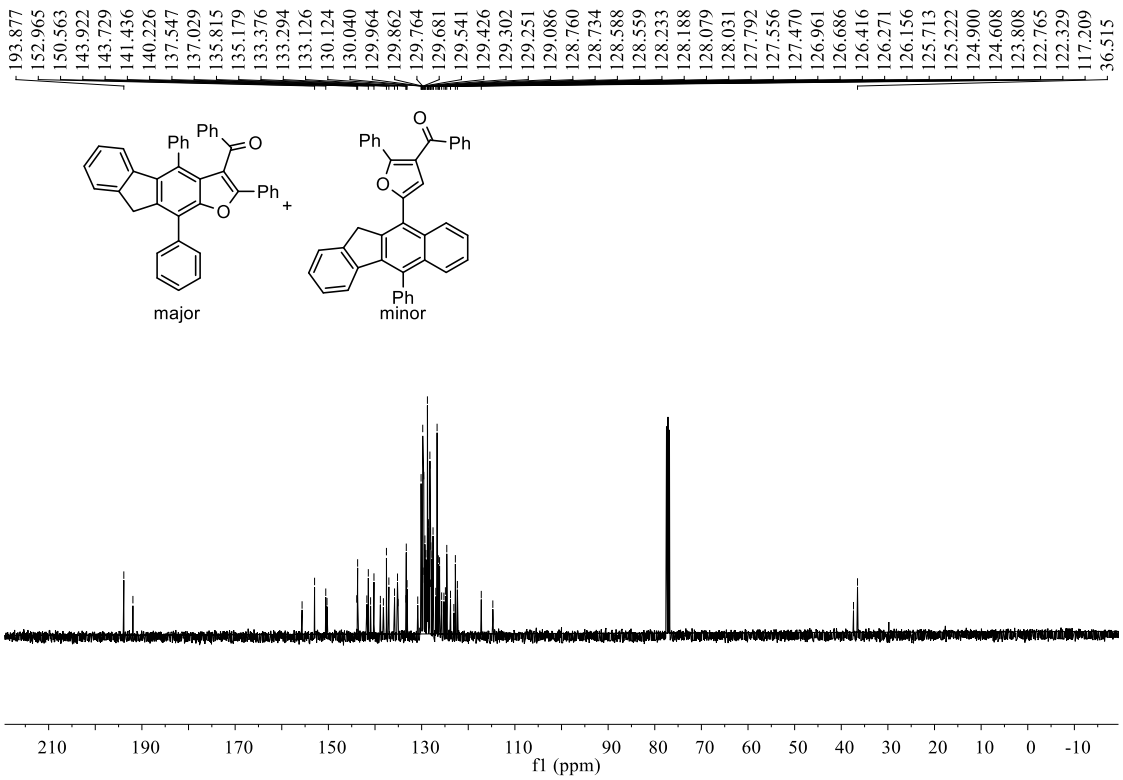

8.056
8.035
7.565
7.547
7.464
7.444
7.426
7.407
7.395
7.383
7.375
7.357
7.351
7.332
7.292
7.274
7.084
7.031
7.013
6.994
6.888
6.868
6.849
6.832
6.635
6.615
6.353
6.334


0.21
2.01
10.08
1.76
0.50
1.07
1.49
1.01
0.22
0.44
2.00
0.45
0.49
2.08
2.08
0.68
4.11
3.01
10.5
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
-0.5
f1 (ppm)

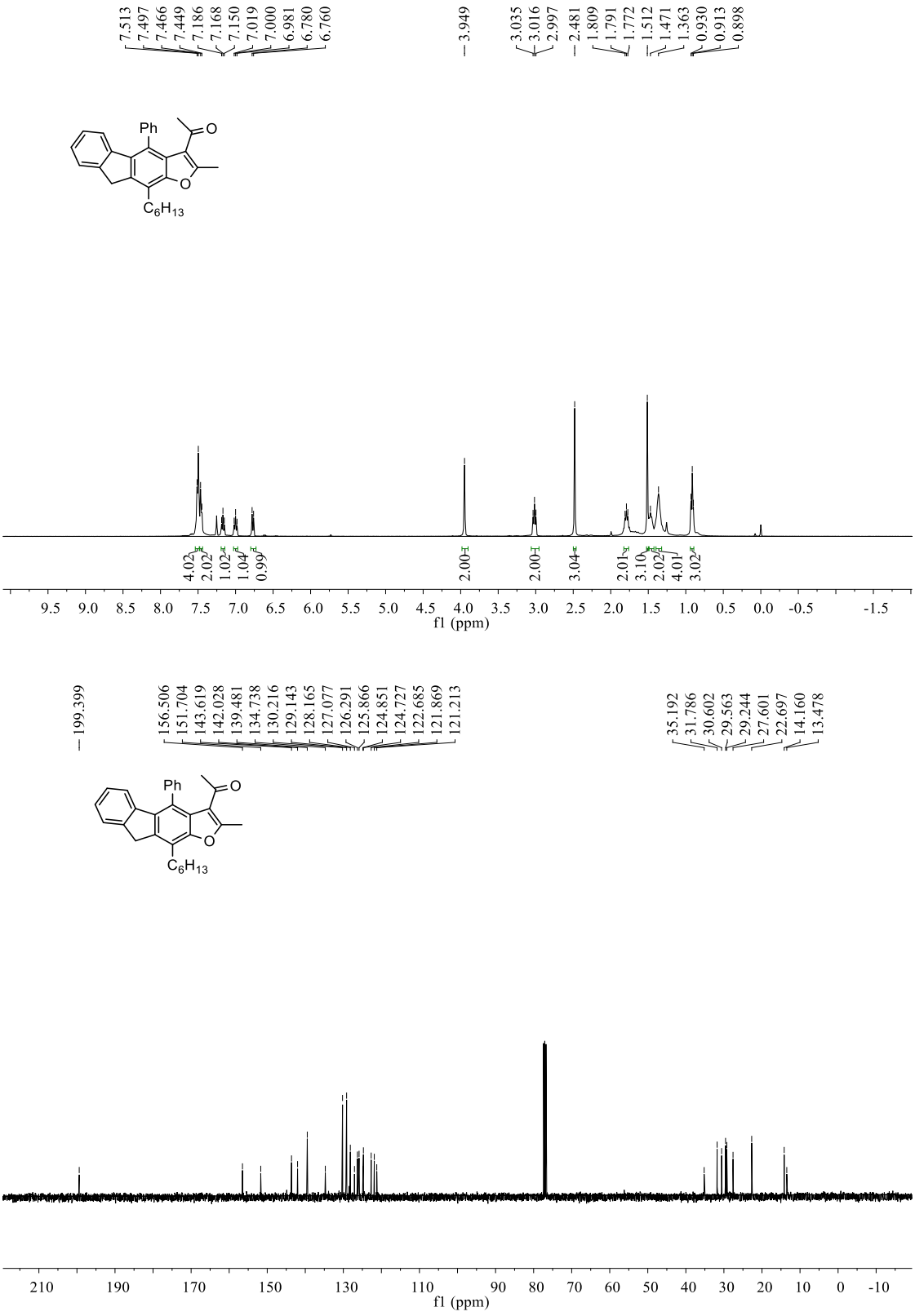


3ak




193.877
152.965
150.563
143.922
143.729
141.436
140.226
137.547
137.029
135.815
135.179
133.376
133.294
133.126
130.124
130.040
129.964
129.862
129.764
129.681
129.541
129.426
129.302
129.251
129.086
128.760
128.734
128.588
128.559
128.233
128.188
128.079
128.031
127.792
127.556
127.470
126.961
126.686
126.416
126.271
126.156
125.713
125.222
124.900
124.608
123.808
122.765
122.329
117.209
36.515
Ph
Ph
O
Ph
O
+
major
O
Ph
Ph
O
Ph
minor
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

3al


7.513
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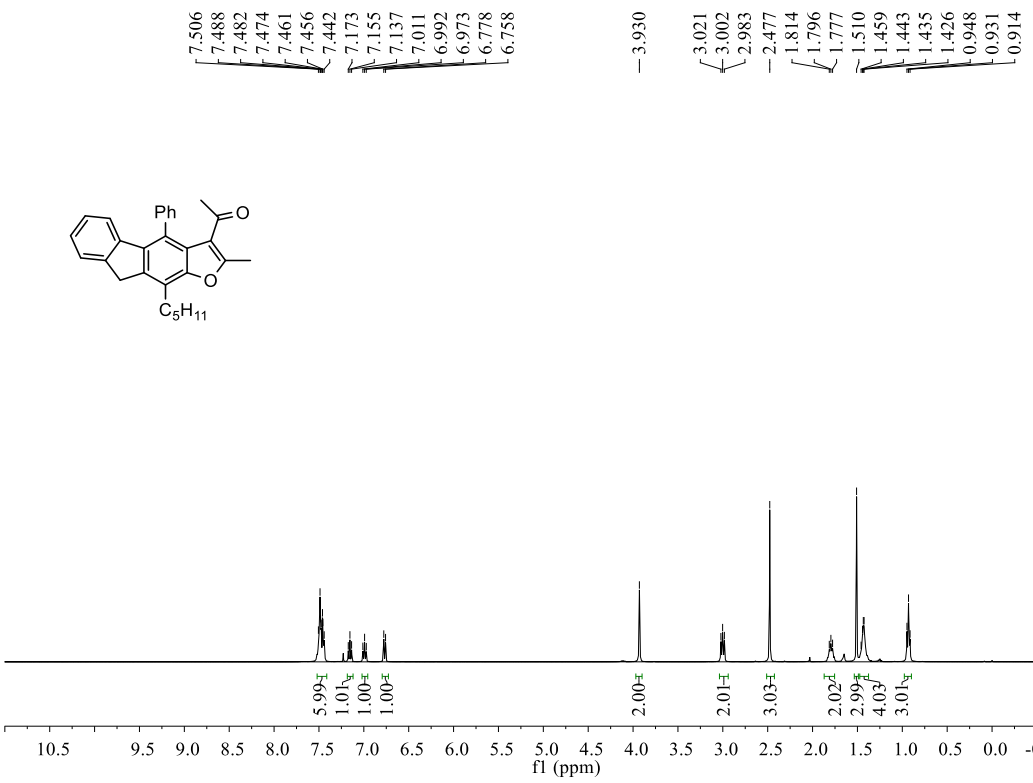
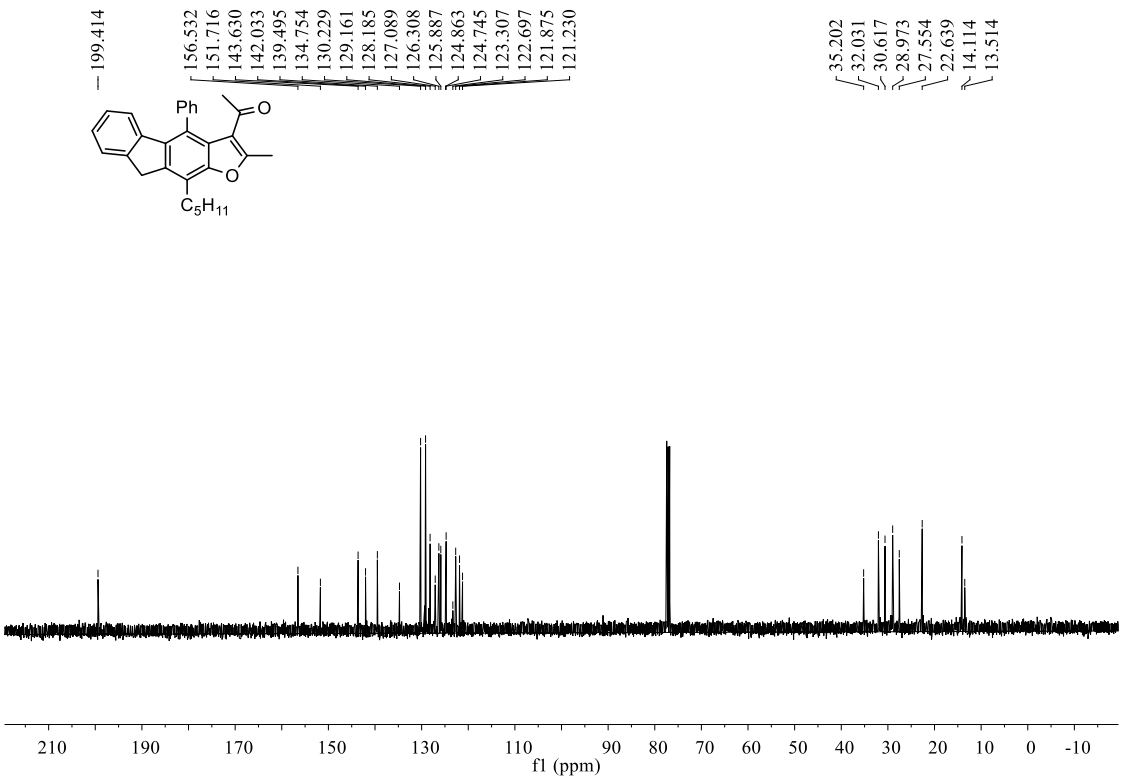
7.466
7.449
7.186
7.168
7.150
7.019
7.000
6.981
6.780
6.760
3.949
3.035
3.016
2.997
2.481
1.809
1.791
1.772
1.512
1.471
1.363
0.930
0.913
0.898
Ph
O
O
C6H13
4.02
2.02
1.02
1.04
0.99
2.00
2.00
3.04
2.01
3.10
2.02
4.01
3.02
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.5
f1 (ppm)
199.399
156.506
151.704
143.619
142.028
139.481
134.738
130.216
129.143
128.165
127.077
126.291
125.866
124.851
124.727
122.685
121.869
121.213
35.192
31.786
30.602
29.563
29.244
27.601
22.697
14.160
13.478
Ph
O
O
C6H13
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

3am


7.506
7.488
7.482
7.474
7.461
7.456
7.442
7.173
7.155
7.137
7.011
6.992
6.973
6.778
6.758
3.930
3.021
3.002
2.983
2.477
1.814
1.796
1.777
1.510
1.459
1.443
1.435
1.426
0.948
0.931
0.914
Ph
O
O
C5H11
5.99
1.01
1.00
1.00
2.00
2.01
3.03
2.02
2.99
4.03
3.01
10.5
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
-0.5
f1 (ppm)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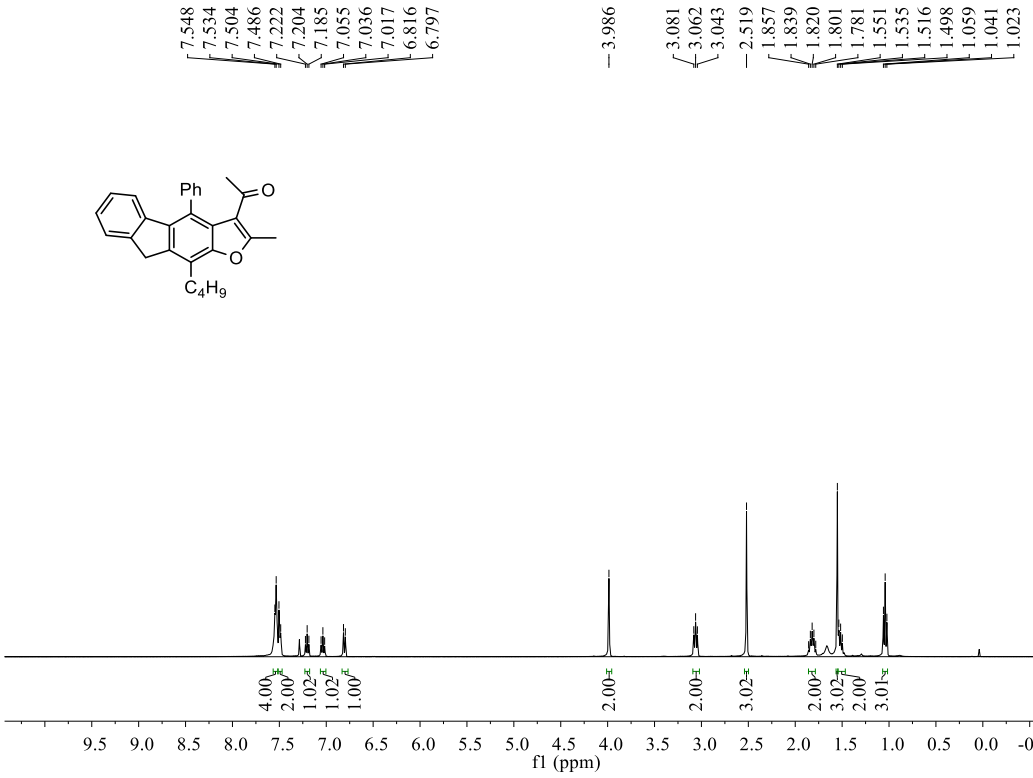
151.716
143.630
142.033
139.495
134.754
130.229
129.161
128.185
127.089
126.308
125.887
124.863
124.745
123.307
122.697
121.875
121.230
35.202
32.031
30.617
28.973
27.554
22.639
14.114
13.514
Ph
O
O
C5H11
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

3an


7.548
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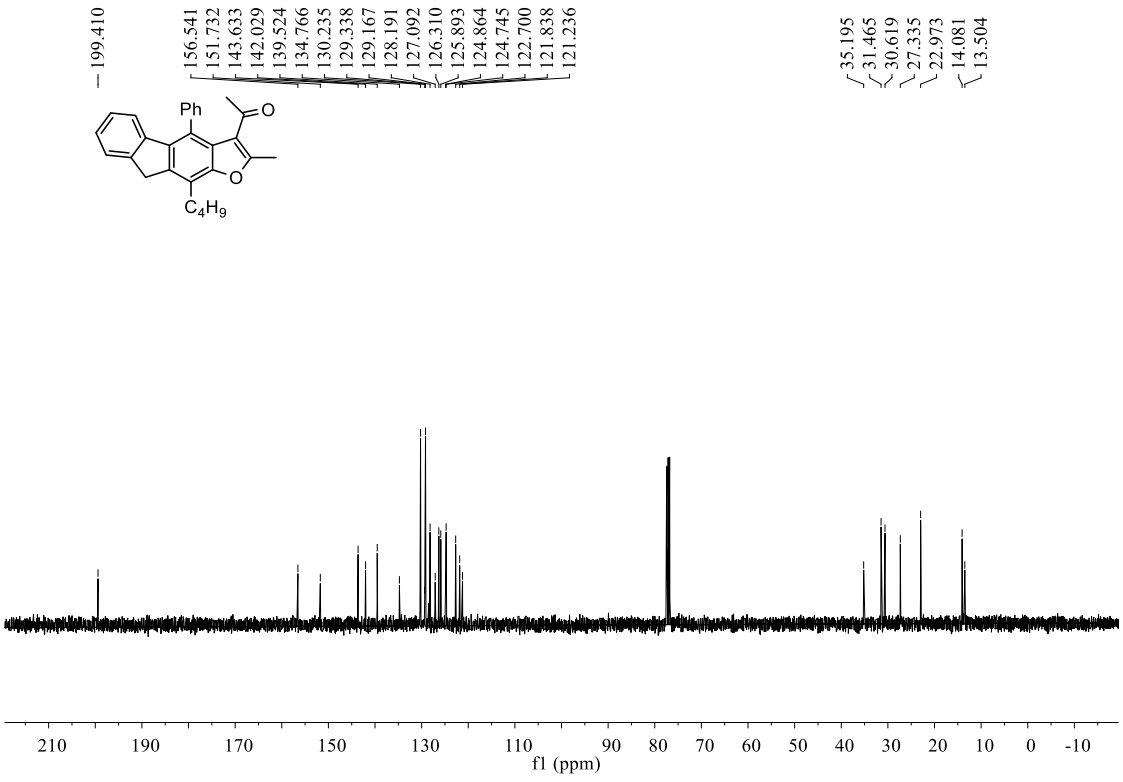
7.486
7.222
7.204
7.185
7.055
7.036
7.017
6.816
6.797
3.986
3.081
3.062
3.043
2.519
1.857
1.839
1.820
1.801
1.781
1.551
1.535
1.516
1.498
1.059
1.041
1.023
Ph
O
O
C4H9
4.00
2.00
1.02
1.02
1.00
2.00
2.00
3.02
2.00
3.02
2.00
3.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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143.633
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139.524
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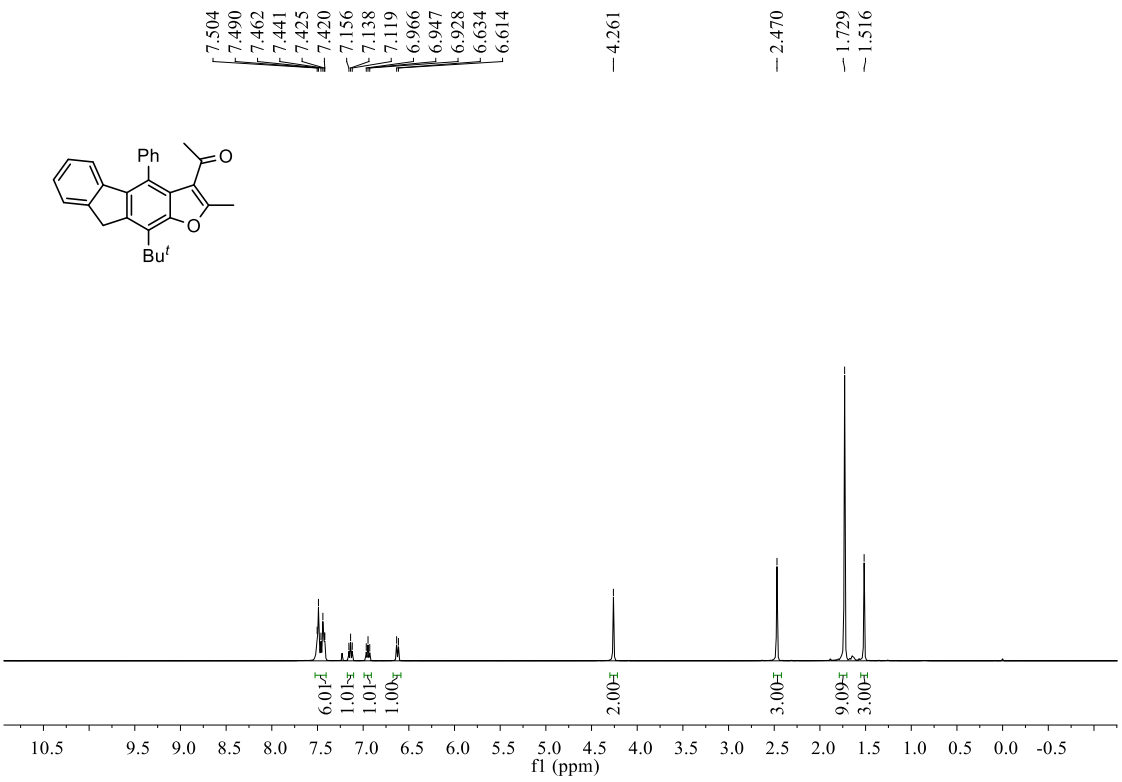
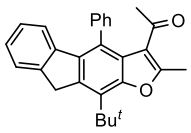
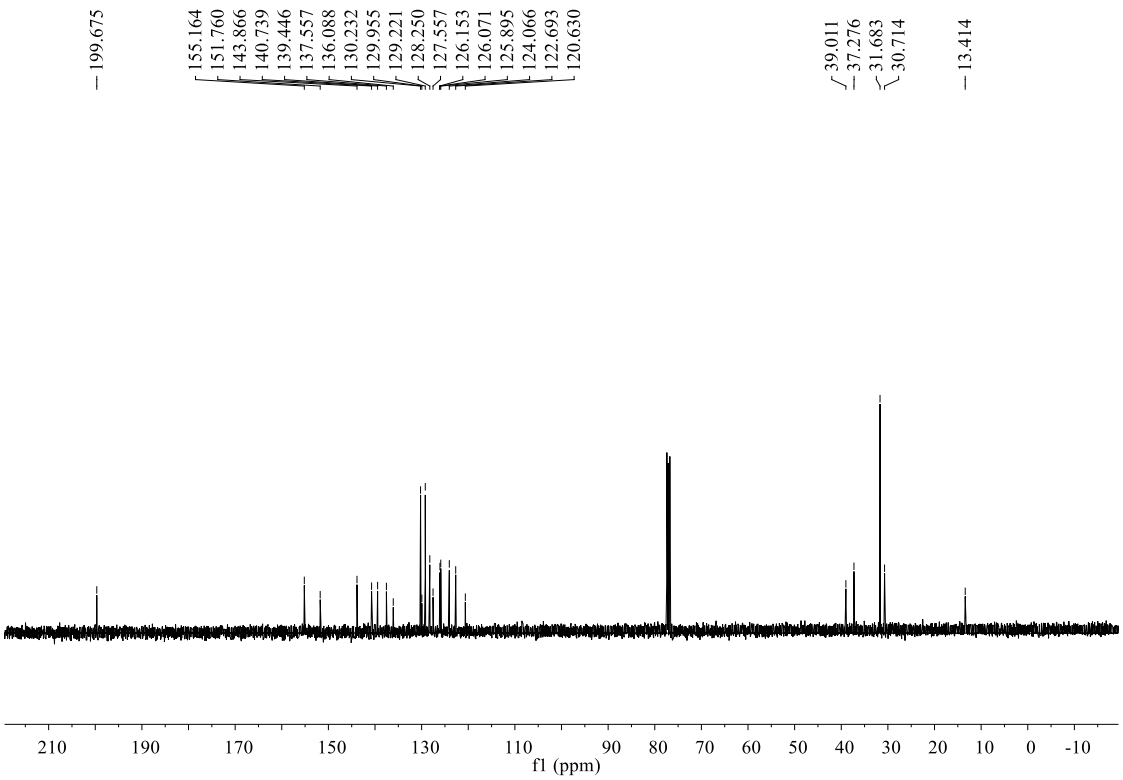
130.235
129.338
129.167
128.191
127.092
126.310
125.893
124.864
124.745
122.700
121.838
121.236
35.195
31.465
30.619
27.335
22.973
14.081
13.504
Ph
O
O
C4H9
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

3ao


7.504
7.490
7.462
7.441
7.425
7.420
7.156
7.138
7.119
6.966
6.947
6.928
6.634
6.614
4.261
2.470
1.729
1.516
Ph
O
O
Bu^t
6.01
1.01
1.01
1.00
2.00
3.00
9.09
3.00
10.5 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 -0.5
f1 (ppm)


Ph
O
O
Bu^t


199.675
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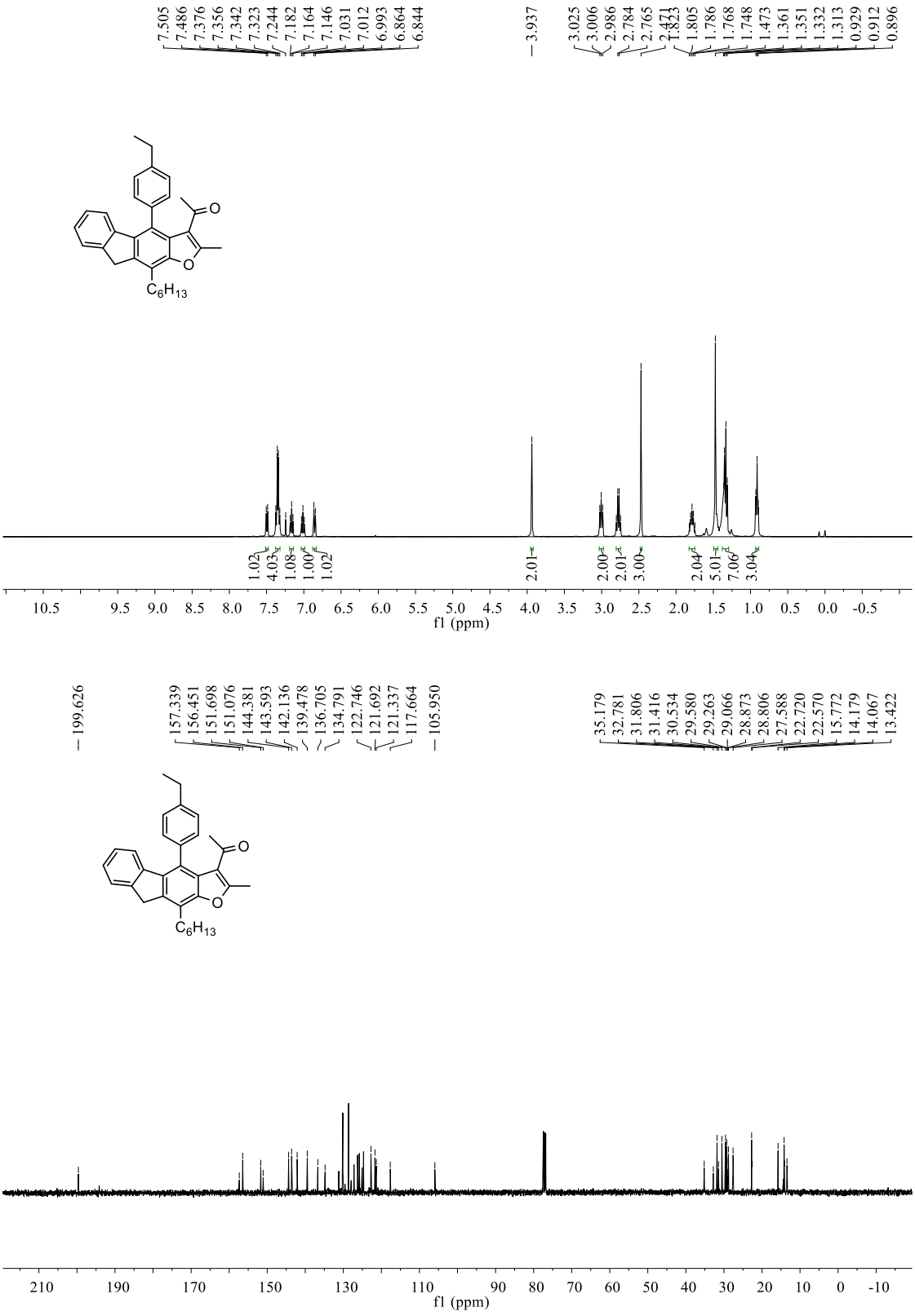
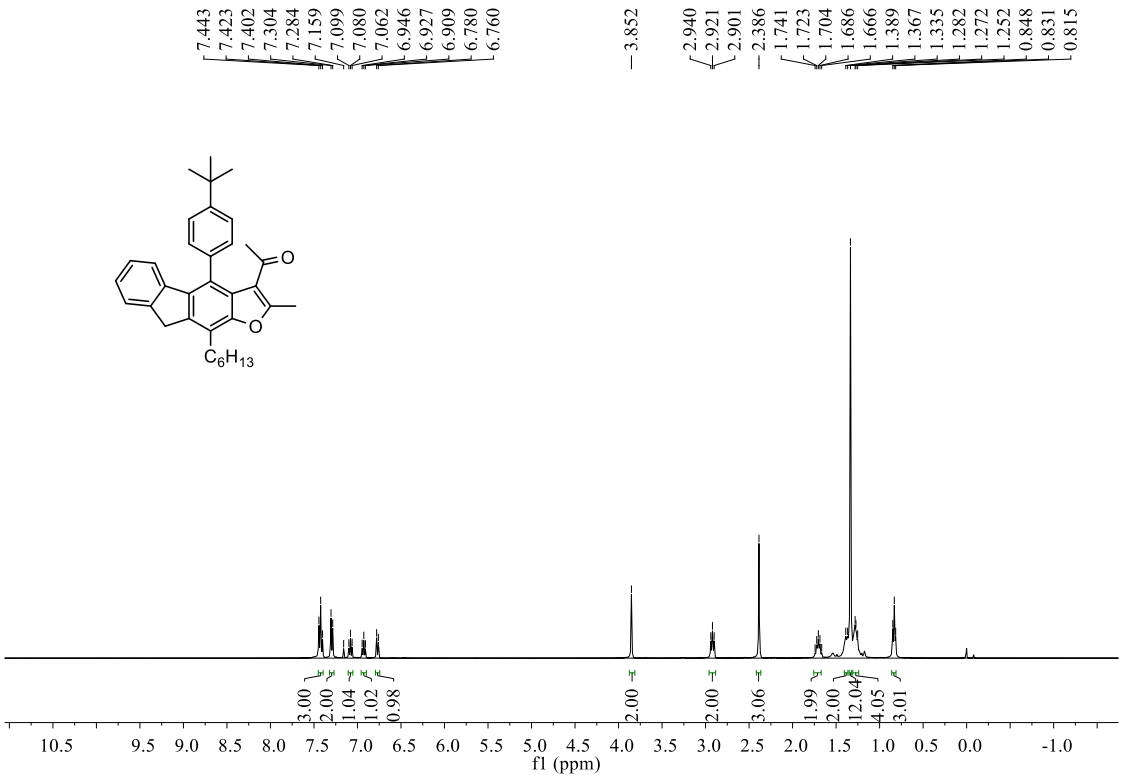
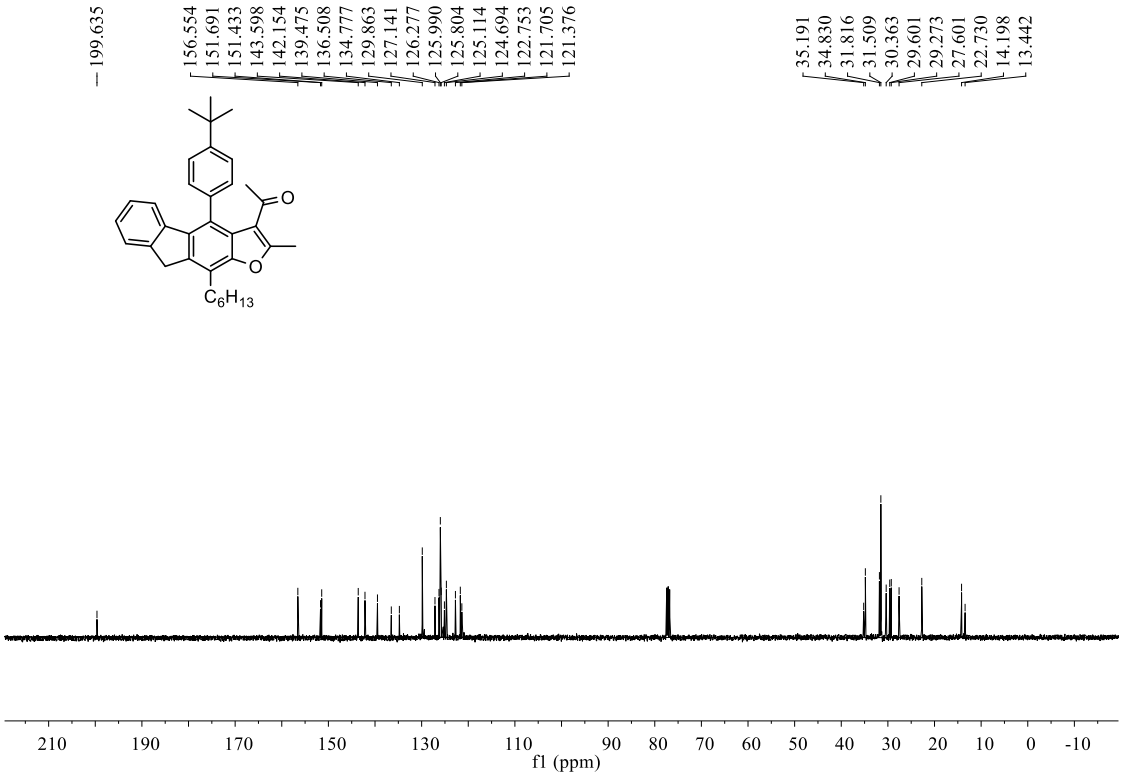
151.760
143.866
140.739
139.446
137.557
136.088
130.232
129.955
129.221
128.250
127.557
126.153
126.071
125.895
124.066
122.693
120.630
39.011
37.276
31.683
30.714
13.414
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

3ba


7.505
7.486
7.376
7.356
7.342
7.323
7.244
7.182
7.164
7.146
7.031
7.012
6.993
6.864
6.844
3.937
3.025
3.006
2.986
2.784
2.765
2.471
1.823
1.805
1.786
1.768
1.748
1.473
1.361
1.351
1.332
1.313
0.929
0.912
0.896
O
O
C6H13
1.02
4.03
1.08
1.00
1.02
2.01
2.00
2.01
3.00
2.04
5.01
7.06
3.04
10.5 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 -0.5
f1 (ppm)
199.626
157.339
156.451
151.698
151.076
144.381
143.593
142.136
139.478
136.705
134.791
122.746
121.692
121.337
117.664
105.950
35.179
32.781
31.806
31.416
30.534
29.580
29.263
29.066
28.873
28.806
27.588
22.720
22.570
15.772
14.179
14.067
13.422
O
O
C6H13
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

3bb


7.443
7.423
7.402
7.304
7.284
7.159
7.099
7.080
7.062
6.946
6.927
6.909
6.780
6.760
3.852
2.940
2.921
2.901
2.386
1.741
1.723
1.704
1.686
1.666
1.389
1.367
1.335
1.282
1.272
1.252
0.848
0.831
0.815
O
O
C6H13
3.00
2.00
1.04
1.02
0.98
2.00
2.00
3.06
1.99
2.00
12.04
4.05
3.01
10.5
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
-1.0
f1 (ppm)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151.691
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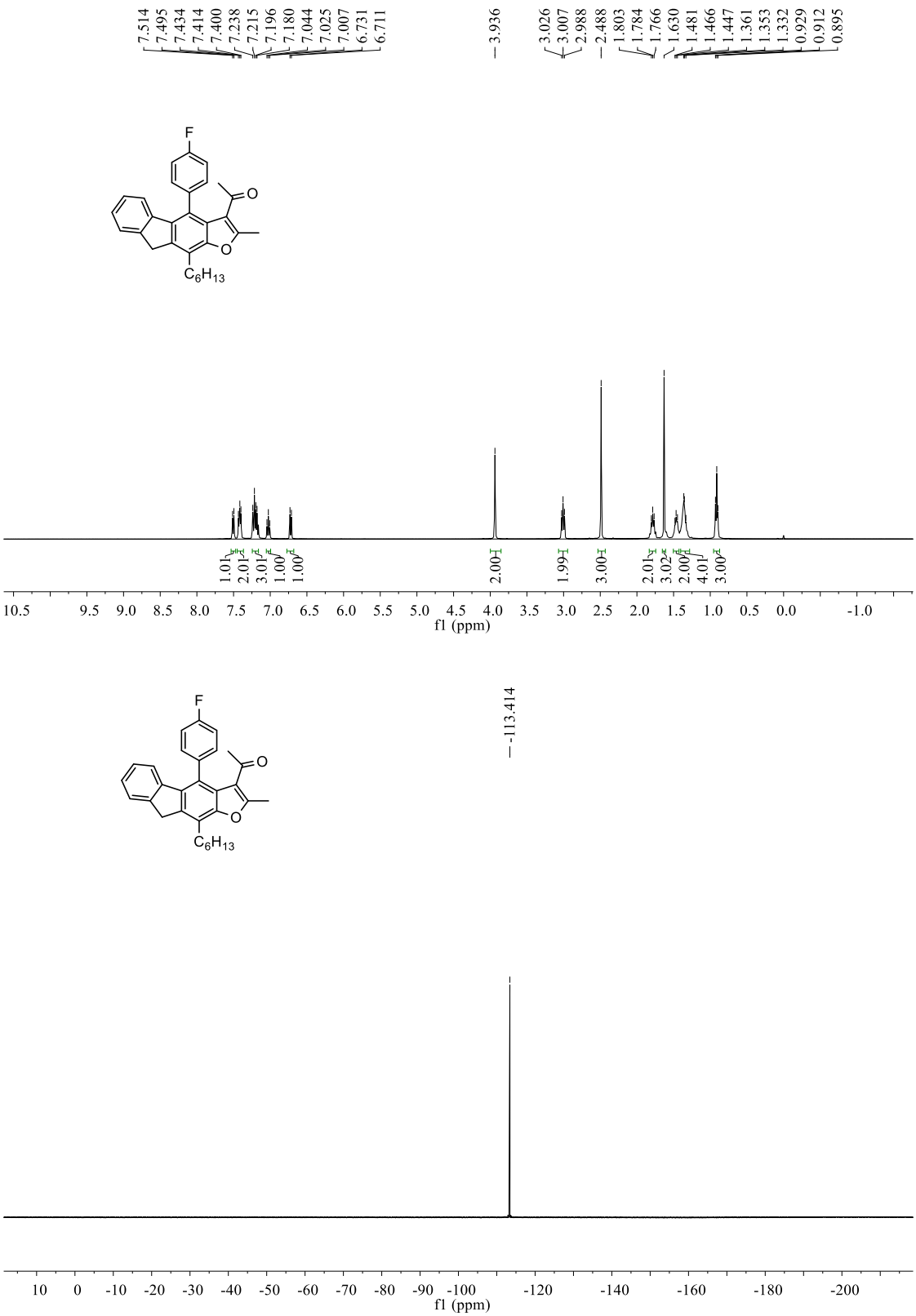
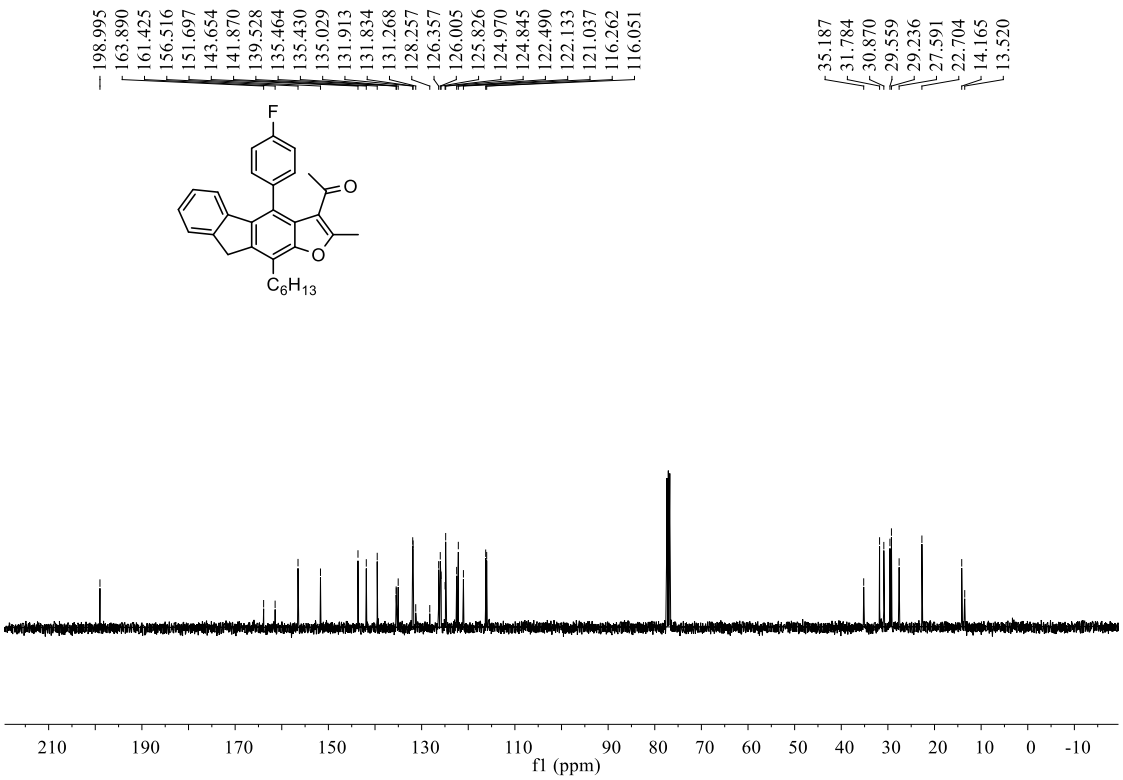
142.154
139.475
136.508
134.777
129.863
127.141
126.277
125.990
125.804
125.114
124.694
122.753
121.705
121.376
35.191
34.830
31.816
31.509
30.363
29.601
29.273
27.601
22.730
14.198
13.442
O
O
C6H13
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

3bc


7.514
7.495
7.434
7.414
7.400
7.238
7.215
7.196
7.180
7.044
7.025
7.007
6.731
6.711
3.936
3.026
3.007
2.988
2.488
1.803
1.784
1.766
1.630
1.481
1.466
1.447
1.361
1.353
1.332
0.929
0.912
0.895
F
O
O
C6H13
1.01
2.01
3.01
1.00
1.00
2.00
1.99
3.00
2.01
3.02
2.00
4.01
3.00
10.5 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 -1.0
f1 (ppm)
F
O
O
C6H13
-113.414
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)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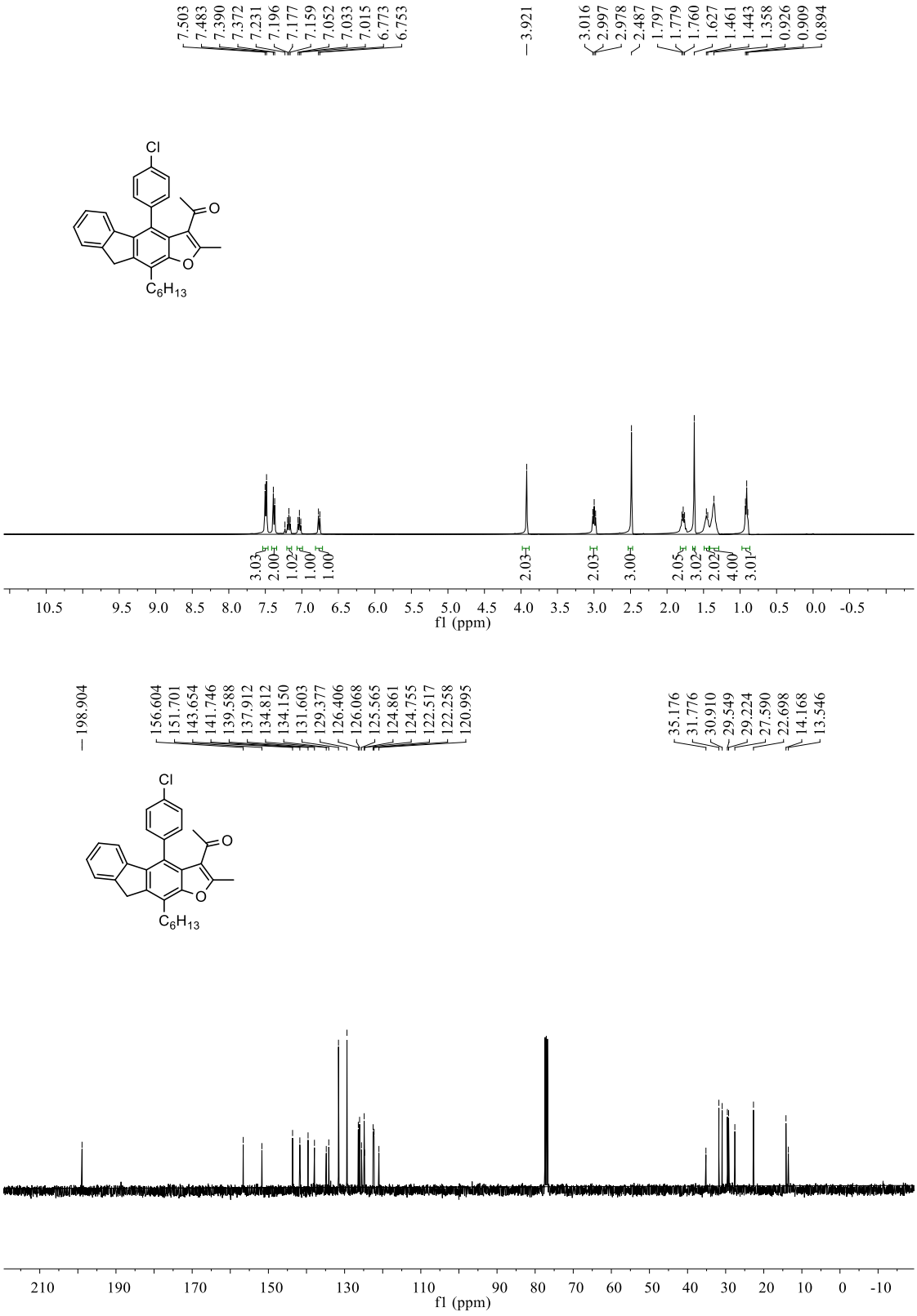
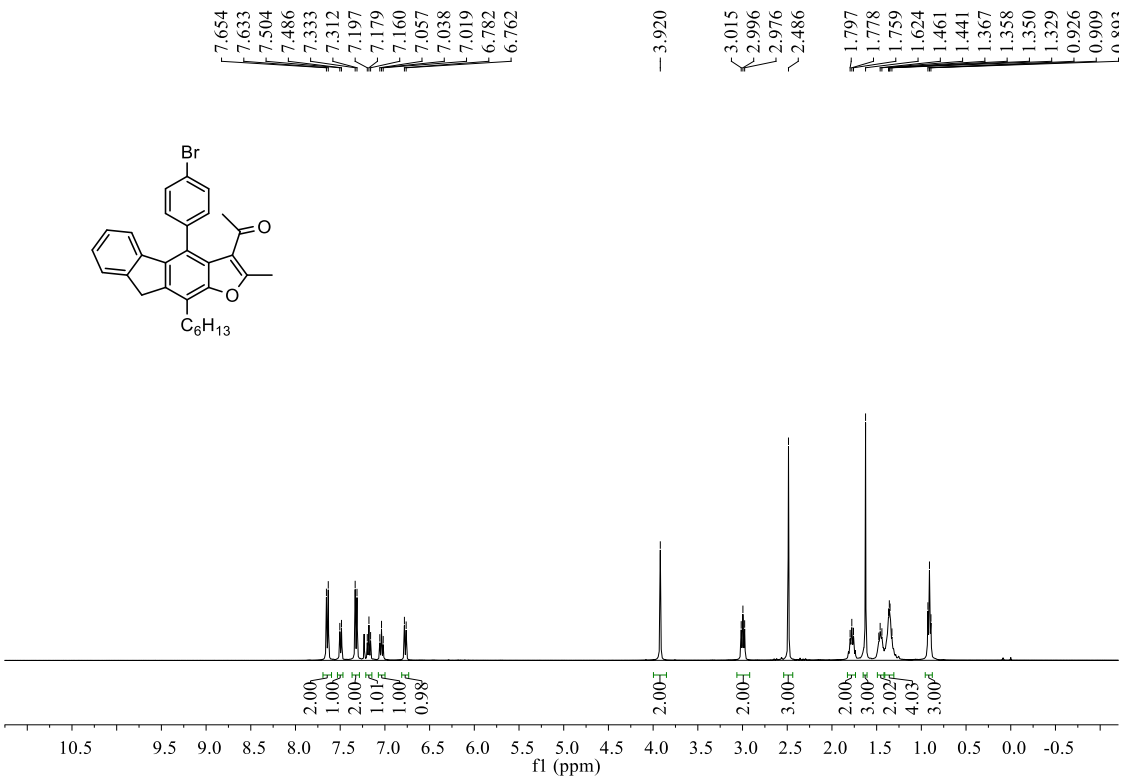
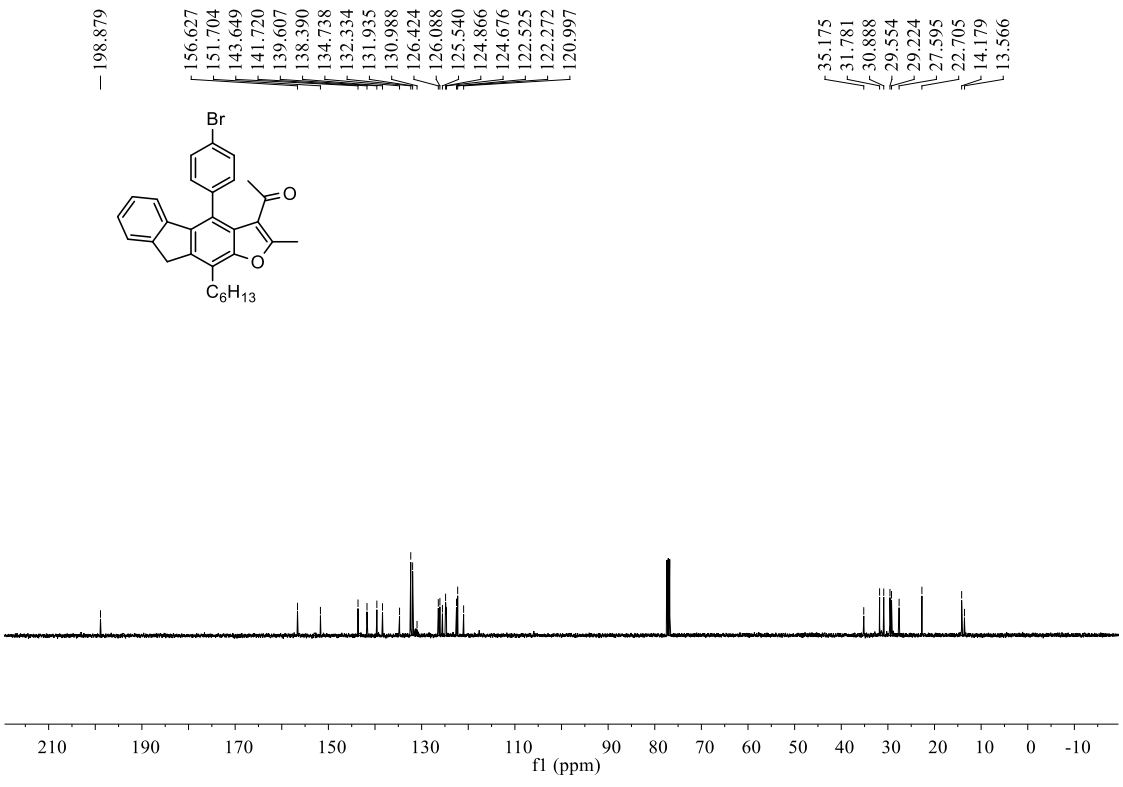
163.890
161.425
156.516
151.697
143.654
141.870
139.528
135.464
135.430
135.029
131.913
131.834
131.268
128.257
126.357
126.005
125.826
124.970
124.845
122.490
122.133
121.037
116.262
116.051
35.187
31.784
30.870
29.559
29.236
27.591
22.704
14.165
13.520
F
O
O
C6H13
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

3bd


7.503
7.483
7.390
7.372
7.231
7.196
7.177
7.159
7.052
7.033
7.015
6.773
6.753
3.921
3.016
2.997
2.978
2.487
1.797
1.779
1.760
1.627
1.461
1.443
1.358
0.926
0.909
0.894
Cl
O
O
C6H13
3.03
2.00
1.02
1.00
1.00
2.03
2.03
3.00
2.05
3.02
2.02
4.00
3.01
10.5 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 -0.5
f1 (ppm)
198.904
156.604
151.701
143.654
141.746
139.588
137.912
134.812
134.150
131.603
129.377
126.406
126.068
125.565
124.861
124.755
122.517
122.258
120.995
35.176
31.776
30.910
29.549
29.224
27.590
22.698
14.168
13.546
Cl
O
O
C6H13
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

3be


7.654
7.633
7.504
7.486
7.333
7.312
7.197
7.179
7.160
7.057
7.038
7.019
6.782
6.762
3.920
3.015
2.996
2.976
2.486
1.797
1.778
1.759
1.624
1.461
1.441
1.367
1.358
1.350
1.329
0.926
0.909
Br
O
O
C6H13
2.00
1.00
2.00
1.01
1.00
0.98
2.00
2.00
3.00
2.00
3.00
2.02
4.03
3.00
10.5 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 -0.5
f1 (ppm)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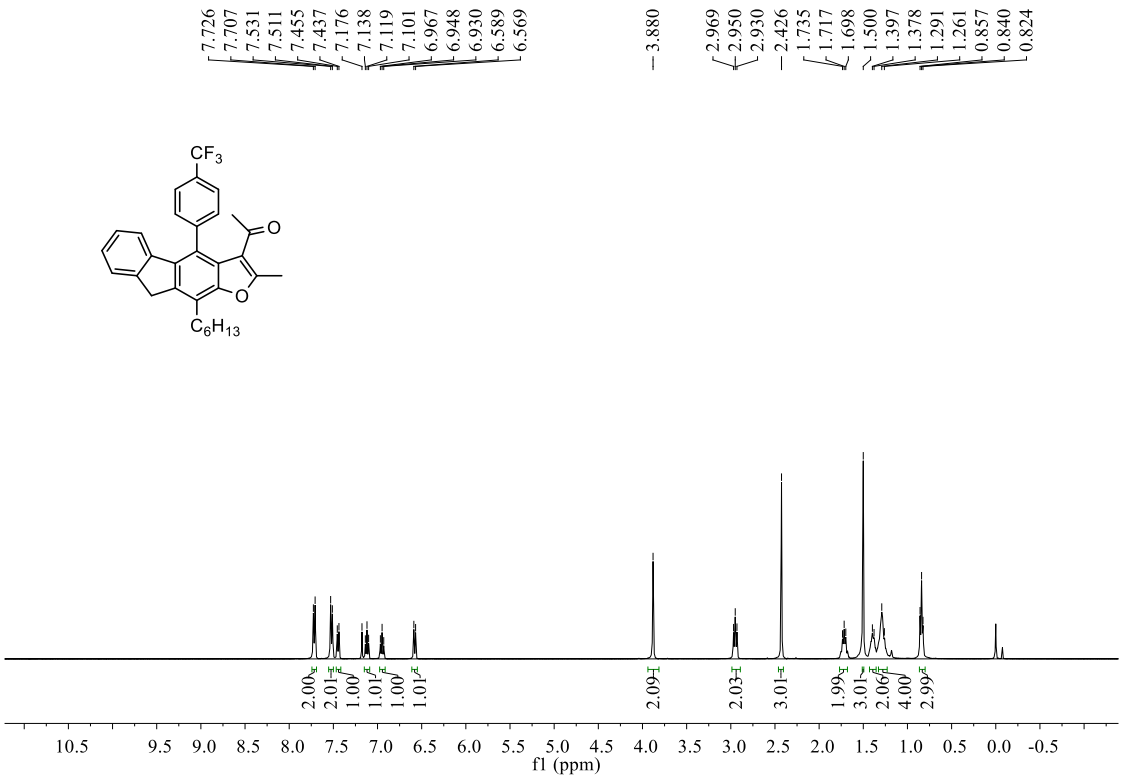
156.627
151.704
143.649
141.720
139.607
138.390
134.738
132.334
131.935
130.988
126.424
126.088
125.540
124.866
124.676
122.525
122.272
120.997
35.175
31.781
30.888
29.554
29.224
27.595
22.705
14.179
13.566
Br
O
O
C6H13
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

3bf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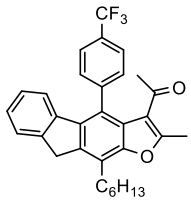
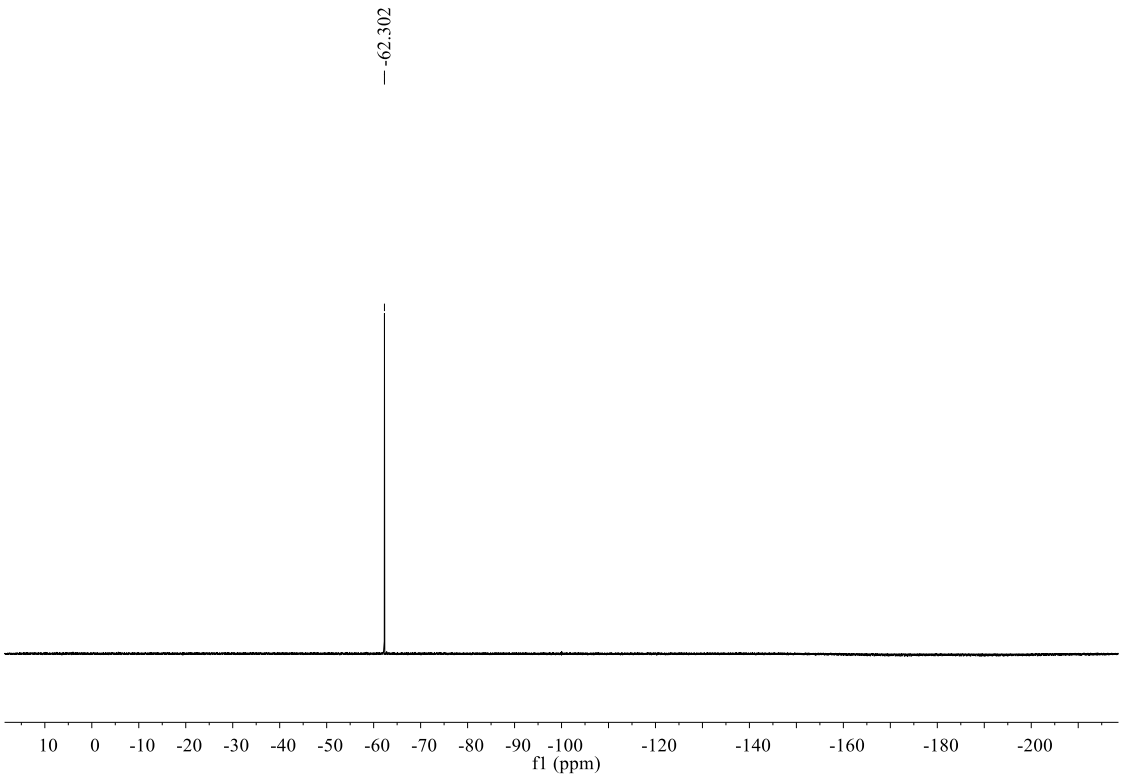
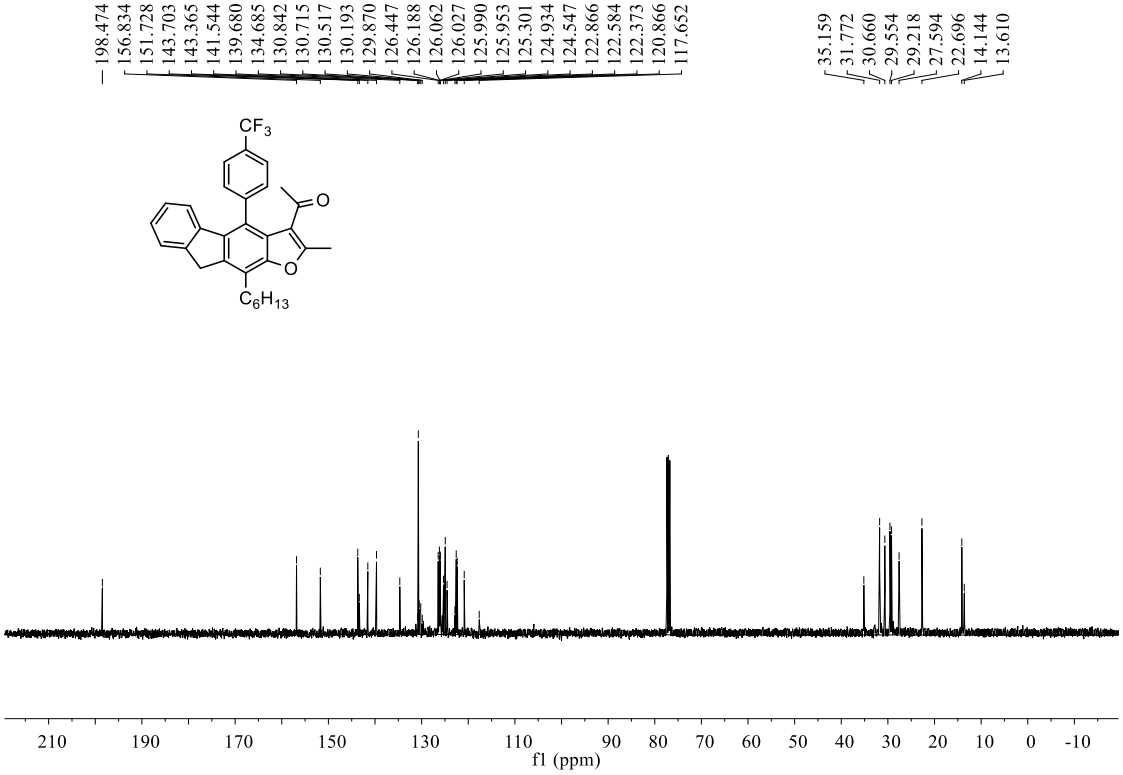
7.707
7.531
7.511
7.455
7.437
7.176
7.138
7.119
7.101
6.967
6.948
6.930
6.589
6.569
3.880
2.969
2.950
2.930
2.426
1.735
1.717
1.698
1.500
1.397
1.378
1.291
1.261
0.857
0.840
0.824
CF3
O
O
C6H13
2.00
2.01
1.00
1.01
1.00
1.01
2.09
2.03
3.01
1.99
3.01
2.06
4.00
2.99
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


CF3
O
O
C6H13


-62.302
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)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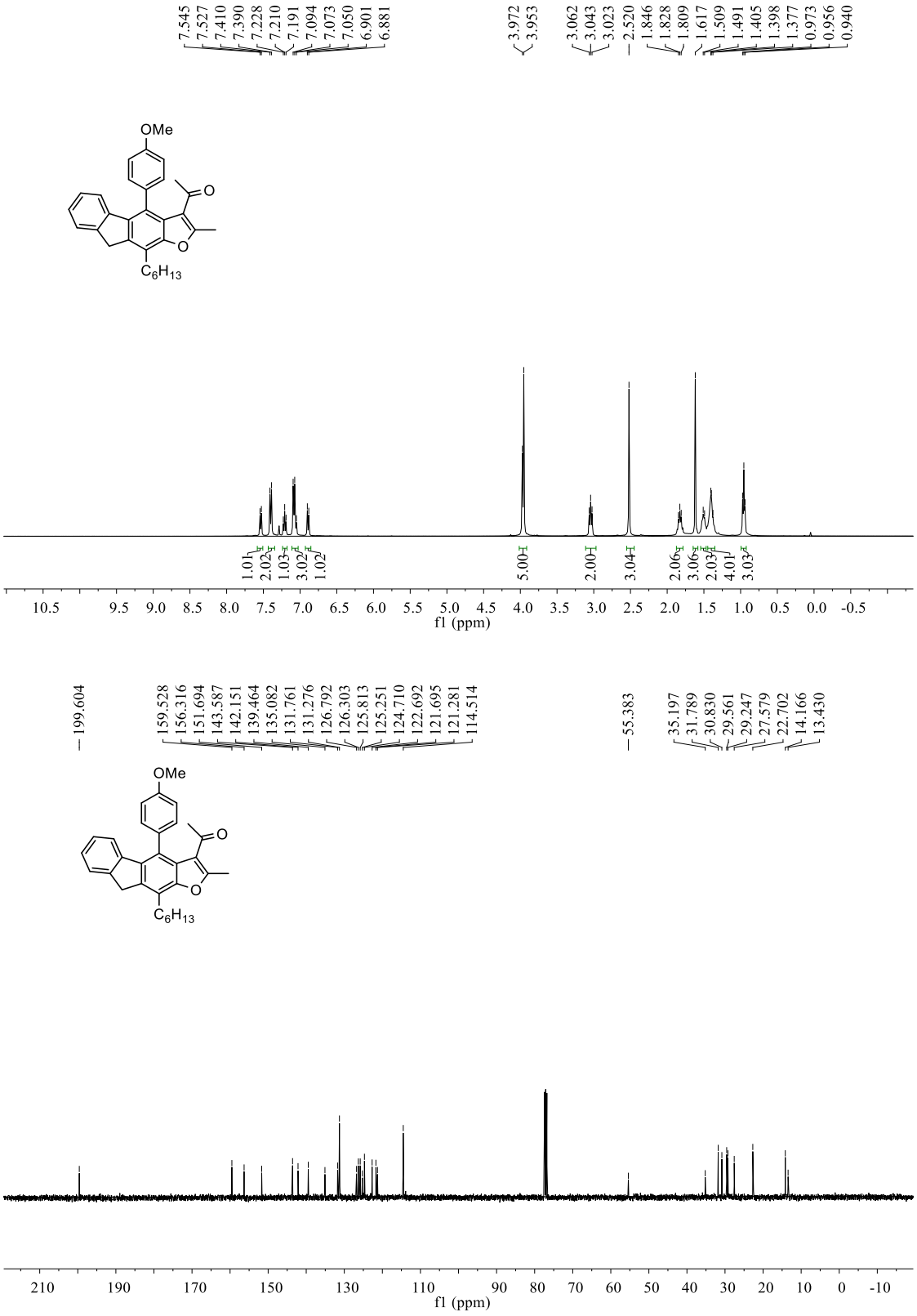
156.834
151.728
143.703
143.365
141.544
139.680
134.685
130.842
130.715
130.517
130.193
129.870
126.447
126.188
126.062
126.027
125.990
125.953
125.301
124.934
124.547
122.866
122.584
122.373
120.866
117.652
35.159
31.772
30.660
29.554
29.218
27.594
22.696
14.144
13.610
CF3
O
O
C6H13
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

3bg


7.545
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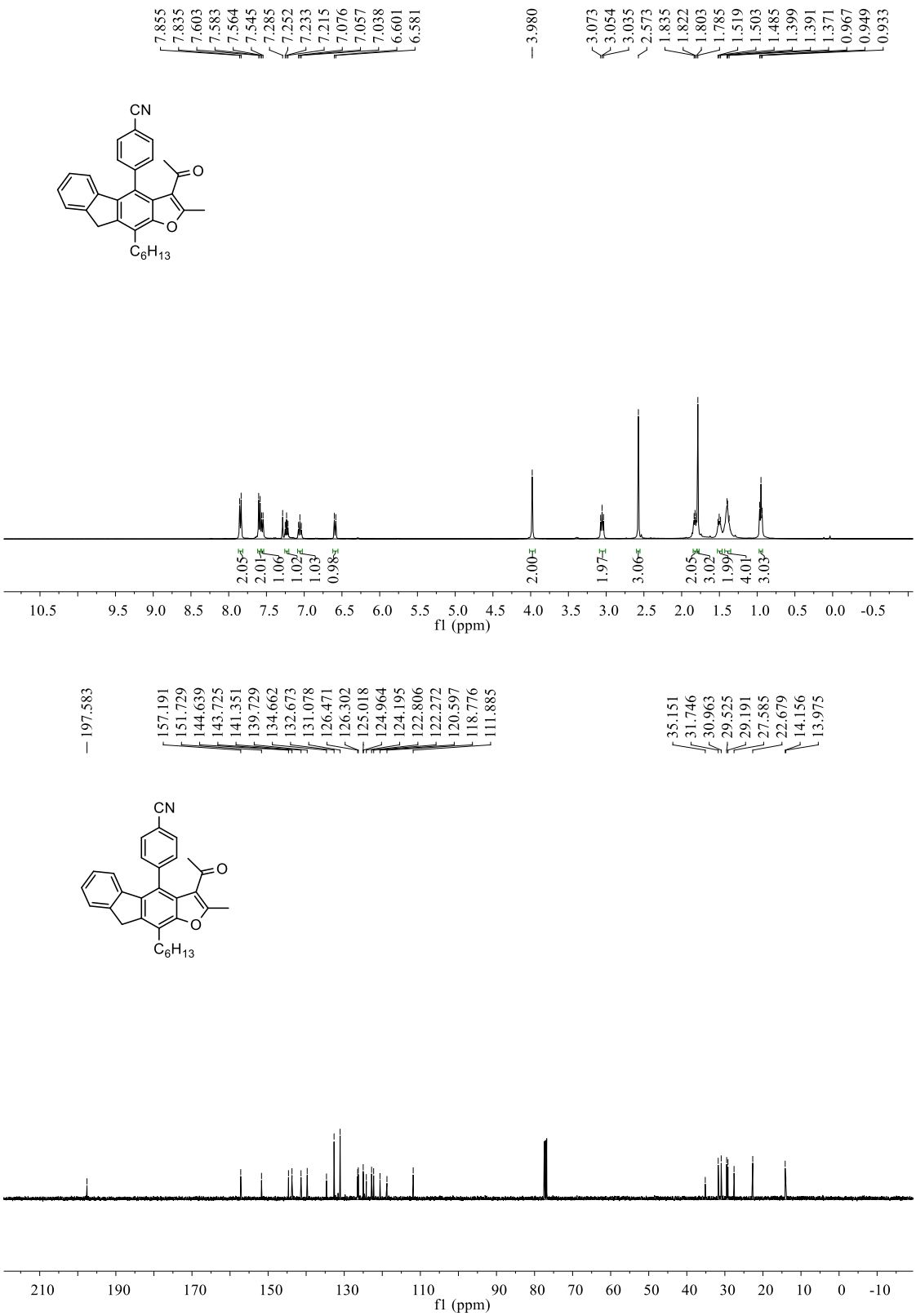
7.410
7.390
7.228
7.210
7.191
7.094
7.073
7.050
6.901
6.881
3.972
3.953
3.062
3.043
3.023
2.520
1.846
1.828
1.809
1.617
1.509
1.491
1.405
1.398
1.377
0.973
0.956
0.940
OMe
O
O
C6H13
1.01
2.02
1.03
3.02
1.02
5.00
2.00
3.04
2.06
3.06
2.03
4.01
3.03
10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)
199.604
159.528
156.316
151.694
143.587
142.151
139.464
135.082
131.761
131.276
126.792
126.303
125.813
125.251
124.710
122.692
121.695
121.281
114.514
55.383
35.197
31.789
30.830
29.561
29.247
27.579
22.702
14.166
13.430
OMe
O
O
C6H13
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

3bh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7.583
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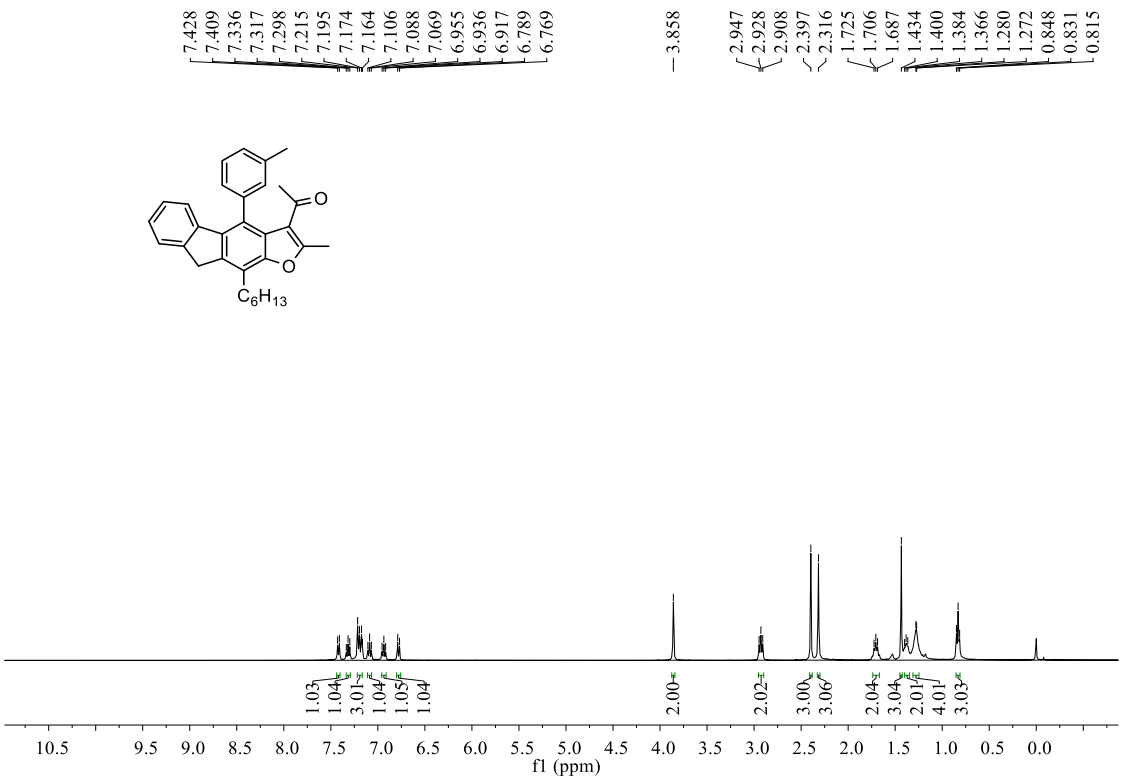
7.545
7.285
7.252
7.233
7.215
7.076
7.057
7.038
6.601
6.581
3.980
3.073
3.054
3.035
2.573
1.835
1.822
1.803
1.785
1.519
1.503
1.485
1.399
1.391
1.371
0.967
0.949
0.933
CN
O
O
C6H13
2.05
2.01
1.06
1.02
1.03
0.98
2.00
1.97
3.06
2.05
3.02
1.99
4.01
3.03
10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)
197.583
157.191
151.729
144.639
143.725
141.351
139.729
134.662
132.673
131.078
126.471
126.302
125.018
124.964
124.195
122.806
122.272
120.597
118.776
111.885
35.151
31.746
30.963
29.525
29.191
27.585
22.679
14.156
13.975
CN
O
O
C6H13
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

3bi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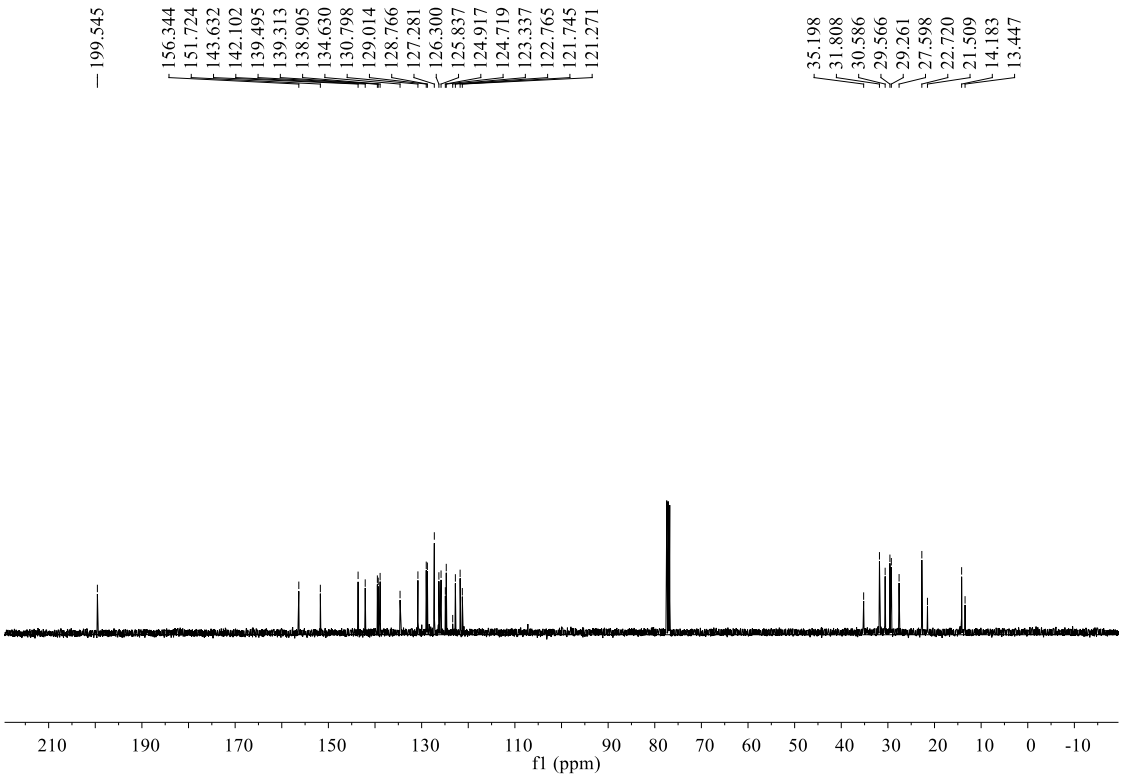
7.298
7.215
7.195
7.174
7.164
7.106
7.088
7.069
6.955
6.936
6.917
6.789
6.769
3.858
2.947
2.928
2.908
2.397
2.316
1.725
1.706
1.687
1.434
1.400
1.384
1.366
1.280
1.272
0.848
0.831
0.815
O
O
C6H13
1.03
1.04
3.01
1.04
1.05
1.04
2.00
2.02
3.00
3.06
2.04
3.04
2.01
4.01
3.03
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
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)

O
O
C6H13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151.724
143.632
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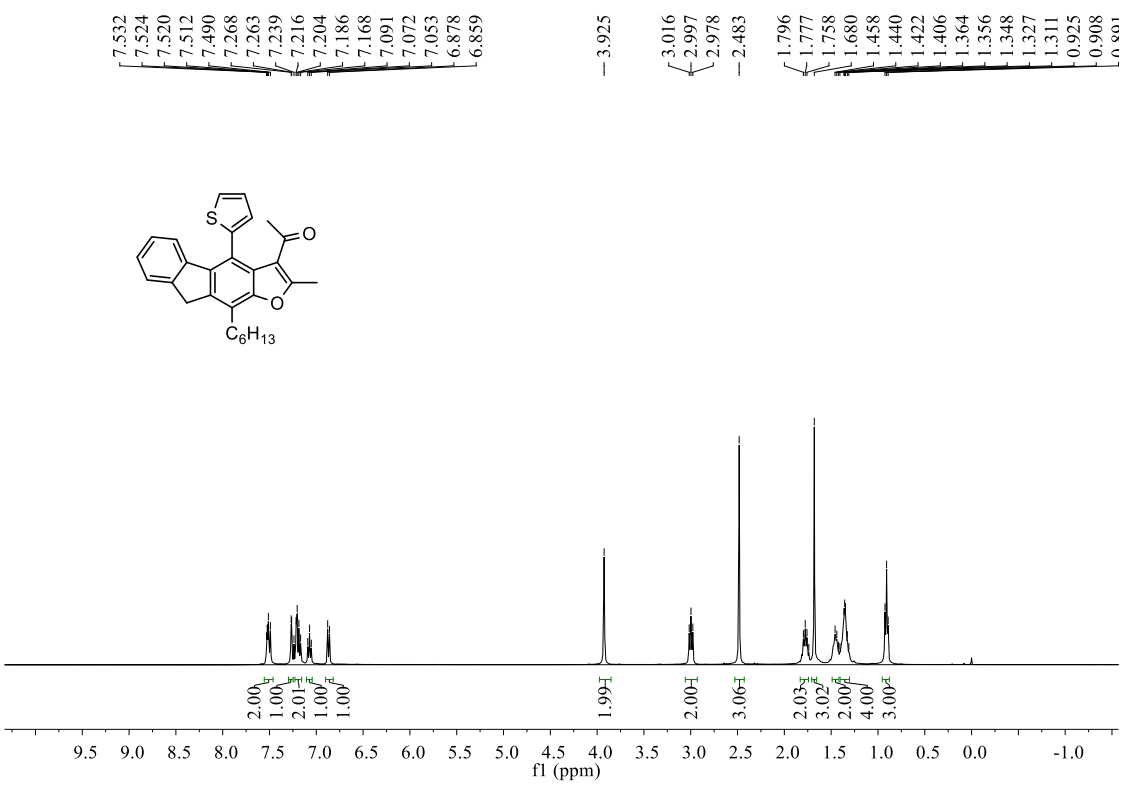
139.313
138.905
134.630
130.798
129.014
128.766
127.281
126.300
125.837
124.917
124.719
123.337
122.765
121.745
121.271
35.198
31.808
30.586
29.566
29.261
27.598
22.720
21.509
14.183
13.447
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

3bj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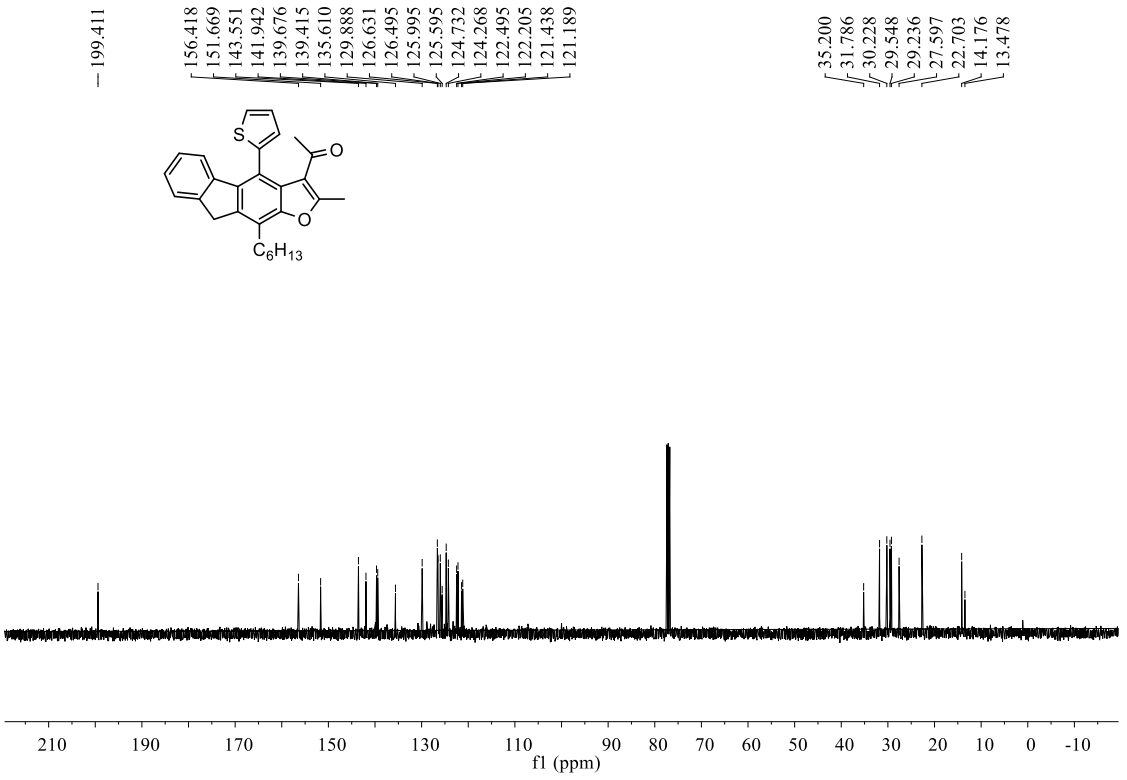
7.512
7.490
7.268
7.263
7.239
7.216
7.204
7.186
7.168
7.091
7.072
7.053
6.878
6.859
3.925
3.016
2.997
2.978
2.483
1.796
1.777
1.758
1.680
1.458
1.440
1.422
1.406
1.364
1.356
1.348
1.327
1.311
0.925
0.908
S
O
O
C6H13
2.00
1.00
2.01
1.00
1.00
1.99
2.00
3.06
2.03
3.02
2.00
4.00
3.00
9.5 9.0 8.5 8.0 7.5 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 -1.0
f1 (ppm)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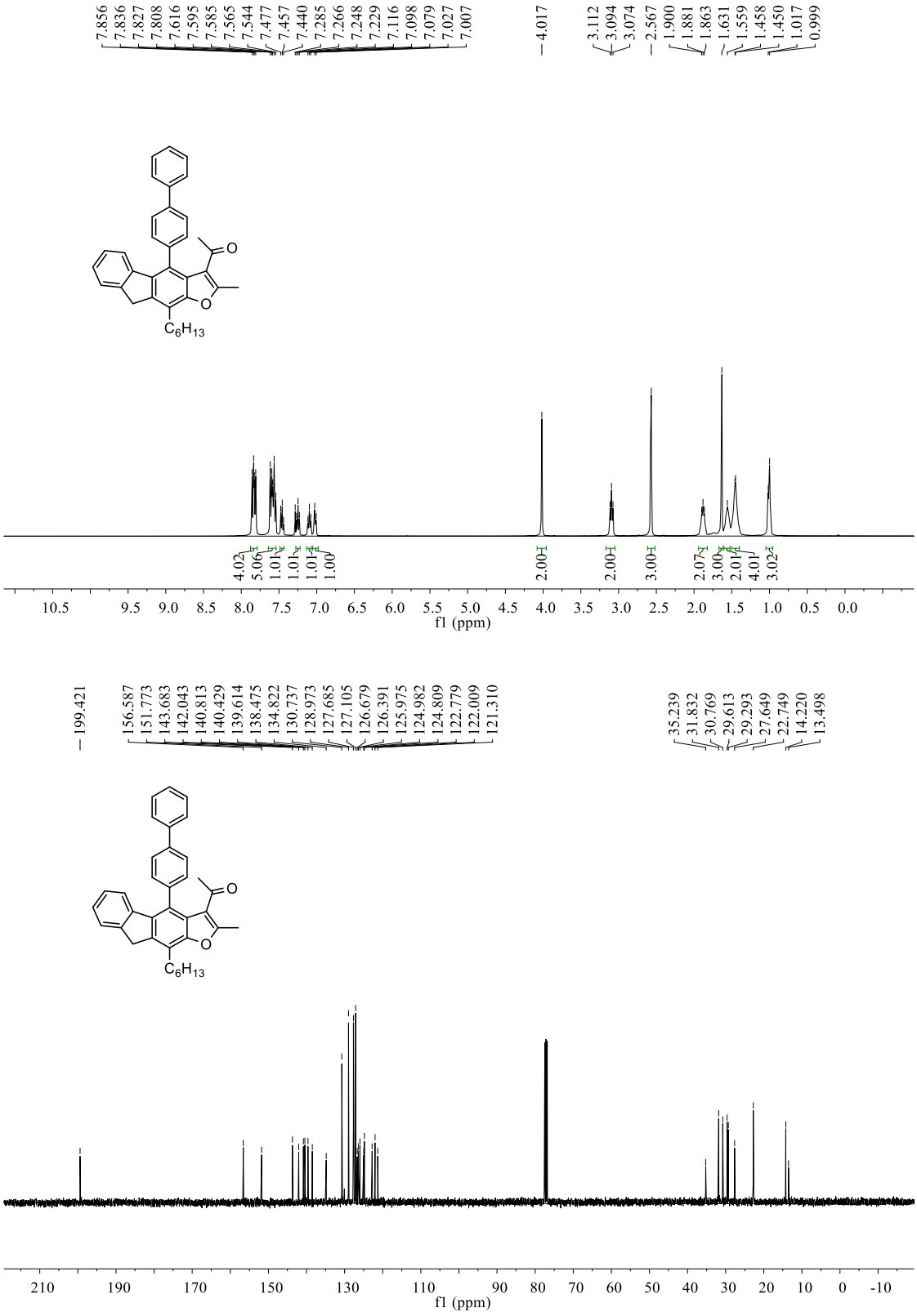
156.418
151.669
143.551
141.942
139.676
139.415
135.610
129.888
126.631
126.495
125.995
125.595
124.732
124.268
122.495
122.205
121.438
121.189
35.200
31.786
30.228
29.548
29.236
27.597
22.703
14.176
13.478
S
O
O
C6H13
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

3bk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7.565
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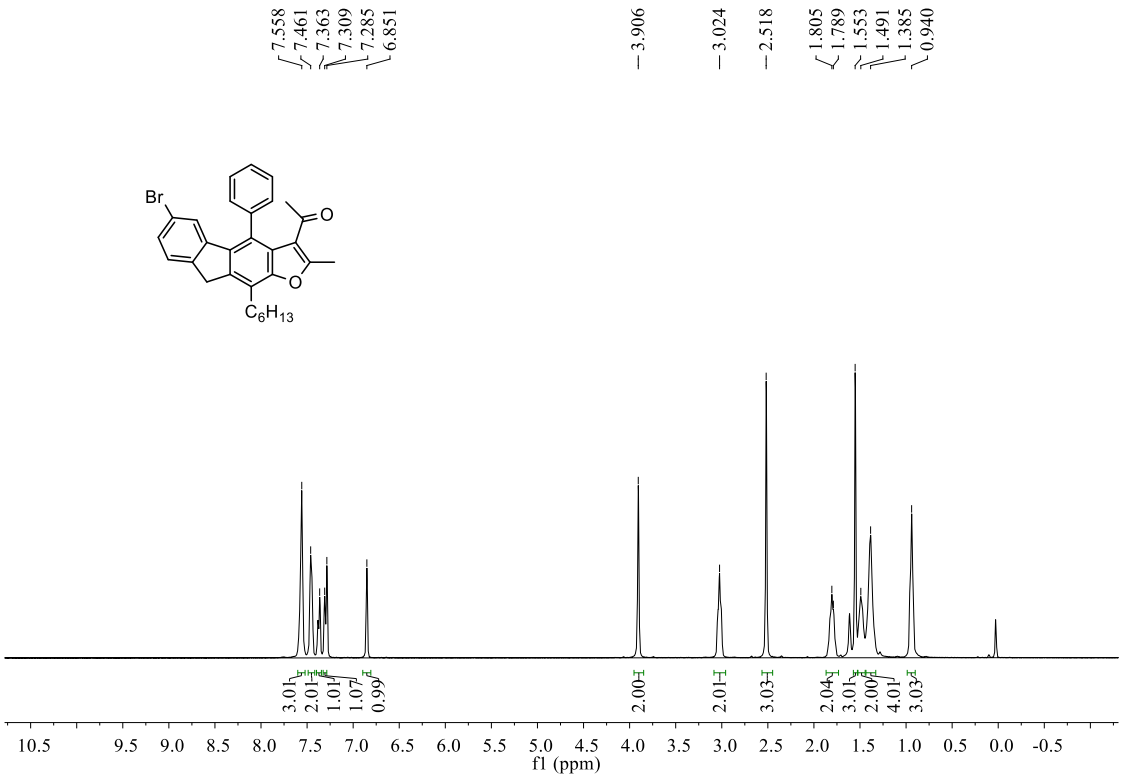
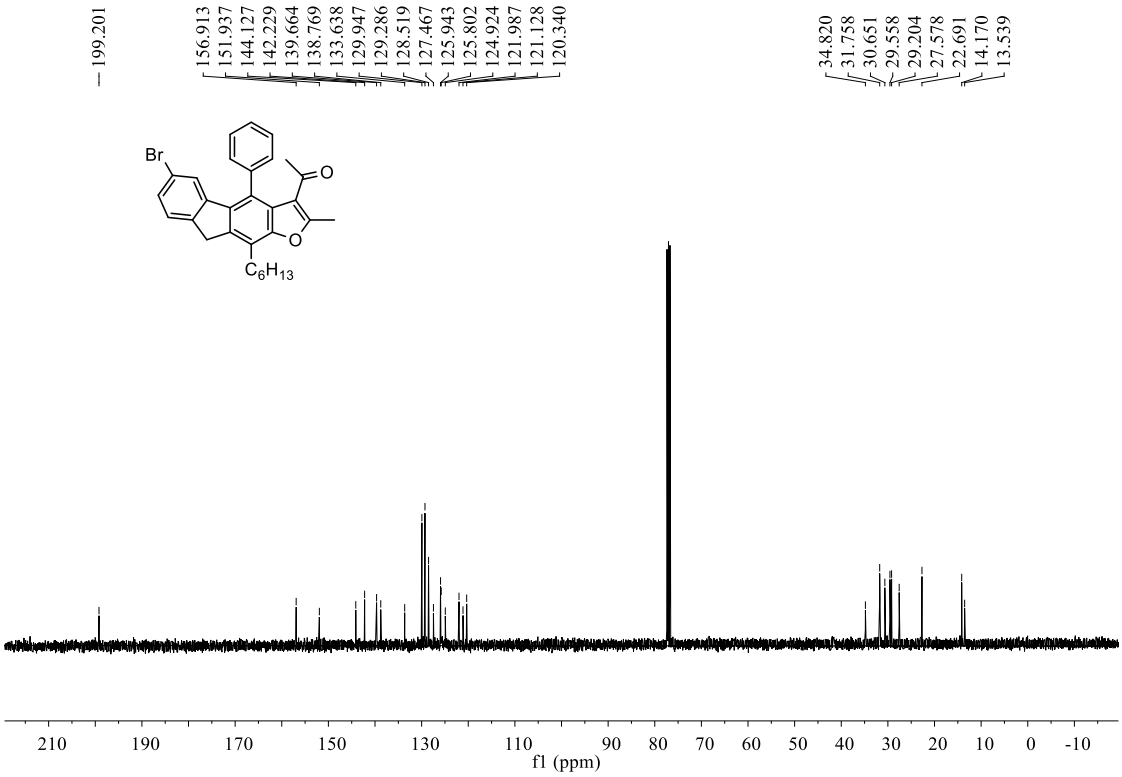
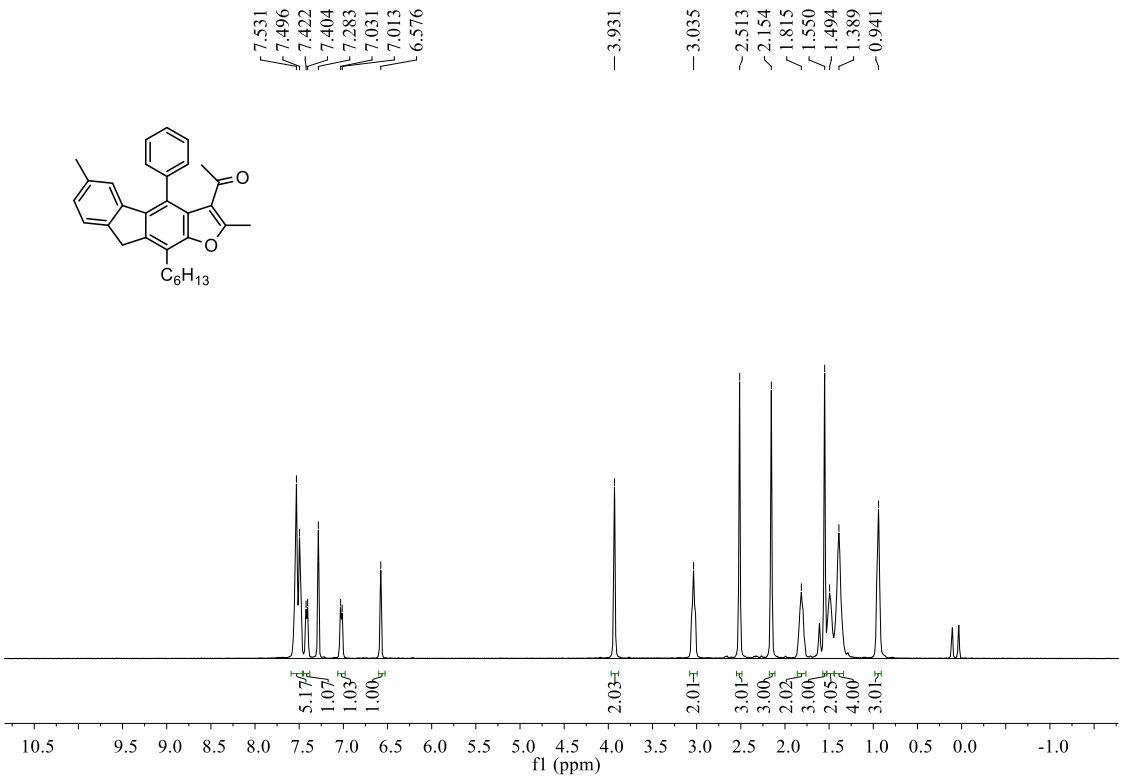
7.477
7.457
7.440
7.285
7.266
7.248
7.229
7.116
7.098
7.079
7.027
7.007
4.017
3.112
3.094
3.074
2.567
1.900
1.881
1.863
1.631
1.559
1.458
1.450
1.017
0.999
O
O
C6H13
4.02
5.06
1.01
1.01
1.01
1.00
2.00
2.00
3.00
2.07
3.00
2.01
4.01
3.02
10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
199.421
156.587
151.773
143.683
142.043
140.813
140.429
139.614
138.475
134.822
130.737
128.973
127.685
127.105
126.679
126.391
125.975
124.982
124.809
122.779
122.009
121.310
35.239
31.832
30.769
29.613
29.293
27.649
22.749
14.220
13.498
O
O
C6H13
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

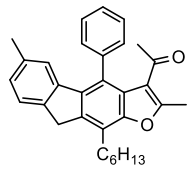
3bl

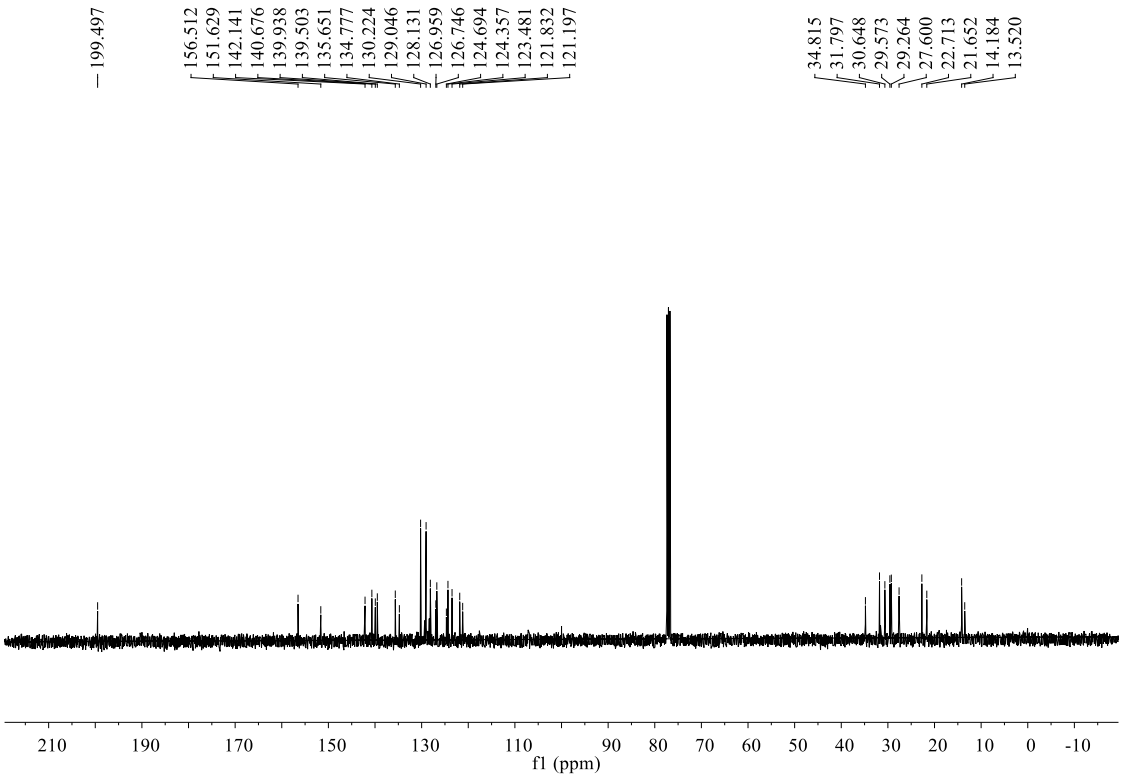

7.558
7.461
7.363
7.309
7.285
6.851
3.906
3.024
2.518
1.805
1.789
1.553
1.491
1.385
0.940
Br
O
O
C6H13
3.01
2.01
1.01
1.07
0.99
2.00
2.01
3.03
2.04
3.01
2.00
4.01
3.03
10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


199.201
156.913
151.937
144.127
142.229
139.664
138.769
133.638
129.947
129.286
128.519
127.467
125.943
125.802
124.924
121.987
121.128
120.340
34.820
31.758
30.651
29.558
29.204
27.578
22.691
14.170
13.539
Br
O
O
C6H13
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

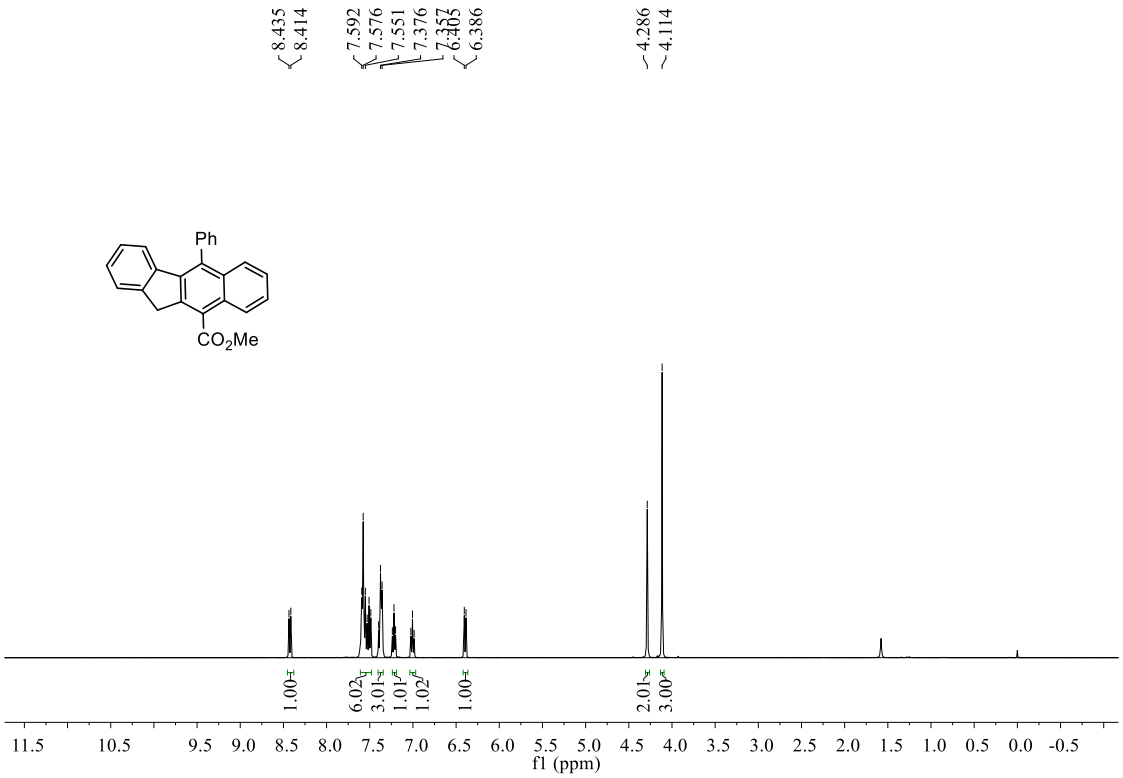
3bm

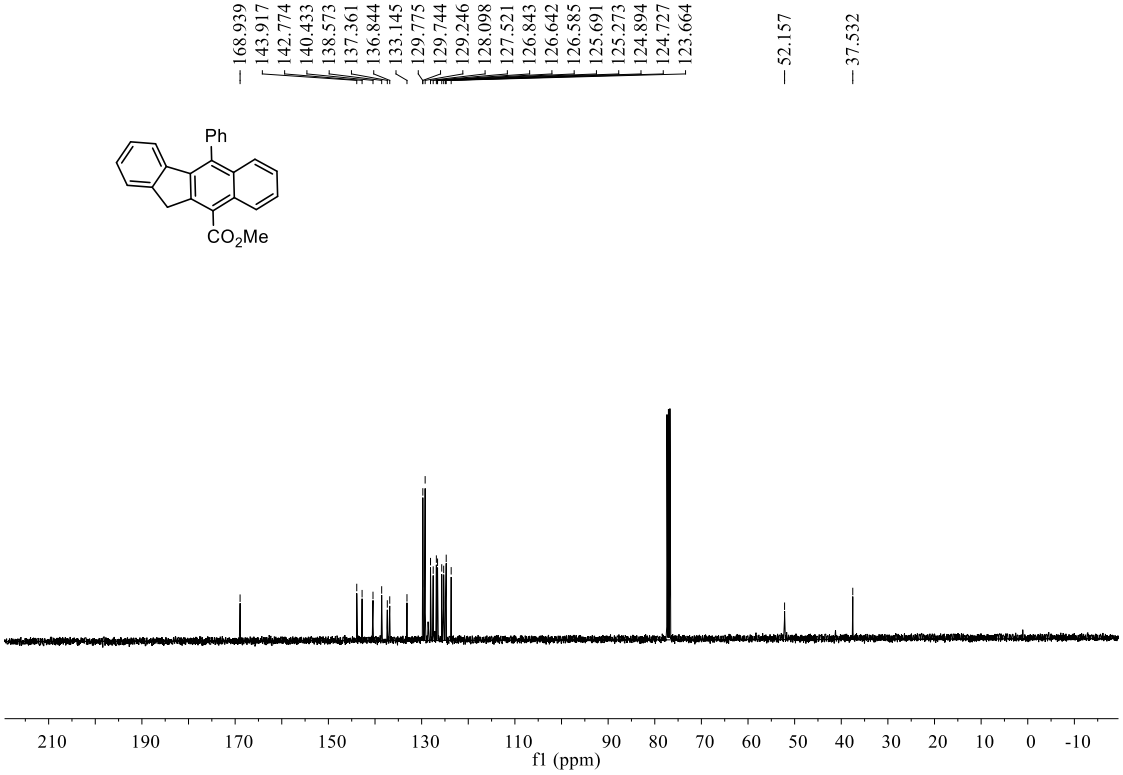

7.531
7.496
7.422
7.404
7.283
7.031
7.013
6.576
3.931
3.035
2.513
2.154
1.815
1.550
1.494
1.389
0.941
O
O
C6H13
5.17
1.07
1.03
1.00
2.03
2.01
3.01
3.00
2.02
3.00
2.05
4.00
3.01
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-1.0
f1 (ppm)


O
O
C6H13

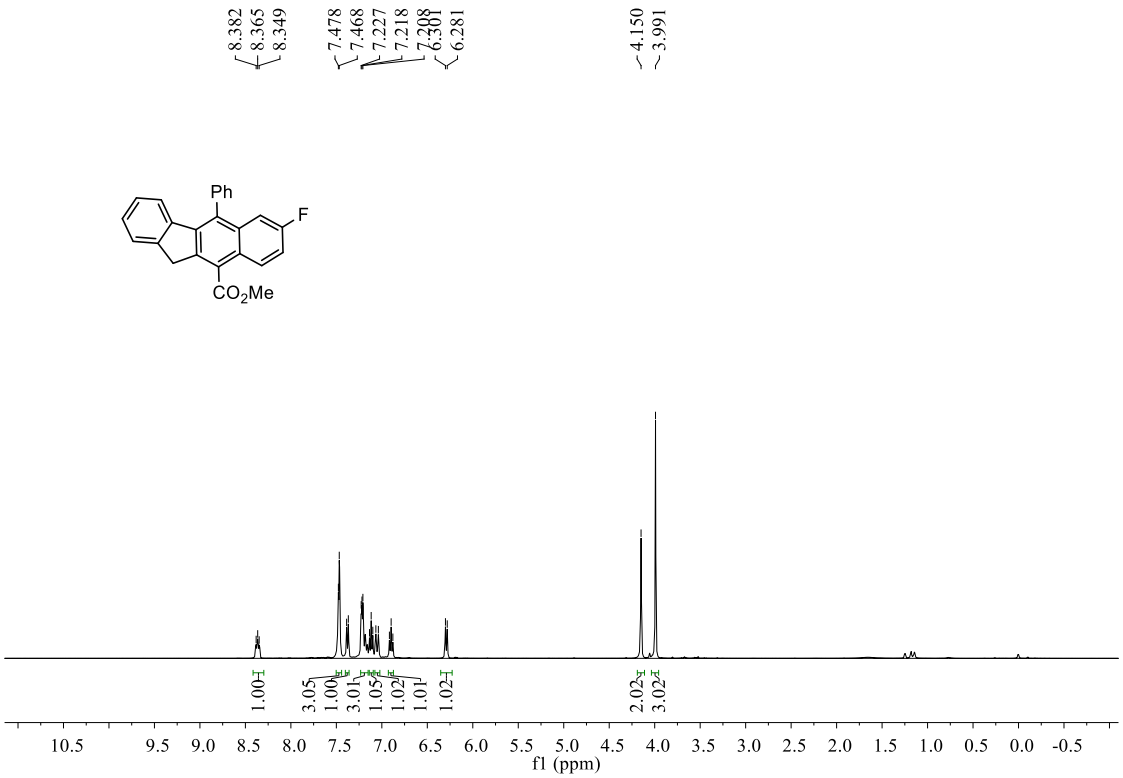

199.497
156.512
151.629
142.141
140.676
139.938
139.503
135.651
134.777
130.224
129.046
128.131
126.959
126.746
124.694
124.357
123.481
121.832
121.197
34.815
31.797
30.648
29.573
29.264
27.600
22.713
21.652
14.184
13.520
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

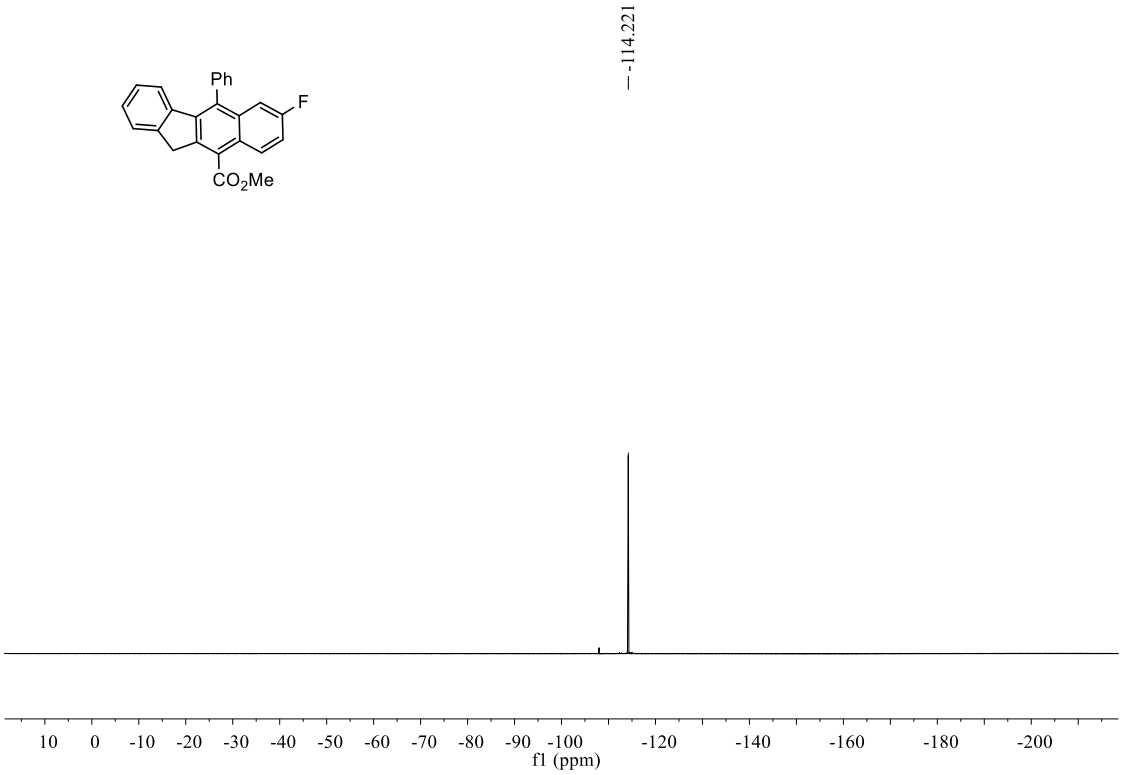
6a

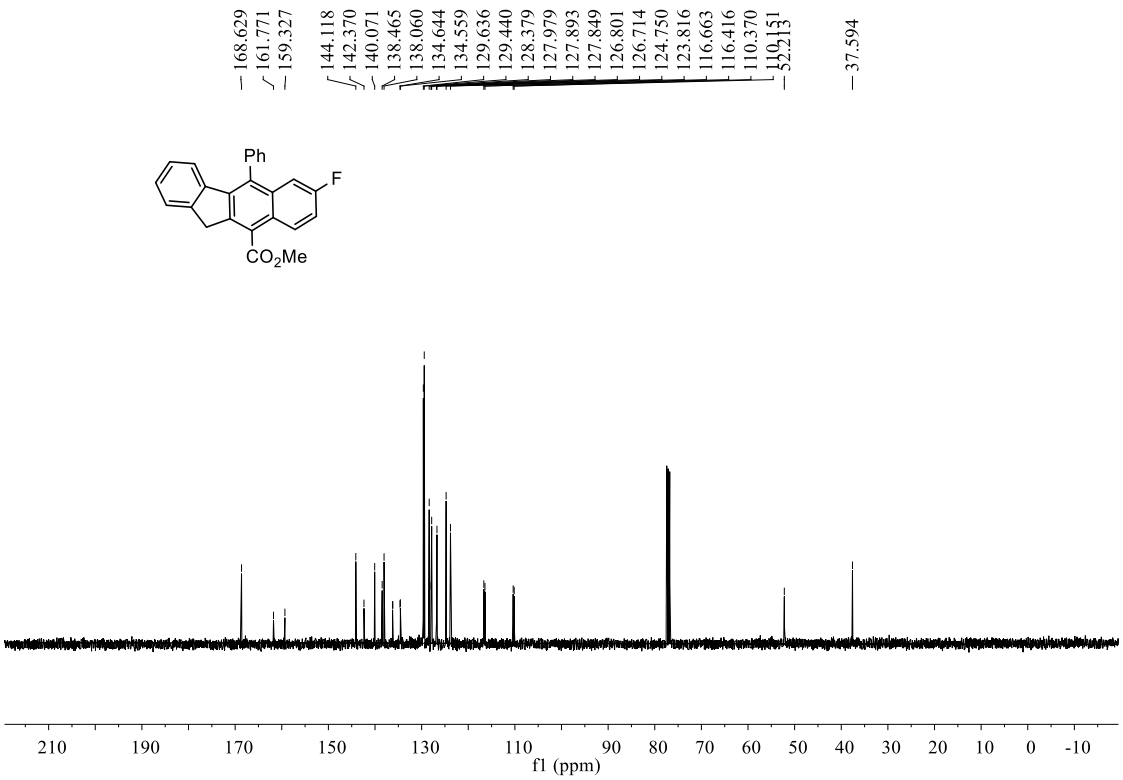

8.435
8.414
7.592
7.576
7.551
7.376
7.357
7.405
6.386
4.286
4.114
Ph
CO2Me
1.00
6.02
3.01
1.01
1.02
1.00
2.01
3.00
11.5 10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


168.939
143.917
142.774
140.433
138.573
137.361
136.844
133.145
129.775
129.744
129.246
128.098
127.521
126.843
126.642
126.585
125.691
125.273
124.894
124.727
123.664
52.157
37.532
Ph
CO2Me
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

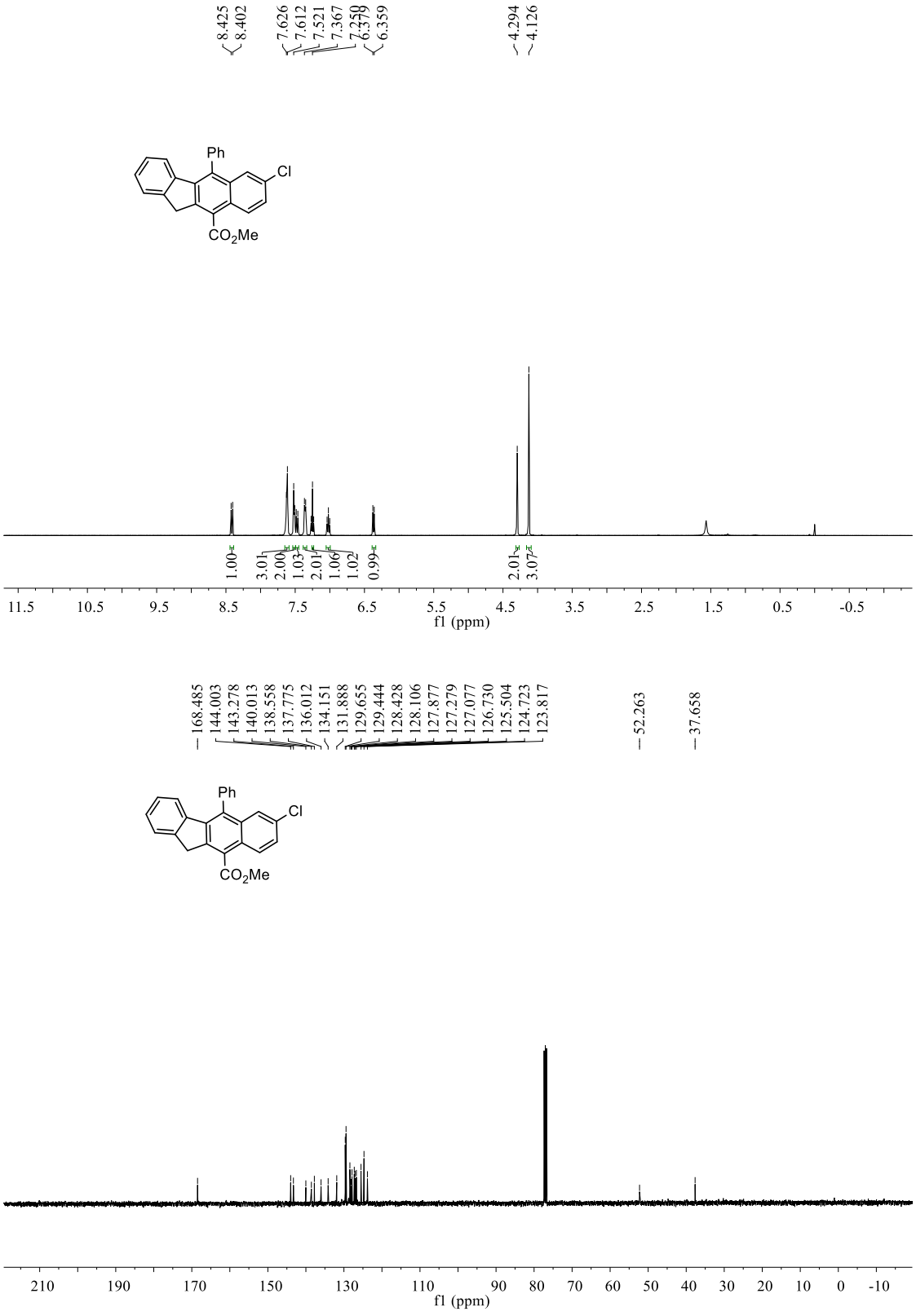
6b


8.382
8.365
8.349
7.478
7.468
7.227
7.218
7.208
6.301
6.281
4.150
3.991
Ph
F
CO2Me
1.00
3.05
1.00
3.01
1.05
1.02
1.01
1.02
2.02
3.02
10.5 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 -0.5
f1 (ppm)

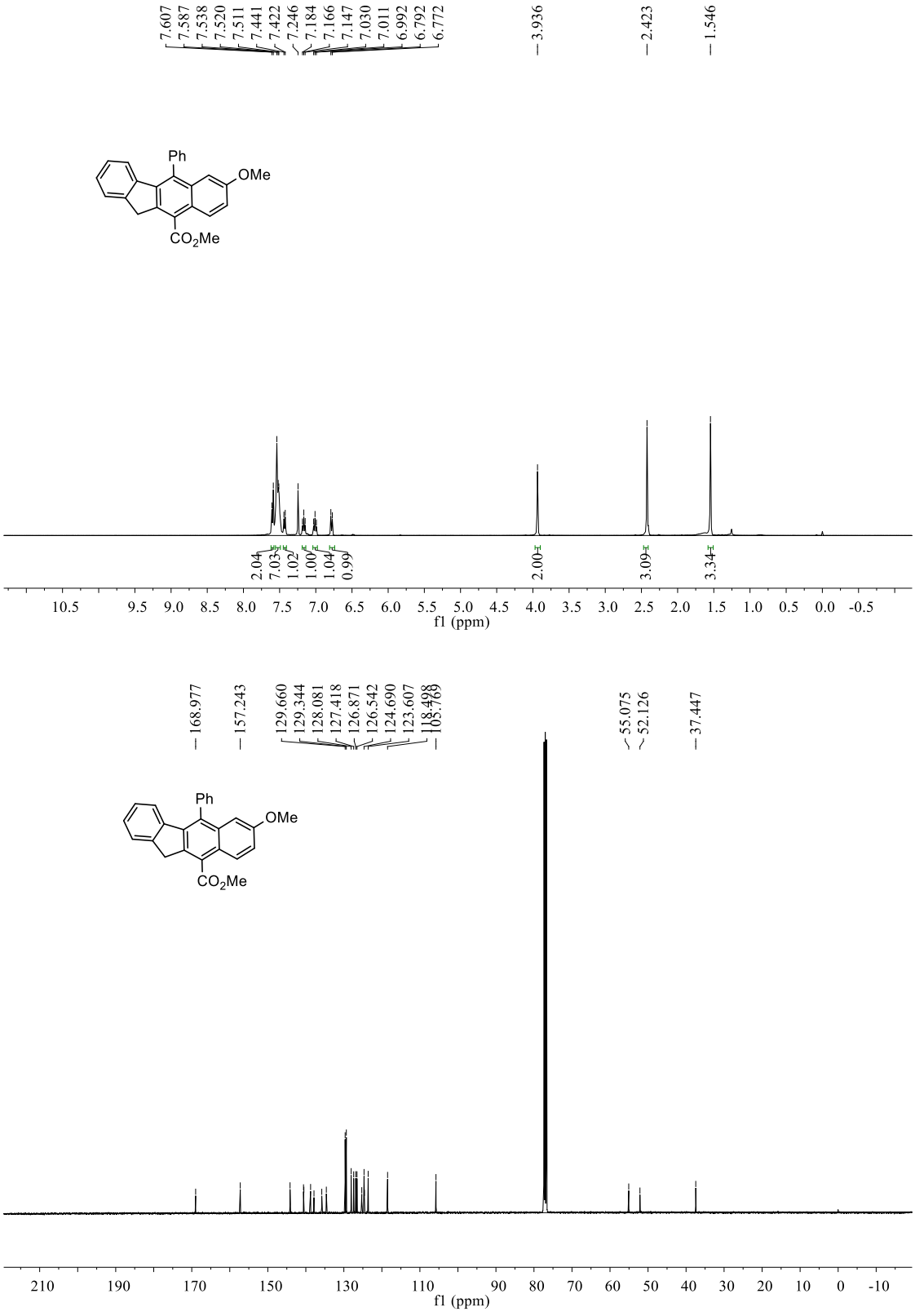

-114.221
Ph
F
CO2Me
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)


168.629
161.771
159.327
144.118
142.370
140.071
138.465
138.060
134.644
134.559
129.636
129.440
128.379
127.979
127.893
127.849
126.801
126.714
124.750
123.816
116.663
116.416
110.370
110.151
52.213
37.594
Ph
F
CO2Me
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

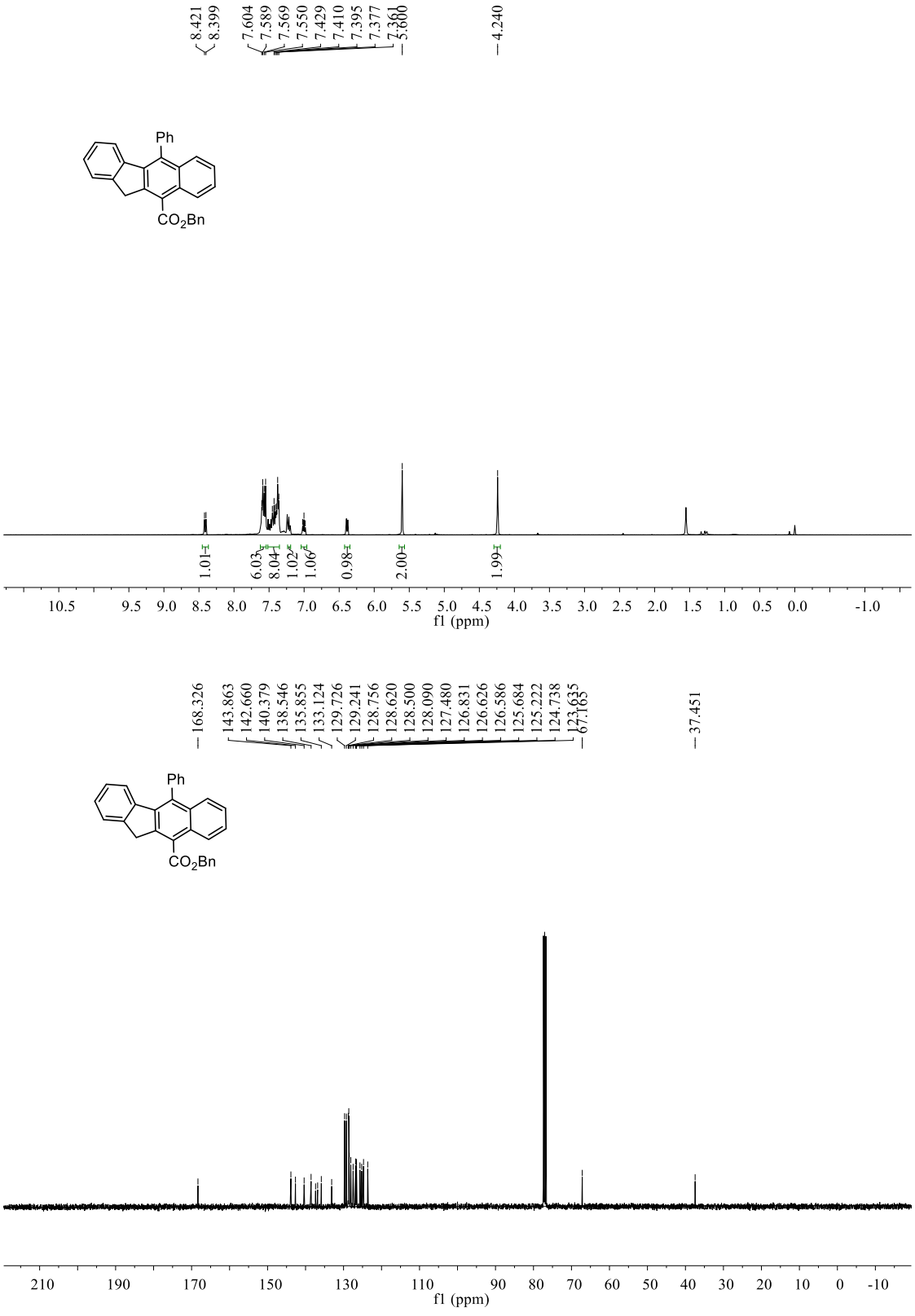
6c


8.425
8.402
7.626
7.612
7.521
7.367
7.250
6.379
6.359
4.294
4.126
Ph
Cl
CO2Me
1.00
3.01
2.00
1.03
2.01
1.06
1.02
0.99
2.01
3.07
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)
168.485
144.003
143.278
140.013
138.558
137.775
136.012
134.151
131.888
129.655
129.444
128.428
128.106
127.877
127.279
127.077
126.730
125.504
124.723
123.817
52.263
37.658
Ph
Cl
CO2Me
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

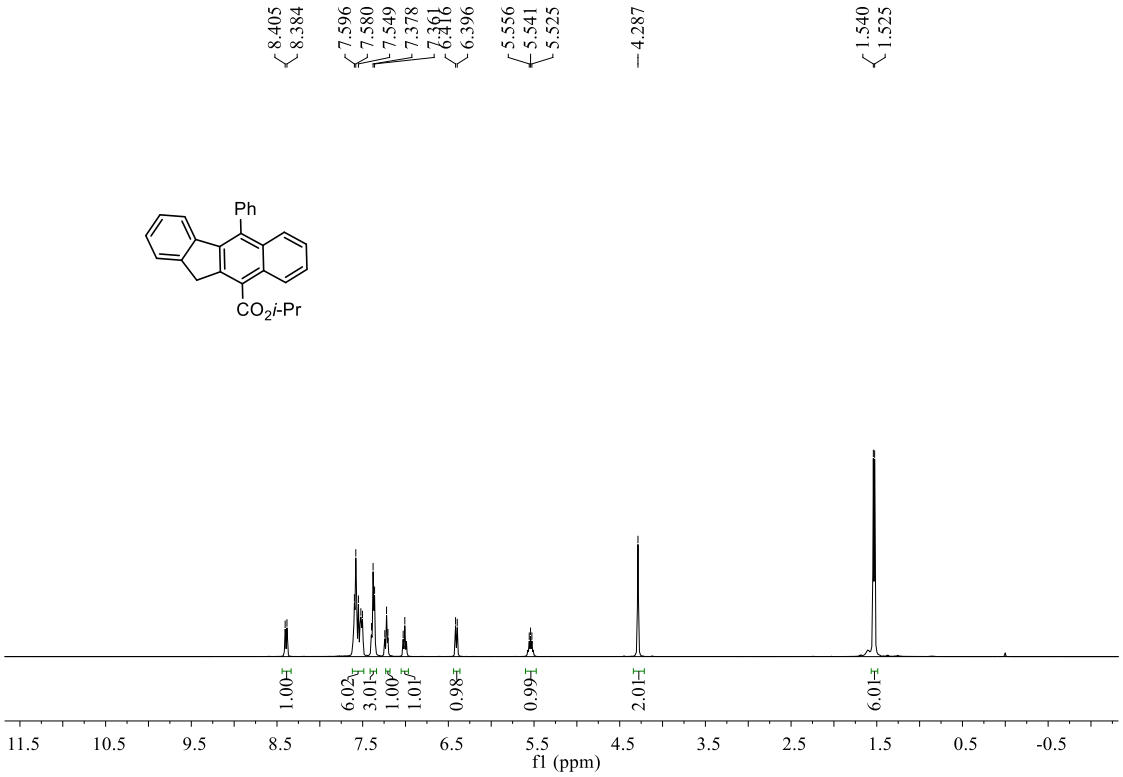
6d

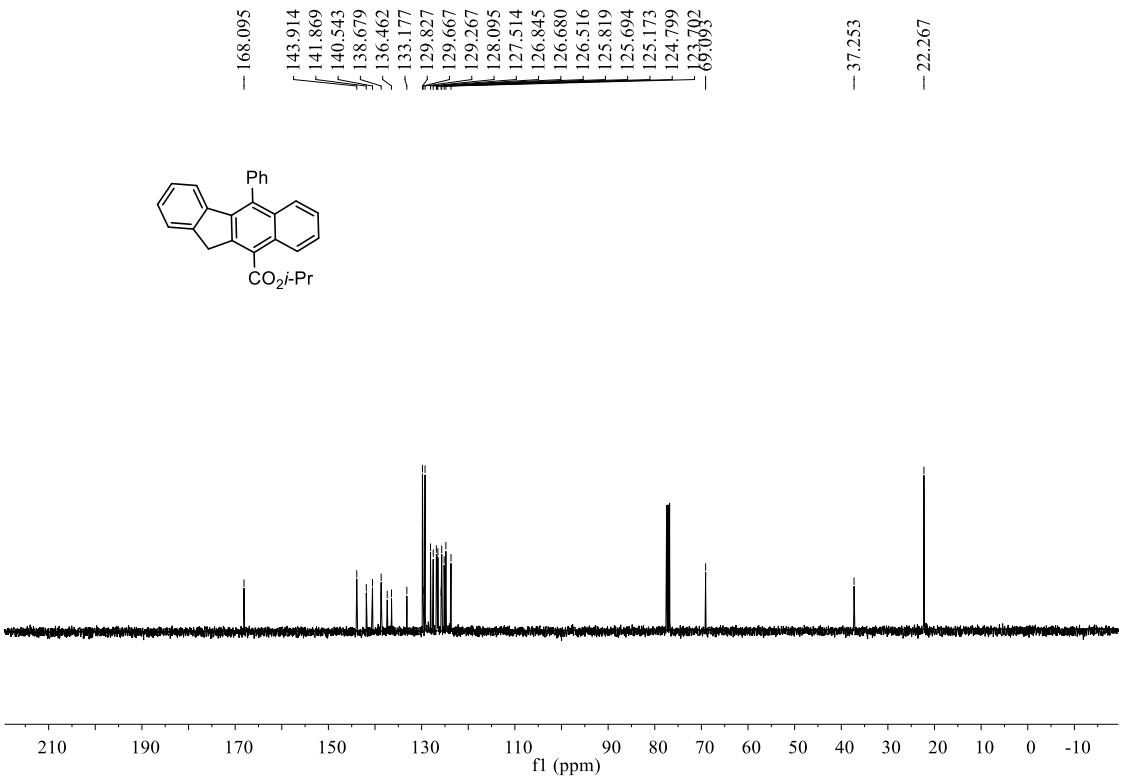

7.607
7.587
7.538
7.520
7.511
7.441
7.422
7.246
7.184
7.166
7.147
7.030
7.011
6.992
6.792
6.772
3.936
2.423
1.546
Ph
OMe
CO2Me
2.04
7.03
1.02
1.00
1.04
0.99
2.00
3.09
3.34
f1 (ppm)
168.977
157.243
129.660
129.344
128.081
127.418
126.871
126.542
124.690
123.607
118.498
105.769
55.075
52.126
37.447
f1 (ppm)

6e

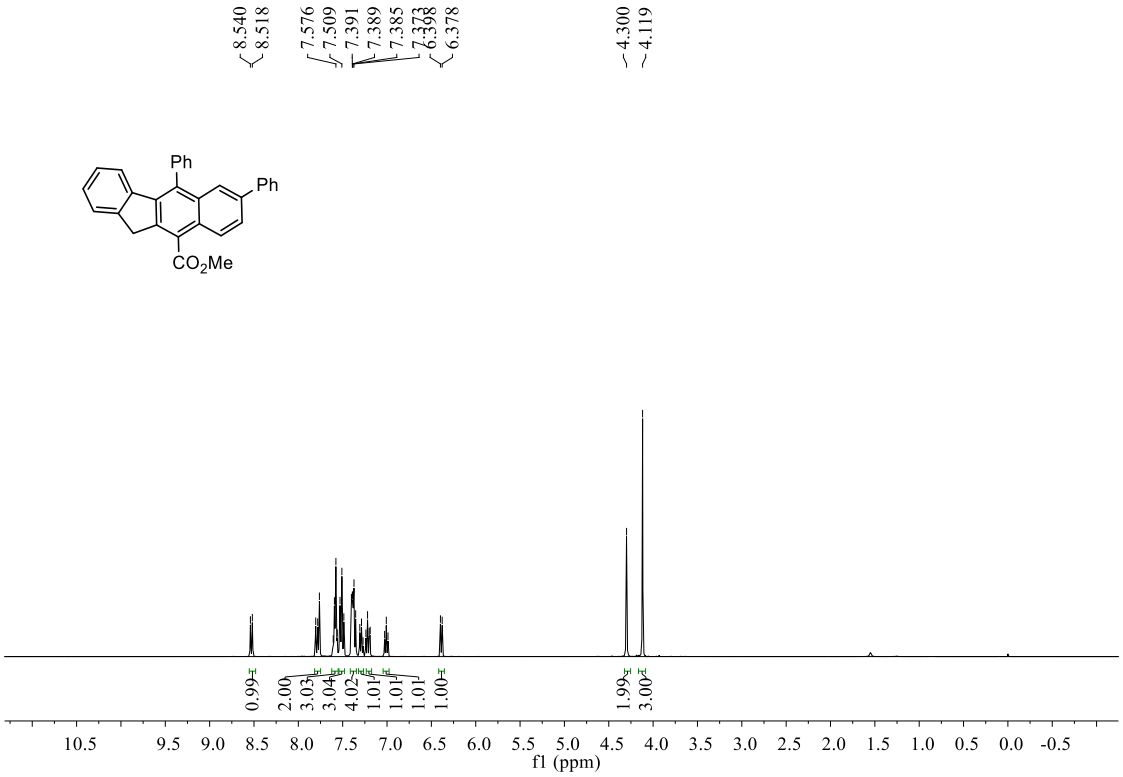

8.421
8.399
7.604
7.589
7.569
7.550
7.429
7.410
7.395
7.377
5.600
4.240
Ph
CO2Bn
1.01
6.03
8.04
1.02
1.06
0.98
2.00
1.99
fl (ppm)
168.326
143.863
142.660
140.379
138.546
135.855
133.124
129.726
129.241
128.756
128.620
128.500
128.090
127.480
126.831
126.626
126.586
125.684
125.222
124.738
123.635
67.163
37.451
Ph
CO2Bn
fl (ppm)

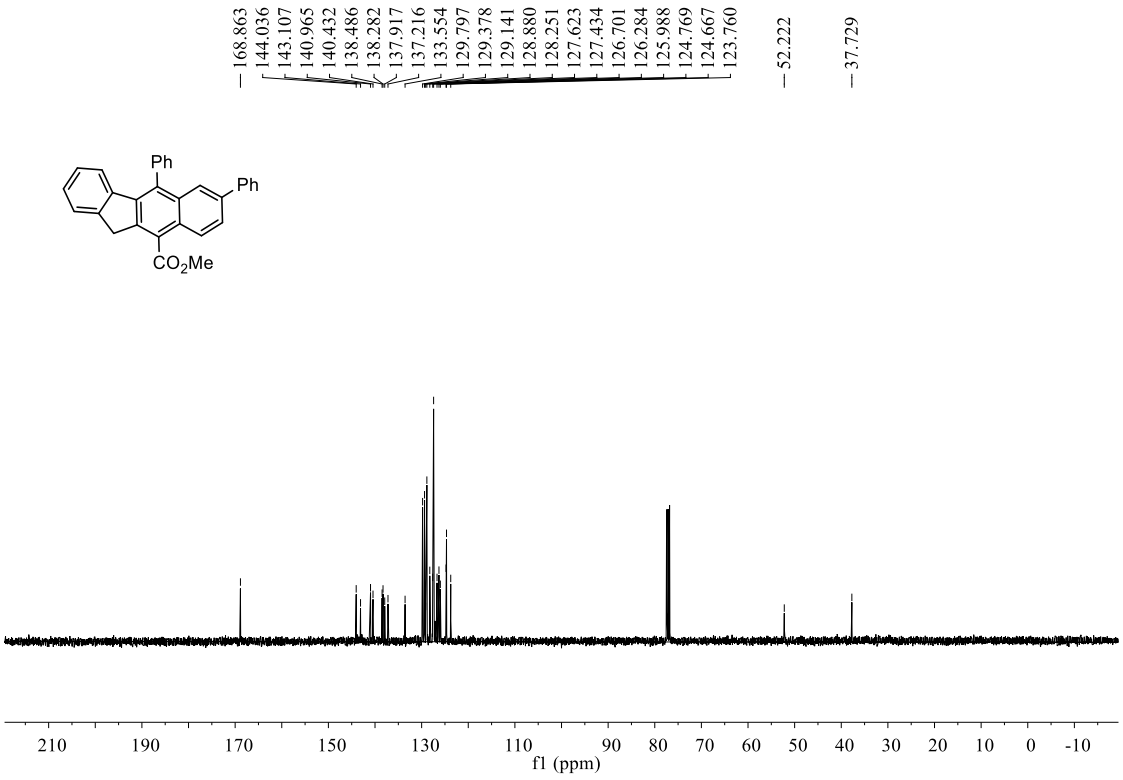
6f


8.405
8.384
7.596
7.580
7.549
7.378
7.361
6.416
6.396
5.556
5.541
5.525
4.287
1.540
1.525
Ph
CO2i-Pr
1.00
6.02
3.01
1.00
1.01
0.98
0.99
2.01
6.01
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

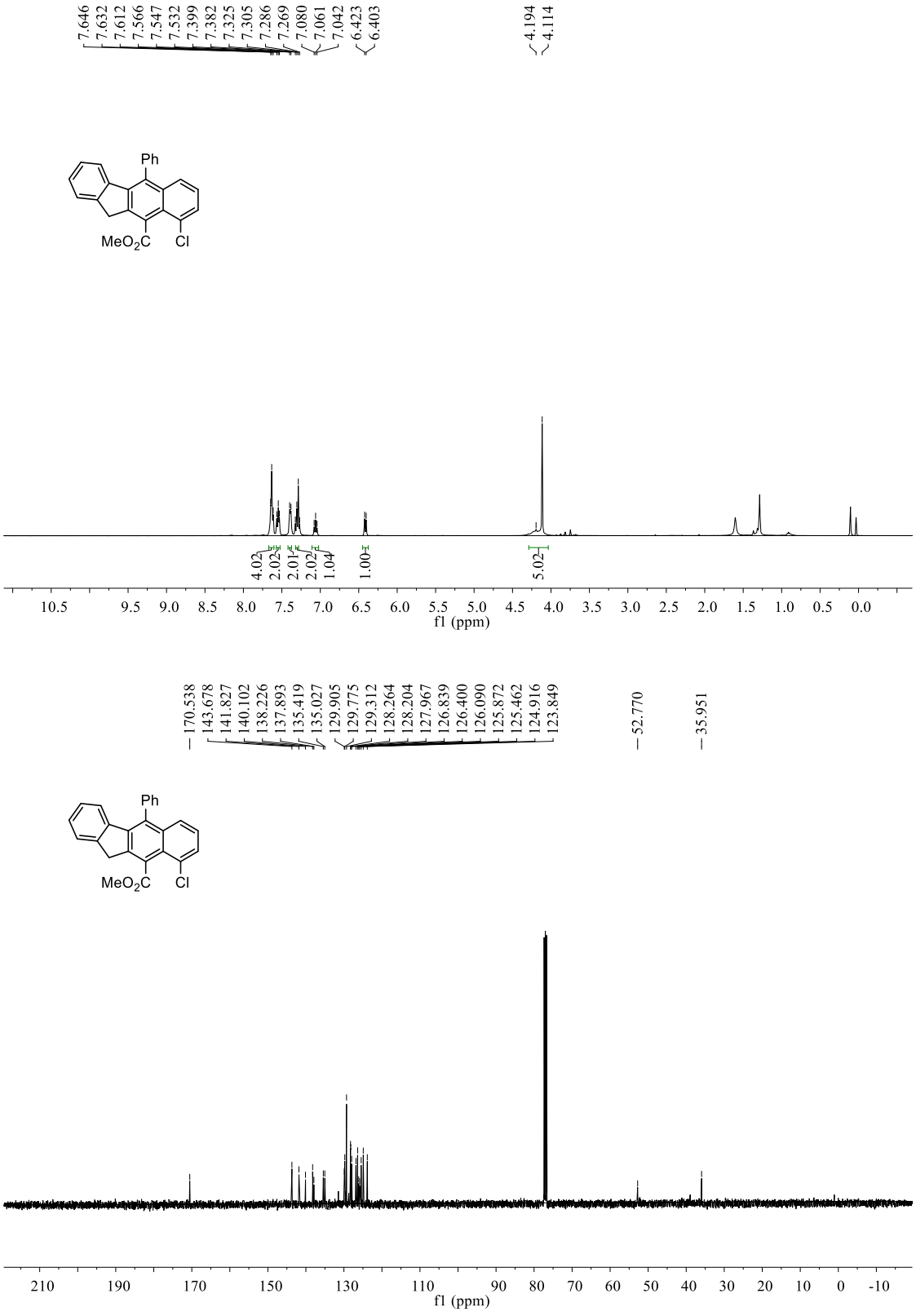

168.095
143.914
141.869
140.543
138.679
136.462
133.177
129.827
129.667
129.267
128.095
127.514
126.845
126.680
126.516
125.819
125.694
125.173
124.799
123.702
69.093
37.253
22.267
Ph
CO2i-Pr
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

6g

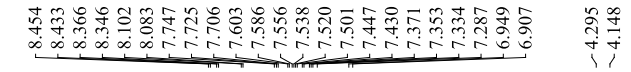

8.540
8.518
7.576
7.509
7.391
7.389
7.385
7.373
7.368
6.378
4.300
4.119
Ph
Ph
CO2Me
0.99
2.00
3.03
3.04
4.02
1.01
1.01
1.01
1.00
1.99
3.00
10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

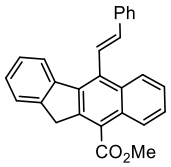

168.863
144.036
143.107
140.965
140.432
138.486
138.282
137.917
137.216
133.554
129.797
129.378
129.141
128.880
128.251
127.623
127.434
126.701
126.284
125.988
124.769
124.667
123.760
52.222
37.729
Ph
Ph
CO2Me
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

6h

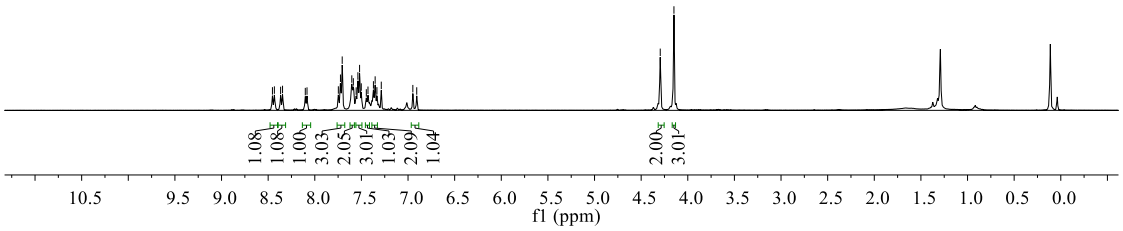

7.646
7.632
7.612
7.566
7.547
7.532
7.399
7.382
7.325
7.305
7.286
7.269
7.080
7.061
7.042
6.423
6.403
4.194
4.114
Ph
MeO2C
Cl
4.02
2.02
2.01
2.02
1.04
1.00
5.02
fl (ppm)
170.538
143.678
141.827
140.102
138.226
137.893
135.419
135.027
129.905
129.775
129.312
128.264
128.204
127.967
126.839
126.400
126.090
125.872
125.462
124.916
123.849
52.770
35.951
fl (ppm)

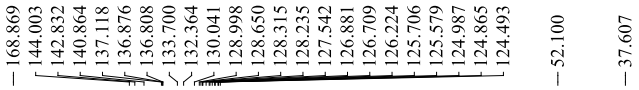
6i (*E* major)

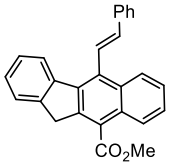




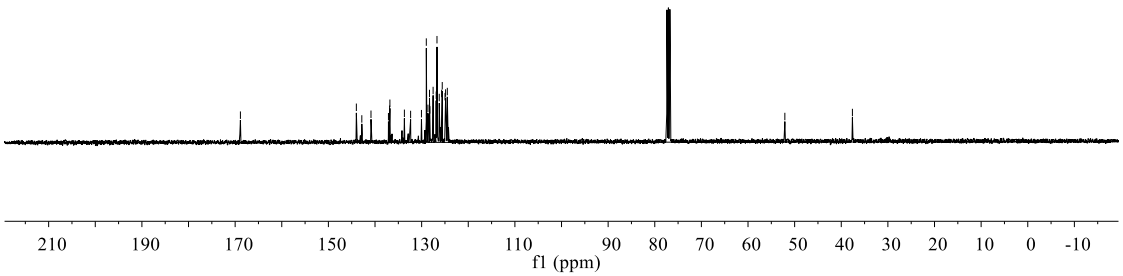
E major



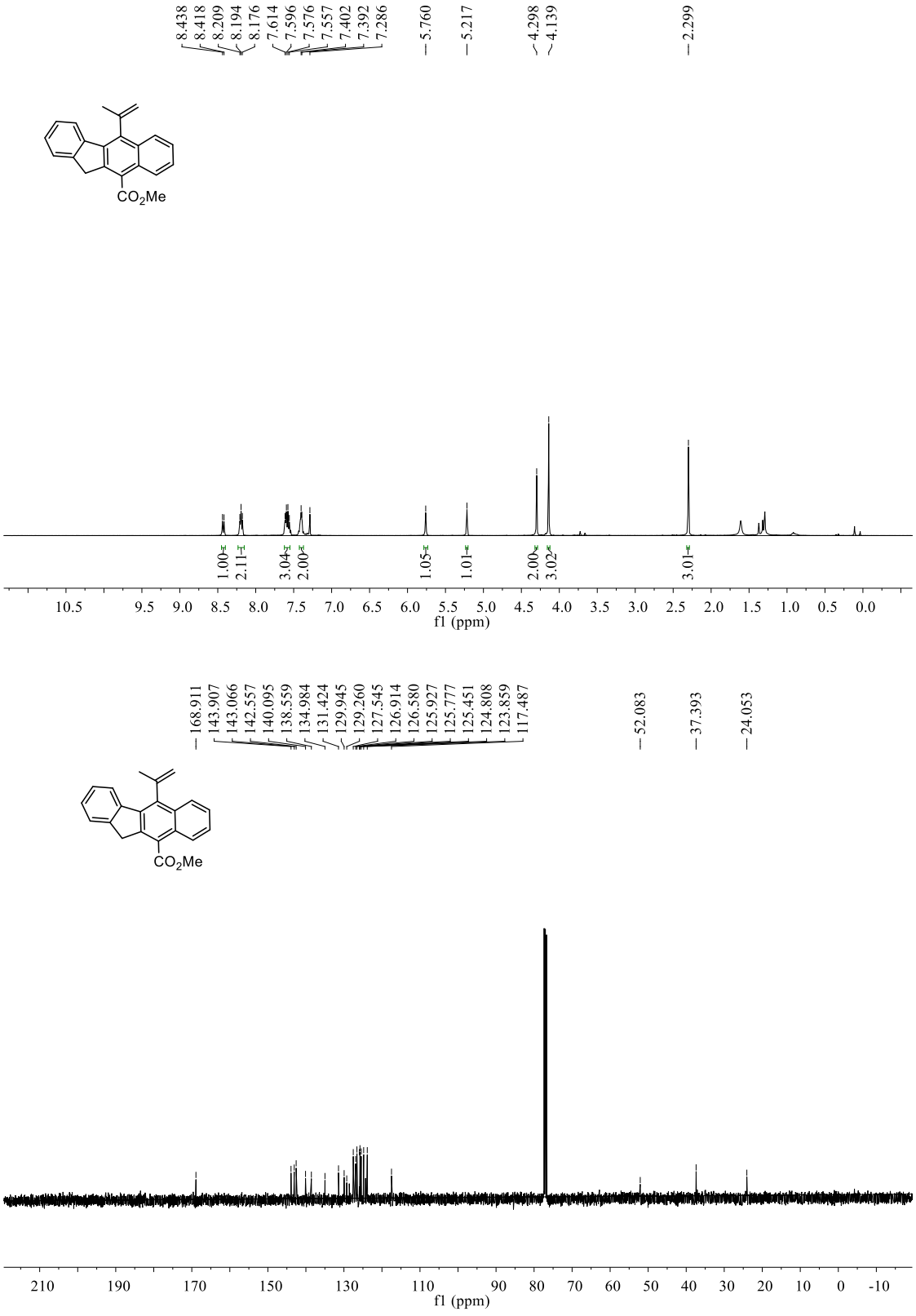


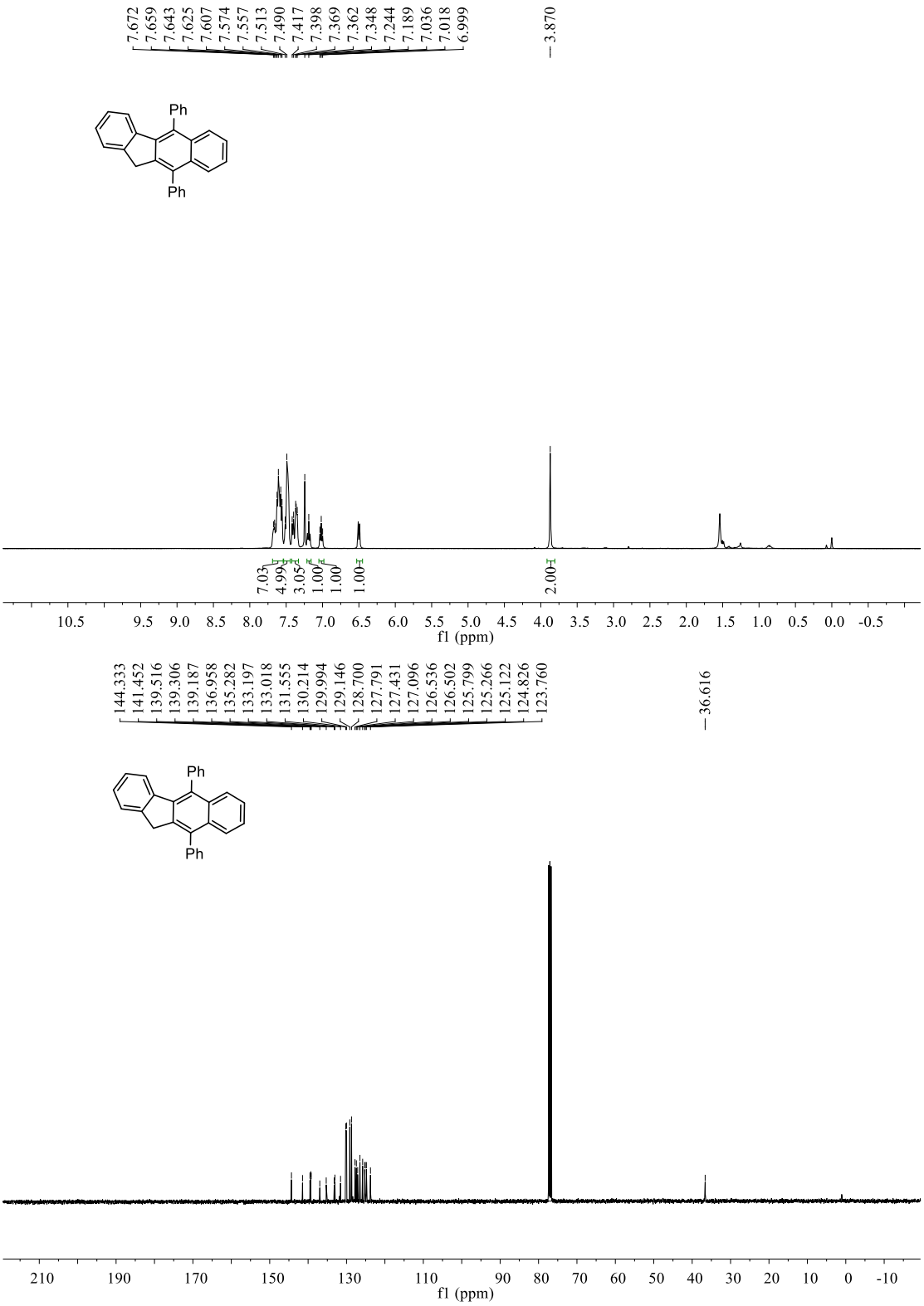


E major



6j


8.438
8.418
8.209
8.194
8.176
7.614
7.596
7.576
7.557
7.402
7.392
7.286
5.760
5.217
4.298
4.139
2.299
CO2Me
1.00
2.11
3.04
2.00
1.05
1.01
2.00
3.02
3.01
10.5 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)
168.911
143.907
143.066
142.557
140.095
138.559
134.984
131.424
129.945
129.260
127.545
126.914
126.580
125.927
125.777
125.451
124.808
123.859
117.487
52.083
37.393
24.053
CO2Me
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.672
7.659
7.643
7.625
7.607
7.574
7.557
7.513
7.490
7.417
7.398
7.369
7.362
7.348
7.244
7.189
7.036
7.018
6.999
3.870
Ph
Ph
7.03
4.99
3.05
1.00
1.00
1.00
2.00
f1 (ppm)
144.333
141.452
139.516
139.306
139.187
136.958
135.282
133.197
133.018
131.555
130.214
129.994
129.146
128.700
127.791
127.431
127.096
126.536
126.502
125.799
125.266
125.122
124.826
123.760
36.616
Ph
Ph
f1 (ppm)