Supporting Information

Ni-catalyzed regioselective hydrobenzylation of alkenes to afford C(sp^3)-C(sp^3) bonds using BH_3 as reductant

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I. Experimental Section

Part 1. General Information

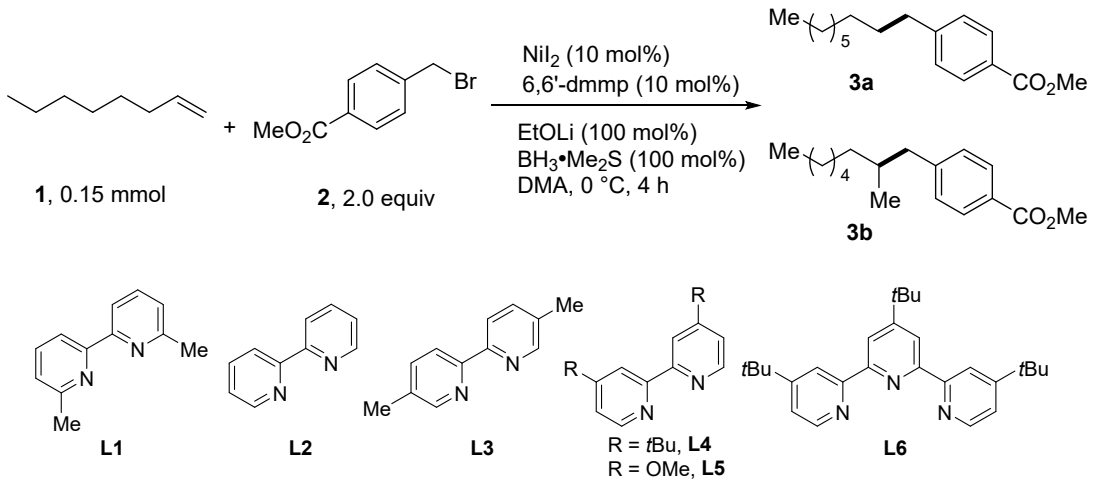
1. Chemical and Reagents

Unless otherwise mentioned, all reactions were performed under an atmosphere of nitrogen using anhydrous solvents in flame-dried tubes. Extra dry DMA, CH_3CN, Propylenecarbonate (99%, with molecular sieves, water ≤ 50 ppm (by K.F.)) was purchased from Energy Chemical, China. Deuterated solvents were used as received ($CDCl_3$ from J&K Co., China). Unless otherwise noted, all other reagents and starting materials were purchased from commercial sources and used without further purification.

2. Physical Method

Column chromatography was performed using silica gel 200-300 mesh (purchased from Qingdao-Haiyang Co., China) as the solid support. All NMR spectra were recorded on JNM-ECZ400s/L or a Bruker Avance 600 MHz spectrometer at STP. NMR spectra are internally referenced to residual proton solvent signals (note: $CDCl_3$ referenced at 7.26 for ^1H NMR and 77.0 ppm for ^{13}C NMR). Data for ^1H NMR spectra are reported as follows: chemical shift (δ ppm), multiplicity, coupling constant (Hz) and integration. ^{13}C NMR spectra were recorded at 151 MHz or 101 MHz. Coupling constants were reported in Hz, and multiplicity was indicated as follows: s (singlet); d (doublet); t (triplet); q (quartet); quint (quintet); m (multiplet); dd (doublet of doublets); br (broad). High-resolution mass spectra (HRMS) were obtained using Thermo Fisher Scientific Ultimate 3000-Q Exactive Focus Quadrupole-Orbitrap and Thermo Fisher Scientific LTQ FTICR-MS. Melting point was recorded on a micro melting point apparatus (X-4, YUHUA Co., Ltd, Gongyi, China)

Part 2. Optimization of the reaction conditions



Entry	Cat.(10 mol%)	Ligand (10 mol%)	Base (100mol%)	Solvent (2.5 mL)	T °C	Yield (3a/3b)[a]
1	NiI_2	**L1**	EtOLi	DMA	0	80%[78%][b](8/1)
2	$NiBr_2$	**L1**	EtOLi	DMA	0	56%(4/1)
3	$NiCl_2$	**L1**	EtOLi	DMA	0	59%(4/1)
4	$Ni(COD)_2$	**L1**	EtOLi	DMA	0	67%(5/1)
5	$NiBr_2$•DME	**L1**	EtOLi	DMA	0	80%(3/1)
6	$Ni(acac)_2$	**L1**	EtOLi	DMA	0	32%(2/1)
7	NiI_2	**L2**	EtOLi	DMA	0	28%(3/1)
8	NiI_2	**L3**	EtOLi	DMA	0	39%(2/1)
9	NiI_2	**L4**	EtOLi	DMA	0	44%(1.2/1)
10	NiI_2	**L5**	EtOLi	DMA	0	43%(1.5/1)
11	NiI_2	**L6**	EtOLi	DMA	0	trace
12	NiI_2	**L1**	EtOLi	DMF	0	67%(4/1)
13	NiI_2	**L1**	EtOLi	DCE	0	trace
14	NiI_2	**L1**	EtOLi	DME	0	trace
15	NiI_2	**L1**	EtOLi	DMSO	0	16%(7/1)
16	NiI_2	**L1**	EtOLi	CH_3CN	0	76%(1.2/1)
17	NiI_2	**L1**	EtOLi	THF	0	trace
18	NiI_2	**L1**	EtOLi	Toluene	0	trace
19	NiI_2	**L1**	MeOLi	DMA	0	76%(8/1)
20	NiI_2	**L1**	MeONa	DMA	0	29%(5/1)
21	NiI_2	**L1**	NaF	DMA	0	15%(10/1)
22	NiI_2	**L1**	KF	DMA	0	35%(10/1)
23	NiI_2	**L1**	CsF	DMA	0	trace
24	NiI_2	**L1**	Na_2CO_3	DMA	0	53%(8/1)
25	NiI_2	**L1**	*t*BuOK	DMA	0	35%(3/1)
26	NiI_2	**L1**	*t*BuOLi	DMA	0	50%(5/1)
27	NiI_2	**L1**	EtOLi	DMA(2 mL)	0	78%(8/1)
28	NiI_2	**L1**	EtOLi	DMA (3 mL)	0	73%(8/1)
29	NiI_2	**L1**	EtOLi	DMA	−10	80%(7/1)
30	NiI_2	**L1**	EtOLi	DMA	10	74%(6.5/1)

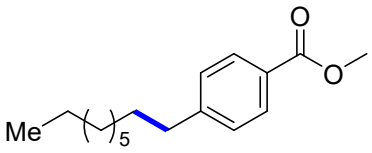
[a] NMR yields， [b] Isolated yield.

Part 3. Experimental Procedures and Characterization Data

General procedure: To an oven-dried Schlenk tube (10 mL) were charged with methyl 4-

(bromomethyl)benzoate (**2**, 0.3 mmol, 200 mol%), **L1** (0.015 mmol, 10 mol%), EtOLi (0.15 mmol, 100 mol%) and NiI_2 (0.015 mmol, 10 mol%). After the mixture was evacuated and backfilled nitrogen three times, oct-1-ene (**1**, 0.15 mmol, 100 mol%), DMA (2.5 mL) and BH_3•SMe_2 (0.15 mmol, 100 mol%, Note: added last.). The reaction mixture was allowed to stir for ~4 h under a N_2 atmosphere at 0 °C, and was directly loaded onto a silica column without work-up. The residue was rinsed with small amount of DCM or the eluent, and the mixture was loaded onto the same silica column. Flash column chromatography afforded the product containing **3a** and **3b** as a colorless liquid (30.6 mg, 78% yield, **L/B** = 8:1). (Note: The ratio of **a** and **b** isomers were determined by ^{1}H NMR spectroscopic analysis of the characteristic peaks of the purified product after flash column chromatography.)

Methyl 4-nonylbenzoate (3)

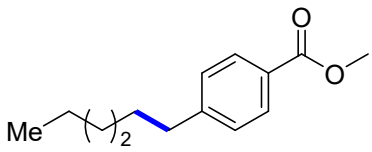


^{1}H NMR (600 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.2 Hz, 2H), 7.24 (d, *J* = 8.1 Hz, 2H), 3.90 (s, 3H), 2.66 - 2.63 (m, 2H), 1.64 - 1.54 (m, 2H), 1.34 - 1.25 (m, 12H), 0.87 (t, *J* = 7.0 Hz, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.2, 148.5, 129.6, 128.4, 127.6, 51.9, 36.0, 31.9, 31.1, 29.5, 29.4, 29.3, 29.2, 22.7, 14.1.

HRMS (ESI) m/z ($[M+H]^+$) calcd for $C_{17}H_{27}O_2^+$: 263.2006. Found: 263.2008.

Methyl 4-hexylbenzoate (4)



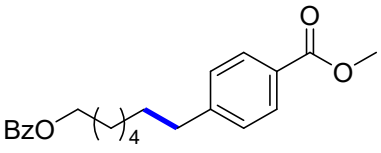
Following the general procedure: using pent-1-ene (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **4** as a colorless oil (17.5 mg, 53% yield, **L/B** = 8:1)

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.3 Hz, 2H), 7.24 (d, *J* = 8.4 Hz, 2H), 3.90 (s, 3H), 2.67 - 2.63 (m, 2H), 1.65 - 1.58 (m, 2H), 1.39 - 1.23 (m, 6H), 0.88 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 167.2, 148.5, 129.6, 128.4, 127.5, 51.9, 36.0, 31.6, 31.1, 28.9, 22.5, 14.0.

HRMS (DART) m/z ($[M+H]^+$) calcd for $C_{14}H_{21}O_2^+$: 221.1536. Found: 221.1537.

Methyl 4-(7-(benzoyloxy)heptyl)benzoate (5)



Following the general procedure: using hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **5** as a colorless oil (45.1 mg, 85% yield, **L/B** = 8:1)

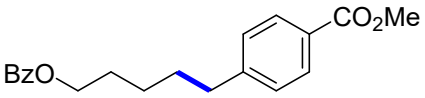
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.04 (d, *J* = 8.1 Hz, 2H), 7.94 (d, *J* = 8.1 Hz, 2H), 7.56 - 7.53 (m,

1H), 7.43 (t, *J* = 7.7 Hz, 2H), 7.23 (d, *J* = 8.0 Hz, 2H), 4.31 (t, *J* = 6.6 Hz, 2H), 3.90 (s, 3H), 2.65 (t, *J* = 7.7 Hz, 2H), 1.78 - 1.73 (m, 2H), 1.66 - 1.61 (m, 2H), 1.46 - 1.34 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.2, 166.7, 148.3, 132.8, 130.5, 129.6, 129.5, 128.4, 128.3, 127.6, 65.0, 51.9, 35.9, 31.0, 29.1, 29.0, 28.6, 25.9.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{22}H_{26}O_4Na^+$: 377.1723. Found: 377.1726.

Methyl 4-(5-(benzoyloxy)pentyl)benzoate (6)



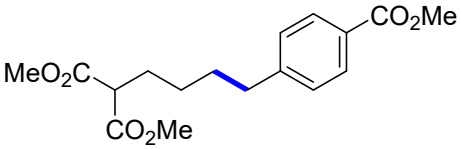
Following the general procedure: using but-3-en-1-yl benzoate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **6** as a colorless oil (40.0 mg, 82% yield, **L/B** = 1.7:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 – 7.98 (m, 2H), 7.98 – 7.92 (m, 2H), 7.58 – 7.52 (m, 1H), 7.46 – 7.39 (m, 2H), 7.24 (dd, *J* = 8.1, 5.7 Hz, 2H), 4.31 (t, *J* = 6.6 Hz, 2H), 3.90 (s, 3H), 2.69 (t, *J* = 7.7 Hz, 2H), 1.82 – 1.76 (m, 2H), 1.75 – 1.67 (m, 2H), 1.53 – 1.45 (m, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.1, 166.6, 147.9, 132.8, 130.4, 129.6, 129.5, 128.4, 128.3, 127.7, 64.8, 51.9, 35.7, 30.6, 28.5, 25.5.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{20}H_{22}O_4Na^+$: 349.1410. Found: 349.1408.

Dimethyl 2-(5-(4-(methoxycarbonyl)phenyl)pentyl)malonate (7)



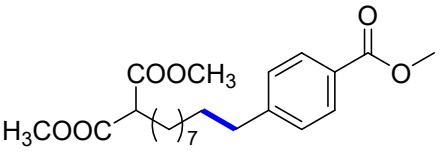
Following the general procedure: using dimethyl 2-allylmalonate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **7** as a colorless oil (25.6 mg, 53% yield, **L/B** = 1.7:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.2 Hz, 2H), 7.22 (d, *J* = 8.2 Hz, 2H), 3.89 (s, 3H), 3.72 (s, 6H), 3.34 (t, *J* = 7.5 Hz, 1H), 2.65 (t, *J* = 7.7 Hz, 2H), 1.96 – 1.89 (m, 2H), 1.69 – 1.61 (m, 2H), 1.39 – 1.30 (m, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 169.8, 167.1, 147.7, 129.7, 129.1, 128.4, 52.5, 51.9, 51.5, 35.5, 30.6, 28.6, 26.8.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{17}H_{22}O_6Na^+$: 345.1309. Found: 345.1302.

Dimethyl 2-(9-(4-(methoxycarbonyl)phenyl)nonyl)malonate (8)



Following the general procedure: using dimethyl 2-(oct-7-en-1-yl)malonate (0.15 mmol, 100 mol%) and methyl 4-

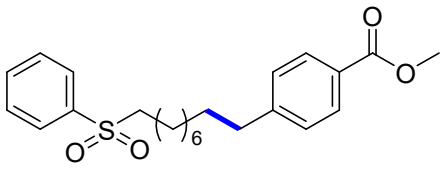
(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **8** as a colorless oil (50.0 mg, 85% yield, **L/B** = 9.6:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.2 Hz, 2H), 7.23 (d, *J* = 8.2 Hz, 2H), 3.89 (s, 3H), 3.72 (s, 6H), 3.34 (t, *J* = 7.6 Hz, 1H), 2.65 - 2.62 (m, 2H), 1.90 - 1.86 (m, 2H), 1.63 - 1.58 (m, 2H), 1.28 - 1.25 (m, 12H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 169.9, 167.2, 148.4, 129.6, 128.4, 127.6, 52.4, 51.9, 51.7, 35.9, 31.1, 29.3, 29.19, 29.15, 29.1, 28.8, 27.3.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{22}H_{32}O_6Na^+$: 415.2091. Found: 415.2087.

Methyl 4-(9-(phenylsulfonyl)nonyl)benzoate (9)



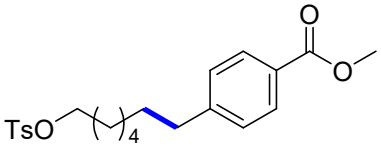
Following the general procedure: using (oct-7-en-1-ylsulfonyl)benzene (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **9** as a colorless oil (52.4 mg, 87% yield, **L/B** = 12.5:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.2 Hz, 2H), 7.90 - 7.89 (m, 2H), 7.64 (t, *J* = 7.4 Hz, 1H), 7.55 (t, *J* = 7.7 Hz, 2H), 7.21 (d, *J* = 8.2 Hz, 2H), 3.88 (s, 3H), 3.07 - 3.05 (m, 2H), 2.63 - 2.61 (m, 2H), 1.71 - 1.75 (m, 4H), 1.33 - 1.22 (m, 10H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.1, 148.3, 139.1, 133.5, 129.5, 129.2, 128.3, 128.0, 127.6, 56.2, 51.9, 35.9, 31.0, 29.2, 29.0, 28.9, 28.1, 22.5.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{23}H_{30}O_4SNa^+$: 425.1757. Found: 425.1744.

Methyl 4-(7-(tosyloxy)heptyl)benzoate (10)



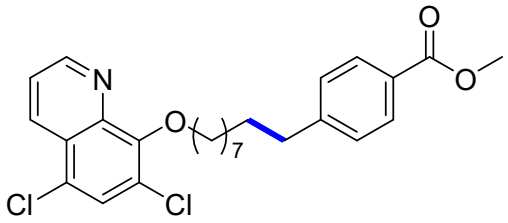
Following the general procedure: using hex-5-en-1-yl 4-methylbenzenesulfonate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **10** as a colorless oil (31.5 mg, 52% yield, **L/B** = 8.5:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.2 Hz, 2H), 7.78 (d, *J* = 8.3 Hz, 2H), 7.33 (d, *J* = 8.1 Hz, 2H), 7.21 (d, *J* = 8.2 Hz, 2H), 4.00 (t, *J* = 6.5 Hz, 2H), 3.89 (s, 3H), 2.63 - 2.61 (m, 2H), 2.43 (s, 3H), 1.64 - 1.55 (m, 4H), 1.31 - 1.23 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.2, 148.2, 144.6, 133.2, 129.8, 129.6, 128.4, 127.8, 70.5, 51.9, 35.8, 30.9, 28.9, 28.73, 28.68, 25.2, 21.6.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{22}H_{28}O_5SNa^+$: 427.1550. Found: 427.1540.

Methyl 4-(9-((5,7-dichloroquinolin-8-yl)oxy)nonyl)benzoate (11)



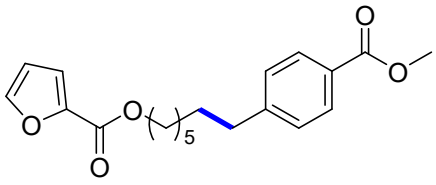
Following the general procedure: using 5,7-dichloro-8-(oct-7-en-1-yloxy)quinoline (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **11** as a light-yellow oil (48.2 mg, 68% yield, **L/B** = 10:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.97 - 8.96 (m, 1H), 8.49 (d, *J* = 8.5 Hz, 1H), 7.94 (d, *J* = 8.2 Hz, 2H), 7.63 (s, 1H), 7.51 - 7.49 (m, 1H), 7.23 (d, *J* = 8.2 Hz, 2H), 4.34 (t, *J* = 6.8 Hz, 2H), 3.89 (s, 3H), 2.65 - 2.62 (m, 2H), 1.94 - 1.89 (m, 2H), 1.66 - 1.50 (m, 4H), 1.40 - 1.32 (m, 8H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.2, 151.0, 150.7, 148.5, 143.9, 133.2, 129.6, 128.4, 127.9, 127.5, 126.7, 126.2, 125.8, 121.9, 75.5, 51.9, 36.0, 31.1, 30.2, 29.4, 29.34, 29.33, 29.2, 25.8.

HRMS (ESI) m/z ($[M+H]^+$) calcd for $C_{26}H_{30}Cl_2NO_3^+$: 474.1597. Found: 474.1571.

7-(4-(methoxycarbonyl)phenyl)heptyl furan-2-carboxylate (12)



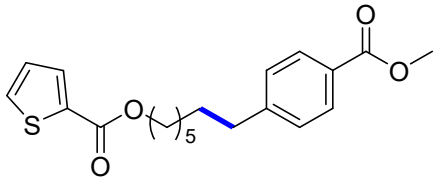
Following the general procedure: using hex-5-en-1-yl furan-2-carboxylate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **12** as a colorless oil (38.7 mg, 75% yield, **L/B** = 5.5:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.0 Hz, 2H), 7.56 (s, 1H), 7.22 (d, *J* = 8.0 Hz, 2H), 7.15 (d, *J* = 3.4 Hz, 1H), 6.49 (s, 1H), 4.28 (t, *J* = 6.6 Hz, 2H), 3.88 (s, 3H), 2.64 (t, *J* = 7.7 Hz, 2H), 1.76 - 1.59 (m, 4H), 1.39 - 1.33 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.1, 158.8, 148.2, 146.1, 144.8, 129.6, 128.4, 127.6, 117.7, 111.7, 64.9, 51.9, 35.9, 30.9, 28.98, 28.95, 28.6, 25.7.

HRMS (ESI) m/z ($[M+Na]^+$) calcd for $C_{20}H_{24}O_5Na^+$: 367.1516. Found: 367.1518.

7-(4-(methoxycarbonyl)phenyl)heptyl thiophene-2-carboxylate (13)



Following the general procedure: using hex-5-en-1-yl thiophene-2-carboxylate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **13** as a colorless oil (33.4 mg, 62% yield, **L/B** = 7:1)

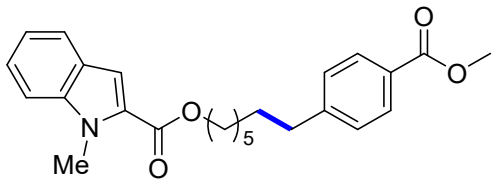
^{1}H NMR (600 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.3 Hz, 2H), 7.79 - 7.78 (m, 1H), 7.54 - 7.53 (m, 1H), 7.23 (d, *J* = 8.3 Hz, 2H), 7.10 - 7.08 (m, 1H), 4.28 (t, *J* = 6.7 Hz, 2H), 3.89 (s, 3H), 2.66 - 2.64 (m,

2H), 1.75 - 1.70 (m, 2H), 1.66 - 1.61 (m, 2H), 1.46 - 1.32 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.2, 162.3, 148.3, 133.2, 132.1, 129.6, 128.4, 127.7, 65.1, 51.9, 35.9, 30.9, 29.02, 28.97, 28.6, 25.8.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{20}H_{24}O_4SNa$: 383.1288. Found: 383.1273.

7-(4-(methoxycarbonyl)phenyl)heptyl 1-methyl-1H-indole-2-carboxylate (14)



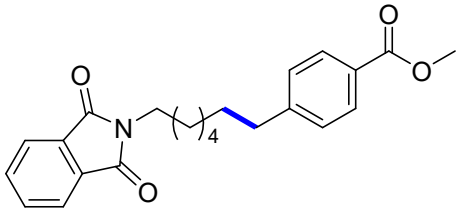
Following the general procedure: using hex-5-en-1-yl 1-methyl-1H-indole-2-carboxylate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **14** as a colorless oil (40.9 mg, 67% yield, **L/B** = 7:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.2 Hz, 2H), 7.67 (d, *J* = 8.0 Hz, 1H), 7.40 - 7.34 (m, 2H), 7.30 (s, 1H), 7.24 (d, *J* = 8.2 Hz, 2H), 7.16 (t, *J* = 7.3 Hz, 1H), 4.31 (t, *J* = 6.6 Hz, 2H), 4.08 (s, 3H), 3.90 (s, 3H), 2.68 - 2.65 (m, 2H), 1.80 - 1.75 (m, 2H), 1.67 - 1.63 (m, 2H), 1.49 - 1.36 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.2, 162.3, 148.3, 139.6, 129.6, 128.2, 127.6, 125.8, 124.9, 122.5, 120.5, 110.2, 110.0, 64.5, 51.9, 35.9, 31.6, 31.0, 29.1, 29.0, 28.7, 25.9.

HRMS (ESI) m/z ([M+H]$^+$) calcd for $C_{25}H_{30}NO_4^+$: 408.2169. Found: 408.2163.

Methyl 4-(7-(1,3-dioxoisoindolin-2-yl)heptyl)benzoate (15)



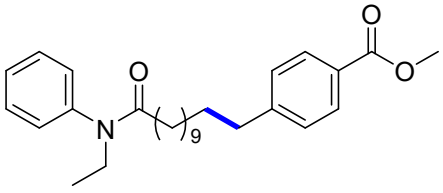
Following the general procedure: using 2-(hex-5-en-1-yl)isoindoline-1,3-dione (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **15** as a white solid (35.8 mg, 63% yield, **L/B** = 7:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.92 (d, *J* = 8.0 Hz, 2H), 7.83 - 7.82 (m, 2H), 7.70 - 7.69 (m, 2H), 7.21 (d, *J* = 8.0 Hz, 2H), 3.88 (s, 3H), 3.66 (t, *J* = 7.3 Hz, 2H), 2.64 - 2.61 (m, 2H), 1.68 - 1.58 (m, 4H), 1.38 - 1.30 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 168.4, 167.2, 148.3, 133.8, 132.1, 129.6, 128.4, 123.1, 51.9, 37.9, 35.9, 30.9, 29.0, 28.9, 28.5, 26.7.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{23}H_{25}NO_4Na^+$: 402.1676. Found: 402.1657.

Methyl 4-(12-(ethyl(phenyl)amino)-12-oxododecyl)benzoate (16)



Following the general procedure: using N-ethyl-N-

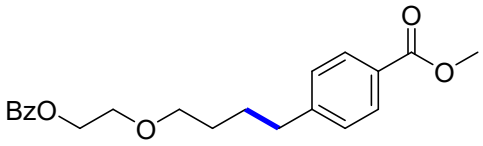
phenylundec-10-enamide (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **16** as a colorless oil (51.1 mg, 78% yield, **L/B** = 11:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.2 Hz, 2H), 7.40 (t, *J* = 7.6 Hz, 2H), 7.33 (t, *J* = 7.4 Hz, 1H), 7.22 (d, *J* = 8.1 Hz, 2H), 7.13 (d, *J* = 7.3 Hz, 2H), 3.88 (s, 3H), 3.73 (q, *J* = 7.1 Hz, 2H), 2.64 - 2.61 (m, 2H), 1.98 (t, *J* = 7.6 Hz, 2H), 1.62 - 1.52 (m, 4H), 1.31 - 1.15 (m, 14H), 1.09 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 172.6, 167.1, 148.4, 142.5, 129.54, 129.51, 128.38, 128.35, 127.7, 127.5, 51.9, 43.9, 35.9, 34.4, 31.1, 29.46, 29.42, 29.35, 29.3, 29.23, 29.16, 13.0.

HRMS (ESI) m/z ($[M+H]^+$) calcd for $C_{28}H_{40}NO_3^+$: 438.3003. Found: 438.2993.

Methyl 4-(4-(2-(benzoyloxy)ethoxy)butyl)benzoate (17)



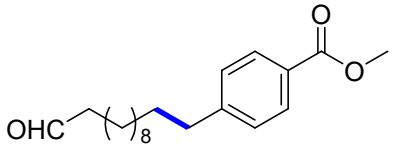
Following the general procedure: using 2-(allyloxy)ethyl benzoate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **17** as a colorless oil (21.4 mg, 40% yield, **L/B** > 20:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.04 (d, *J* = 7.3 Hz, 2H), 7.92 (d, *J* = 8.1 Hz, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.41 (t, *J* = 7.7 Hz, 2H), 7.21 (d, *J* = 8.1 Hz, 2H), 4.47 - 4.45 (m, 2H), 3.89 (s, 3H), 3.75 - 3.74 (m, 2H), 3.53 (t, *J* = 6.3 Hz, 2H), 2.67 (t, *J* = 7.6 Hz, 2H), 1.72 - 1.61 (m, 4H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.1, 166.5, 147.9, 132.9, 130.1, 129.6, 128.4, 128.3, 127.7, 71.0, 68.7, 64.1, 51.9, 35.6, 29.2, 27.6.

HRMS (ESI) m/z ($[M+Na]^+$) calcd for $C_{21}H_{24}O_5Na^+$: 379.1516. Found: 379.1516.

Methyl 4-(12-oxododecyl)benzoate (18)



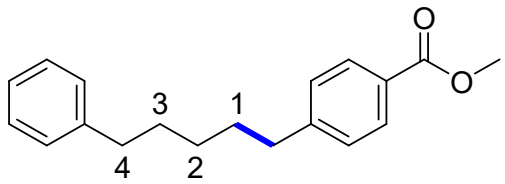
Following the general procedure: using undec-10-enal (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **18** as a colorless oil (19.1 mg, 40% yield, **L/B** = 9.5:1)

^{1}H NMR (400 MHz, $CDCl_3$) δ 9.76 (t, *J* = 1.9 Hz, 1H), 7.94 (d, *J* = 8.3 Hz, 2H), 7.23 (d, *J* = 8.4 Hz, 2H), 3.90 (s, 3H), 2.67 - 2.63 (m, 2H), 2.44 - 2.39 (m, 2H), 1.67 - 1.60 (m, 2H), 1.29 - 1.25 (m, 16H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 203.0, 167.2, 148.5, 129.6, 128.4, 127.6, 52.0, 43.9, 36.0, 31.1, 29.5, 29.41, 29.37, 29.3, 29.2, 29.1, 22.1.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{20}H_{30}O_3Na^+$: 341.2087. Found: 341.2072.

Methyl 4-(5-phenylpentyl)benzoate (19)



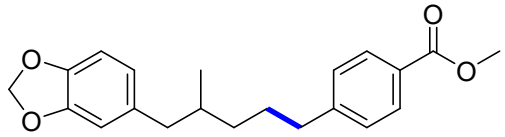
Following the general procedure: using but-3-en-1-ylbenzene (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **19** as a colorless oil (35.9 mg, 85% yield, C1:C2:C4=14:1:2.5)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.1 Hz, 2H), 7.28 - 7.25 (m, 7H), 3.89 (s, 3H), 2.65 - 2.58 (m, 4H), 1.68 - 1.61 (m, 4H), 1.40 - 1.34 (m, 2H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.1, 148.3, 142.6, 129.6, 128.4, 128.3, 128.2, 125.6, 51.9, 35.9, 35.8, 31.2, 30.9, 28.8.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{19}H_{22}O_2Na^+$: 305.1512. Found: 305.1510.

Methyl 4-(5-(benzo[d][1,3]dioxol-5-yl)-4-methylpentyl)benzoate (20)



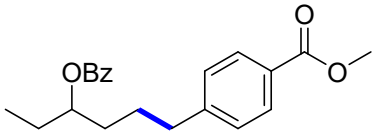
Following the general procedure: using 5-(2-methylbut-3-en-1-yl)benzo[d][1,3]dioxole (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **20** as a colorless oil (45.9 mg, 90% yield)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.2 Hz, 2H), 7.22 (d, *J* = 8.2 Hz, 2H), 6.71 (d, *J* = 7.9 Hz, 1H), 6.61 (d, *J* = 1.5 Hz, 1H), 6.57 - 6.55 (m, 1H), 5.92 (s, 2H), 3.90 (s, 3H), 2.66 - 2.57 (m, 2H), 2.55 - 2.50 (m, 1H), 2.31 - 2.28 (m, 1H), 1.70 - 1.59 (m, 3H), 1.41 - 1.35 (m, 1H), 1.22 - 1.14 (m, 1H), 0.85 (d, *J* = 6.6 Hz, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.1, 148.2, 147.3, 145.4, 135.1, 129.6, 128.4, 127.6, 121.8, 109.4, 107.9, 100.7, 51.9, 43.3, 36.1, 35.9, 35.0, 28.6, 19.3.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{21}H_{24}O_4Na^+$: 363.1567. Found: 363.1565.

Methyl 4-(4-(benzoyloxy)hexyl)benzoate (21)



Following the general procedure: using pent-1-en-3-yl benzoate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **21** as a colorless oil (21.4 mg, 42% yield)

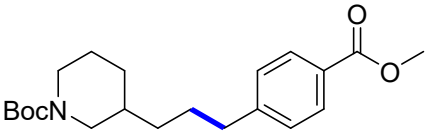
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 - 8.03 (m, 2H), 7.93 (d, *J* = 8.2 Hz, 2H), 7.56 (t, *J* = 7.4 Hz,

1H), 7.44 (t, *J* = 7.8 Hz, 2H), 7.22 (d, *J* = 8.2 Hz, 2H), 5.13 - 5.10 (m, 1H), 3.89 (s, 3H), 2.73 - 2.64 (m, 2H), 1.76 - 1.68 (m, 6H), 0.93 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.1, 166.4, 147.6, 132.8, 130.6, 129.7, 129.5, 128.4, 128.3, 127.8, 75.7, 52.0, 35.7 33.2, 27.1, 26.7, 9.6.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{21}H_{24}O_4Na^+$: 363.1567. Found: 363.1566.

***Tert*-butyl 3-(3-(4-(methoxycarbonyl)phenyl)propyl)piperidine-1-carboxylate (22)**



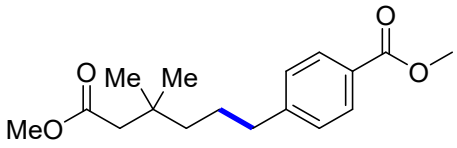
Following the general procedure: using *tert*-butyl 3-vinylpiperidine-1-carboxylate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **22** as a light-yellow oil (49.8 mg, 92% yield)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.1 Hz, 2H), 7.21 (d, *J* = 8.1 Hz, 2H), 4.02 - 3.75 (m, 5H), 2.73 - 2.62 (m, 3H), 1.80 - 1.77 (m, 1H), 1.68 - 1.56 (m, 3H), 1.45 - 1.38 (m, 12H), 1.27 - 1.03 (m, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.1, 154.8, 147.9, 129.6, 128.3, 127.7, 79.1, 51.9, 36.0, 35.7, 30.9, 28.4, 28.1.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{21}H_{31}NO_4Na^+$: 384.2145. Found: 384.2141.

Methyl 4-(6-methoxy-4,4-dimethyl-6-oxohexyl)benzoate (23)



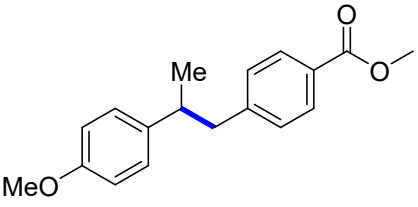
Following the general procedure: using methyl 3,3-dimethylpent-4-enoate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **23** as a colorless oil (28.4 mg, 65% yield)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.2 Hz, 2H), 7.24 (d, *J* = 8.2 Hz, 2H), 3.89 (s, 3H), 3.61 (s, 3H), 2.63 (t, *J* = 7.7 Hz, 2H), 2.18 (s, 2H), 1.64 - 1.59 (m, 2H), 1.35 - 1.32 (m, 2H), 0.96 (s, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 172.7, 167.1, 148.1, 129.6, 128.4, 127.7, 51.9, 51.1, 45.7, 41.6, 36.5, 33.2, 27.2, 25.7.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{17}H_{24}O_4Na^+$: 315.1567. Found: 315.1556.

Methyl 4-(2-(4-methoxyphenyl)propyl)benzoate (24)



Following the general procedure: using 1-methoxy-4-vinylbenzene (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford

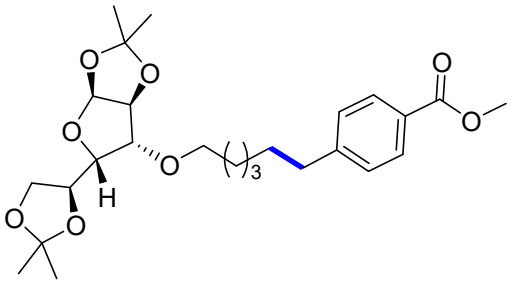
compound **24** as a colorless oil (25.5 mg, 60% yield, **L**/**B** = 1:7.5)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.2 Hz, 2H)), 7.11 - 7.06 (m, 4H), 6.81 (d, *J* = 8.7 Hz, 2H), 3.89 (s, 3H), 3.78 (s, 3H), 3.01 - 2.81 (m, 3H), 1.24 (d, *J* = 6.9 Hz, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.2, 157.9, 146.4, 138.3, 129.4, 129.2, 127.8, 113.7, 55.2, 51.9, 45.2, 40.8, 21.5.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{18}H_{20}O_3Na^+$: 307.1305. Found: 307.1286.

Methyl-4-(6-(((3a*S*,5*S*,6*R*,6a*S*)-5-((*S*)-2,2-dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyltetrahydrofuro[2,3-*d*][1,3]dioxol-6-yl)oxy)hexyl)benzoate (25)



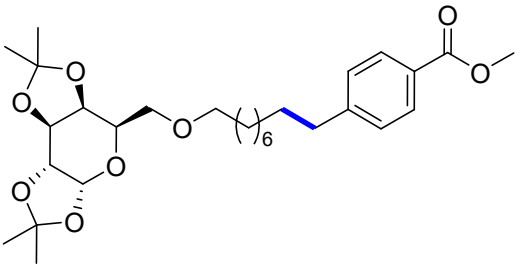
Following the general procedure: using (3a*S*,5*S*,6*R*,6a*S*)-5-((*S*)-2,2-dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyl-6-(pent-4-en-1-yloxy)tetrahydrofuro[2,3-*d*][1,3]dioxole (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **25** as a colorless oil (51.6 mg, 72% yield, **L**/**B** = 10:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.2 Hz, 2H), 7.22 (d, *J* = 8.1 Hz, 2H), 5.85 (d, *J* = 3.7 Hz, 1H), 4.50 (d, *J* = 3.7 Hz, 1H), 4.30 - 4.26 (m, 1H), 4.12 - 4.05 (m, 2H), 3.98 - 3.96 (m, 1H), 3.88 (s, 3H), 3.83 (d, *J* = 3.0 Hz, 1H), 3.58 - 3.47 (m, 2H), 2.65 - 2.63 (m, 2H), 1.64 - 1.59 (m, 2H), 1.56 - 1.52 (m, 2H), 1.48 (s, 3H), 1.41 (s, 3H), 1.38 - 1.30 (m, 10H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.1, 148.2, 129.6, 128.4, 127.6, 111.7, 108.8, 105.2, 82.5, 82.05, 81.12, 72.5, 70.5, 67.2, 51.9, 35.9, 31.0, 29.6, 28.9, 26.8, 26.7, 26.2, 25.9, 25.4.

HRMS (ESI) m/z ([M+H]$^+$) calcd for $C_{26}H_{39}O_8^+$: 479.2640. Found: 479.2630.

Methyl-4-(9-(((3a*R*,5*R*,5a*S*,8a*S*,8b*R*)-2,2,7,7-tetramethyltetrahydro-5*H*-bis([1,3]dioxolo)[4,5-*b*:4',5'-*d*]pyran-5-yl)methoxy)nonyl)benzoate (26)



Following the general procedure: using (3a*R*,5*R*,5a*S*,8a*S*,8b*R*)-2,2,7,7-tetramethyl-5-((oct-7-en-1-yloxy)methyl)tetrahydro-5*H*-bis([1,3]dioxolo)[4,5-*b*:4',5'-*d*]pyran (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **26** as a colorless oil (60.8 mg, 78% yield, **L**/**B** = 13:1)

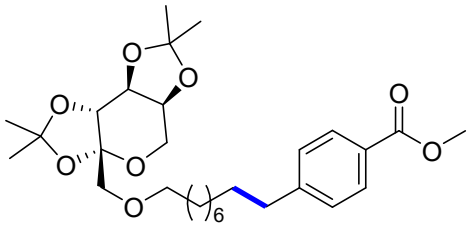
^{1}H NMR (600 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.1 Hz, 2H), 7.23 (d, *J* = 8.1 Hz, 2H), 5.54 (d, *J* = 5.0

Hz, 1H), 4.60 - 4.59 (m, 1H), 4.31 - 4.25 (m, 2H), 3.96 (t, *J* = 6.2 Hz, 1H), 3.89 (s, 3H), 3.65 - 3.56 (m, 2H), 3.52 - 3.43 (m, 2H), 2.64 (t, *J* = 7.7 Hz, 2H), 1.64 - 1.54 (m, 7H), 1.45 (s, 3H), 1.34 - 1.28 (m, 16H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.1, 148.4, 129.5, 128.3, 127.5, 109.1, 108.4, 96.3, 71.5, 71.1, 70.6, 70.5, 69.3, 66.7, 51.9, 35.9, 31.0, 29.5, 29.4, 29.34, 29.30, 29.2, 26.00, 25.94, 25.9, 24.9, 24.4.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{29}H_{44}O_8Na^+$: 543.2928. Found: 543.2917.

Methyl 4-(9-(((3a*R*,5a*S*,8a*S*,8b*R*)-2,2,7,7-tetramethyltetrahydro-3a*H*-bis([1,3]dioxolo)[4,5-*b*:4',5'-*d*]pyran-3a-yl)methoxy)nonyl)benzoate (27)



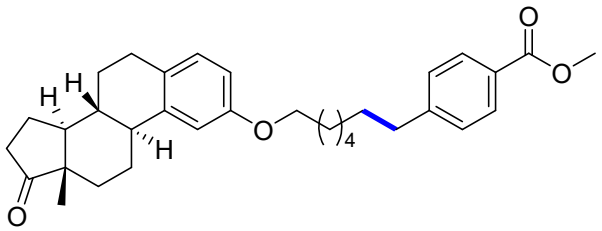
Following the general procedure: using (3a*R*,5a*S*,8a*S*,8b*R*)-2,2,7,7-tetramethyl-3a-((oct-7-en-1-yloxy)methyl)tetrahydro-5*H*-bis([1,3]dioxolo)[4,5-*b*:4',5'-*d*]pyran (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **27** as a colorless oil (54.6 mg, 70% yield, **L**/**B** = 12:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.2 Hz, 2H), 7.22 (d, *J* = 8.2 Hz, 2H), 4.59 - 4.57 (m, 1H), 4.39 (d, *J* = 2.6 Hz, 1H), 4.22 - 4.21 (m, 1H), 3.91 - 3.88 (m, 4H), 3.72 - 3.70 (m, 1H), 3.56 - 3.42 (m, 4H), 2.65 - 2.62 (m, 2H), 1.62 - 1.52 (m, 7H), 1.46 (s, 3H), 1.41 (s, 3H), 1.33 - 1.26 (m, 13H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.1, 148.4, 129.6, 128.4, 127.6, 108.8, 108.4, 102.7, 72.0, 71.0, 70.2, 69.9, 60.9, 51.9, 35.9, 31.1, 29.5, 29.39, 29.36, 29.3, 29.2, 26.5, 26.0, 25.8, 25.3, 24.0.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{29}H_{44}O_8Na^+$: 543.2928. Found: 543.2922.

Methyl-4-(7-(((8*R*,9*S*,13*S*,14*S*)-13-methyl-17-oxo-7,8,9,11,12,13,14,15,16,17-decahydro-6H-cyclopenta[*a*]phenanthren-2-yl)oxy)heptyl)benzoate (28)



Following the general procedure: using (8*R*,9*S*,13*S*,14*S*)-2-(hex-5-en-1-yloxy)-13-methyl-6,7,8,9,11,12,13,14,15,16-decahydro-17H-cyclopenta[*a*]phenanthren-17-one (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **28** as a white solid (56.4 mg, 75% yield, **L**/**B** = 10:1)

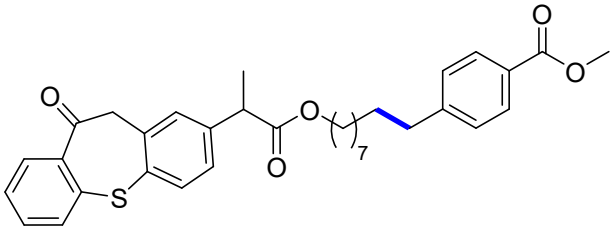
^{1}H NMR (600 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.2 Hz, 2H), 7.25 - 7.18 (m, 3H), 6.72 - 6.70 (m, 1H), 6.64 (d, *J* = 2.5 Hz, 1H), 3.93 - 3.90 (m, 5H), 2.91 - 2.88 (m, 2H), 2.67 - 2.65 (m, 2H), 2.52 - 2.48 (m, 1H), 2.43 - 2.36 (m, 1H), 2.29 - 2.23 (m, 1H), 2.17 - 1.94 (m, 4H), 1.78 - 1.73 (m, 2H), 1.67 - 1.35 (m,

14H), 0.91 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.1, 157.1, 148.3, 137.6, 131.8, 129.6, 128.4, 127.6, 126.2, 114.5, 112.0, 67.7, 51.9, 50.3, 47.9, 43.9, 38.3, 35.9, 35.8, 31.5, 31.0, 29.6, 29.09, 29.06, 26.5, 25.89, 25.85, 21.5, 13.8.

HRMS (ESI) m/z ([M+H]$^+$) calcd for $C_{33}H_{43}O_4^+$: 503.3156. Found: 503.3137.

Methyl-4-(9-((2-(10-oxo-10,11-dihydrodibenzo[*b*,*f*]thiepin-2-yl)propanoyl)oxy)nonyl)benzoate (29)



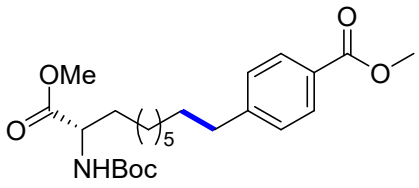
Following the general procedure: using oct-7-en-1-yl 2-(10-oxo-10,11-dihydrodibenzo[*b*,*f*]thiepin-2-yl)propanoate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **29** as a yellow oil (50.2 mg, 60% yield, **L/B** = 19:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.20 - 8.18 (m, 1H), 7.94 (d, *J* = 8.2 Hz, 2H), 7.57 (d, *J* = 8.0 Hz, 2H), 7.42 - 7.38 (m, 2H), 7.30 (t, *J* = 8.0 Hz, 1H), 7.23 (d, *J* = 8.1 Hz, 2H), 7.15 - 7.13 (m, 1H), 4.34 (s, 2H), 4.03 (t, *J* = 6.7 Hz, 2H), 3.89 (s, 3H), 3.70 (q, *J* = 7.2 Hz, 1H), 2.65 - 2.62 (m, 2H), 1.62 - 1.53 (m, 4H), 1.47 (d, *J* = 7.2 Hz, 3H), 1.30 - 1.20 (m, 10H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 191.2, 173.9, 167.1, 148.4, 142.8, 140.2, 137.8, 136.1, 133.1, 132.4, 131.5, 131.3, 130.8, 129.6, 128.6, 128.4, 127.6, 126.8, 126.3, 65.0, 51.9, 51.0, 45.2, 35.9, 31.0, 29.3, 29.2, 29.1, 29.0, 28.4, 25.7, 18.3.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{34}H_{38}O_5SNa^+$: 581.2332. Found: 581.2315.

Methyl (*S*)-4-(9-((*tert*-butoxycarbonyl)amino)-10-methoxy-10-oxodecyl)benzoate (30)



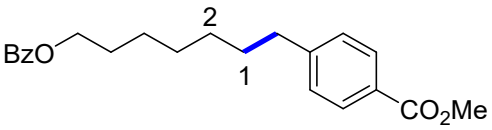
Following the general procedure: using methyl (*S*)-2-((*tert*-butoxycarbonyl)amino)non-8-enoate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **30** as a colorless oil (49.5 mg, 76% yield, **L/B** = 13:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.2 Hz, 2H), 7.22 (d, *J* = 8.2 Hz, 2H), 5.01 (d, *J* = 8.0 Hz, 1H), 4.28 - 4.25 (m, 1H), 3.88 (s, 3H), 3.71 (s, 3H), 2.64 - 2.61 (m, 2H), 1.80 - 1.71 (m, 1H), 1.64 - 1.53 (s, 3H), 1.43 (s, 9H), 1.32 - 1.26 (m, 10H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 173.5, 167.1, 155.3, 148.4, 129.6, 128.4, 127.6, 79.7, 53.4, 52.1, 51.9, 35.9, 32.7, 31.0, 29.22, 29.20, 29.09, 29.05, 28.3, 25.2.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{24}H_{37}NO_6Na^+$: 458.2513. Found: 458.2507.

Methyl 4-(6-(benzoyloxy)hexyl)benzoate (31)



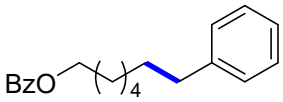
Following the general procedure: using (*E*)-hex-4-en- 1-yl benzoate (0.15 mmol, 100 mol%) and methyl 4-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **31** as a colorless oil (29.2 mg, 55% yield, C1/C2/C**x** = 9:3:1, C**x**: It's uncertain the position of C**x** in the carbon chain.)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.08 – 8.01 (m, 2H), 7.94 (dd, *J* = 8.4, 2.3 Hz, 2H), 7.55 (td, *J* = 7.3, 1.4 Hz, 1H), 7.47 – 7.39 (m 2H), 7.23 (d, *J* = 8.2 Hz, 2H), 4.31 (t, *J* = 6.6 Hz, 2H), 3.90 (s, 3H), 2.65 (t, *J* = 7.8, 2H), 1.81 – 1.71 (m, 2H), 1.67 – 1.59 (m, 2H), 1.48 – 1.30 (m, 4H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.2, 166.6, 148.3, 132.8, 130.5, 129.6, 129.5, 129.1, 128.4, 128.3, 65.0, 51.9, 35.9, 31.0, 29.0, 29.0, 28.6, 25.9.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{22}H_{26}O_4Na^+$: 377.1723. Found: 377.1718.

7-phenylheptyl benzoate (32)



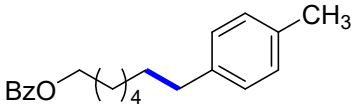
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and (bromomethyl)benzene (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **32** as a colorless oil (31.1 mg, 70% yield, **L/B** = 11:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.07 - 8.05 (m, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.46 - 7.44 (m, 2H), 7.30 - 7.27 (m, 2H), 7.20 - 7.15 (m, 3H), 4.33 (t, *J* = 6.7 Hz, 2H), 2.63 - 2.61 (m, 2H), 1.80 - 1.74 (m, 2H), 1.67 - 1.62 (m, 2H), 1.47 - 1.37 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.7, 142.7, 132.8, 130.5, 129.5, 128.4, 128.3, 128.2, 125.6, 65.1, 35.9, 31.4, 29.13, 29.11, 28.7, 25.9.

HRMS (ESI) m/z ([M+H]$^+$) calcd for $C_{20}H_{24}O_2^+$: 297.1849. Found: 297.1834.

7-(*p*-tolyl)heptyl benzoate (33)



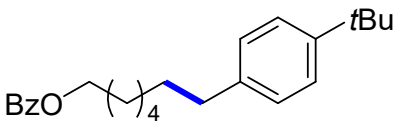
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and 1-(bromomethyl)-4-methylbenzene (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **33** as a colorless oil (36.2 mg, 78% yield, **L/B** = 12:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.07 - 8.05 (m, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.8 Hz, 2H), 7.11 - 7.07 (m, 4H), 4.32 (t, *J* = 6.7 Hz, 2H), 2.59 - 2.57 (m, 2H), 2.33 (s, 3H), 1.80 - 1.75 (m, 2H), 1.64 - 1.59 (m, 2H), 1.47 - 1.36 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.7, 139.6, 135.0, 132.8, 130.5, 129.5, 128.9, 128.3, 128.2, 65.1, 35.4, 31.5, 29.13, 29.12, 28.7, 26.0, 21.0.

HRMS (ESI) m/z ($[M+Na]^+$) calcd for $C_{21}H_{26}O_2Na^+$: 333.1825. Found: 333.1826.

7-(4-(*tert*-butyl)phenyl)heptyl benzoate (34)



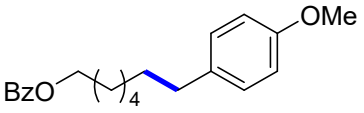
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and 1-(bromomethyl)-4-(*tert*-butyl)benzene (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **34** as a colorless oil (45.4 mg, 86% yield, **L/B** =10:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.08 - 8.07 (m, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.47 - 7.44 (m, 2H), 7.32 (d, *J* = 8.3 Hz, 2H), 7.14 (d, *J* = 8.2 Hz, 2H), 4.34 (t, *J* = 6.7 Hz, 2H), 2.62 - 2.59 (m, 2H), 1.82 - 1.77 (m, 2H), 1.68 - 1.62 (m, 2H), 1.50 - 1.41 (m, 6H), 1.34 (s, 9H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.6, 148.3, 139.6, 132.7, 130.5, 129.5, 128.3, 128.0, 125.1, 65.1, 35.3, 34.3, 31.4, 31.3, 29.2, 29.1, 28.7, 26.0.

HRMS (ESI) m/z ($[M+H]^+$) calcd for $C_{24}H_{33}O_2^+$: 353.2475. Found: 353.2476.

7-(4-methoxyphenyl)heptyl benzoate (35)



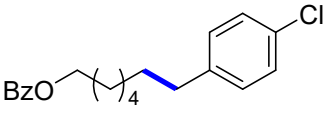
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and 1-(bromomethyl)-4-methoxybenzene (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **35** as a colorless oil (33.2 mg, 68% yield, **L/B** = 26.5:1)

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.08 - 8.06 (m, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.6 Hz, 2H), 7.11 (d, *J* = 8.7 Hz, 2H), 6.84 (d, *J* = 8.7 Hz, 2H), 4.33 (t, *J* = 6.7 Hz, 2H), 3.80 (s, 3H), 2.59 - 2.55 (m, 2H), 1.81 - 1.75 (m, 2H), 1.65 - 1.58 (m, 2H), 1.50 - 1.33 (m, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 166.6, 157.5, 134.8, 132.7, 130.4, 129.5, 129.16, 128.3, 113.6, 65.0, 55.1, 34.9, 31.6, 29.1, 29.0, 28.6, 25.9.

HRMS (DART) m/z ($[M+H]^+$) calcd for $C_{21}H_{27}O_3^+$: 327.1955. Found: 327.1956.

7-(4-chlorophenyl)heptyl benzoate (36)



Following the general procedure: using methyl hex-5-en-1-yl benzoate

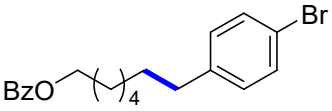
(0.15 mmol, 100 mol%) and 1-(bromomethyl)-4-chlorobenzene (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **36** as a colorless oil (35.6 mg, 72% yield, **L/B** = 12:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.06 - 8.04 (m, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.8 Hz, 2H), 7.23 (d, *J* = 8.4 Hz, 2H), 7.09 (d, *J* = 8.4 Hz, 2H), 4.32 (t, *J* = 6.7 Hz, 2H), 2.59 - 2.56 (m, 2H), 1.79 - 1.74 (m, 2H), 1.63 - 1.58 (m, 2H), 1.46 - 1.33 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.7, 141.1, 132.8, 131.2, 130.5, 129.7, 129.5, 128.29, 128.28, 65.0, 35.2, 31.2, 29.04, 28.99, 28.7, 25.9.

HRMS (ESI) m/z ([M+H]$^+$) calcd for $C_{20}H_{24}ClO_2^+$: 331.1459. Found: 331.1459.

7-(4-bromophenyl)heptyl benzoate (37)



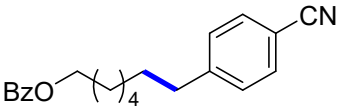
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and 1-bromo-4-(bromomethyl)benzene (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **37** as a colorless oil (46.0 mg, 82% yield, **L/B** = 10.5:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 - 8.04 (m, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.8 Hz, 2H), 7.38 (d, *J* = 8.3 Hz, 2H), 7.04 (d, *J* = 8.3 Hz, 2H), 4.32 (t, *J* = 6.7 Hz, 2H), 2.57 - 2.54 (m, 2H), 1.79 - 1.74 (m, 2H), 1.61 - 1.57 (m, 2H), 1.46 - 1.34 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.6, 141.6, 132.8, 131.2, 131.1, 130.5, 130.1, 129.5, 128.3, 119.3, 65.0, 35.2, 31.2, 29.04, 28.98, 28.7, 25.9.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{20}H_{23}BrO_2Na^+$: 397.0774. Found: 397.0773.

7-(4-cyanophenyl)heptyl benzoate (38)



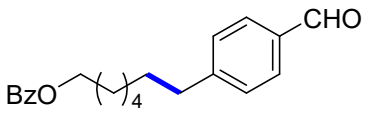
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and 4-(bromomethyl)benzonitrile (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **38** as a colorless oil (34.1 mg, 71% yield, **L/B** = 5:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 - 8.03 (m, 2H), 7.55 (d, *J* = 8.2 Hz, 3H), 7.44 (t, *J* = 7.8 Hz, 2H), 7.26 (d, *J* = 8.0 Hz, 2H), 4.31 (t, *J* = 6.6 Hz, 2H), 2.67 - 2.64 (m, 2H), 1.78 - 1.74 (m, 2H), 1.65 - 1.60 (m, 2H), 1.47 - 1.32 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.6, 148.4, 132.8, 132.1, 130.4, 129.5, 129.1, 128.3, 119.1, 109.5, 64.9, 36.0, 30.8, 28.96, 28.95, 28.6, 25.8.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{21}H_{23}NO_2Na^+$: 344.1621. Found: 344.1612.

7-(4-formylphenyl)heptyl benzoate (39)



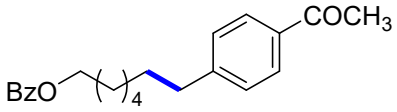
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and 4-(bromomethyl)benzaldehyde (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **39** as a colorless oil (29.1 mg, 60% yield, **L/B** = 15:1)

^{1}H NMR (400 MHz, $CDCl_3$) δ 11.84 (s, 1H), 8.05 - 8.02 (m, 2H), 7.79 (d, *J* = 8.2 Hz, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.45 - 7.41 (m, 2H), 7.33 (d, *J* = 8.0 Hz, 2H), 4.31 (t, *J* = 6.6 Hz, 2H), 2.70 - 2.67 (m, 2H), 1.80 - 1.73 (m, 2H), 1.67 - 1.62 (m, 2H), 1.46 - 1.35 (m, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 192.0, 166.7, 150.3, 134.4, 132.8, 130.4, 129.9, 129.5, 129.0, 128.3, 65.0, 36.1, 30.9, 29.1, 29.0, 28.6, 25.9.

HRMS (ESI) m/z ($[M+H]^+$) calcd for $C_{21}H_{25}O_3^+$: 325.1798. Found: 325.1794.

7-(4-acetylphenyl)heptyl benzoate (40)



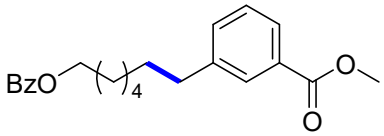
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and 1-(4-(bromomethyl)phenyl)ethan-1-one (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **40** as a colorless oil (41.7 mg, 82% yield, **L/B** = 14:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.04 - 8.03 (m, 2H), 7.87 (d, *J* = 8.3 Hz, 2H), 7.56 - 7.54 (m, 1H), 7.44 - 7.42 (m, 2H), 7.26 - 7.24 (m, 2H), 4.31 (t, *J* = 6.7 Hz, 2H), 2.67 - 2.64 (m, 2H), 2.57 (s, 3H), 1.79 - 1.73 (m, 2H), 1.66 - 1.61 (m, 2H), 1.46 - 1.32 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 197.8, 166.6, 148.6, 134.9, 132.8, 130.4, 129.5, 128.5, 128.4, 128.3, 64.9, 35.9, 30.9, 29.02, 29.00, 28.6, 26.5, 25.9.

HRMS (ESI) m/z ($[M+Na]^+$) calcd for $C_{22}H_{26}O_3Na^+$: 361.1774. Found: 361.1758.

Methyl 3-(7-(benzoyloxy)heptyl)benzoate (41)



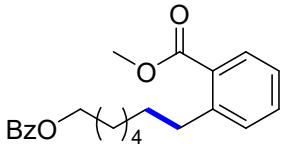
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and methyl 3-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **41** as a colorless oil (41.4 mg, 78% yield, **L/B** = 11.5:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 - 8.03 (m, 2H), 7.86 - 7.83 (m, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.43 (t, *J* = 7.8 Hz, 2H), 7.37 - 7.32 (m, 2H), 4.31 (t, *J* = 6.7 Hz, 2H), 3.90 (s, 3H), 2.66 - 2.64 (m, 2H), 1.78 - 1.73 (m, 2H), 1.67 - 1.62 (m, 2H), 1.47 - 1.34 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 167.3, 166.6, 143.0, 133.0, 132.8, 130.4, 130.1, 129.5, 129.4, 128.3, 128.2, 126.9, 65.0, 52.0, 35.6, 31.2, 29.1, 29.0, 28.6, 25.9.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{22}H_{26}O_4Na^+$: 377.1723. Found: 377.1727.

Methyl 2-(7-(benzoyloxy)heptyl)benzoate (42)



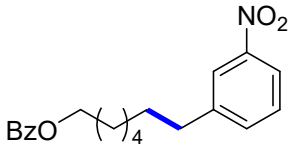
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and methyl 2-(bromomethyl)benzoate (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **42** as a colorless oil (37.1 mg, 70% yield, **L/B** = 11:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 - 8.03 (m, 2H), 7.86 - 7.85 (m, 1H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.45 - 7.39 (m, 3H), 7.24 (d, *J* = 7.6 Hz, 2H), 4.31 (t, *J* = 6.7 Hz, 2H), 3.88 (s, 3H), 2.96 - 2.93 (m, 2H), 1.79 - 1.74 (m, 2H), 1.62 - 1.58 (m, 2H), 1.46 - 1.40 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 168.2, 166.7, 144.6, 132.8, 131.8, 130.9, 130.54, 130.50, 129.5, 129.4, 128.3, 125.7, 65.1, 51.9, 34.4, 31.7, 29.6, 29.1, 28.7, 26.0.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{22}H_{26}O_4Na^+$: 377.1723. Found: 377.1731.

7-(3-nitrophenyl)heptyl benzoate (43)



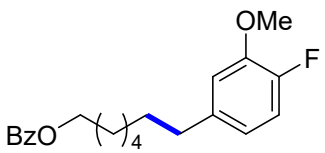
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and 1-(bromomethyl)-3-nitrobenzene (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **43** as a light-yellow oil (25.5 mg, 50% yield, **L/B** = 27:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 - 8.03 (m, 4H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.50 - 7.49 (m, 1H), 7.45 - 7.42 (m, 3H), 4.31 (t, *J* = 6.6 Hz, 2H), 2.73 - 2.70 (m, 2H), 1.79 - 1.74 (m, 2H), 1.69 - 1.64 (m, 2H), 1.47 - 1.35 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.7, 148.3, 144.6, 134.7, 132.8, 130.4, 129.5, 129.1, 128.3, 123.2, 120.9, 65.0, 35.5, 31.0, 29.02, 28.98, 28.7, 25.9.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{20}H_{23}NO_4Na^+$: 364.1519. Found: 364.1521.

7-(4-fluoro-3-methoxyphenyl)heptyl benzoate (44)



Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and 4-(bromomethyl)-1-fluoro-2-methoxybenzene (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **44** as a colorless oil (41.2 mg, 80% yield, **L/B** = 11.5:1)

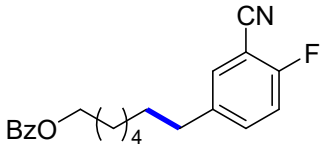
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 - 8.04 (m, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.8 Hz,

2H), 6.98 - 6.94 (m, 1H), 6.77 - 6.66 (m, 2H), 4.32 (t, J = 6.7 Hz, 2H), 3.87 (s, 3H), 2.58 - 2.55 (m, 2H), 1.79 - 1.74 (m, 2H), 1.63 - 1.58 (m, 2H), 1.48 - 1.34 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.6, 151.5, 149.9, 147.2(J_{C-F} = 10.5 Hz), 139.0(J_{C-F} = 3.0 Hz), 132.79, 130.4, 129.5, 128.3, 120.3(J_{C-F} = 6.0 Hz), 115.6(J_{C-F} = 18.1 Hz), 113.5, 65.0, 56.1, 35.6, 31.4, 29.1(J_{C-F} = 1.5 Hz), 28.7, 25.92.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{21}H_{25}FO_3Na^+$: 367.1680. Found: 367.1667.

7-(3-cyano-4-fluorophenyl)heptyl benzoate (45)



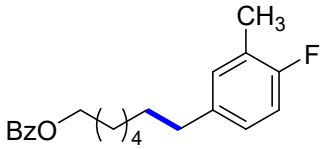
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and 5-(bromomethyl)-2-fluorobenzonitrile (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **45** as a colorless oil (30.5 mg, 60% yield, **L/B** = 21:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.04 - 8.03 (m, 2H), 7.55 (t, J = 7.4 Hz, 1H), 7.43 (t, J = 7.8 Hz, 2H), 7.40 - 7.36 (m, 2H), 7.10 (t, J = 8.6 Hz, 1H), 4.31 (t, J = 6.6 Hz, 2H), 2.61 - 2.59 (m, 2H), 1.78 - 1.74 (m, 2H), 1.62 - 1.57 (m, 2H), 1.46 - 1.32 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.6, 162.3, 160.6, 139.6(J_{C-F} = 3.0 Hz), 135.0(J_{C-F} = 9.1 Hz), 132.8(J_{C-F} = 7.6 Hz), 130.4, 129.5, 128.3, 116.2(J_{C-F} = 19.6 Hz), 114.2, 101.1(J_{C-F} = 16.6 Hz), 64.9, 34.6, 31.0, 29.0, 28.9, 28.6, 25.9.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{21}H_{22}FNO_2Na^+$: 362.1527. Found: 362.1525.

7-(4-fluoro-3-methylphenyl)heptyl benzoate (46)



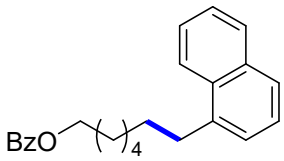
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and 4-(bromomethyl)-1-fluoro-2-methylbenzene (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **46** as a colorless oil (38.3 mg, 78% yield, **L/B** = 15.5:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.06 - 8.05 (m, 2H), 7.56 (t, J = 7.4 Hz, 1H), 7.44 (t, J = 7.8 Hz, 2H), 6.97 - 6.88 (m, 3H), 4.32 (t, J = 6.7 Hz, 2H), 2.55 - 2.52 (m, 2H), 2.25 (s, 3H), 1.79 - 1.75 (m, 2H), 1.62 - 1.57 (m, 2H), 1.47 - 1.34 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.7, 160.4, 158.8, 138.0(J_{C-F} = 4.5 Hz), 132.8, 131.2(J_{C-F} = 4.5 Hz), 130.5, 129.5, 128.3, 126.9(J_{C-F} = 7.6 Hz), 124.3(J_{C-F} = 18.1 Hz), 114.6(J_{C-F} = 22.7 Hz), 65.0, 35.0, 31.5, 29.1(J_{C-F} = 4.5 Hz), 28.7, 25.9, 14.5, 14.5.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{21}H_{25}FO_2Na$: 351.1731. Found: 351.1714.

7-(naphthalen-1-yl)heptyl benzoate (47)



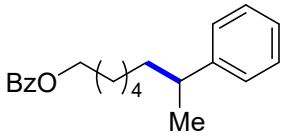
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and 1-(bromomethyl)naphthalene (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **47** as a colorless oil (33.7 mg, 65% yield, **L/B** = 13:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.06 - 8.04 (m, 3H), 7.86 (d, *J* = 7.6 Hz, 1H), 7.71 (d, *J* = 8.2 Hz, 1H), 7.56 (t, *J* = 6.8 Hz, 1H), 7.52 - 7.39 (m, 5H), 7.33 - 7.32 (m, 1H), 4.33 (t, *J* = 6.6 Hz, 2H), 3.09 - 3.07 (m, 2H), 1.82 - 1.75 (m, 4H), 1.51 - 1.44 (m, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.7, 138.8, 133.6 132.8, 131.9, 130.5, 129.5, 128.7, 128.3, 128.3, 126.4, 125.8, 125.6, 125.5, 125.3, 123.8, 65.1, 33.0, 30.2, 29.7, 29.2, 28.7, 26.0.

HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{24}H_{26}O_2Na^+$: 369.1825. Found: 369.1806.

7-phenyloctyl benzoate (48)



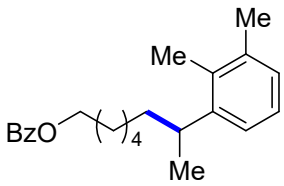
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and (1-chloroethyl)benzene (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **48** as a colorless oil (32.5 mg, 70% yield, **L/B** = 7:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.07 - 8.05 (m, 2H), 7.58 - 7.55 (m, 1H), 7.47 - 7.44 (m, 2H), 7.31 - 7.27 (m, 2H), 7.20 - 7.16 (m, 3H), 4.36 - 4.25 (m, 2H), 2.72 - 2.66 (m, 1H), 1.80 - 1.69 (m, 2H), 1.63 - 1.53 (m, 2H), 1.43 - 1.19 (m, 9H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.6, 147.8, 132.8, 130.5, 129.5, 128.3, 128.2, 126.9, 125.7, 65.0, 39.9, 38.3, 29.3, 28.7, 27.5, 25.9, 22.3.

HRMS (ESI) m/z ([M+H]$^+$) calcd for $C_{21}H_{27}O_2^+$: 311.2006. Found: 311.2001.

7-(2,3-dimethylphenyl)octyl benzoate (49)



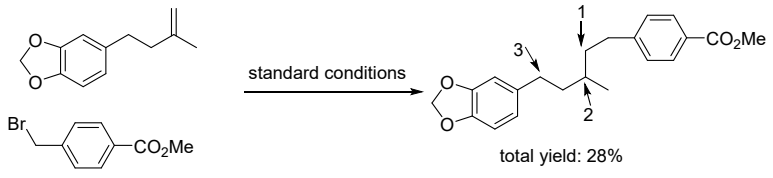
Following the general procedure: using methyl hex-5-en-1-yl benzoate (0.15 mmol, 100 mol%) and 1-(1-chloroethyl)-2,3-dimethylbenzene (0.3 mmol, 200 mol%). The crude mixture was purified by flash column chromatograph to afford compound **49** as a colorless oil (28.8 mg, 57% yield, **L/B** = 50:1)

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05 - 8.04 (m, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.8 Hz, 2H), 7.10 - 7.06 (m, 2H), 7.00 - 6.99 (m, 1H), 4.30 (t, *J* = 6.7 Hz, 2H), 3.07 - 3.01 (m, 1H), 2.30 (s, 3H), 2.22 (s, 3H), 1.77 - 1.72 (m, 2H), 1.66 - 1.60 (m, 1H), 1.57 - 1.49 (m, 1H), 1.45 - 1.40 (m, 2H), 1.38 - 1.32 (m, 3H), 1.27 - 1.22 (m, 1H), 1.19 (d, *J* = 6.9 Hz, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 166.7, 145.7, 136.5, 133.9, 132.8, 130.5, 129.5, 128.3, 127.2, 125.5, 123.0, 65.1, 37.8, 34.5, 29.7, 29.5, 28.7, 27.6, 26.0, 21.7, 21.1, 14.7.

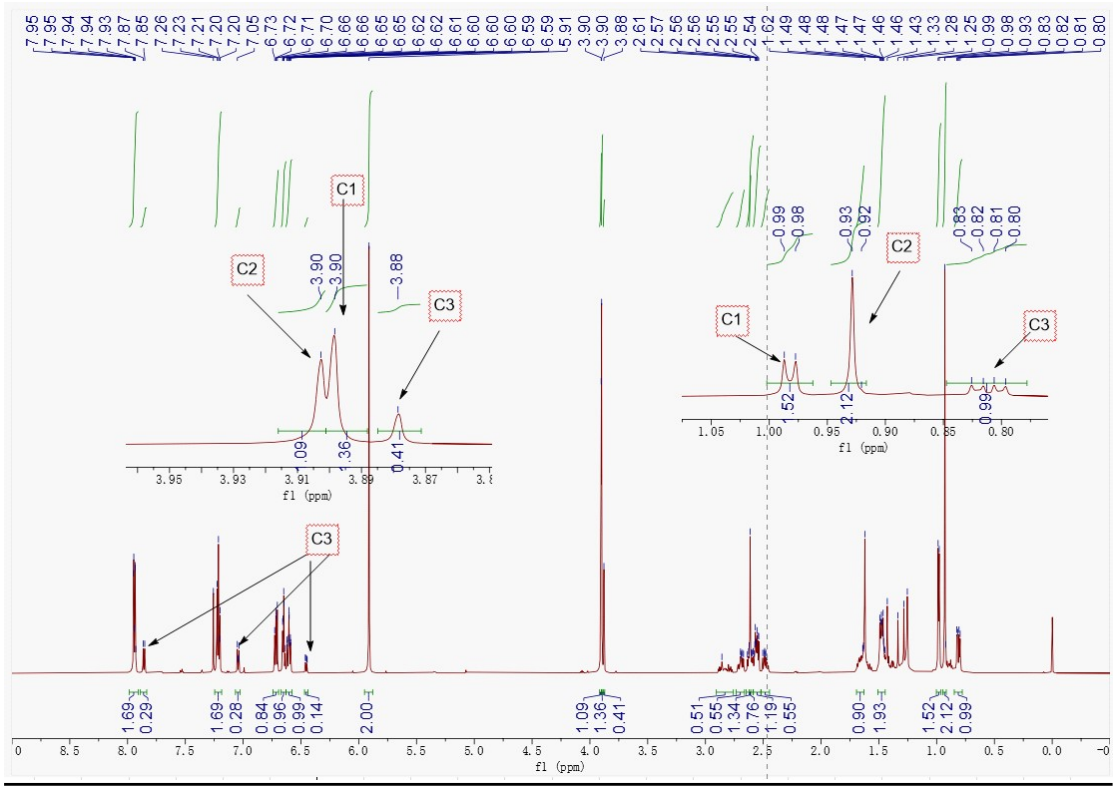
HRMS (ESI) m/z ([M+Na]$^+$) calcd for $C_{23}H_{30}O_2Na^+$: 361.2138. Found: 361.2138.

Part 4. Result of a 1,1-disubstituted alkene

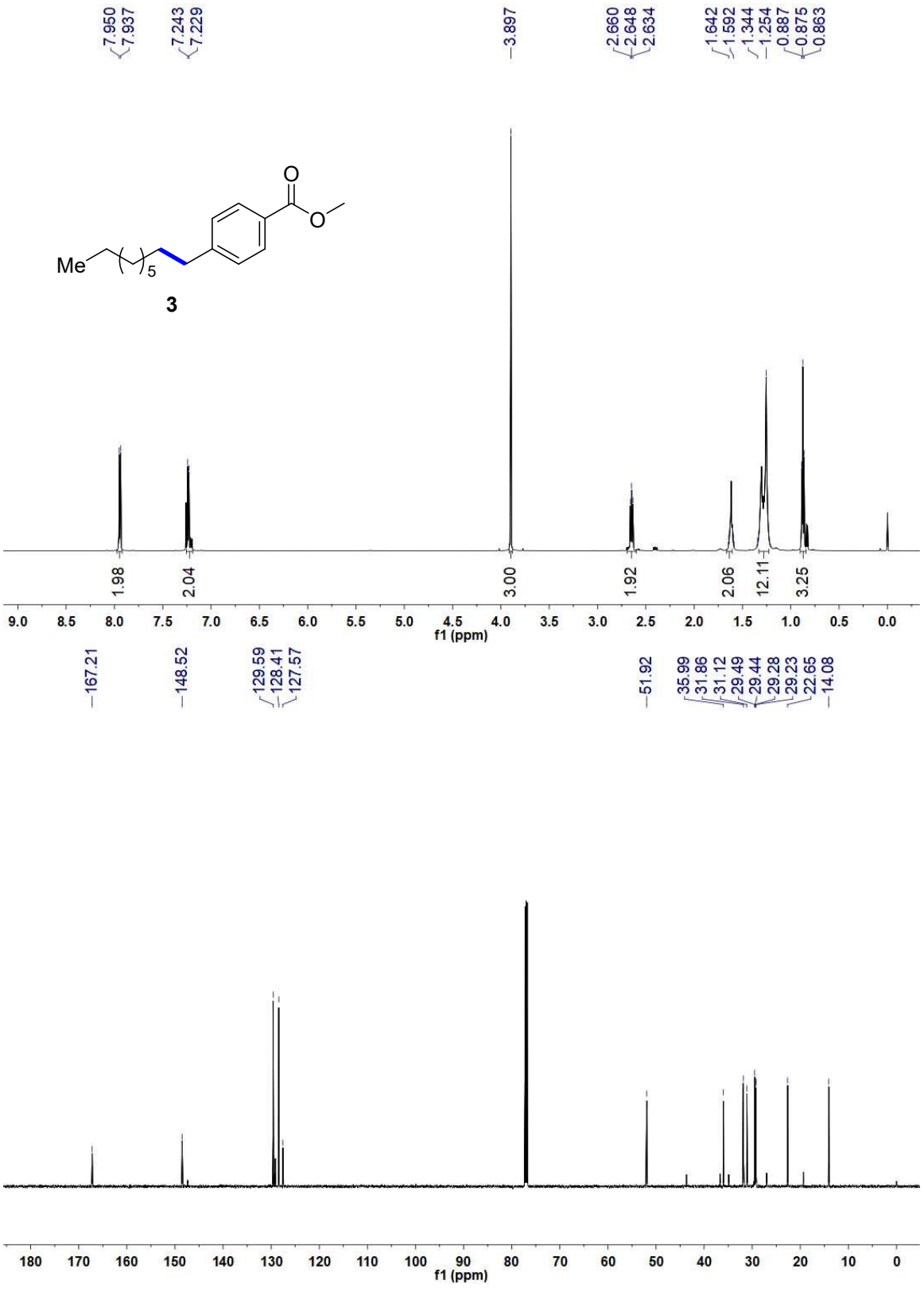


total yield: 28%

C1/C2/C3 = 45%/35%/14% = 3.2/2.5/1



II. Copies of NMR Data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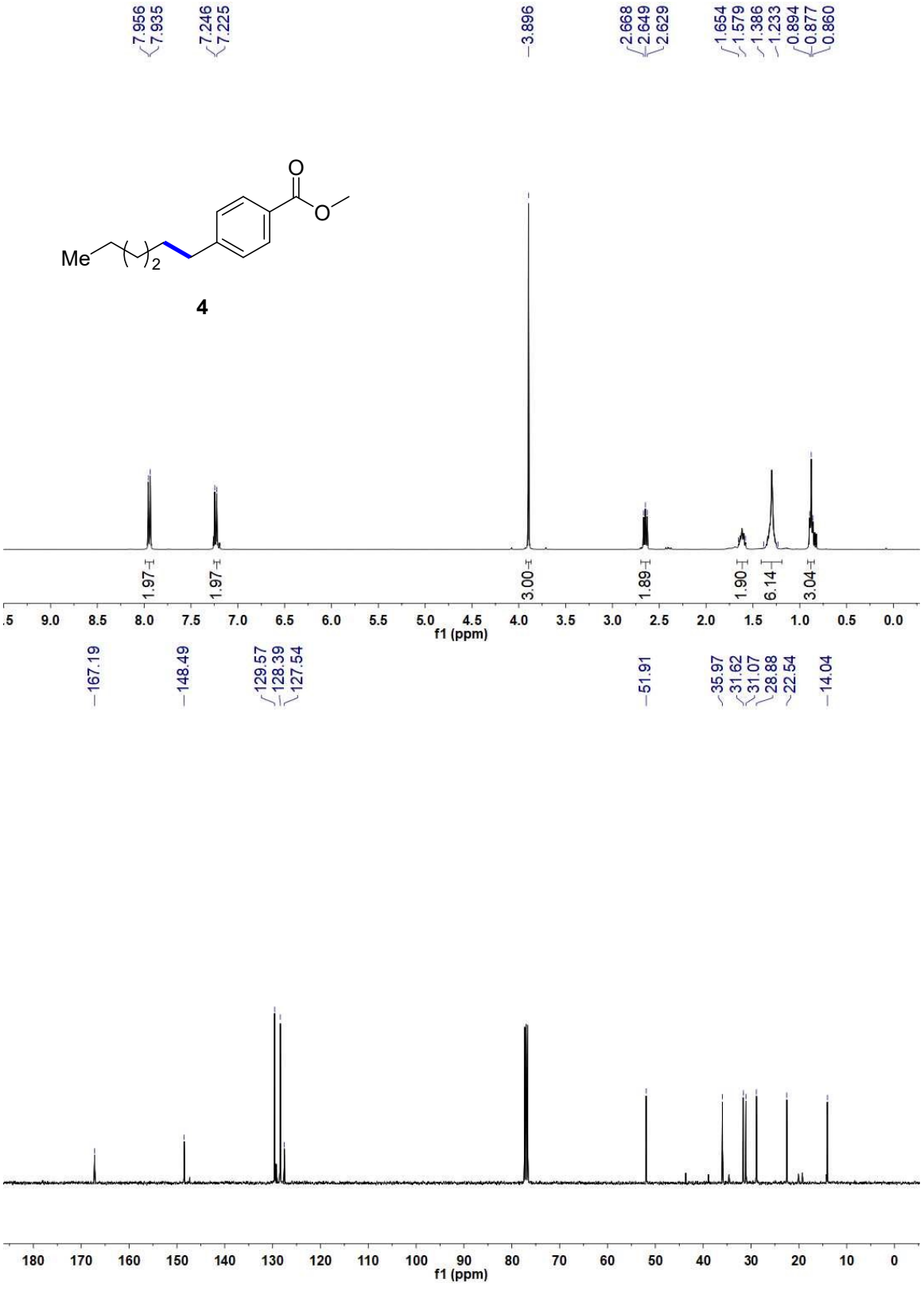
7.243
7.229
3.897
2.660
2.648
2.634
1.642
1.592
1.344
1.254
0.887
0.875
0.863
O
O
Me
5
3
1.98
2.04
3.00
1.92
2.06
12.11
3.25
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
167.21
148.52
129.59
128.41
127.57
51.92
35.99
31.86
31.12
29.49
29.44
29.28
29.23
22.65
14.08
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.246
7.225
3.896
2.668
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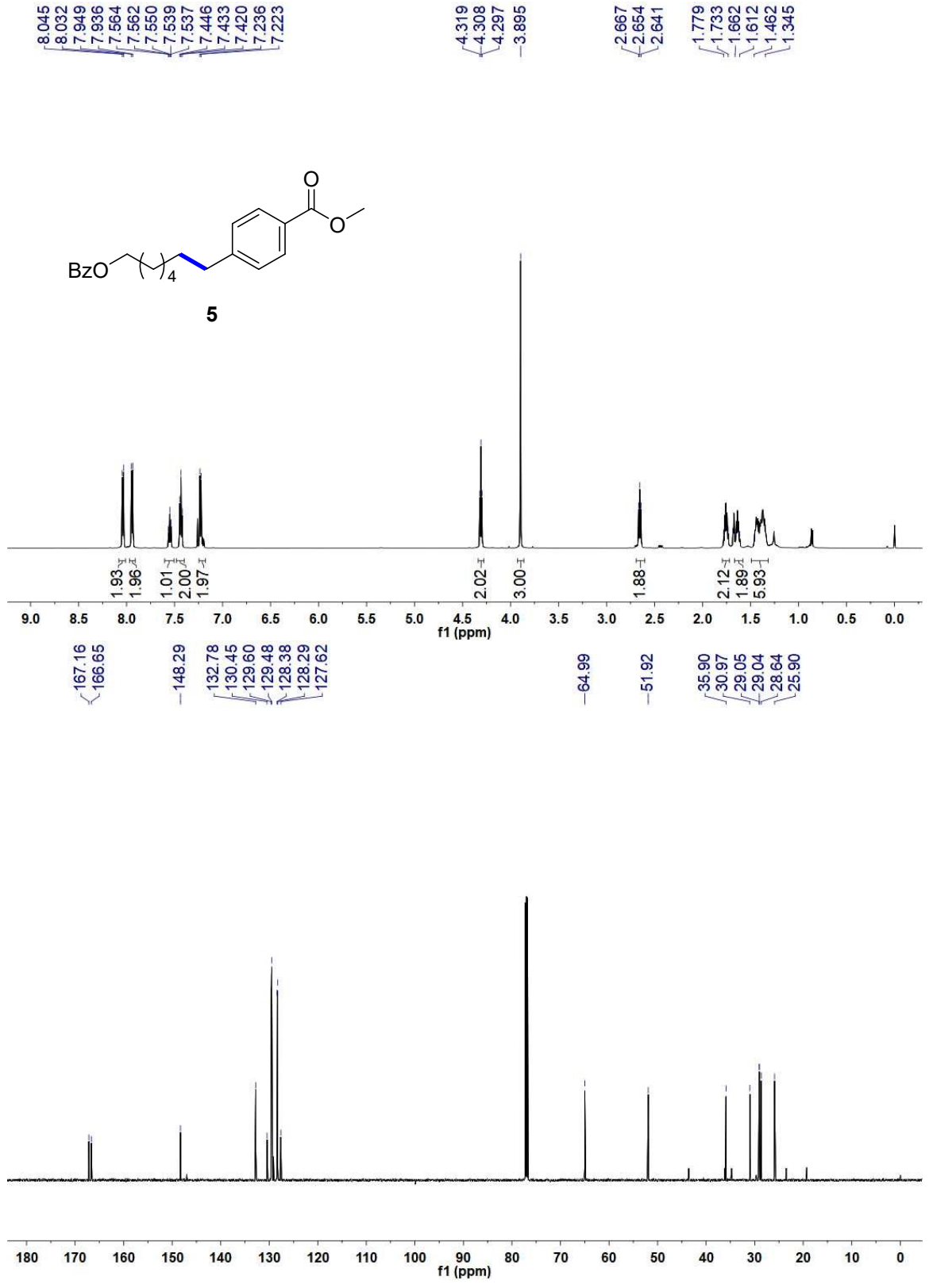
2.629
1.654
1.579
1.386
1.233
0.894
0.877
0.860
O
O
Me
2
1.97
1.97
3.00
1.89
1.90
6.14
3.04
f1 (ppm)
167.19
148.49
129.57
128.39
127.54
51.91
35.97
31.62
31.07
28.88
22.54
14.04
f1 (ppm)

4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7.223
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4.297
3.895
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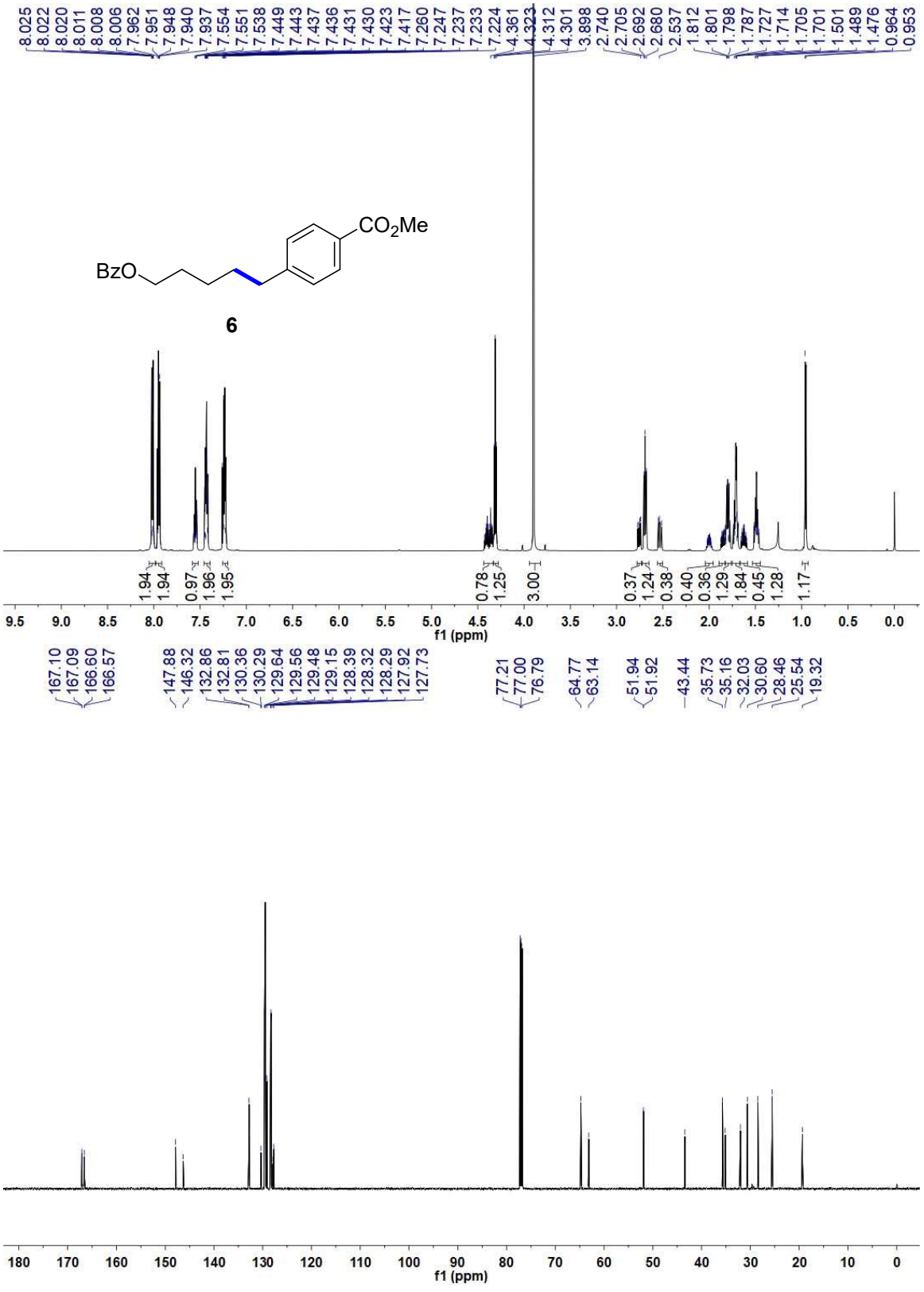
2.641
1.779
1.733
1.662
1.612
1.462
1.345
O
O
BzO
4
5
1.93
1.96
1.01
2.00
1.97
2.02
3.00
1.88
2.12
1.89
5.93
f1 (ppm)
167.16
166.65
148.29
132.78
130.45
129.60
129.48
128.38
128.29
127.62
64.99
51.92
35.90
30.97
29.05
29.04
28.64
25.90
f1 (ppm)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7.538
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1.701
1.501
1.489
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0.953
CO2Me
BzO
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1.94
1.94
0.97
1.96
1.95
0.78
1.25
3.00
0.37
1.24
0.38
0.40
0.36
1.29
1.84
0.45
1.28
1.17
f1 (ppm)
167.10
167.09
166.60
166.57
147.88
146.32
132.86
132.81
130.36
130.29
129.64
129.56
129.48
129.15
128.39
128.32
128.29
127.92
127.73
77.21
77.00
76.79
64.77
63.14
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51.92
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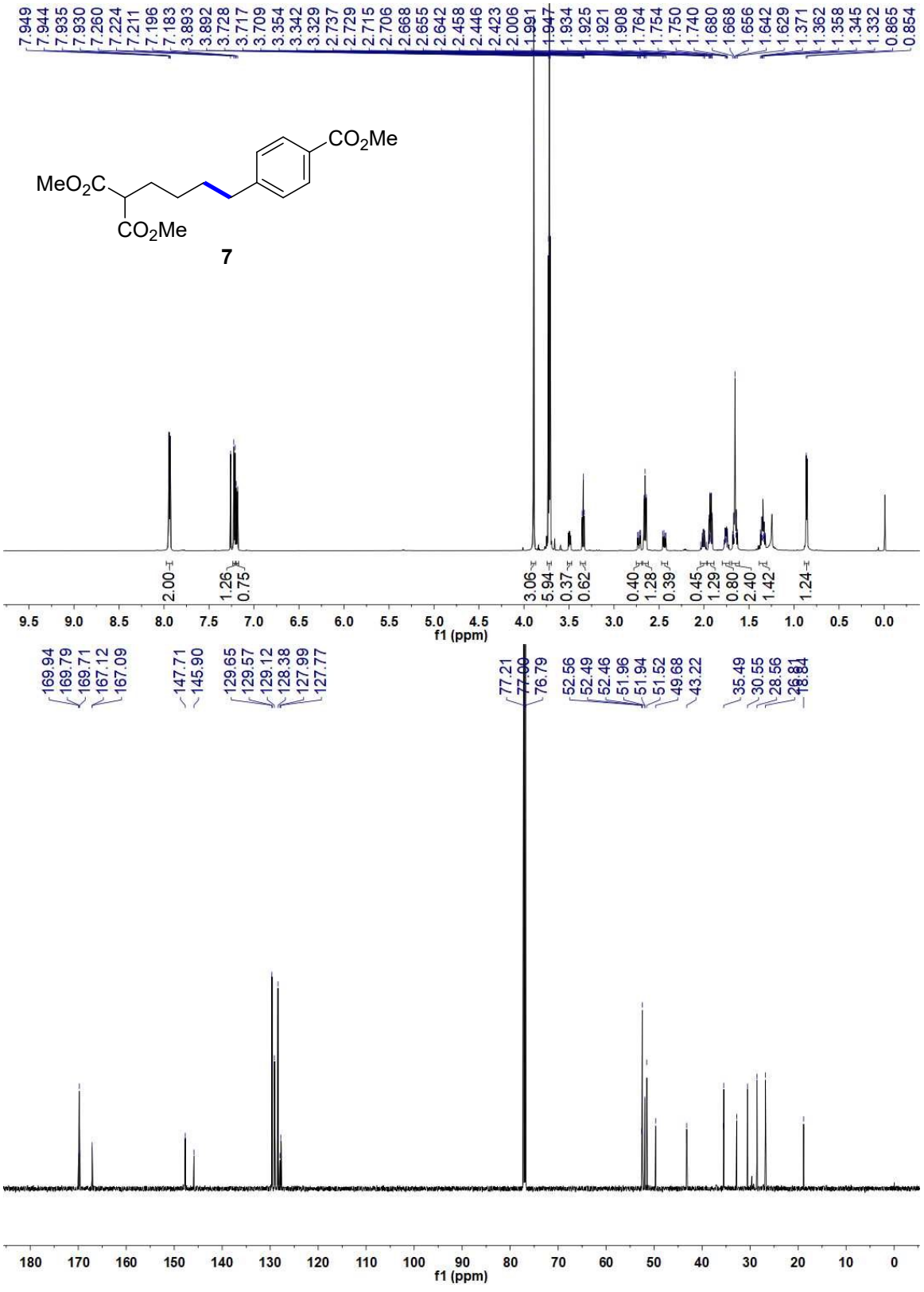
30.60
28.46
25.54
19.32
f1 (ppm)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7.183
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3.892
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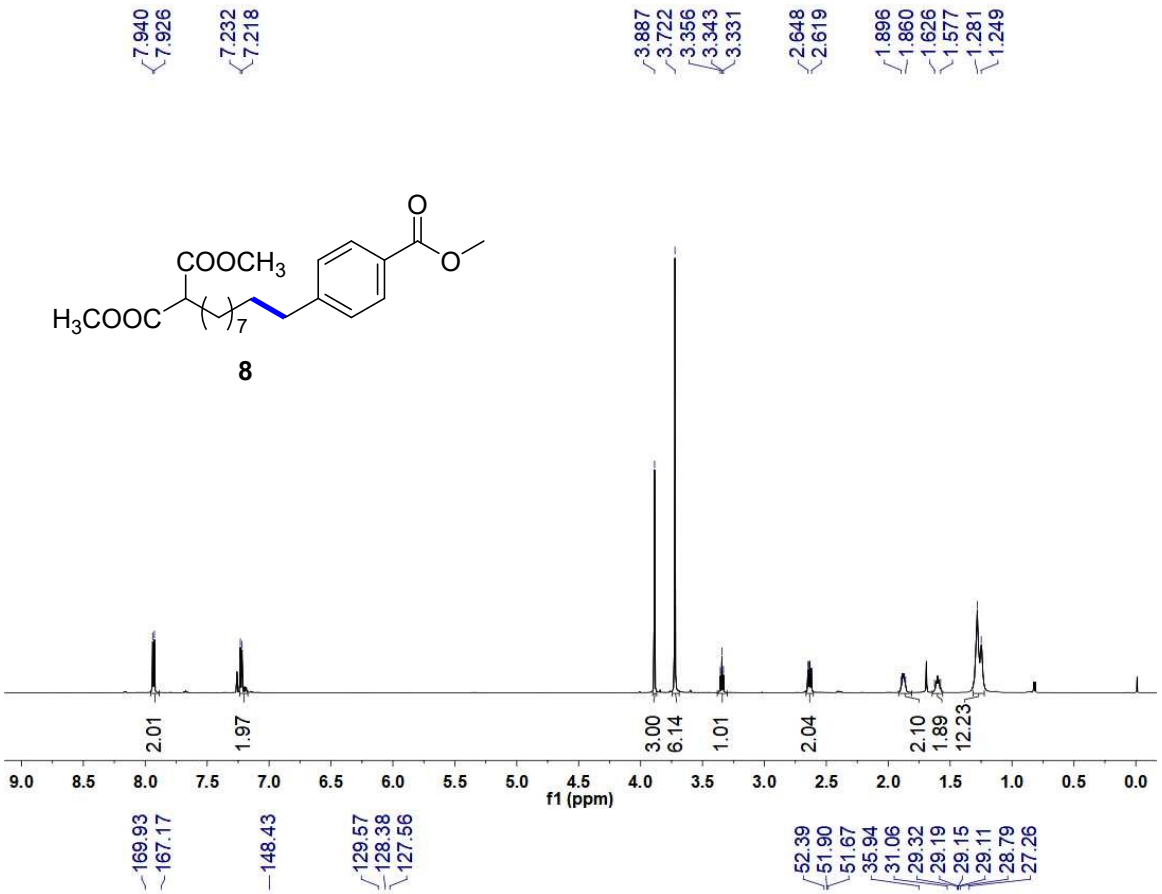
3.717
3.709
3.354
3.342
3.329
2.737
2.729
2.715
2.706
2.668
2.655
2.642
2.458
2.446
2.423
2.006
1.991
1.947
1.934
1.925
1.921
1.908
1.764
1.754
1.750
1.740
1.680
1.668
1.656
1.642
1.629
1.371
1.362
1.358
1.345
1.332
0.865
0.854
CO2Me
MeO2C
CO2Me
7
2.00
1.26
0.75
3.06
5.94
0.37
0.62
0.40
1.28
0.39
0.45
1.29
0.80
2.40
1.42
1.24
f1 (ppm)
169.94
169.79
169.71
167.12
167.09
147.71
145.90
129.65
129.57
129.12
128.38
127.99
127.77
77.21
77.00
76.79
52.56
52.49
52.46
51.96
51.94
51.52
49.68
43.22
35.49
30.55
28.56
f1 (ppm)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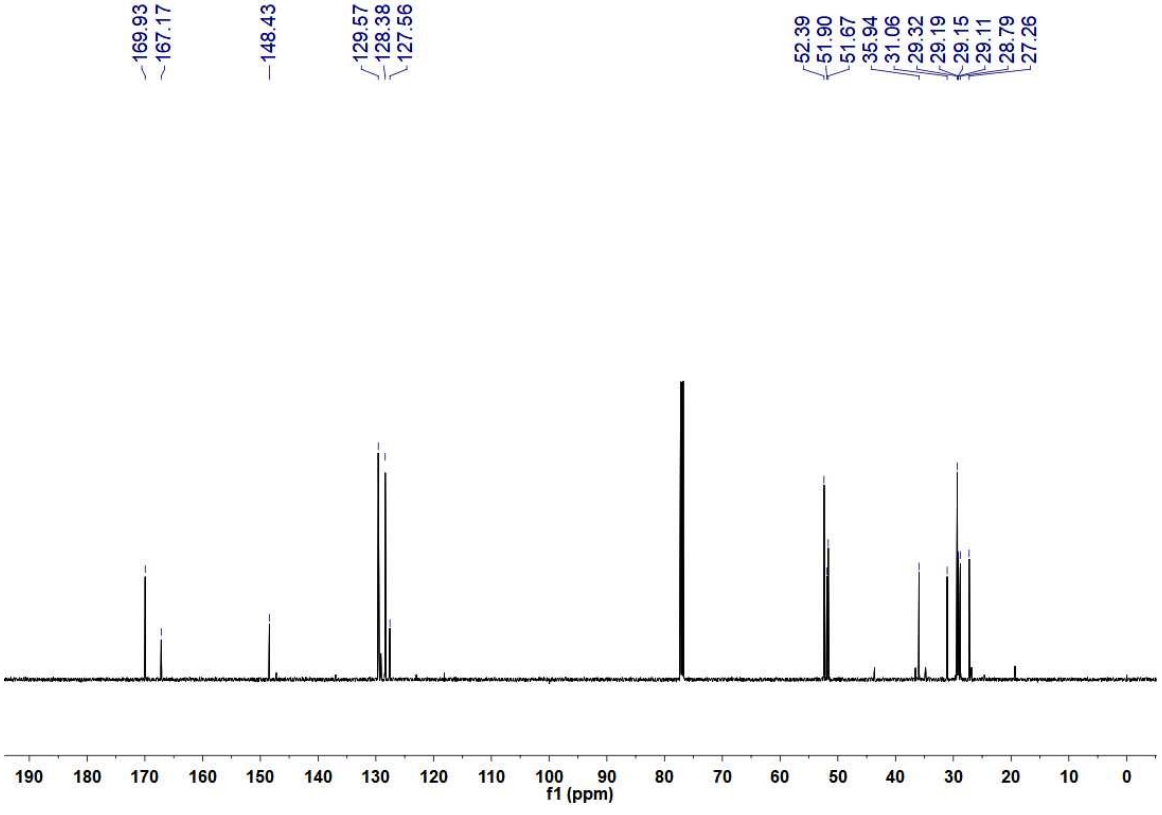
7.232
7.218
3.887
3.722
3.356
3.343
3.331
2.648
2.619
1.896
1.860
1.626
1.577
1.281
1.249
O
COOCH3
O
H3COOC
7
2.01
1.97
3.00
6.14
1.01
2.04
2.10
1.89
12.23
f1 (ppm)

8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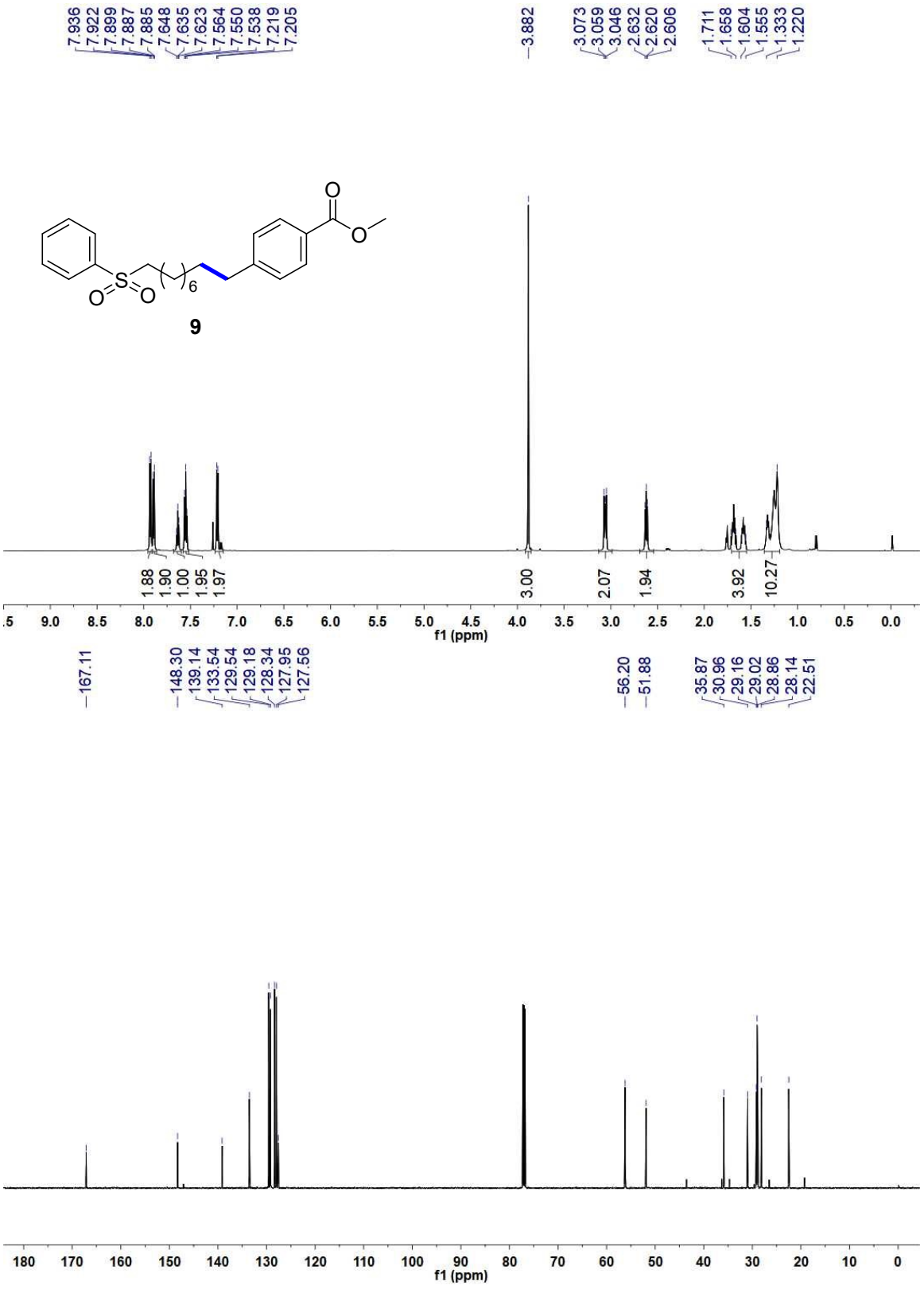
167.17
148.43
129.57
128.38
127.56
52.39
51.90
51.67
35.94
31.06
29.32
29.19
29.15
29.11
28.79
27.26
f1 (ppm)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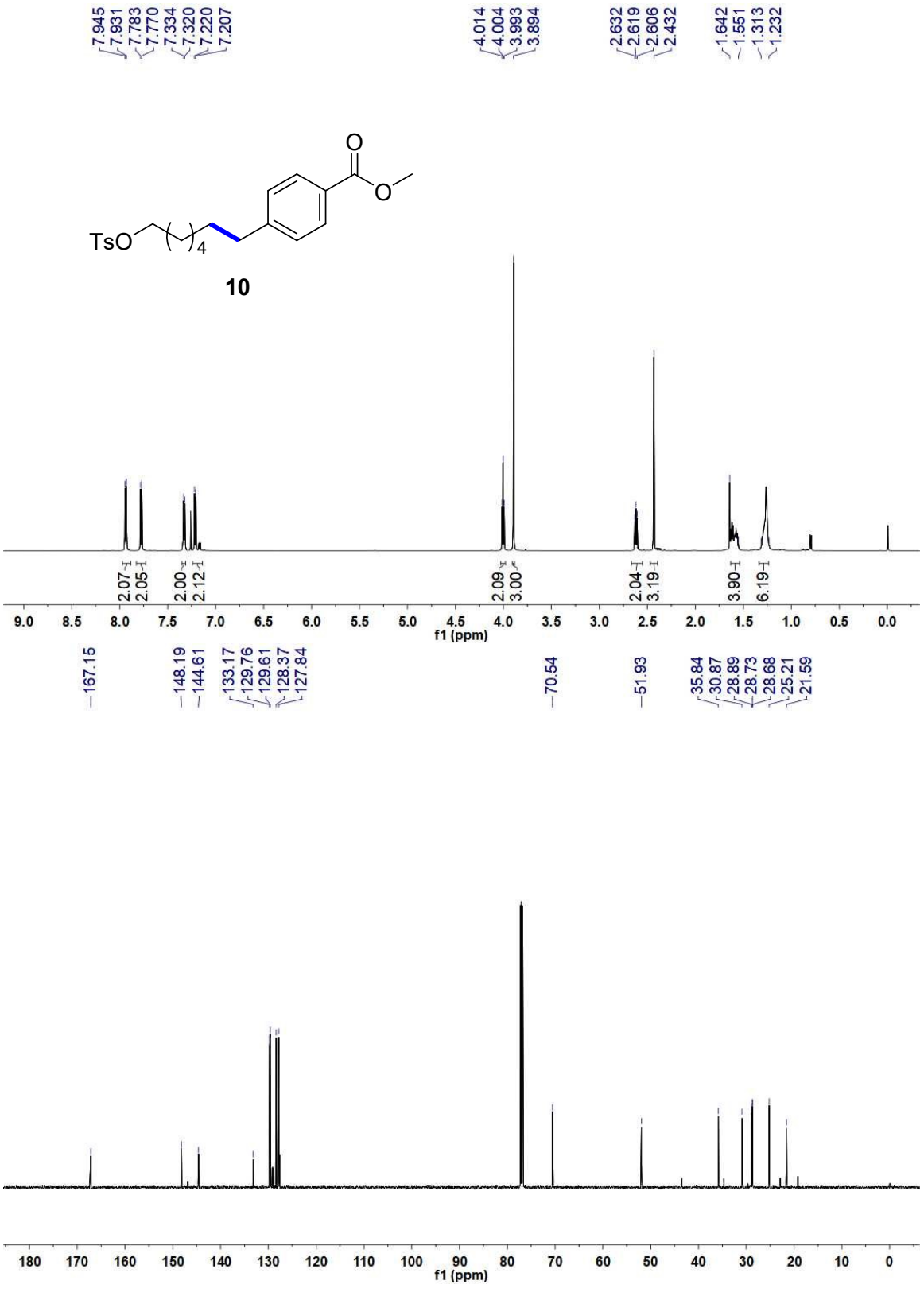
7.648
7.635
7.623
7.564
7.550
7.538
7.219
7.205
3.882
3.073
3.059
3.046
2.632
2.620
2.606
1.711
1.658
1.604
1.555
1.333
1.220
O
O
S
O
O
6
9
1.88
1.90
1.00
1.95
1.97
3.00
2.07
1.94
3.92
10.27
f1 (ppm)
167.11
148.30
139.14
133.54
129.54
129.18
128.34
127.95
127.56
56.20
51.88
35.87
30.96
29.16
29.02
28.86
28.14
22.51
f1 (ppm)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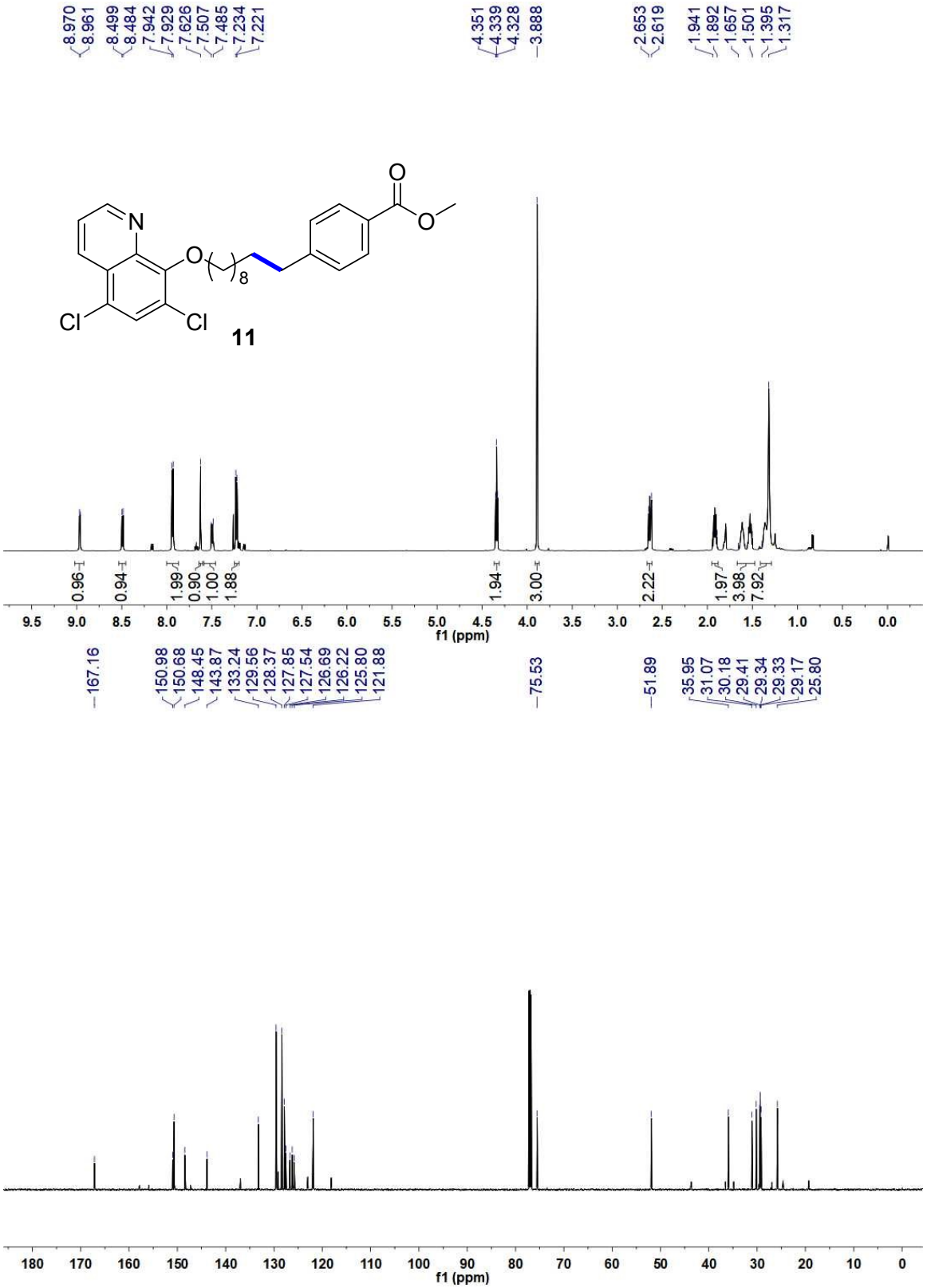
7.783
7.770
7.334
7.320
7.220
7.207
4.014
4.004
3.993
3.894
2.632
2.619
2.606
2.432
1.642
1.551
1.313
1.232
O
O
TsO
4
10
2.07
2.05
2.00
2.12
2.09
3.00
2.04
3.19
3.90
6.19
f1 (ppm)
167.15
148.19
144.61
133.17
129.76
129.61
128.37
127.84
70.54
51.93
35.84
30.87
28.89
28.73
28.68
25.21
21.59
f1 (ppm)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8.499
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7.942
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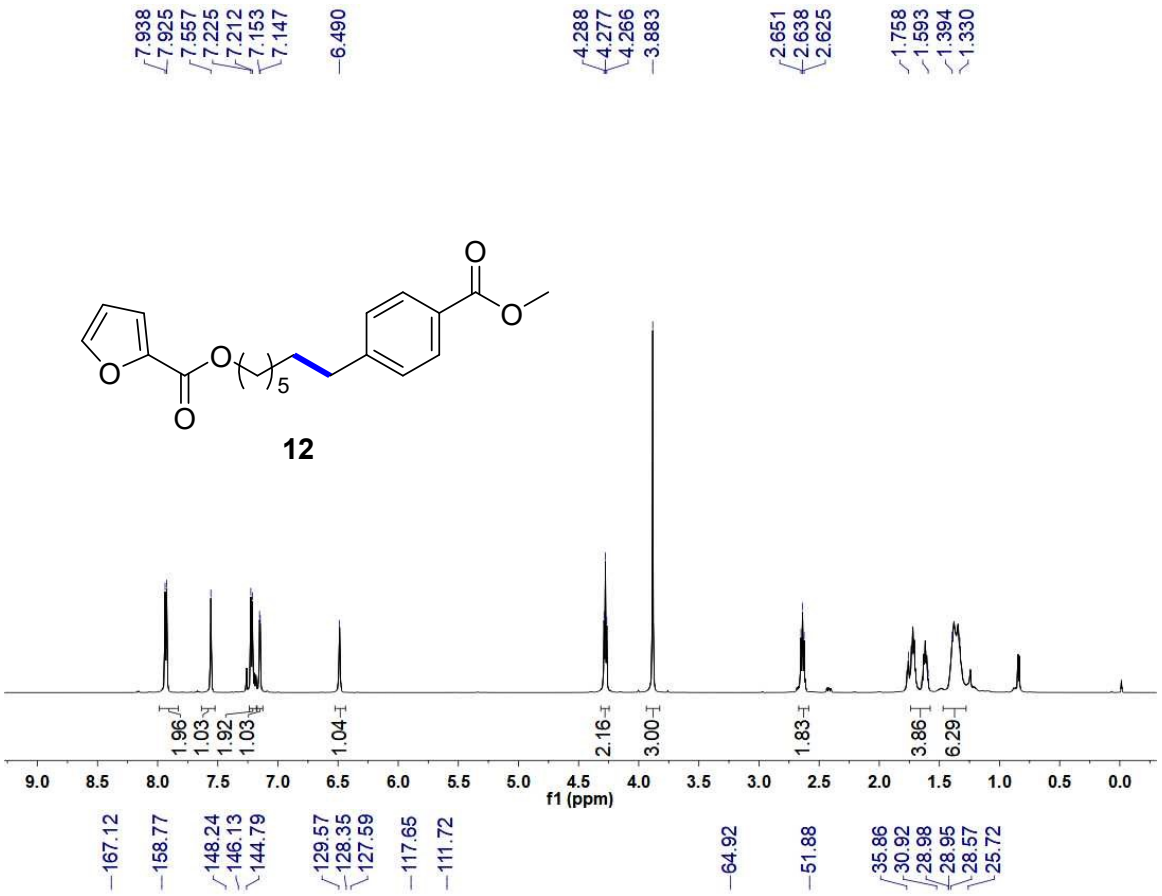
7.626
7.507
7.485
7.234
7.221
4.351
4.339
4.328
3.888
2.653
2.619
1.941
1.892
1.657
1.501
1.395
1.317
O
N
O
O
8
Cl
Cl
11
0.96
0.94
1.99
0.90
1.00
1.88
1.94
3.00
2.22
1.97
3.98
7.92
f1 (ppm)
167.16
150.98
150.68
148.45
143.87
133.24
129.56
128.37
127.85
127.54
126.69
126.22
125.80
121.88
75.53
51.89
35.95
31.07
30.18
29.41
29.34
29.33
29.17
25.80
f1 (ppm)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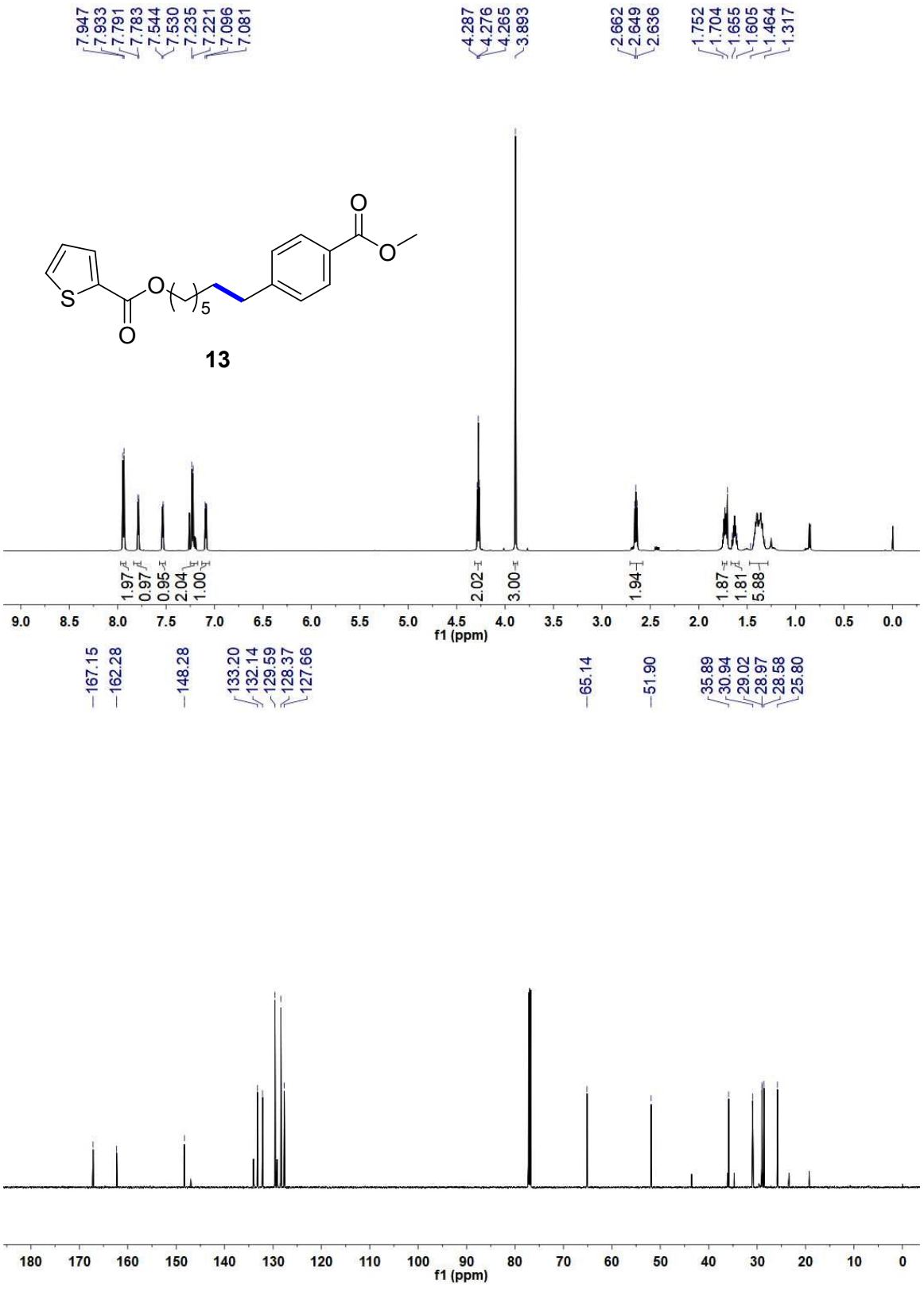
7.153
7.147
6.490
4.288
4.277
4.266
3.883
2.651
2.638
2.625
1.758
1.593
1.394
1.330
O
O
O
O
5
O
12
1.96
1.03
1.92
1.03
1.04
2.16
3.00
1.83
3.86
6.29
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)
167.12
158.77
148.24
146.13
144.79
129.57
128.35
127.59
117.65
111.72
64.92
51.88
35.86
30.92
28.98
28.95
28.57
25.72
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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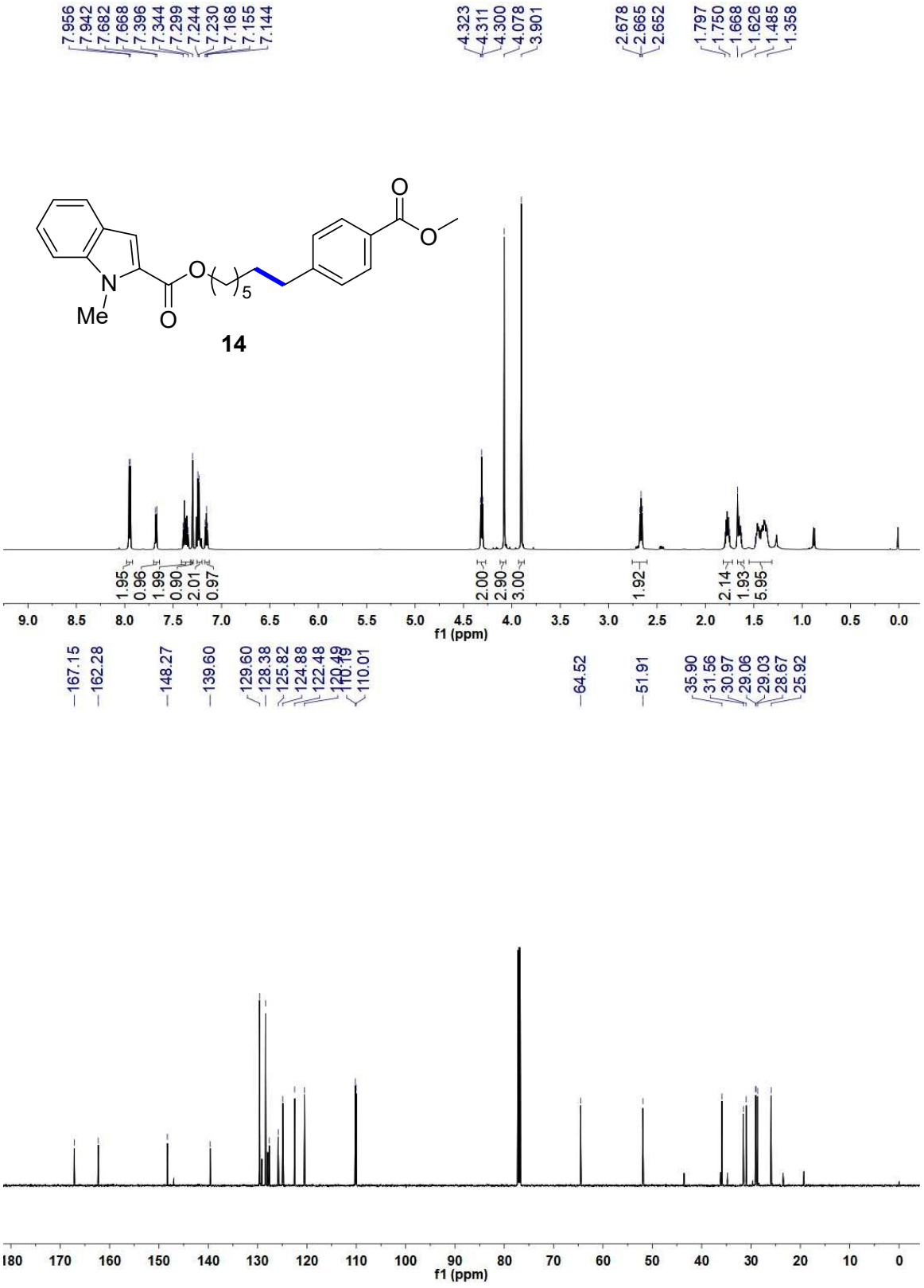
7.791
7.783
7.544
7.530
7.235
7.221
7.096
7.081
4.287
4.276
4.265
3.893
2.662
2.649
2.636
1.752
1.704
1.655
1.605
1.464
1.317
13
1.97
0.97
0.95
2.04
1.00
2.02
3.00
1.94
1.87
1.81
5.88
f1 (ppm)
167.15
162.28
148.28
133.20
132.14
129.59
128.37
127.66
65.14
51.90
35.89
30.94
29.02
28.97
28.58
25.80
f1 (ppm)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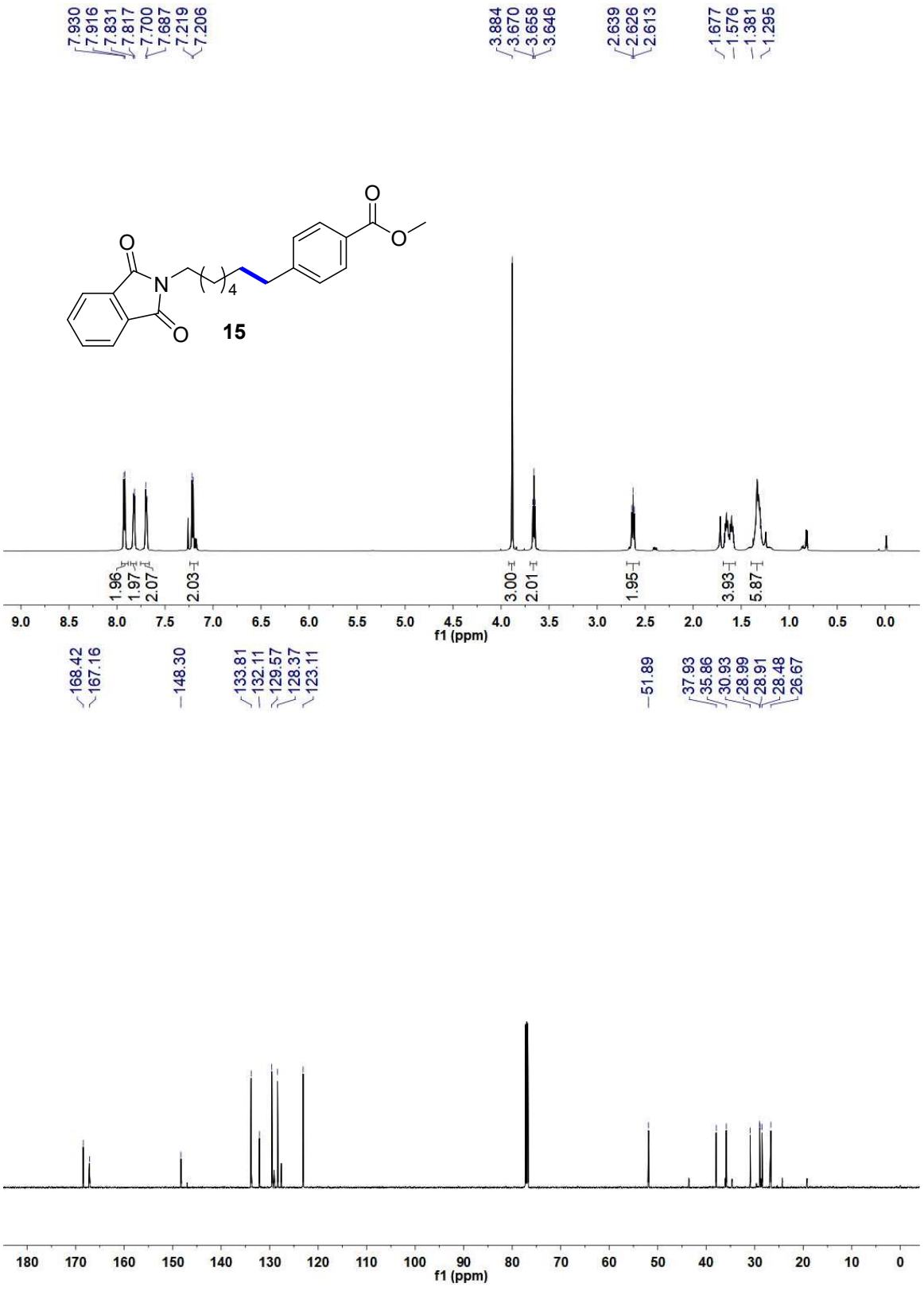
7.942
7.682
7.668
7.396
7.344
7.299
7.244
7.230
7.168
7.155
7.144
4.323
4.311
4.300
4.078
3.901
2.678
2.665
2.652
1.797
1.750
1.668
1.626
1.485
1.358
O
O
N
Me
O
O
5
O
14
1.95
0.96
1.99
0.90
2.01
0.97
2.00
2.90
3.00
1.92
2.14
1.93
5.95
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)
167.15
162.28
148.27
139.60
129.60
128.38
125.82
124.88
122.48
120.49
120.19
110.01
64.52
51.91
35.90
31.56
30.97
29.06
29.03
28.67
25.92
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.930
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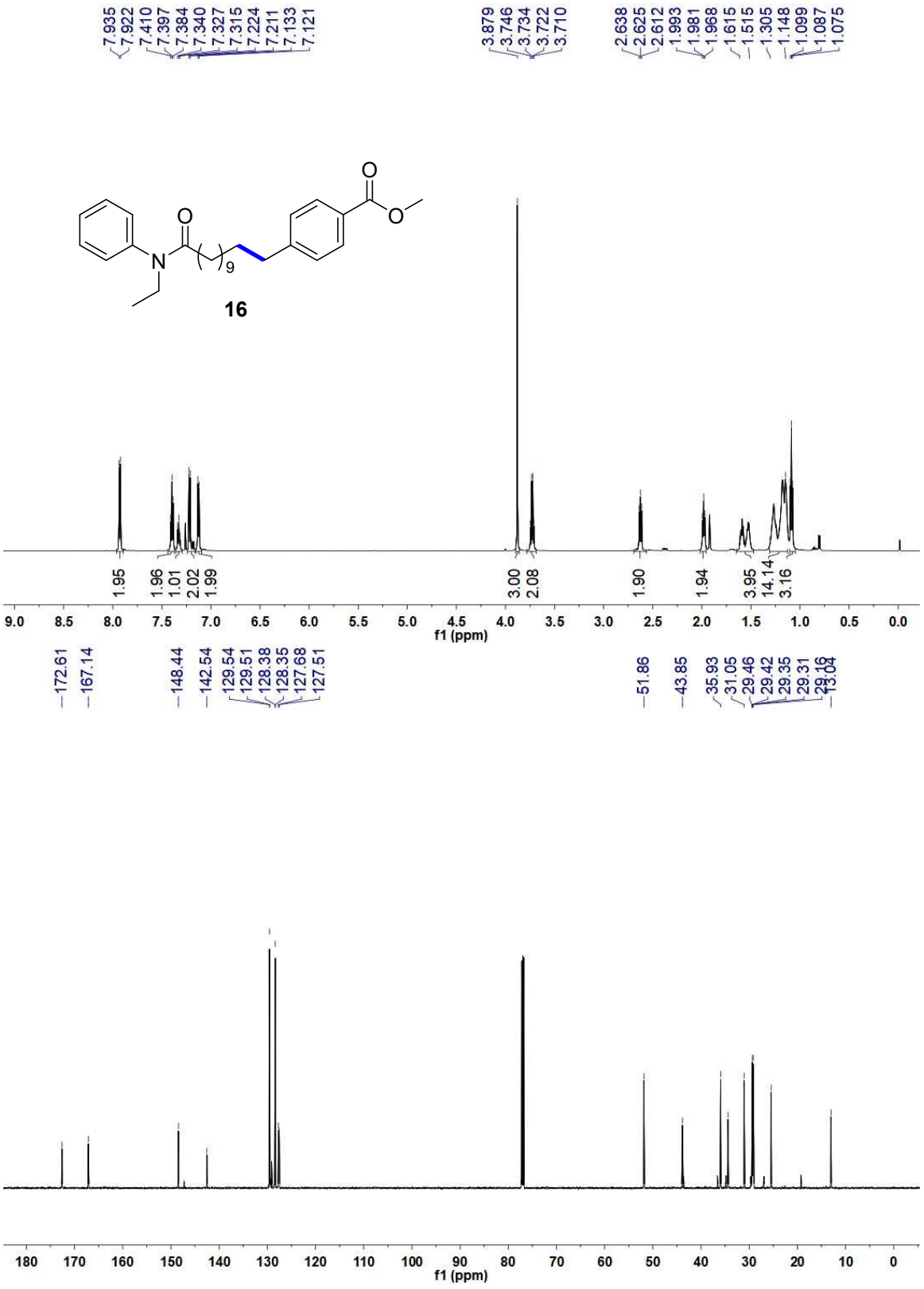
7.831
7.817
7.700
7.687
7.219
7.206
3.884
3.670
3.658
3.646
2.639
2.626
2.613
1.677
1.576
1.381
1.295
O
O
N
O
O
4
15
1.96
1.97
2.07
2.03
3.00
2.01
1.95
3.93
5.87
f1 (ppm)
168.42
167.16
148.30
133.81
132.11
129.57
128.37
123.11
51.89
37.93
35.86
30.93
28.99
28.91
28.48
26.67
f1 (ppm)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7.922
7.410
7.397
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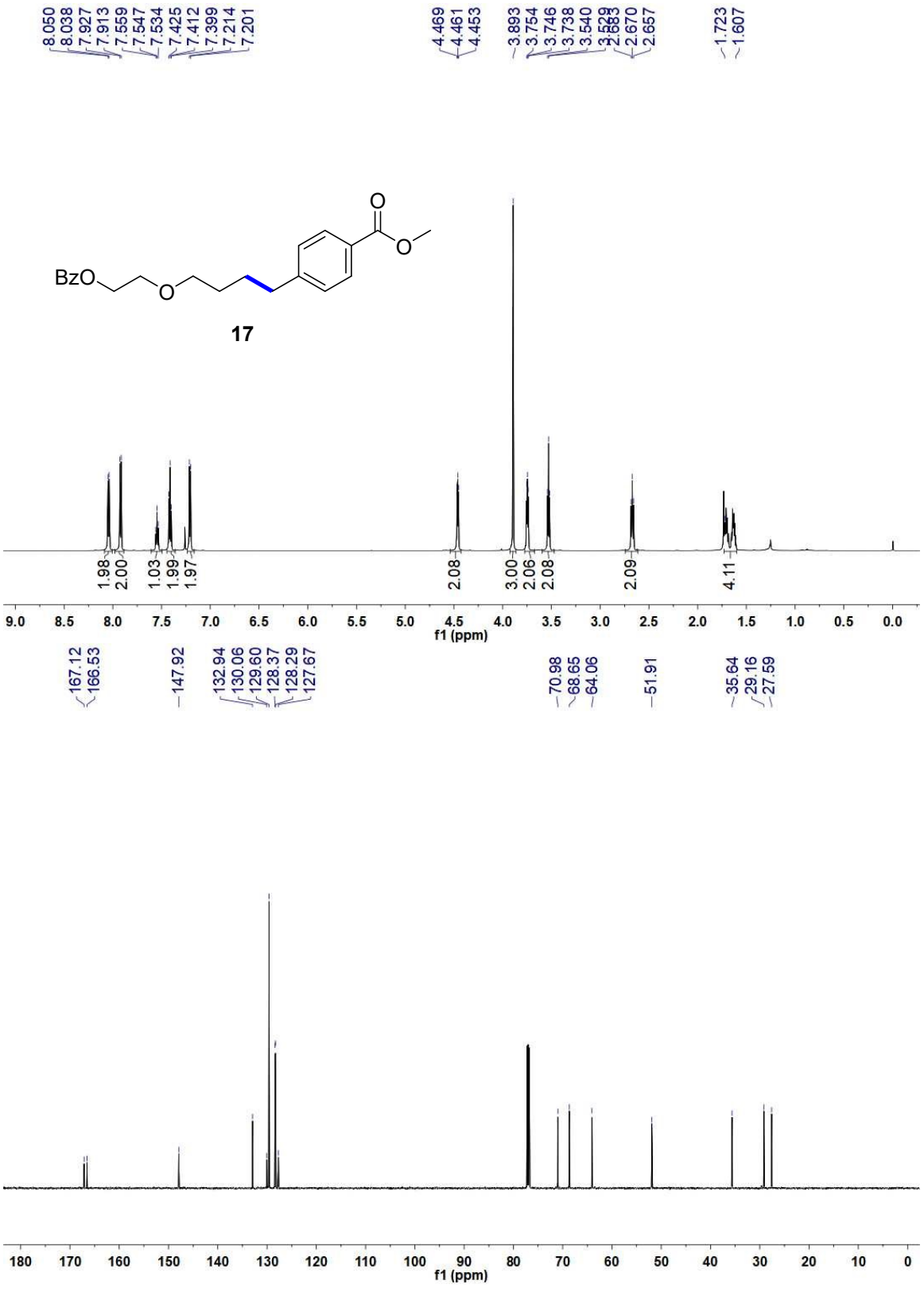
7.340
7.327
7.315
7.224
7.211
7.133
7.121
3.879
3.746
3.734
3.722
3.710
2.638
2.625
2.612
1.993
1.981
1.968
1.615
1.515
1.305
1.148
1.099
1.087
1.075
O
O
O
N
9
16
1.95
1.96
1.01
2.02
1.99
3.00
2.08
1.90
1.94
3.95
14.14
3.16
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
172.61
167.14
148.44
142.54
129.54
129.51
128.38
128.35
127.68
127.51
51.86
43.85
35.93
31.05
29.46
29.42
29.35
29.31
29.16
13.04
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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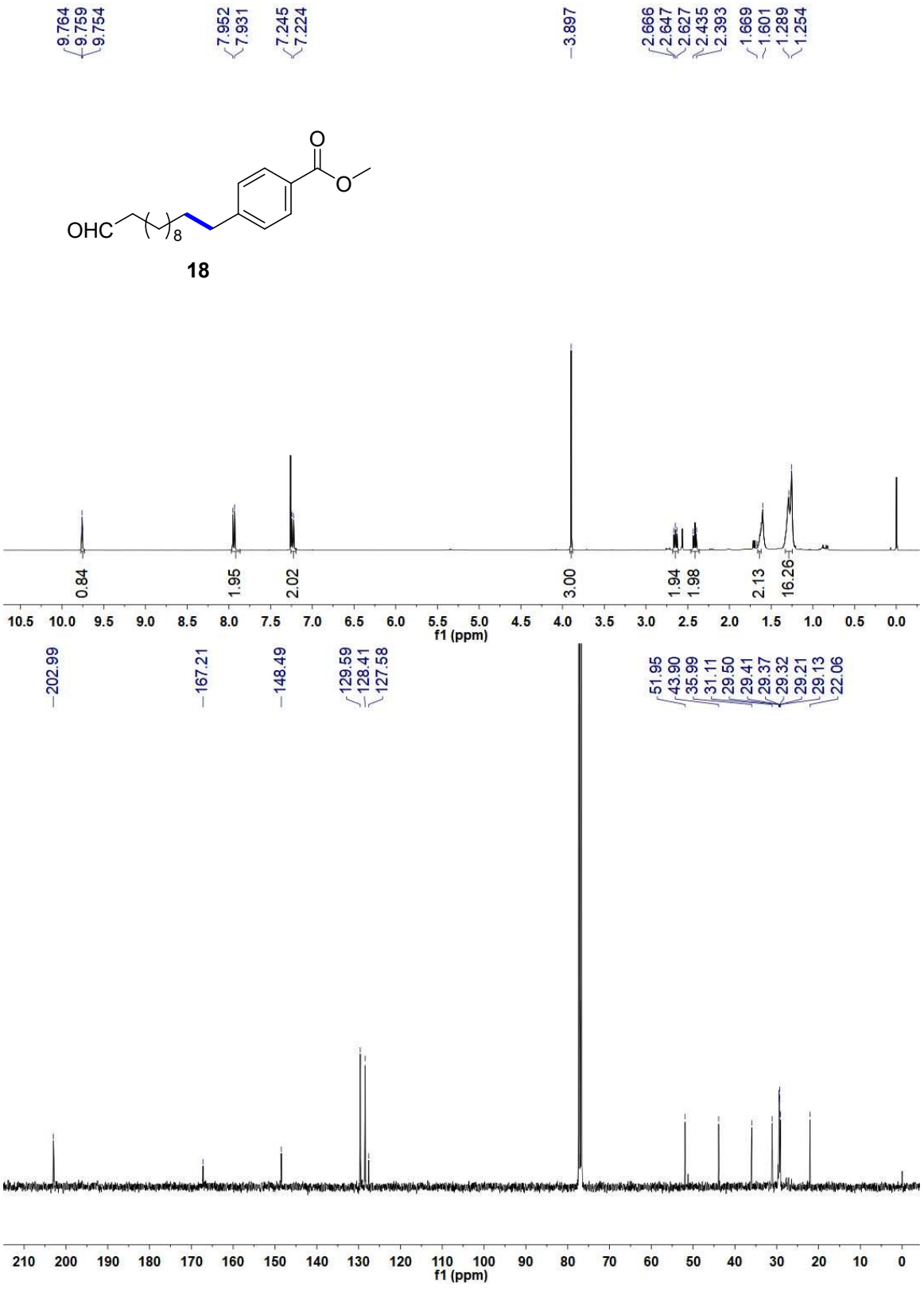
8.038
7.927
7.913
7.559
7.547
7.534
7.425
7.412
7.399
7.214
7.201
4.469
4.461
4.453
3.893
3.754
3.746
3.738
3.540
2.670
2.657
1.723
1.607
BzO
O
O
O
17
1.98
2.00
1.03
1.99
1.97
2.08
3.00
2.06
2.08
2.09
4.11
f1 (ppm)
167.12
166.53
147.92
132.94
130.06
129.60
128.37
128.29
127.67
70.98
68.65
64.06
51.91
35.64
29.16
27.59
f1 (ppm)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2.666
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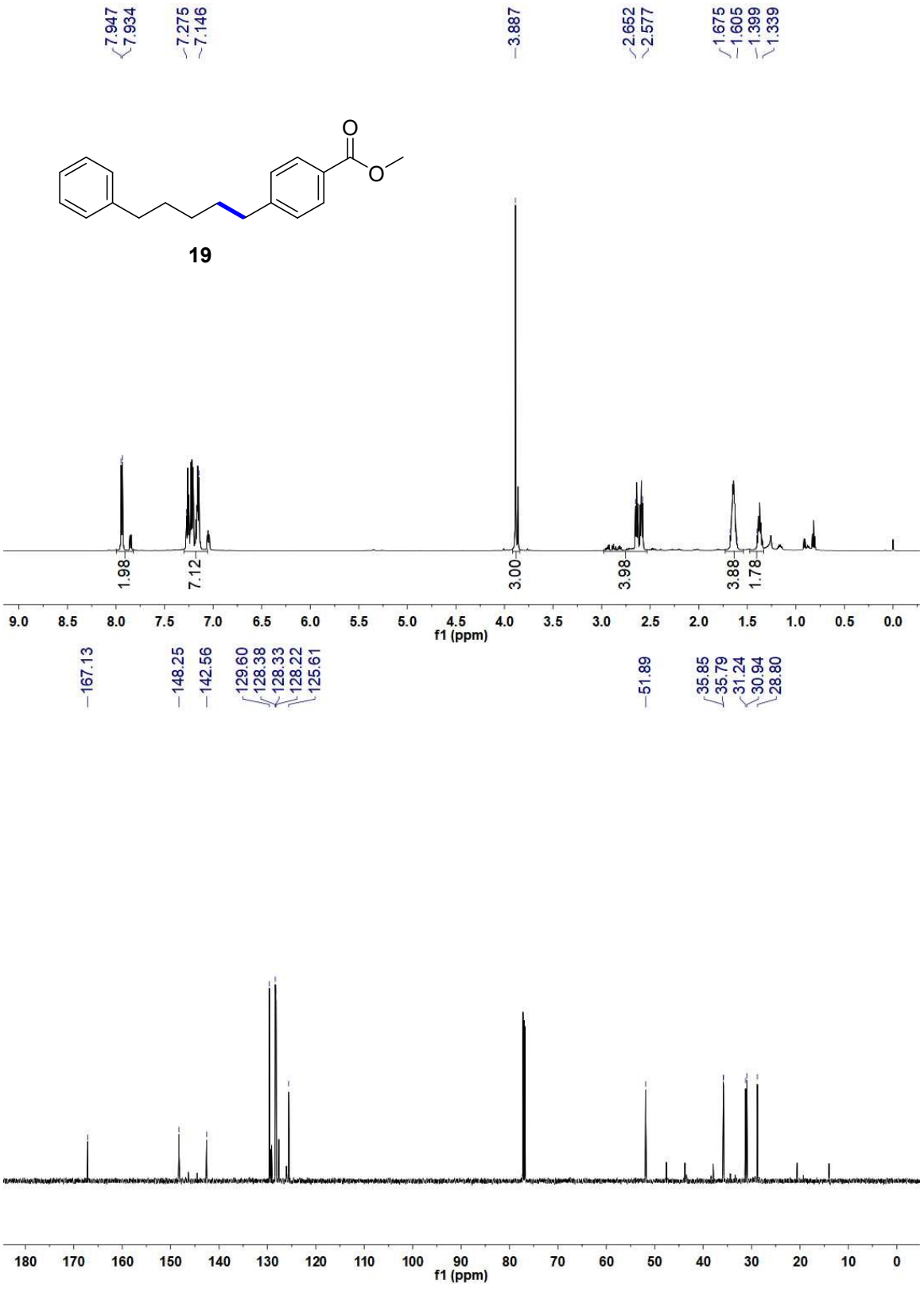
2.435
2.393
1.669
1.601
1.289
1.254
O
O
OHC
8
18
0.84
1.95
2.02
3.00
1.94
1.98
2.13
16.26
f1 (ppm)
202.99
167.21
148.49
129.59
128.41
127.58
51.95
43.90
35.99
31.11
29.50
29.41
29.37
29.32
29.21
29.13
22.06
f1 (ppm)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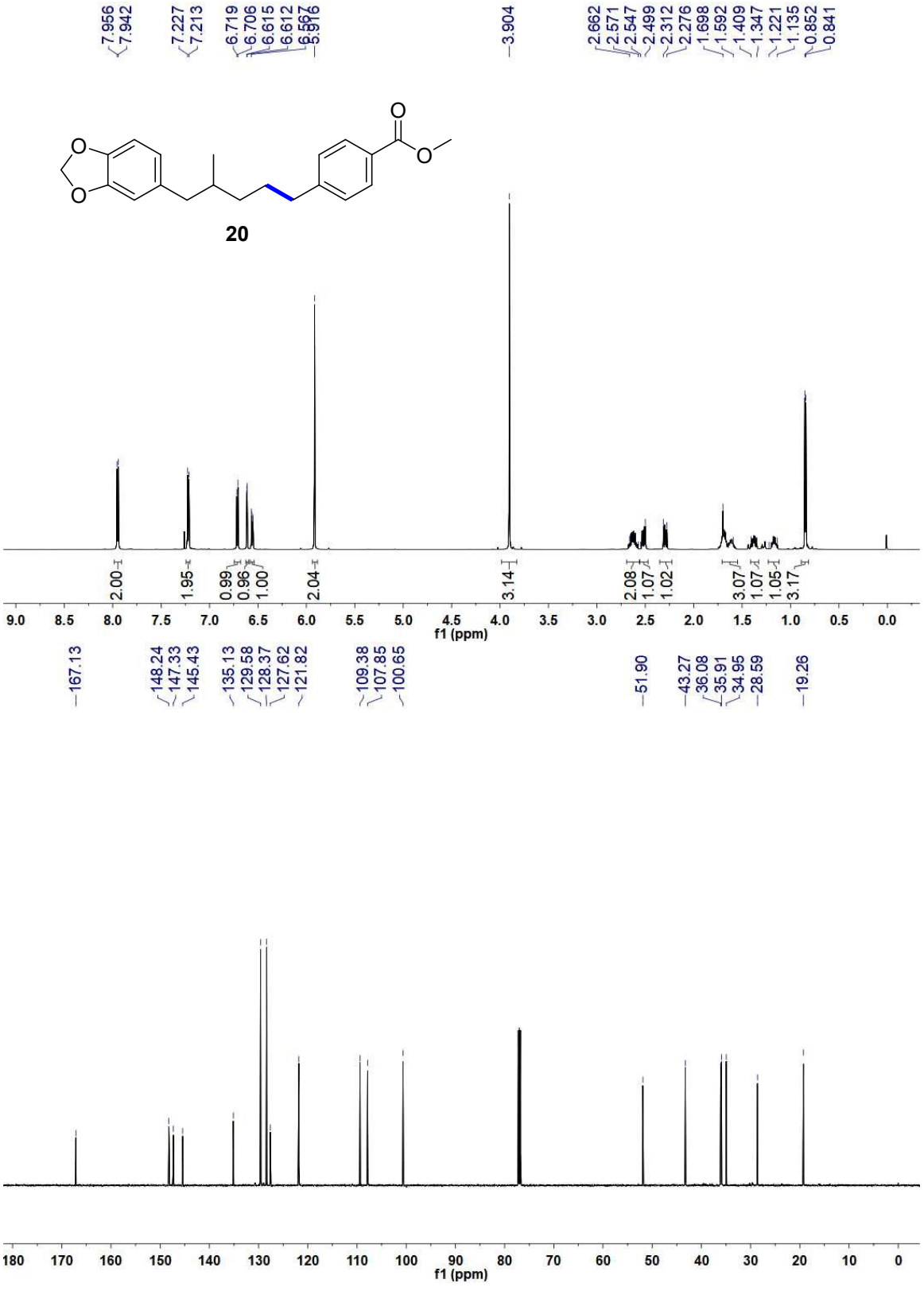
2.652
2.577
1.675
1.605
1.399
1.339
O
O
19
1.98
7.12
3.00
3.98
3.88
1.78
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
167.13
148.25
142.56
129.60
128.38
128.33
128.22
125.61
51.89
35.85
35.79
31.24
30.94
28.80
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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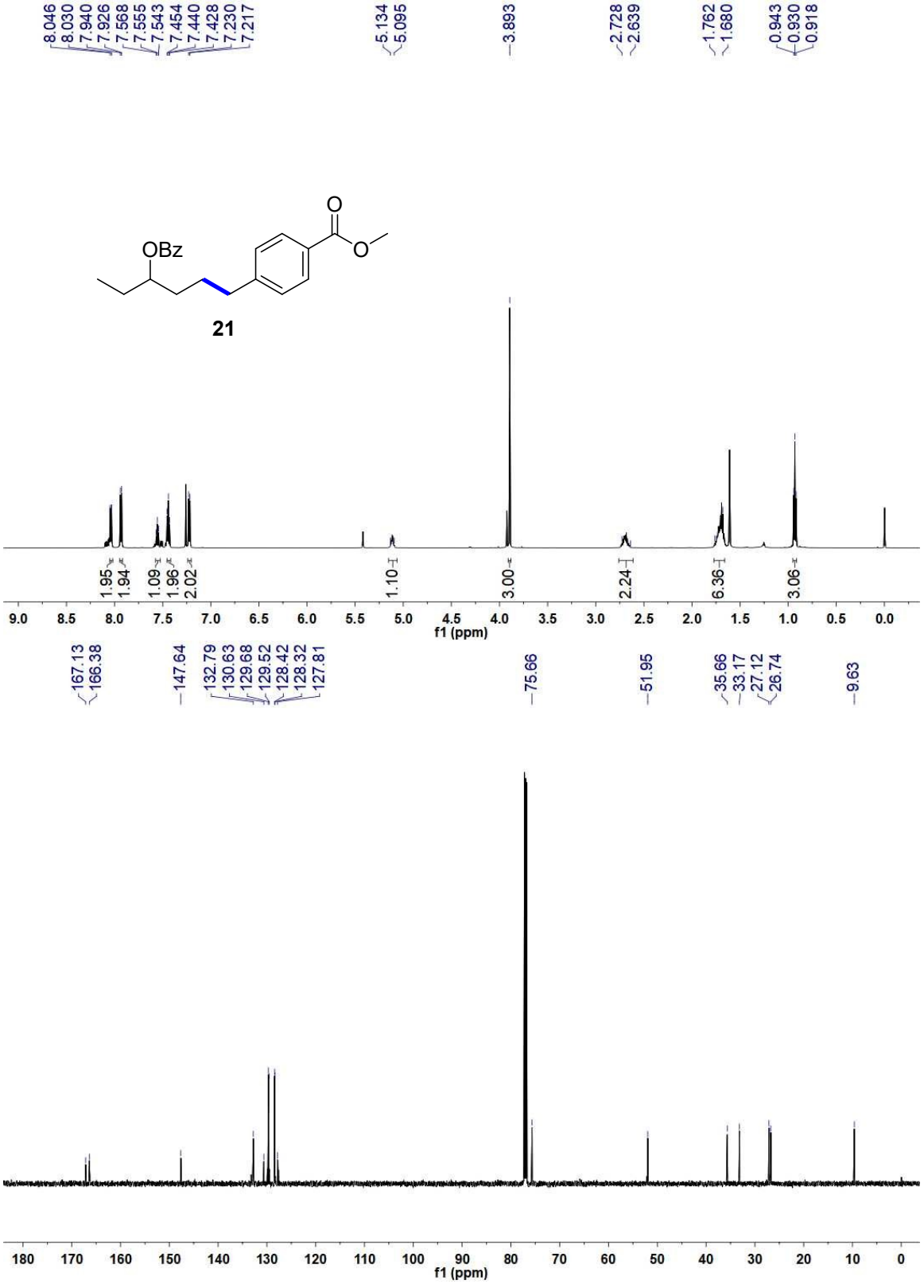
7.227
7.213
6.719
6.706
6.615
6.612
5.916
3.904
2.662
2.571
2.547
2.499
2.312
2.276
1.698
1.592
1.409
1.347
1.221
1.135
0.852
0.841
O
O
O
O
20
2.00
1.95
0.99
0.96
1.00
2.04
3.14
2.08
1.07
1.02
3.07
1.07
1.05
3.17
f1 (ppm)
167.13
148.24
147.33
145.43
135.13
129.58
128.37
127.62
121.82
109.38
107.85
100.65
51.90
43.27
36.08
35.91
34.95
28.59
19.26
f1 (ppm)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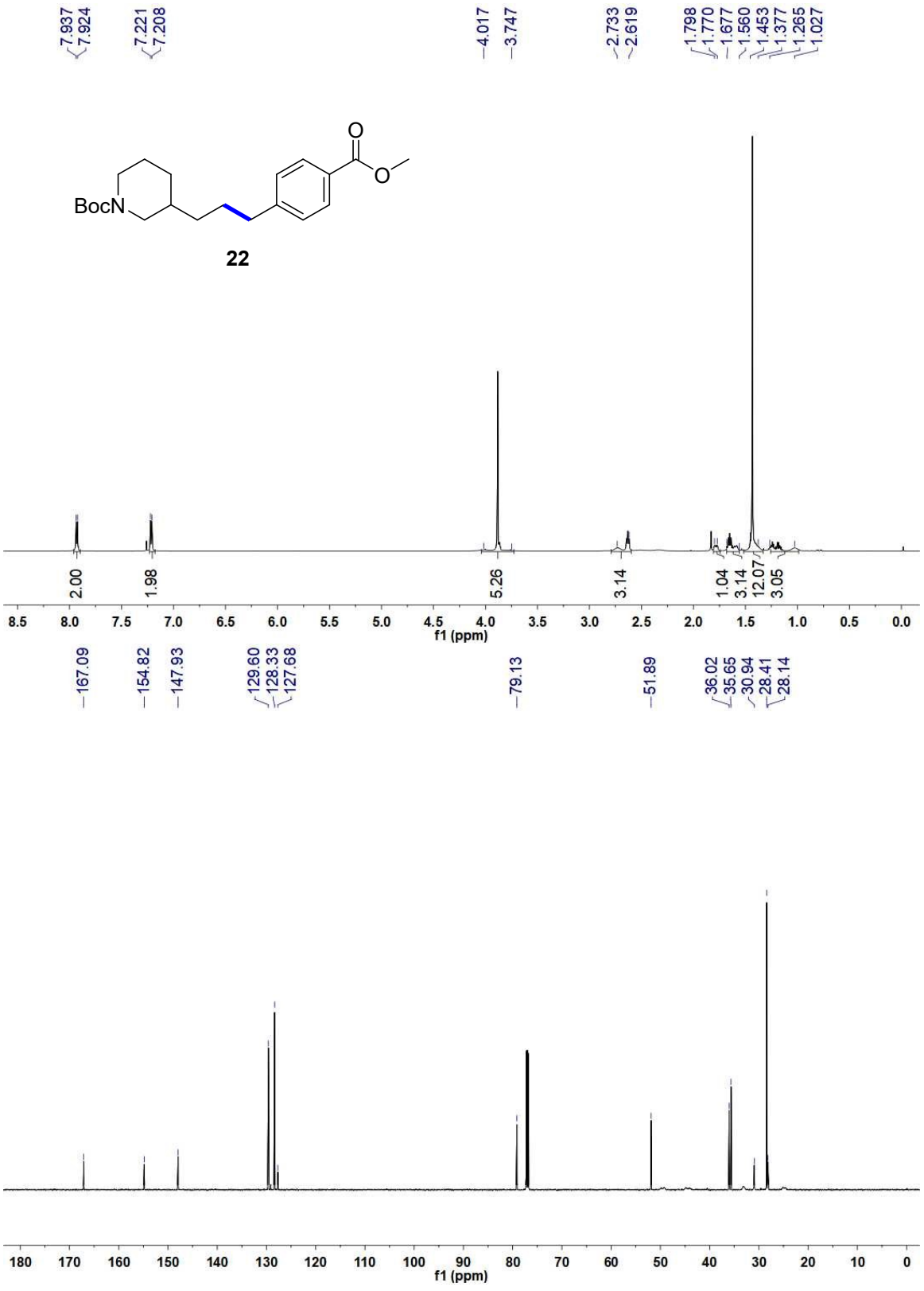
7.428
7.230
7.217
5.134
5.095
3.893
2.728
2.639
1.762
1.680
0.943
0.930
0.918
O
OBz
O
21
1.95
1.94
1.09
1.96
2.02
1.10
3.00
2.24
6.36
3.06
f1 (ppm)
167.13
166.38
147.64
132.79
130.63
129.68
129.52
128.42
128.32
127.81
75.66
51.95
35.66
33.17
27.12
26.74
9.63
f1 (ppm)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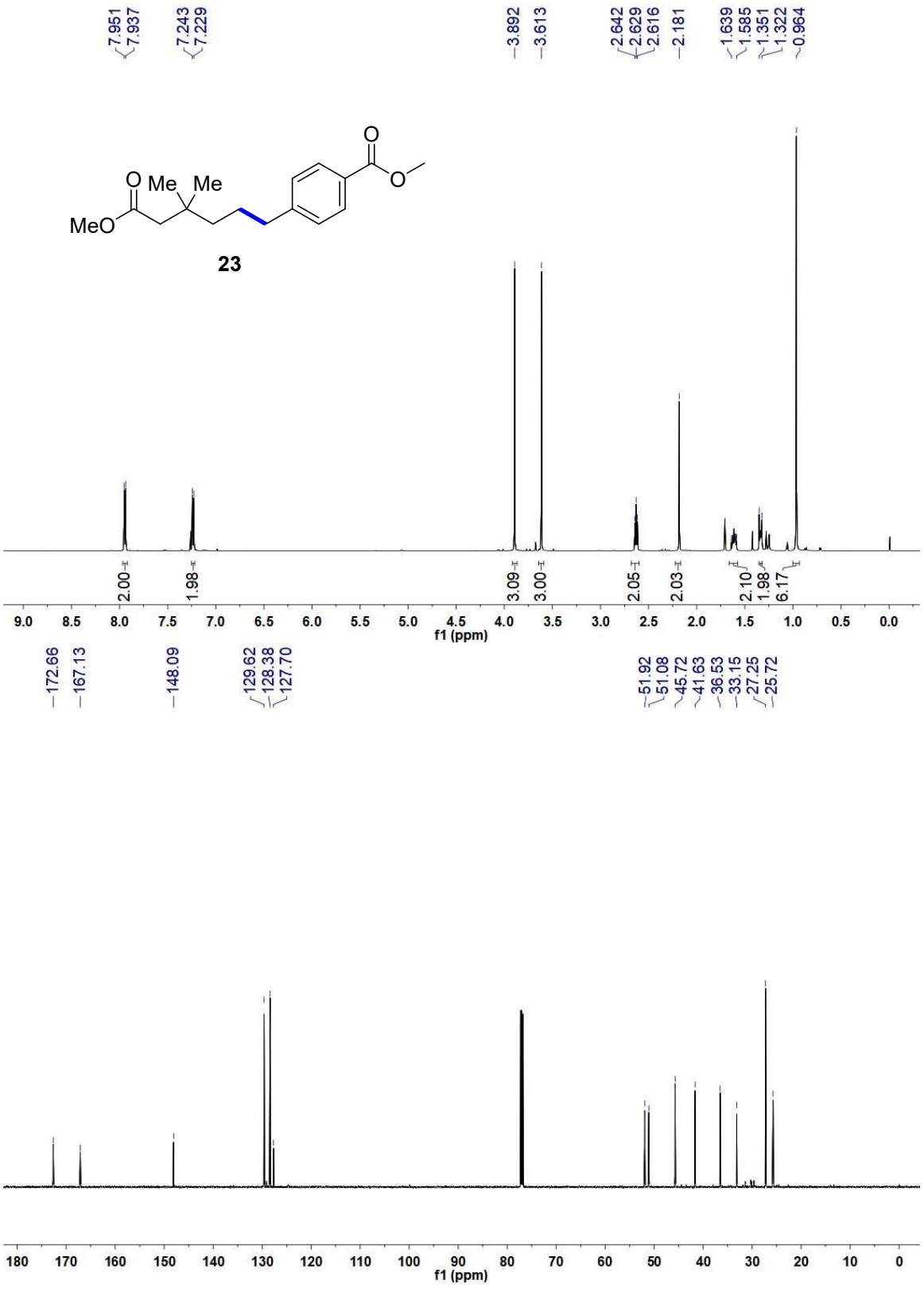
3.747
2.733
2.619
1.798
1.770
1.677
1.560
1.453
1.377
1.265
1.027
O
O
BocN
22
2.00
1.98
5.26
3.14
1.04
3.14
12.07
3.05
f1 (ppm)
167.09
154.82
147.93
129.60
128.33
127.68
79.13
51.89
36.02
35.65
30.94
28.41
28.14
f1 (ppm)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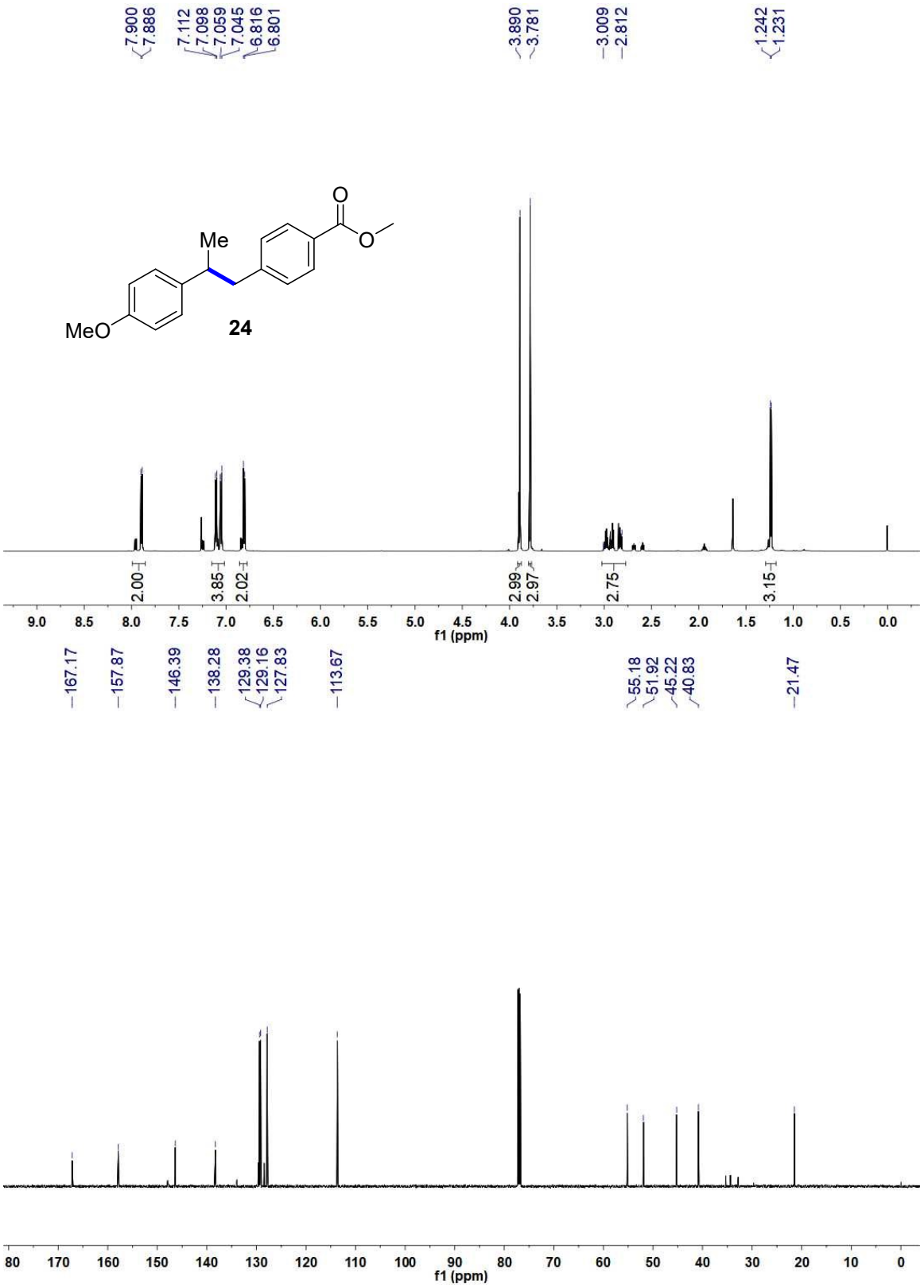
7.229
3.892
3.613
2.642
2.629
2.616
2.181
1.639
1.585
1.351
1.322
0.964
O
O
Me
Me
MeO
O
23
2.00
1.98
3.09
3.00
2.05
2.03
2.10
1.98
6.17
f1 (ppm)
172.66
167.13
148.09
129.62
128.38
127.70
51.92
51.08
45.72
41.63
36.53
33.15
27.25
25.72
f1 (ppm)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7.045
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6.801
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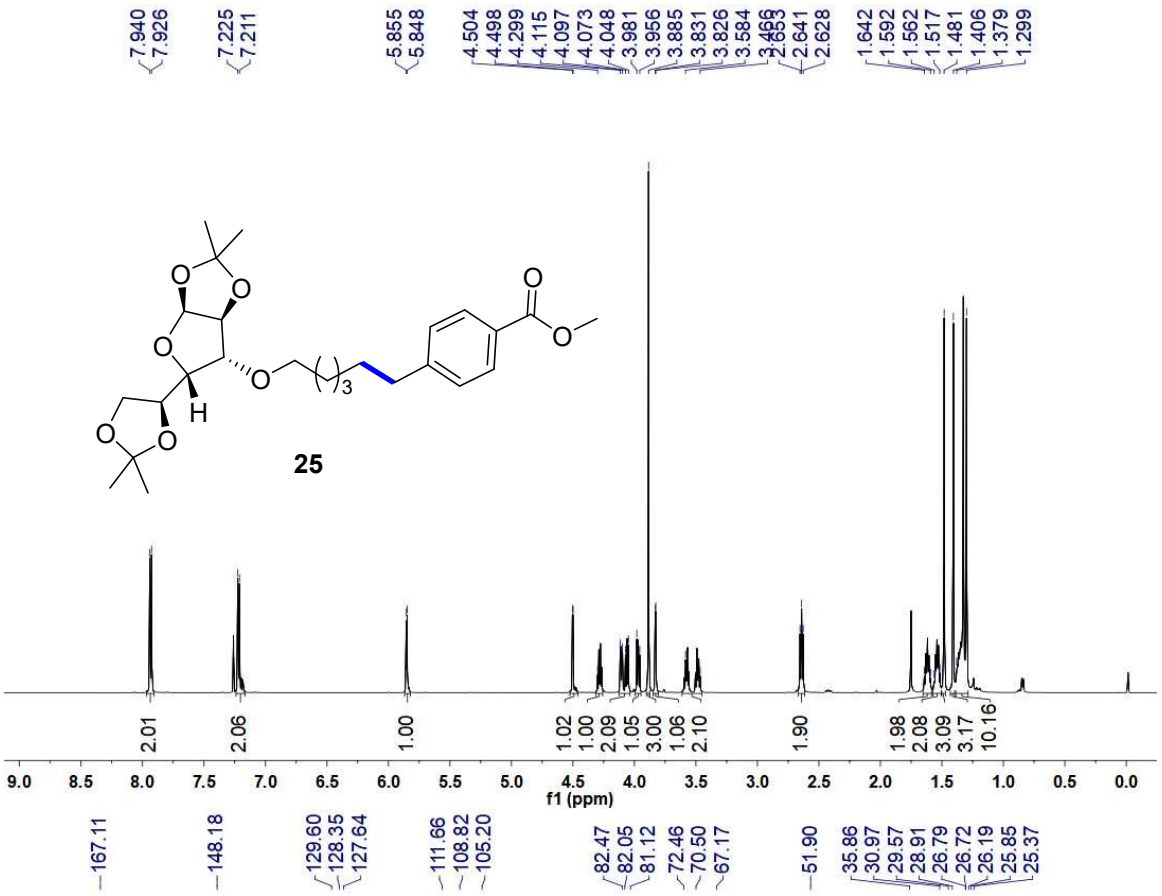
3.781
3.009
2.812
1.242
1.231
O
O
Me
MeO
24
2.00
3.85
2.02
2.99
2.97
2.75
3.15
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
167.17
157.87
146.39
138.28
129.38
129.16
127.83
113.67
55.18
51.92
45.22
40.83
21.47
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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4.504
4.498
4.299
4.115
4.097
4.073
4.048
3.981
3.956
3.885
3.831
3.826
3.584
2.641
2.628
1.642
1.592
1.562
1.517
1.481
1.406
1.379
1.299
O
O
O
O
O
H
O
O
O
3
25
2.01
2.06
1.00
1.02
1.00
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1.06
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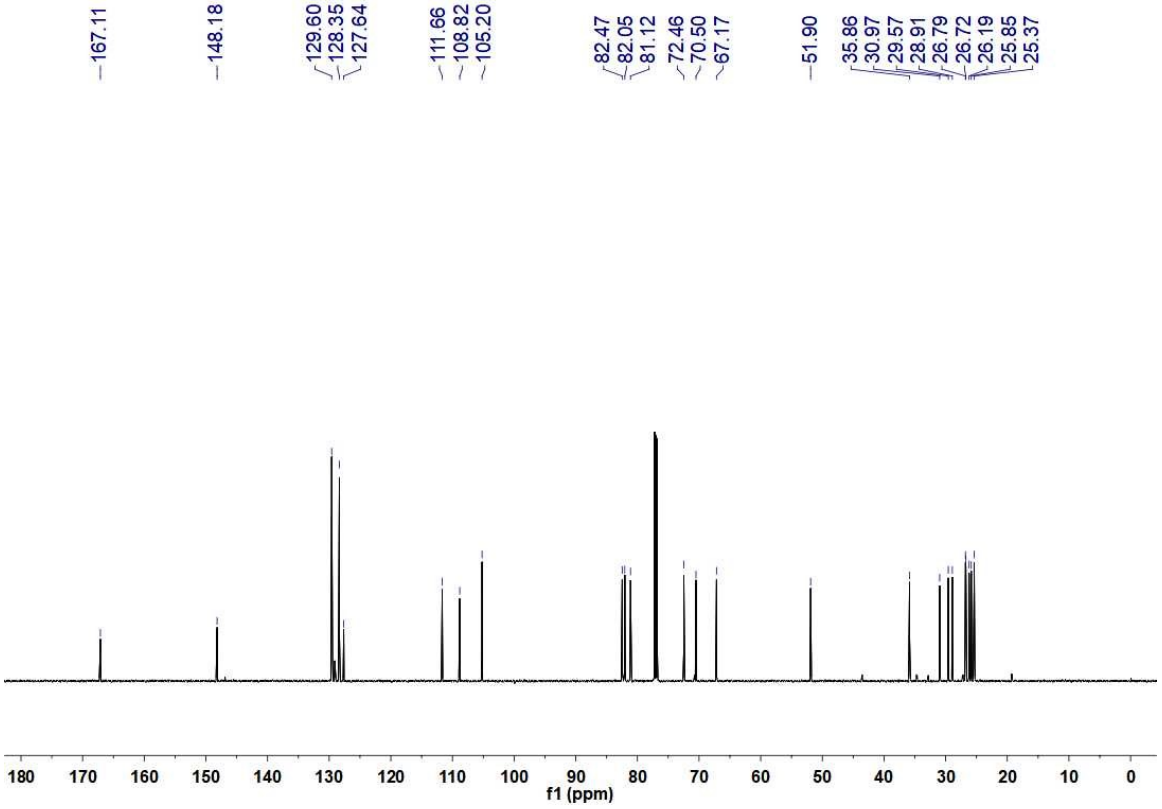
1.98
2.08
3.09
3.17
10.16
f1 (ppm)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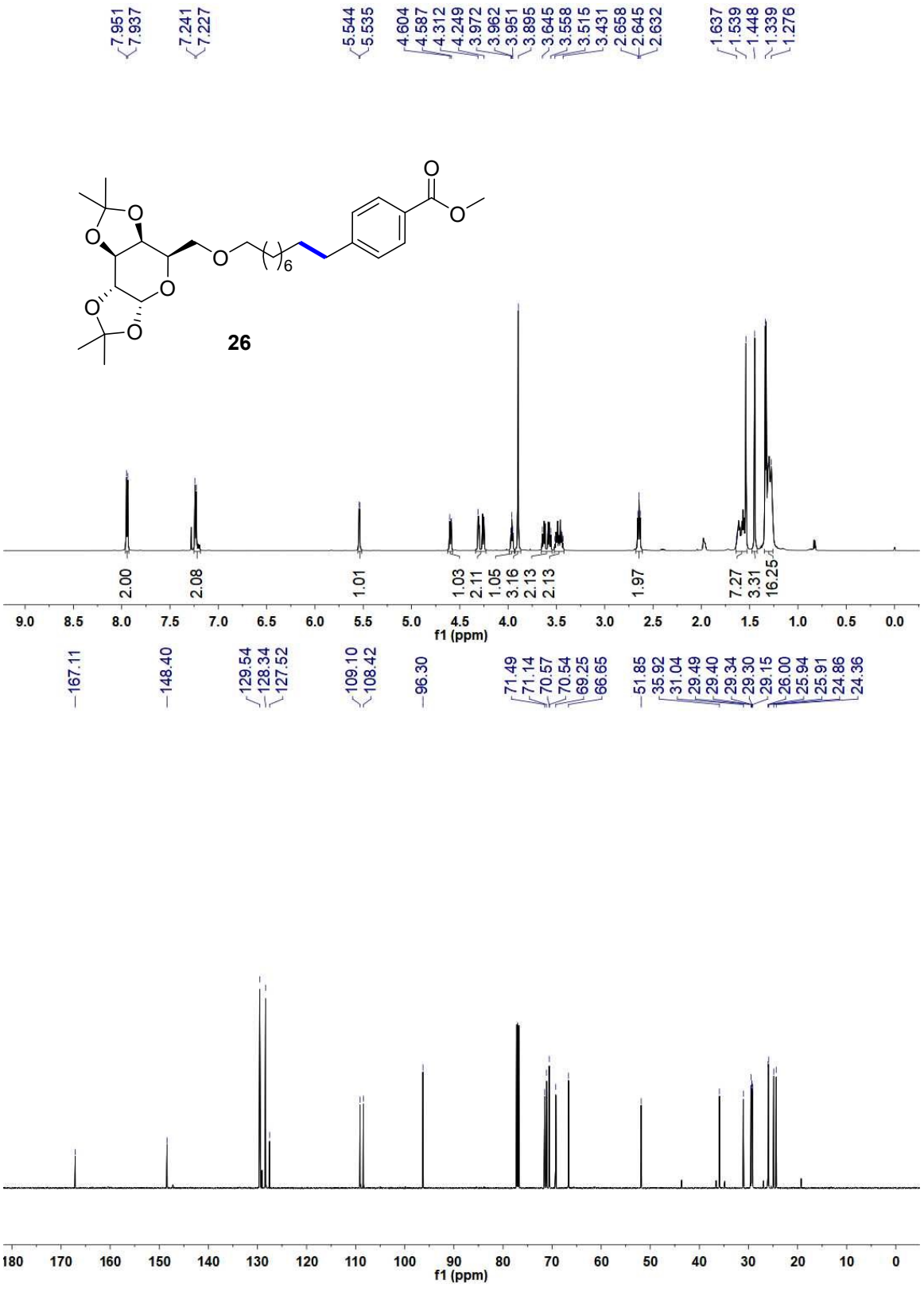
128.35
127.64
111.66
108.82
105.20
82.47
82.05
81.12
72.46
70.50
67.17
51.90
35.86
30.97
29.57
28.91
26.79
26.72
26.19
25.85
25.37
f1 (ppm)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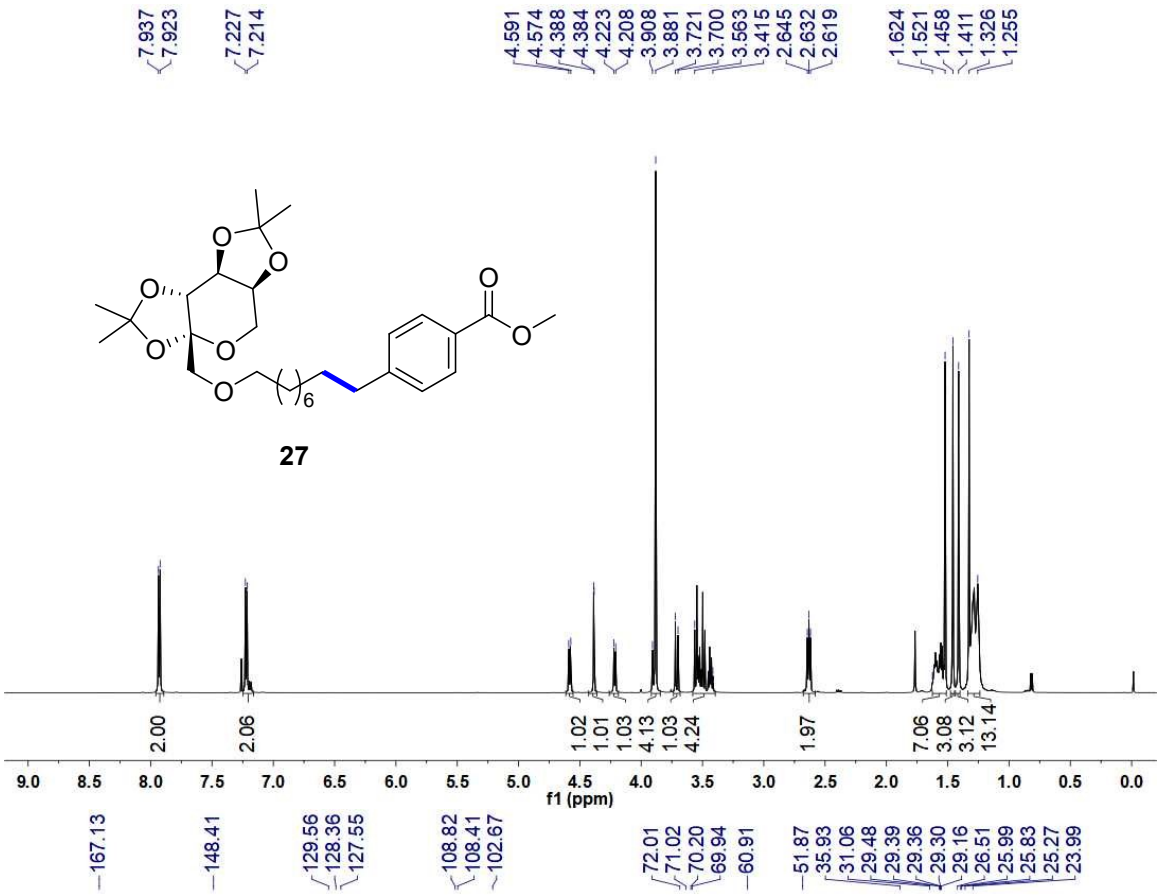
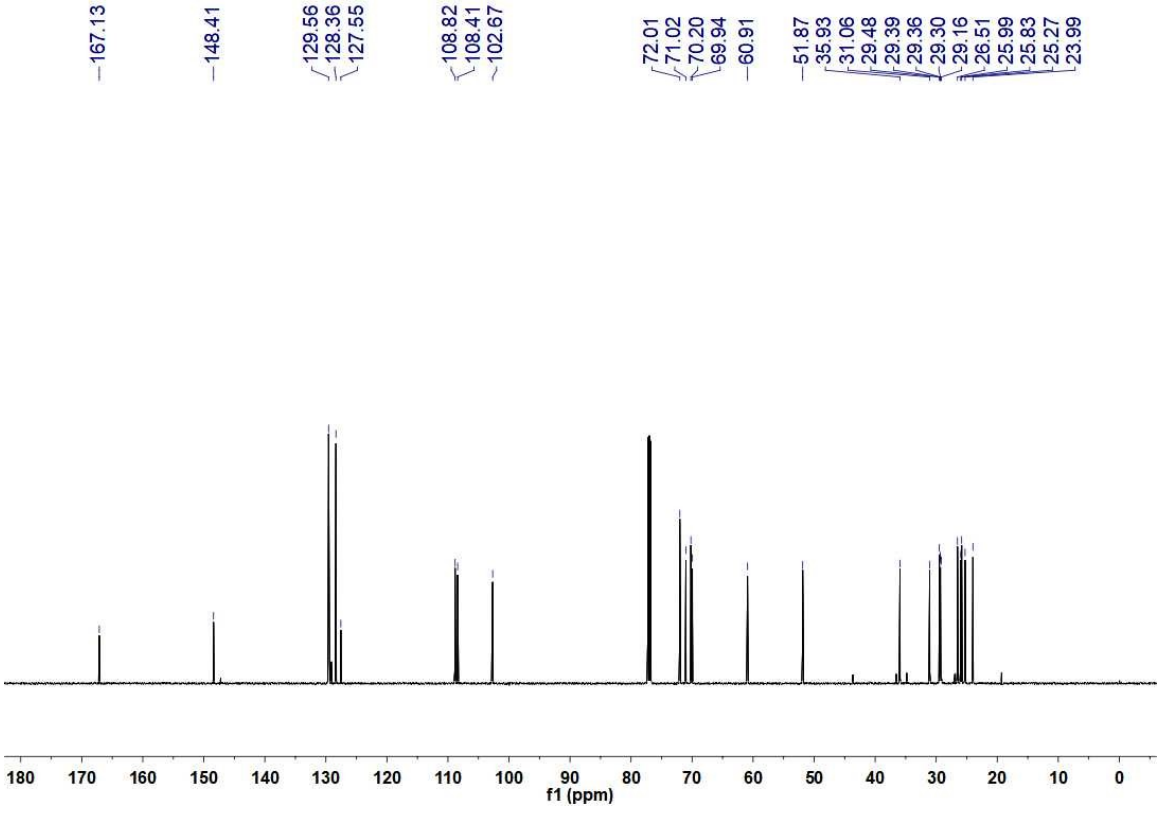
7.937
7.241
7.227
5.544
5.535
4.604
4.587
4.312
4.249
3.972
3.962
3.951
3.895
3.645
3.558
3.515
3.431
2.658
2.645
2.632
1.637
1.539
1.448
1.339
1.276
O
O
O
O
O
O
O
6
26
2.00
2.08
1.01
1.03
2.11
1.05
3.16
2.13
2.13
1.97
7.27
3.31
16.25
f1 (ppm)
167.11
148.40
129.54
128.34
127.52
109.10
108.42
96.30
71.49
71.14
70.57
70.54
69.25
66.65
51.85
35.92
31.04
29.49
29.40
29.34
29.30
29.15
26.00
25.94
25.91
24.86
24.36
f1 (ppm)


7.937
7.923
7.227
7.214
4.591
4.574
4.388
4.384
4.223
4.208
3.908
3.881
3.721
3.700
3.563
3.415
2.645
2.632
2.619
1.624
1.521
1.458
1.411
1.326
1.255
O
O
O
O
O
O
O
O
6
27
2.00
2.06
1.02
1.01
1.03
4.13
1.03
4.24
1.97
7.06
3.08
3.12
13.14
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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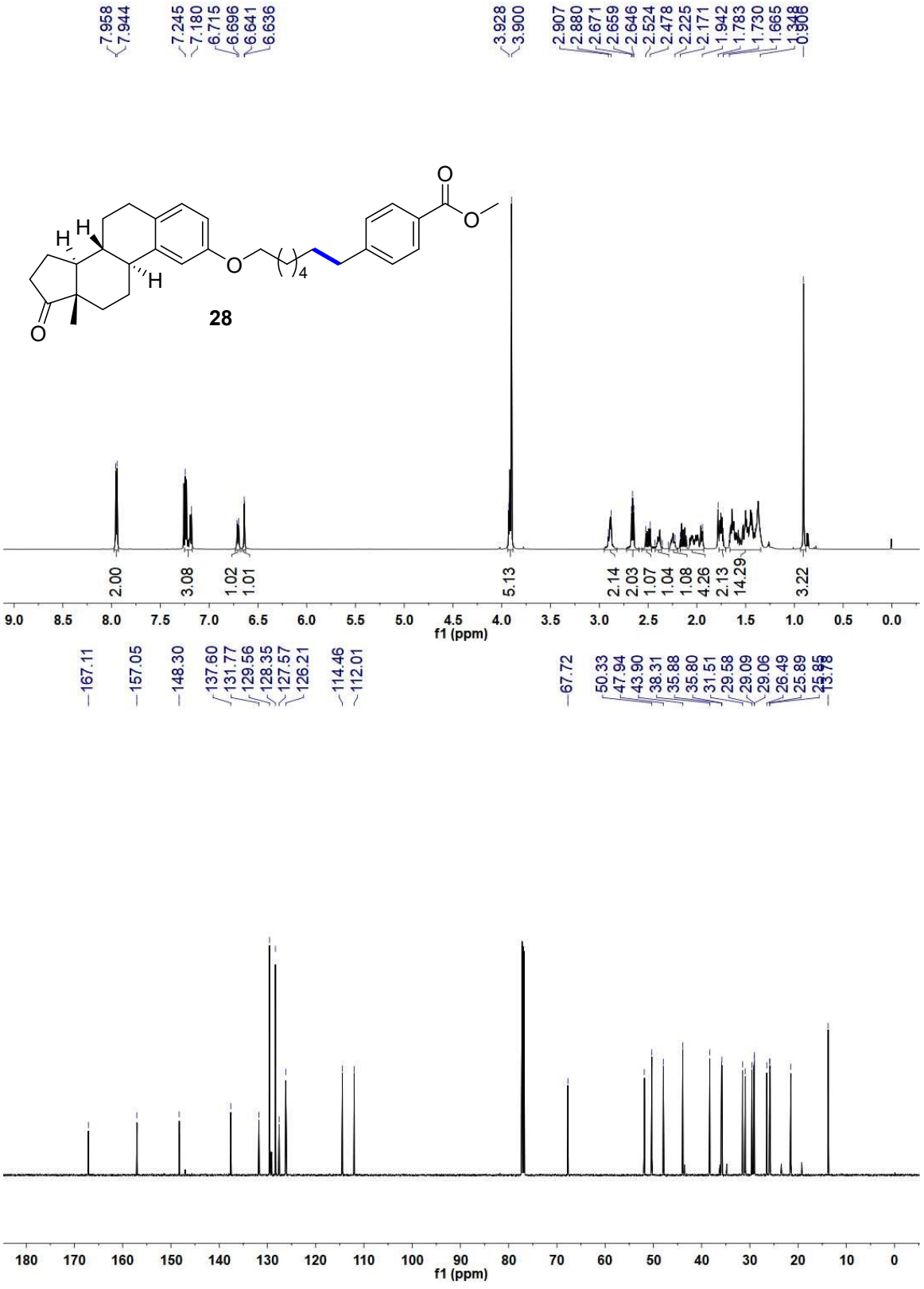
102.67
72.01
71.02
70.20
69.94
60.91
51.87
35.93
31.06
29.48
29.39
29.36
29.30
29.16
26.51
25.99
25.83
25.27
23.99
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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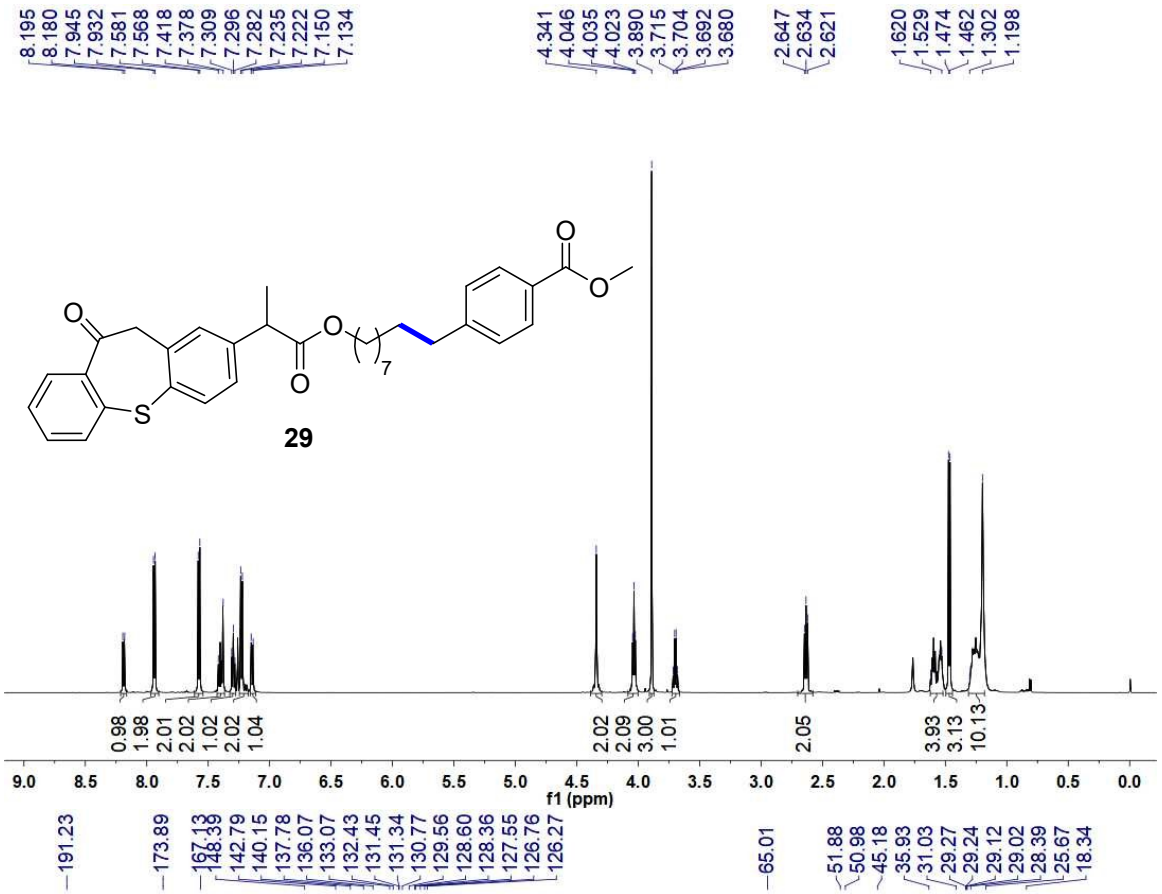
7.944
7.245
7.180
6.715
6.696
6.641
6.636
3.928
3.900
2.907
2.880
2.671
2.659
2.646
2.524
2.478
2.225
2.171
1.942
1.783
1.730
1.665
1.348
0.906
O
O
H
H
H
O
4
O
28
2.00
3.08
1.02
1.01
5.13
2.14
2.03
1.07
1.04
1.08
4.26
2.13
14.29
3.22
f1 (ppm)
167.11
157.05
148.30
137.60
131.77
129.56
128.35
127.57
126.21
114.46
112.01
67.72
50.33
47.94
43.90
38.31
35.88
35.80
31.51
29.58
29.09
29.06
26.49
25.89
13.78
f1 (ppm)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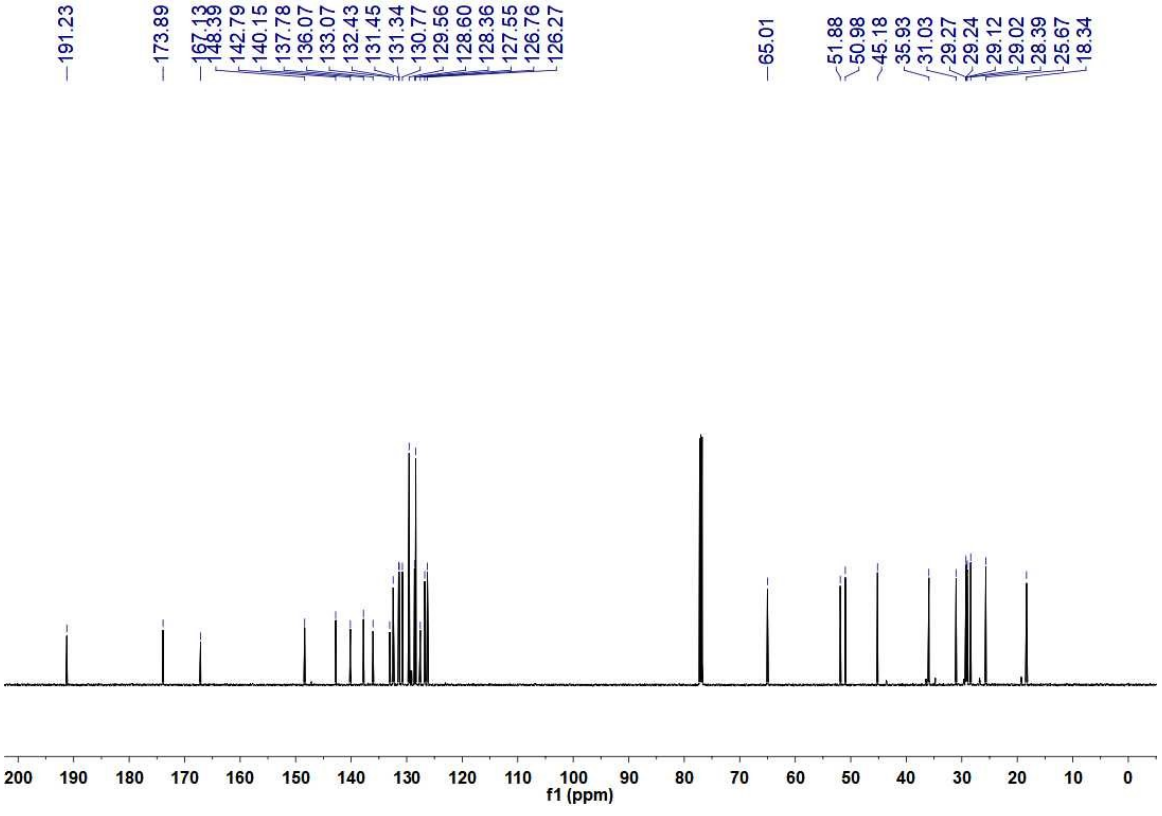
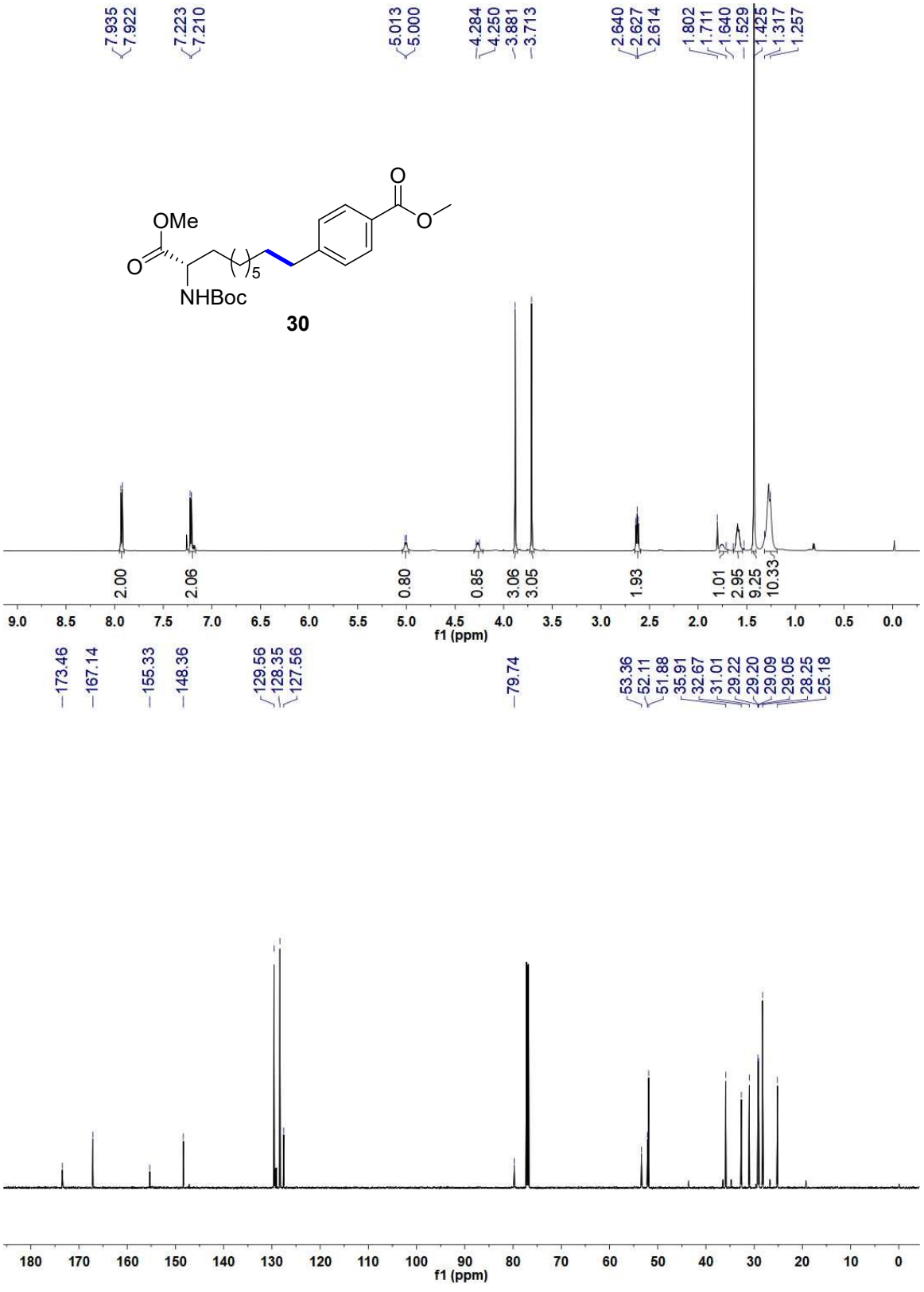
8.180
7.945
7.932
7.581
7.568
7.418
7.378
7.309
7.296
7.282
7.235
7.222
7.150
7.134
4.341
4.046
4.035
4.023
3.890
3.715
3.704
3.692
3.680
2.647
2.634
2.621
1.620
1.529
1.474
1.462
1.302
1.198
O
O
O
O
O
7
S
29
0.98
1.98
2.01
2.02
1.02
2.02
1.04
2.02
2.09
3.00
1.01
2.05
3.93
3.13
10.13
9.0
8.5
8.0
7.5
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)


191.23
173.89
167.13
148.39
142.79
140.15
137.78
136.07
133.07
132.43
131.45
131.34
130.77
129.56
128.60
128.36
127.55
126.76
126.27
65.01
51.88
50.98
45.18
35.93
31.03
29.27
29.24
29.12
29.02
28.39
25.67
18.34
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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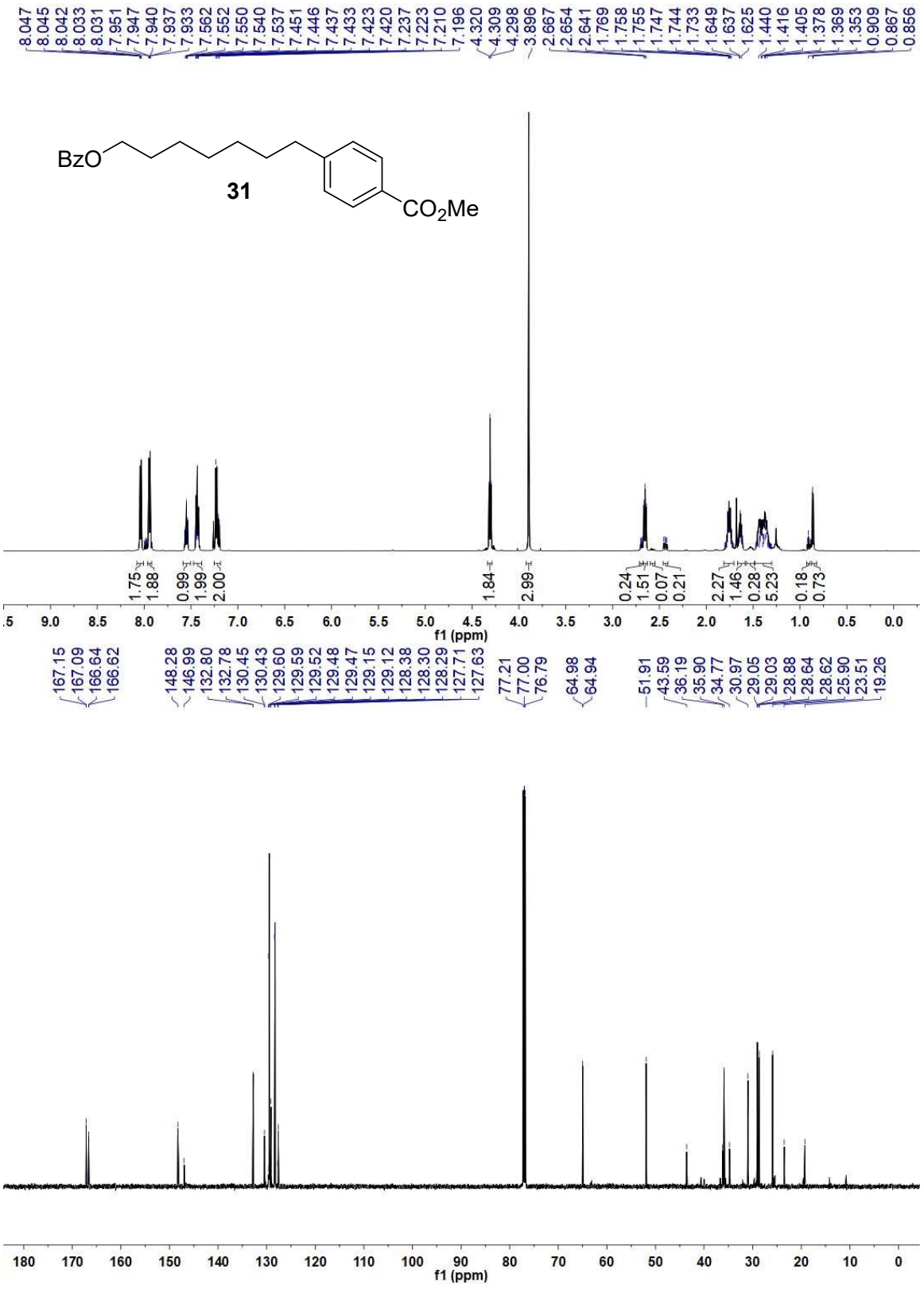
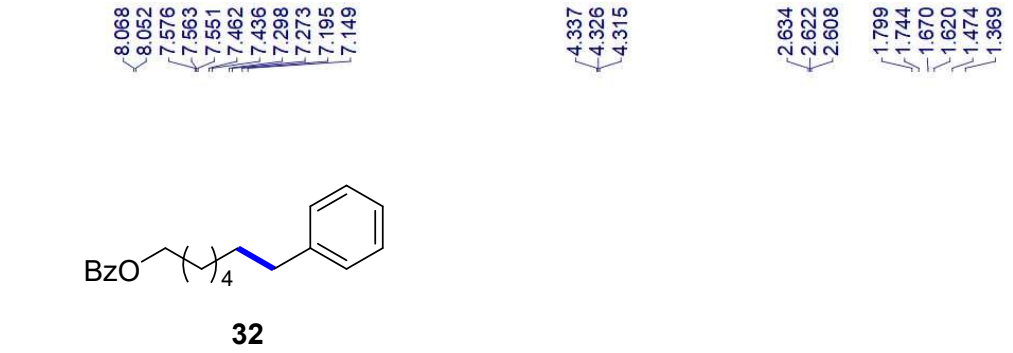
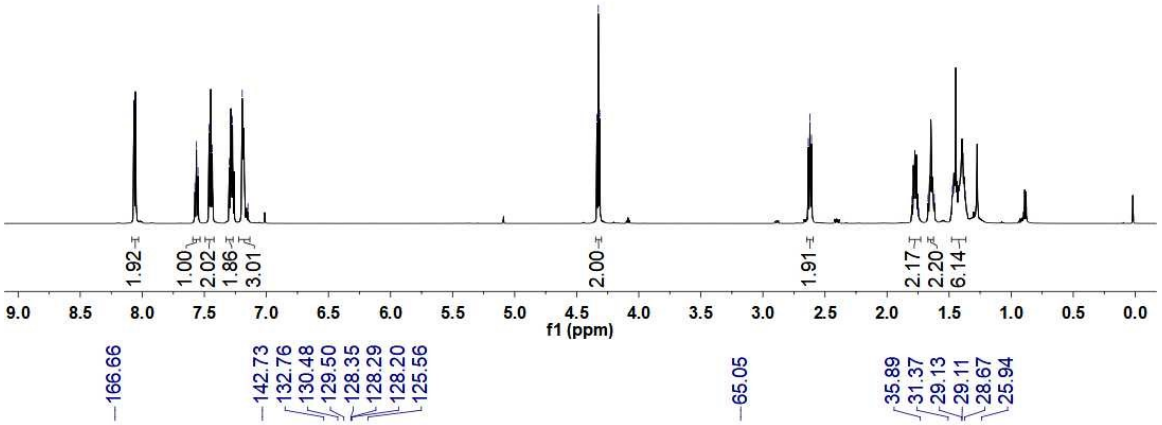
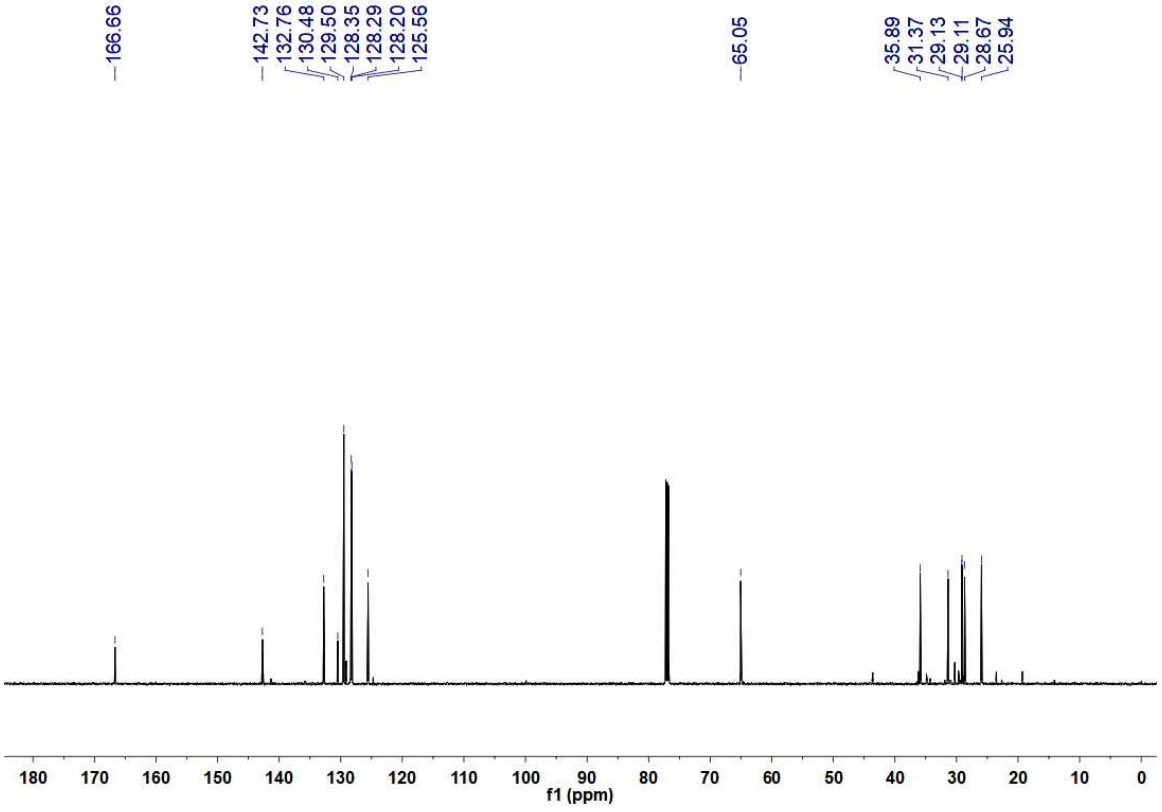
7.922
7.223
7.210
5.013
5.000
4.284
4.250
3.881
3.713
2.640
2.627
2.614
1.802
1.711
1.640
1.529
1.425
1.317
1.257
OMe
O
O
O
5
NHBoc
30
2.00
2.06
0.80
0.85
3.06
3.05
1.93
1.01
2.95
9.25
10.33
f1 (ppm)
173.46
167.14
155.33
148.36
129.56
128.35
127.56
79.74
53.36
52.11
51.88
35.91
32.67
31.01
29.22
29.20
29.09
29.05
28.25
25.18
f1 (ppm)

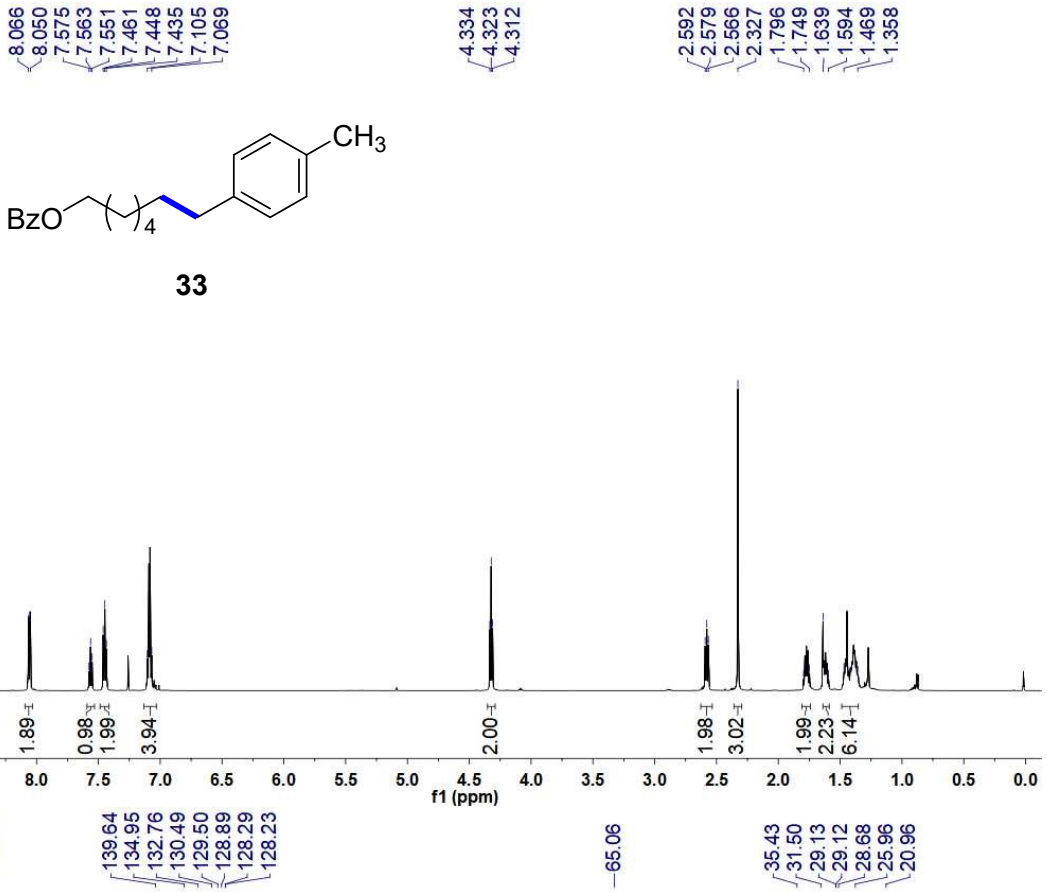

8.047
8.045
8.042
8.033
8.031
7.951
7.947
7.940
7.937
7.933
7.562
7.552
7.550
7.540
7.537
7.451
7.446
7.437
7.433
7.423
7.420
7.237
7.223
7.210
7.196
4.320
4.309
4.298
3.896
2.667
2.654
2.641
1.769
1.758
1.755
1.747
1.744
1.733
1.649
1.637
1.625
1.440
1.416
1.405
1.378
1.369
1.353
0.909
0.867
0.856
BzO
31
CO2Me
1.75
1.88
0.99
1.99
2.00
1.84
2.99
0.24
1.51
0.07
0.21
2.27
1.46
0.28
5.23
0.18
0.73
f1 (ppm)
167.15
167.09
166.64
166.62
148.28
146.99
132.80
132.78
130.45
130.43
129.60
129.59
129.52
129.48
129.47
129.15
129.12
128.38
128.30
128.29
127.71
127.63
77.21
77.00
76.79
64.98
64.94
51.91
43.59
36.19
35.90
34.77
30.97
29.05
29.03
28.88
28.64
28.62
25.90
23.51
19.26
f1 (ppm)


8.068
8.052
7.576
7.563
7.551
7.462
7.436
7.298
7.273
7.195
7.149
4.337
4.326
4.315
2.634
2.622
2.608
1.799
1.744
1.670
1.620
1.474
1.369
BzO
4

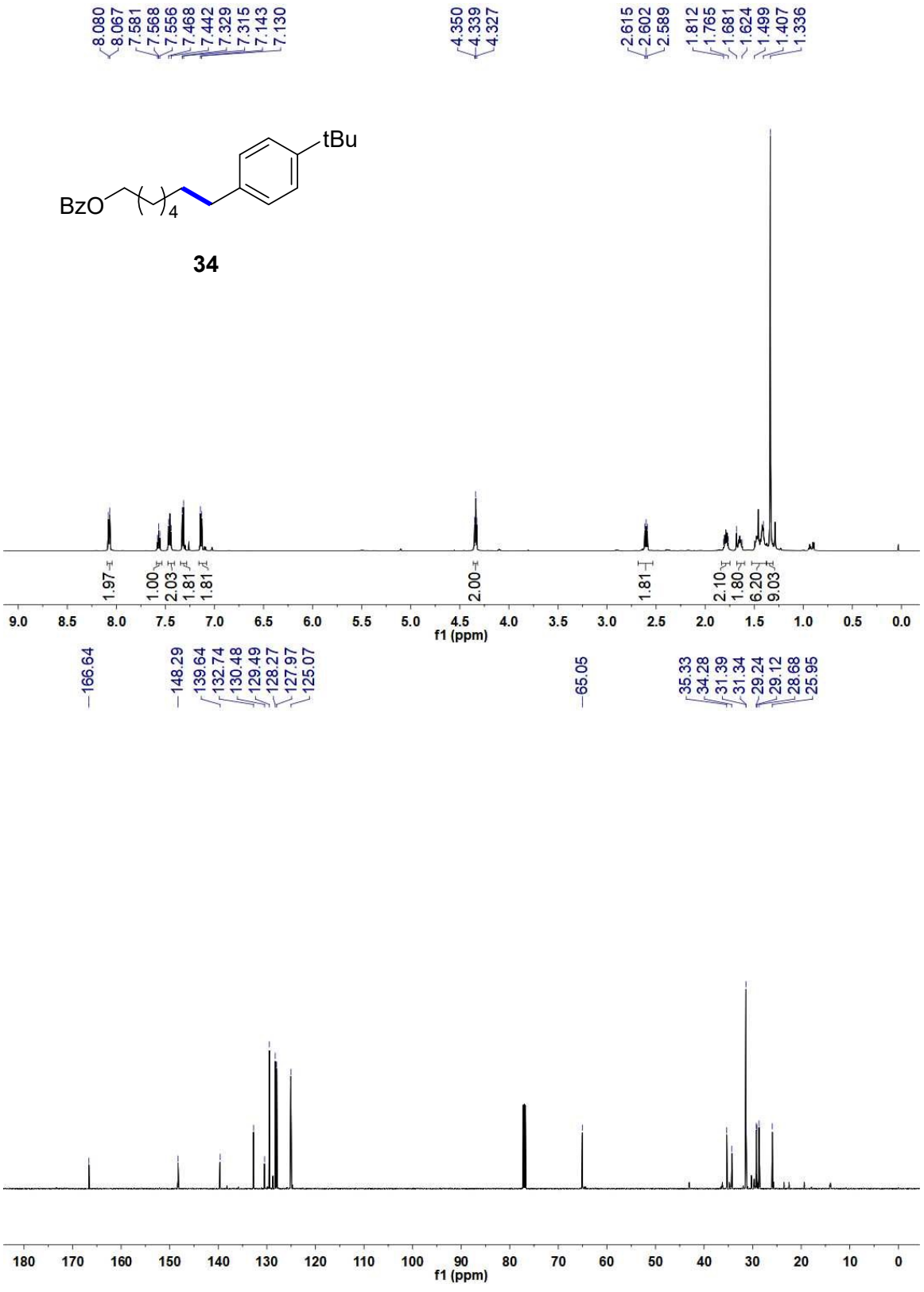
32

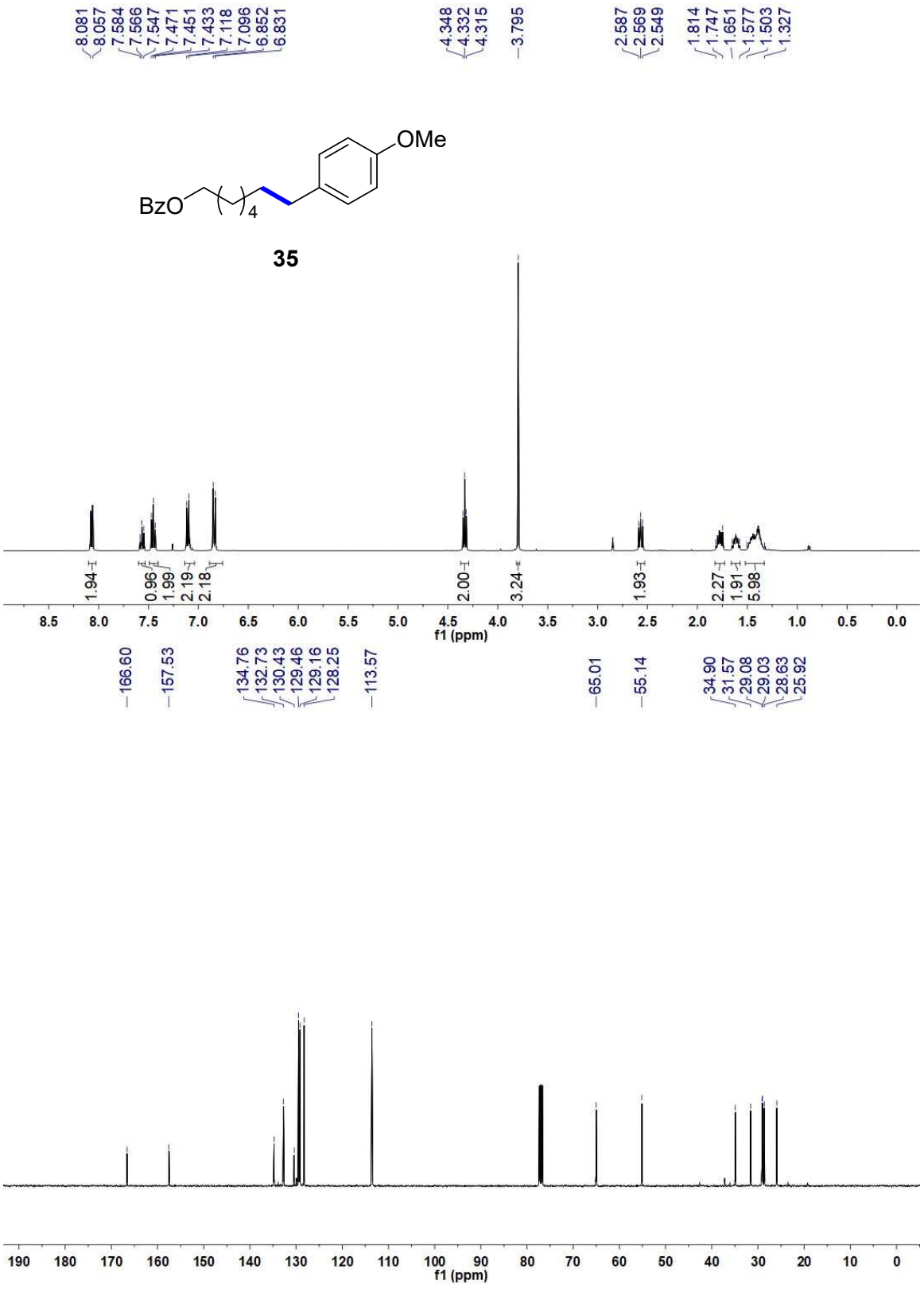

1.92
1.00
2.02
1.86
3.01
2.00
1.91
2.17
2.20
6.14
f1 (ppm)


166.66
142.73
132.76
130.48
129.50
128.35
128.29
128.20
125.56
65.05
35.89
31.37
29.13
29.11
28.67
25.94
f1 (ppm)


8.066
8.050
7.575
7.563
7.551
7.461
7.448
7.435
7.105
7.069
4.334
4.323
4.312
2.592
2.579
2.566
2.327
1.796
1.749
1.639
1.594
1.469
1.358
CH3
BzO
4
1.89
0.98
1.99
3.94
2.00
1.98
3.02
1.99
2.23
6.14
f1 (ppm)
166.66
139.64
134.95
132.76
130.49
129.50
128.89
128.29
128.23
65.06
35.43
31.50
29.13
29.12
28.68
25.96
20.96
f1 (ppm)

33


8.080
8.067
7.581
7.568
7.556
7.468
7.442
7.329
7.315
7.143
7.130
4.350
4.339
4.327
2.615
2.602
2.589
1.812
1.765
1.681
1.624
1.499
1.407
1.336
tBu
BzO
4
34
1.97
1.00
2.03
1.81
1.81
2.00
1.81
2.10
1.80
6.20
9.03
f1 (ppm)
166.64
148.29
139.64
132.74
130.48
129.49
128.27
127.97
125.07
65.05
35.33
34.28
31.39
31.34
29.24
29.12
28.68
25.95
f1 (ppm)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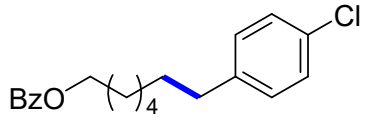
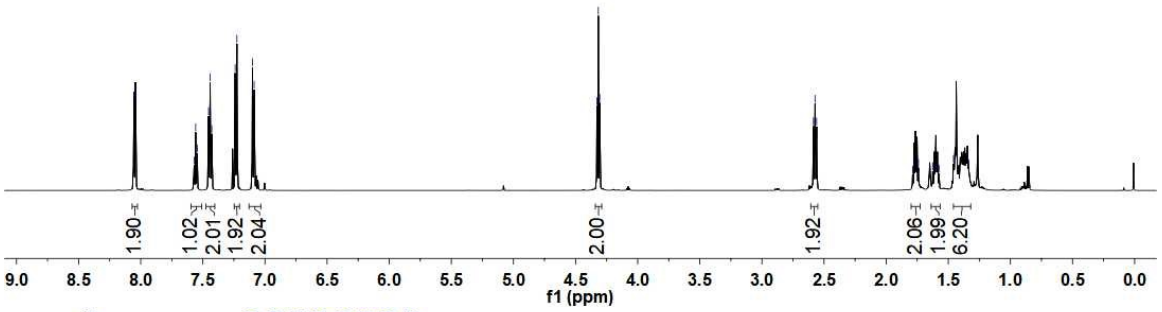
8.057
7.584
7.566
7.547
7.471
7.451
7.433
7.118
7.096
6.852
6.831
4.348
4.332
4.315
3.795
2.587
2.569
2.549
1.814
1.747
1.651
1.577
1.503
1.327
OMe
BzO
4
35
1.94
0.96
1.99
2.19
2.18
2.00
3.24
1.93
2.27
1.91
5.98
f1 (ppm)
166.60
157.53
134.76
132.73
130.43
129.46
129.16
128.25
113.57
65.01
55.14
34.90
31.57
29.08
29.03
28.63
25.92
f1 (ppm)

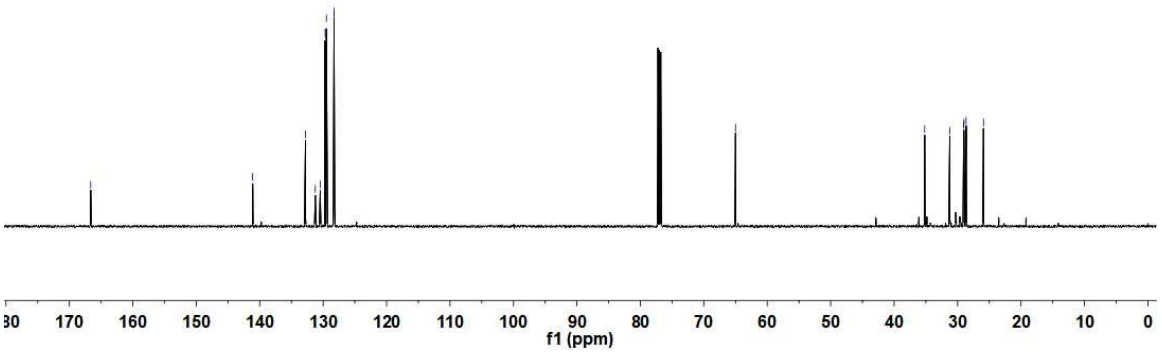

8.056
8.040
7.570
7.558
7.545
7.454
7.441
7.428
7.240
7.226
7.101
7.087
4.328
4.317
4.306
2.585
2.572
2.559
1.787
1.740
1.625
1.575
1.458
1.333


Cl
BzO
4

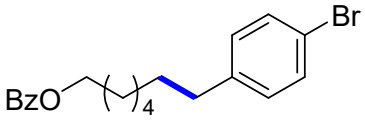
36


1.90
1.02
2.01
1.92
2.04
2.00
1.92
2.06
1.99
6.20
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

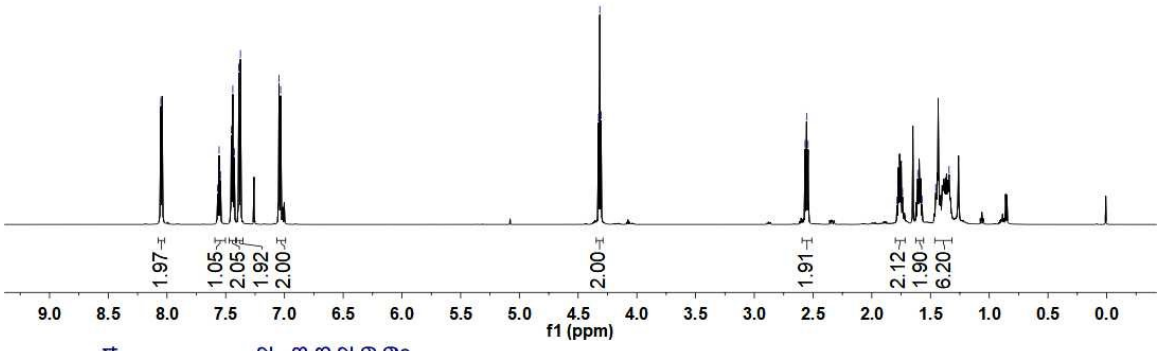

166.65
141.10
132.79
131.24
130.46
129.69
129.49
128.29
128.28
65.00
35.19
31.23
29.04
28.99
28.65
25.91

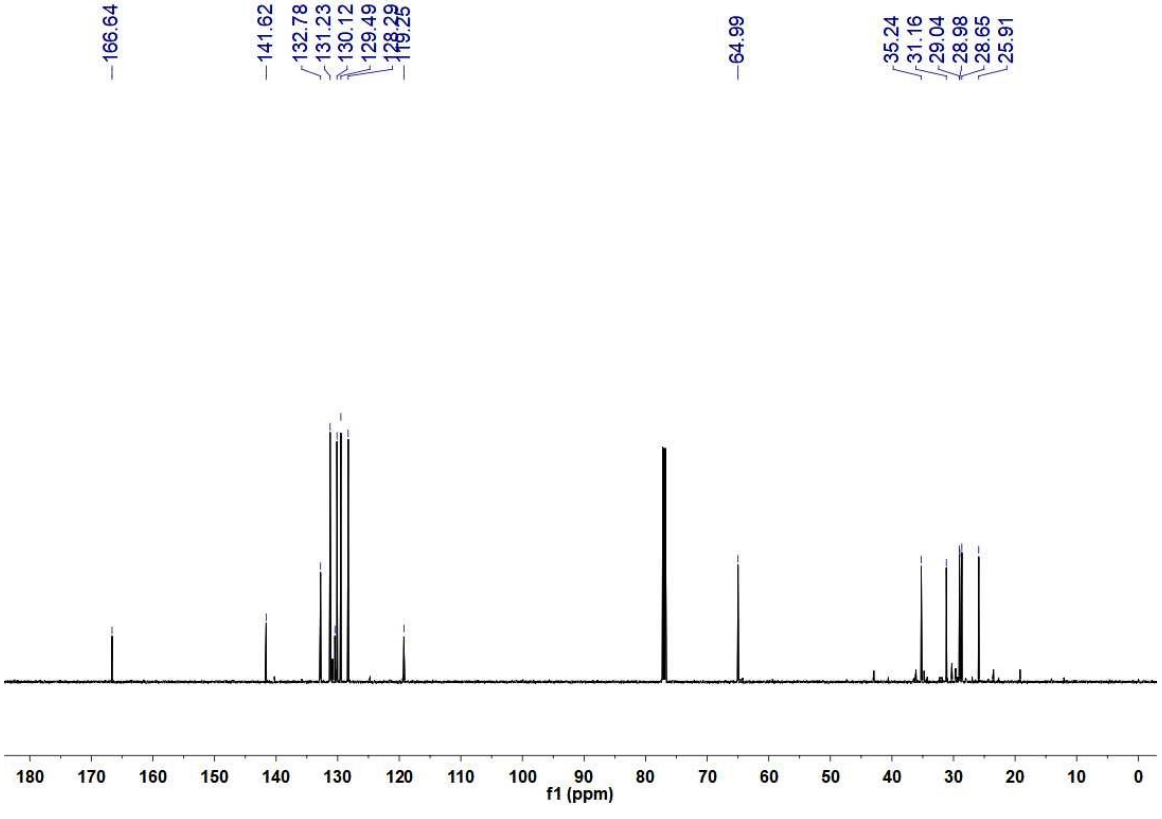

180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

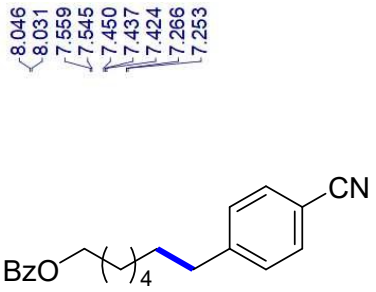

8.053
8.039
7.569
7.557
7.544
7.453
7.440
7.427
7.389
7.375
7.047
7.033
4.326
4.315
4.304
2.568
2.555
2.542
1.785
1.738
1.609
1.572
1.456
1.342


Br
BzO
4

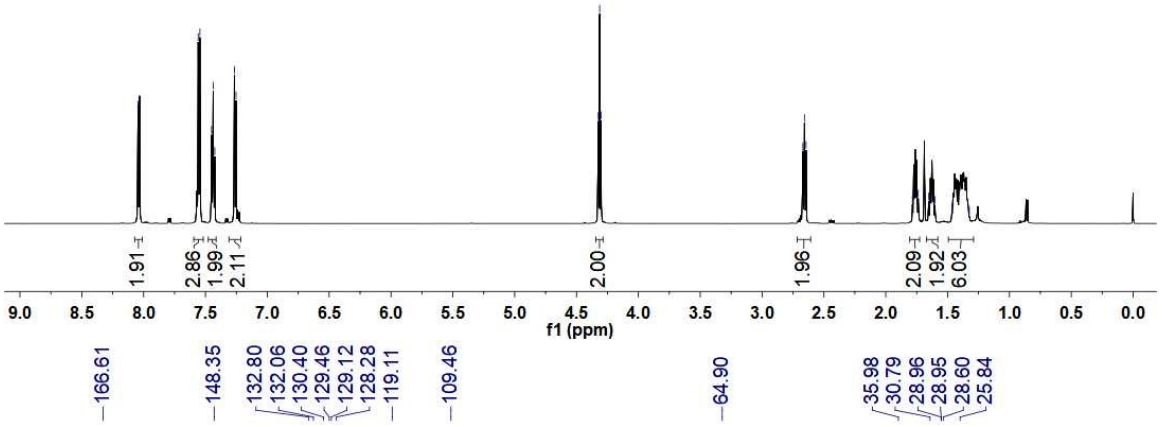
37


1.97
1.05
2.05
1.92
2.00
2.00
1.91
2.12
1.90
6.20
f1 (ppm)


166.64
141.62
132.78
131.23
130.12
129.49
128.29
64.99
35.24
31.16
29.04
28.98
28.65
25.91
f1 (ppm)


CN
BzO
4

38


8.046
8.031
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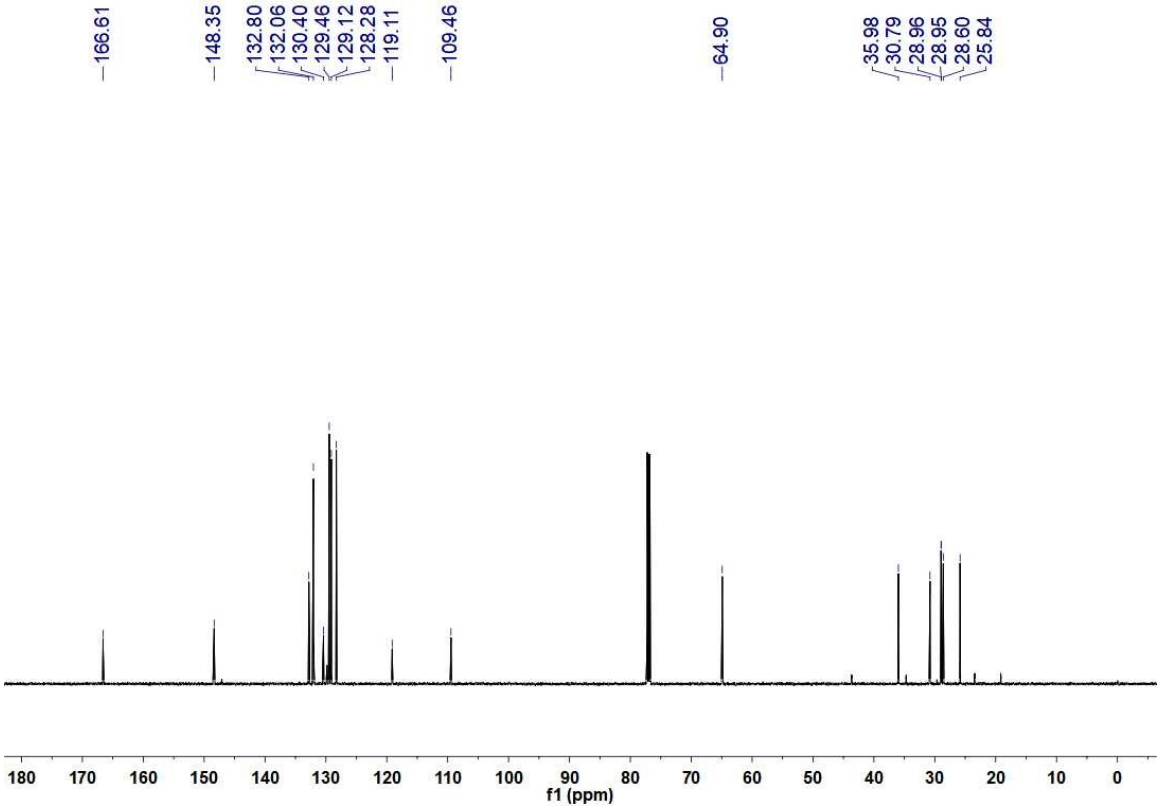
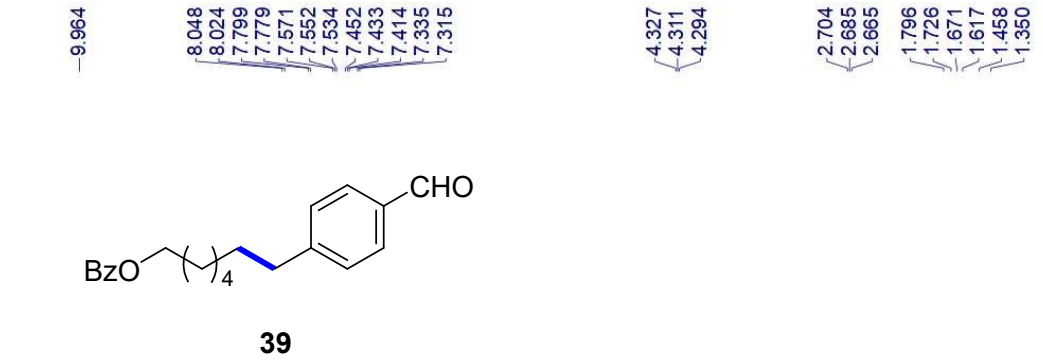
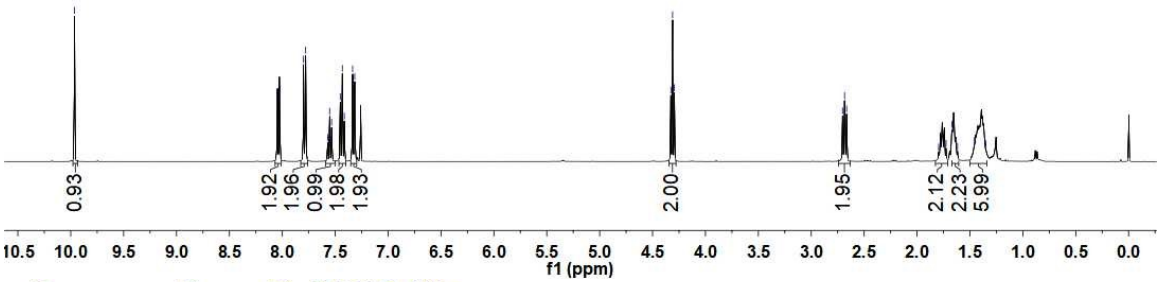
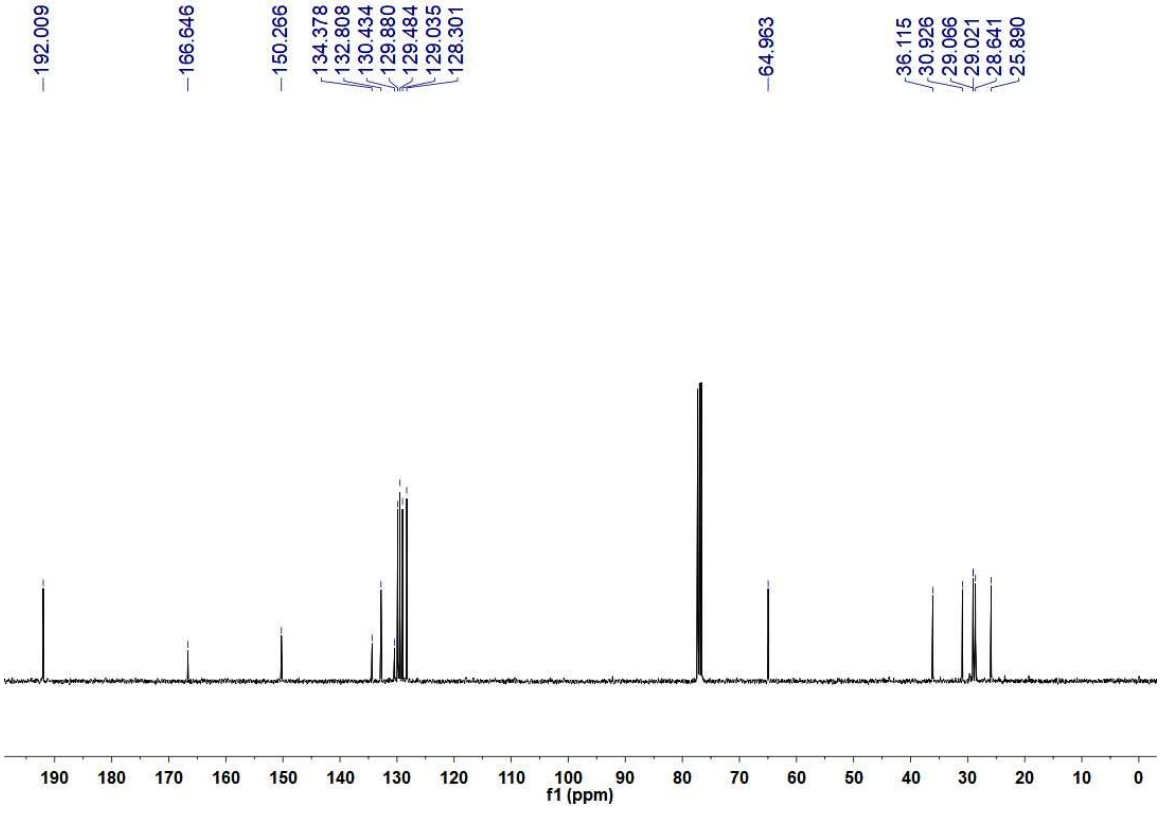
7.545
7.450
7.437
7.424
7.266
7.253
4.324
4.313
4.302
2.670
2.657
2.644
1.784
1.737
1.652
1.602
1.465
1.324
1.91
2.86
1.99
2.11
2.00
1.96
2.09
1.92
6.03
f1 (ppm)

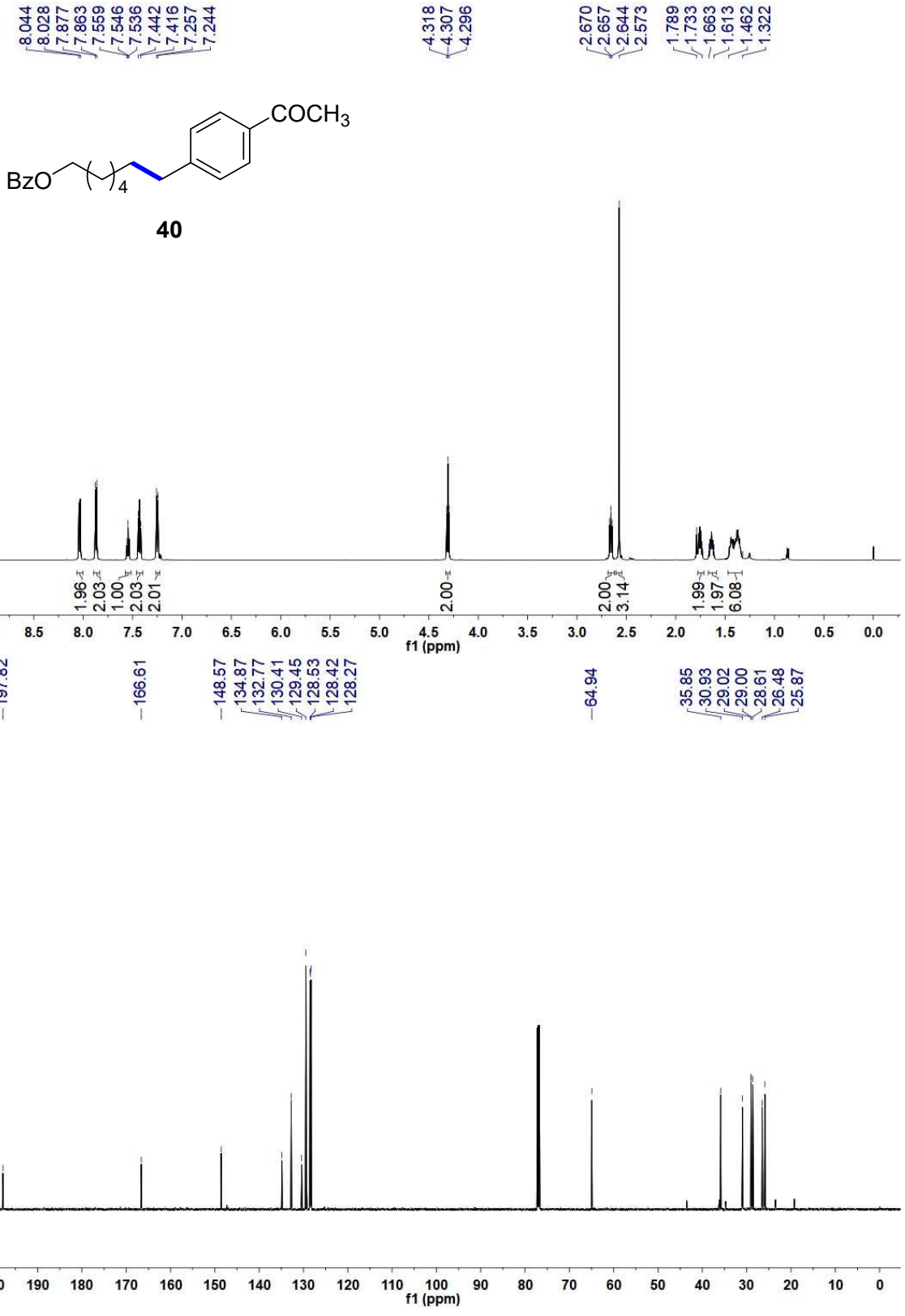

166.61
148.35
132.80
132.06
130.40
129.46
129.12
128.28
119.11
109.46
64.90
35.98
30.79
28.96
28.95
28.60
25.84
f1 (ppm)

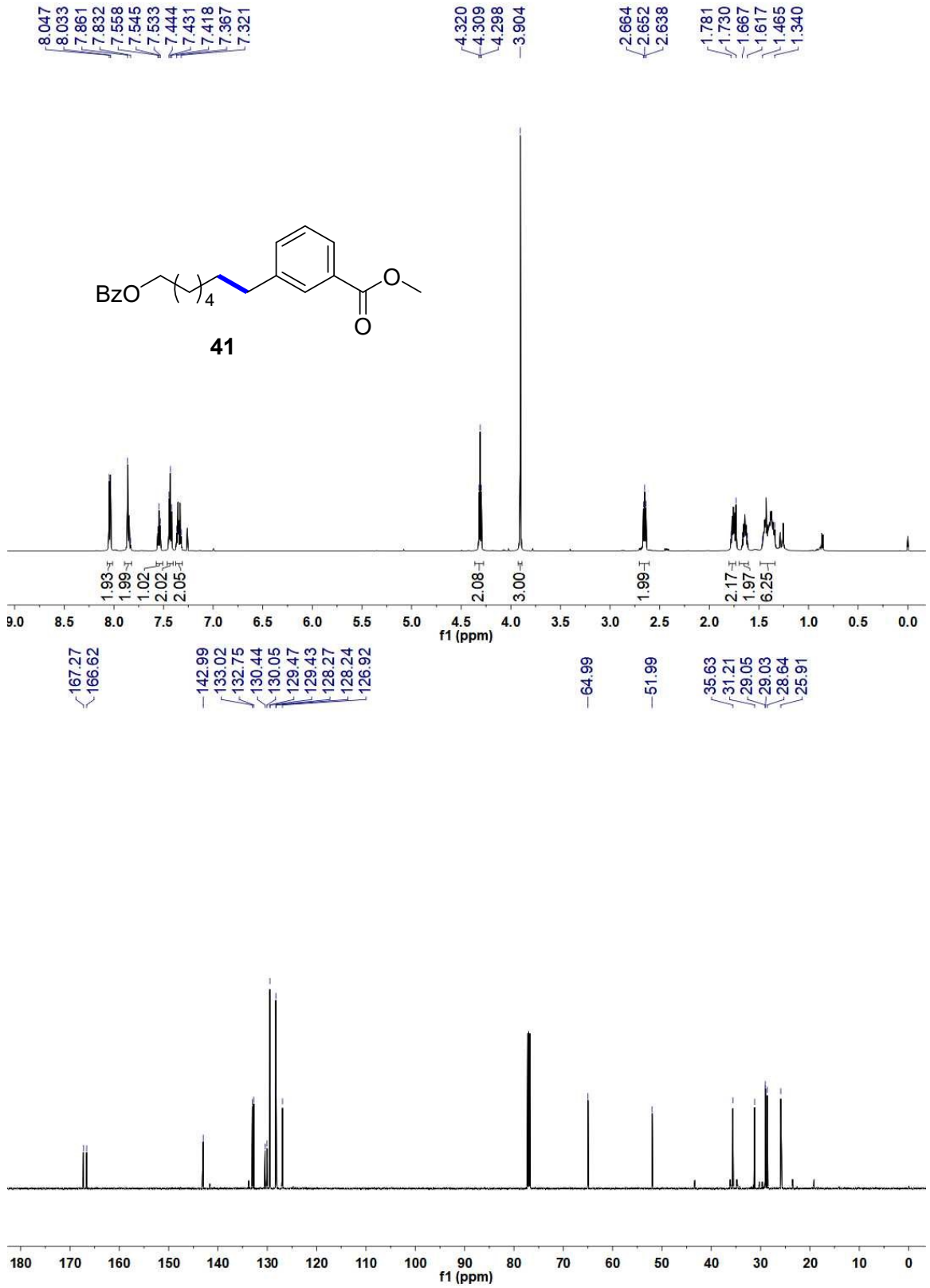

9.964
8.048
8.024
7.799
7.779
7.571
7.552
7.534
7.452
7.433
7.414
7.335
7.315
4.327
4.311
4.294
2.704
2.685
2.665
1.796
1.726
1.671
1.617
1.458
1.350
CHO
BzO
4

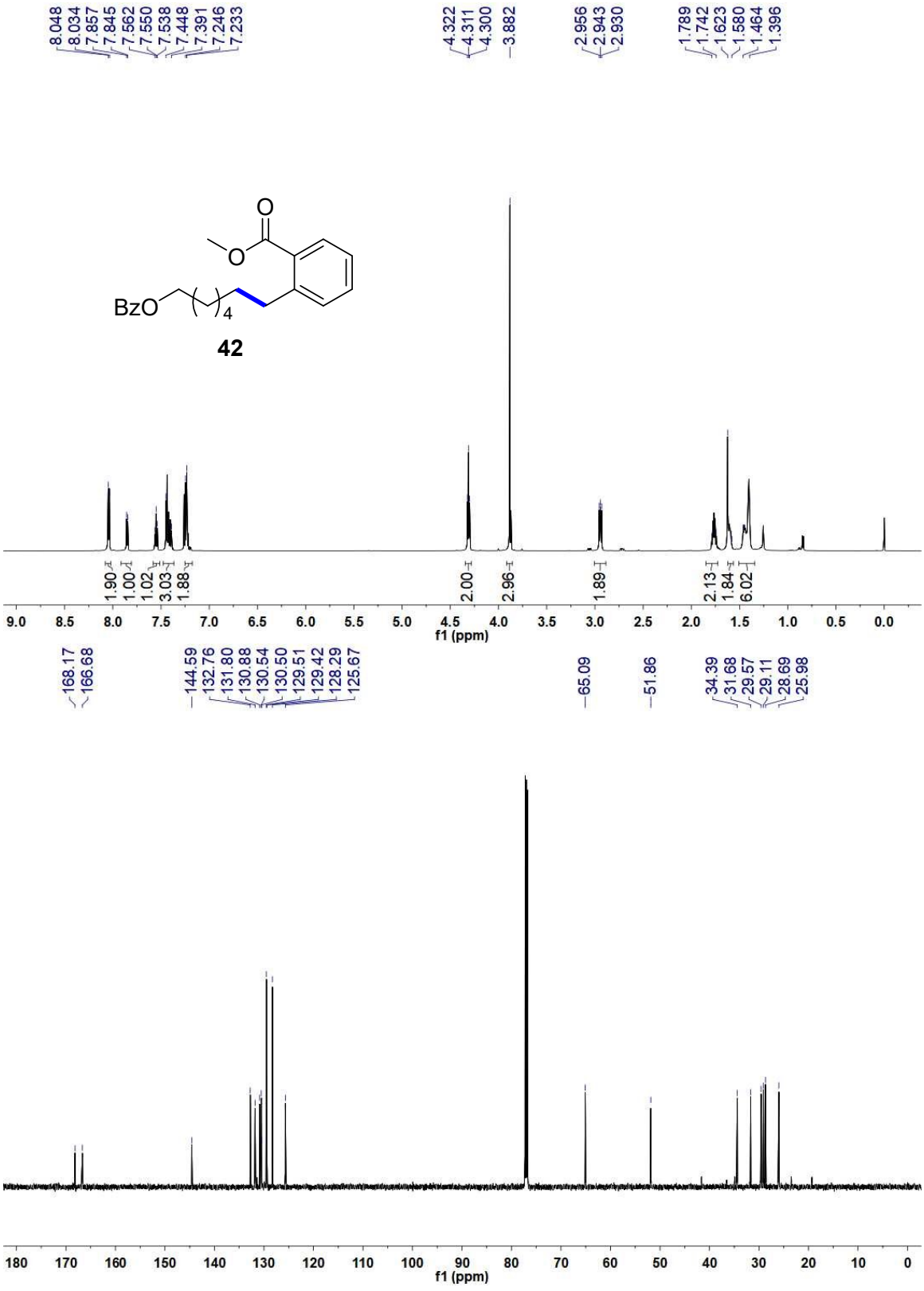
39


0.93
1.92
1.96
0.99
1.98
1.93
2.00
1.95
2.12
2.23
5.99
10.5 10.0 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)

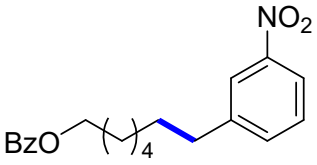

192.009
166.646
150.266
134.378
132.808
130.434
129.880
129.484
129.035
128.301
64.963
36.115
30.926
29.066
29.021
28.641
25.890
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


8.044
8.028
7.877
7.863
7.559
7.546
7.536
7.442
7.416
7.257
7.244
4.318
4.307
4.296
2.670
2.657
2.644
2.573
1.789
1.733
1.663
1.613
1.462
1.322
COCH3
BzO
4
40
1.96
2.03
1.00
2.03
2.01
2.00
2.00
3.14
1.99
1.97
6.08
f1 (ppm)
197.82
166.61
148.57
134.87
132.77
130.41
129.45
128.53
128.42
128.27
64.94
35.85
30.93
29.02
29.00
28.61
26.48
25.87
f1 (ppm)

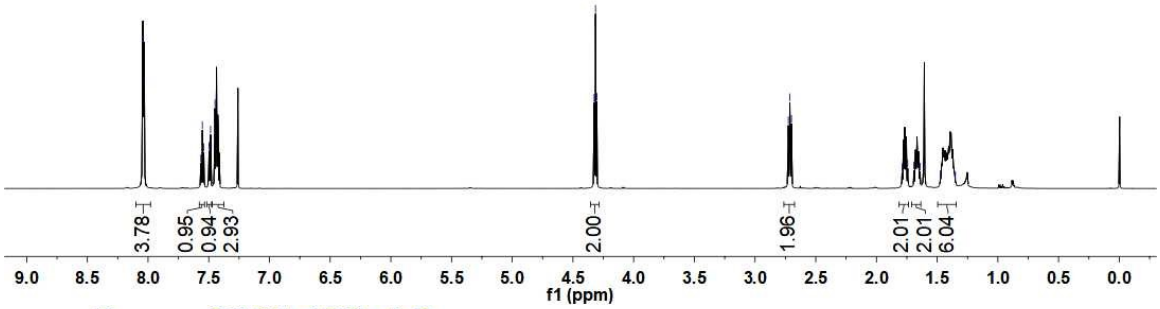

8.047
8.033
7.861
7.832
7.558
7.545
7.533
7.444
7.431
7.418
7.367
7.321
4.320
4.309
4.298
3.904
2.664
2.652
2.638
1.781
1.730
1.667
1.617
1.465
1.340
BzO
4
O
O
41
1.93
1.99
1.02
2.02
2.05
2.08
3.00
1.99
2.17
1.97
6.25
f1 (ppm)
167.27
166.62
142.99
133.02
132.75
130.44
130.05
129.47
129.43
128.27
128.24
126.92
64.99
51.99
35.63
31.21
29.05
29.03
28.64
25.91
f1 (ppm)


8.048
8.034
7.857
7.845
7.562
7.550
7.538
7.448
7.391
7.246
7.233
4.322
4.311
4.300
3.882
2.956
2.943
2.930
1.789
1.742
1.623
1.580
1.464
1.396
O
O
BzO
4
42
1.90
1.00
1.02
3.03
1.88
2.00
2.96
1.89
2.13
1.84
6.02
f1 (ppm)
168.17
166.68
144.59
132.76
131.80
130.88
130.54
130.50
129.51
129.42
128.29
125.67
65.09
51.86
34.39
31.68
29.57
29.11
28.69
25.98
f1 (ppm)

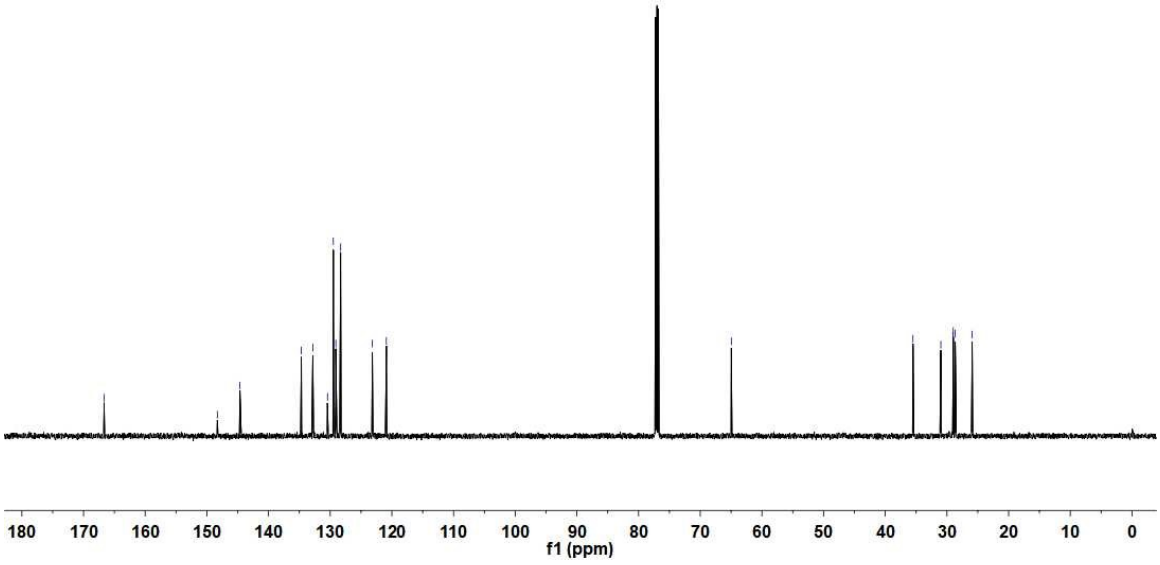

8.045
8.029
7.565
7.553
7.541
7.498
7.485
7.449
7.423
4.325
4.314
4.303
2.726
2.713
2.700
1.789
1.742
1.691
1.641
1.473
1.350

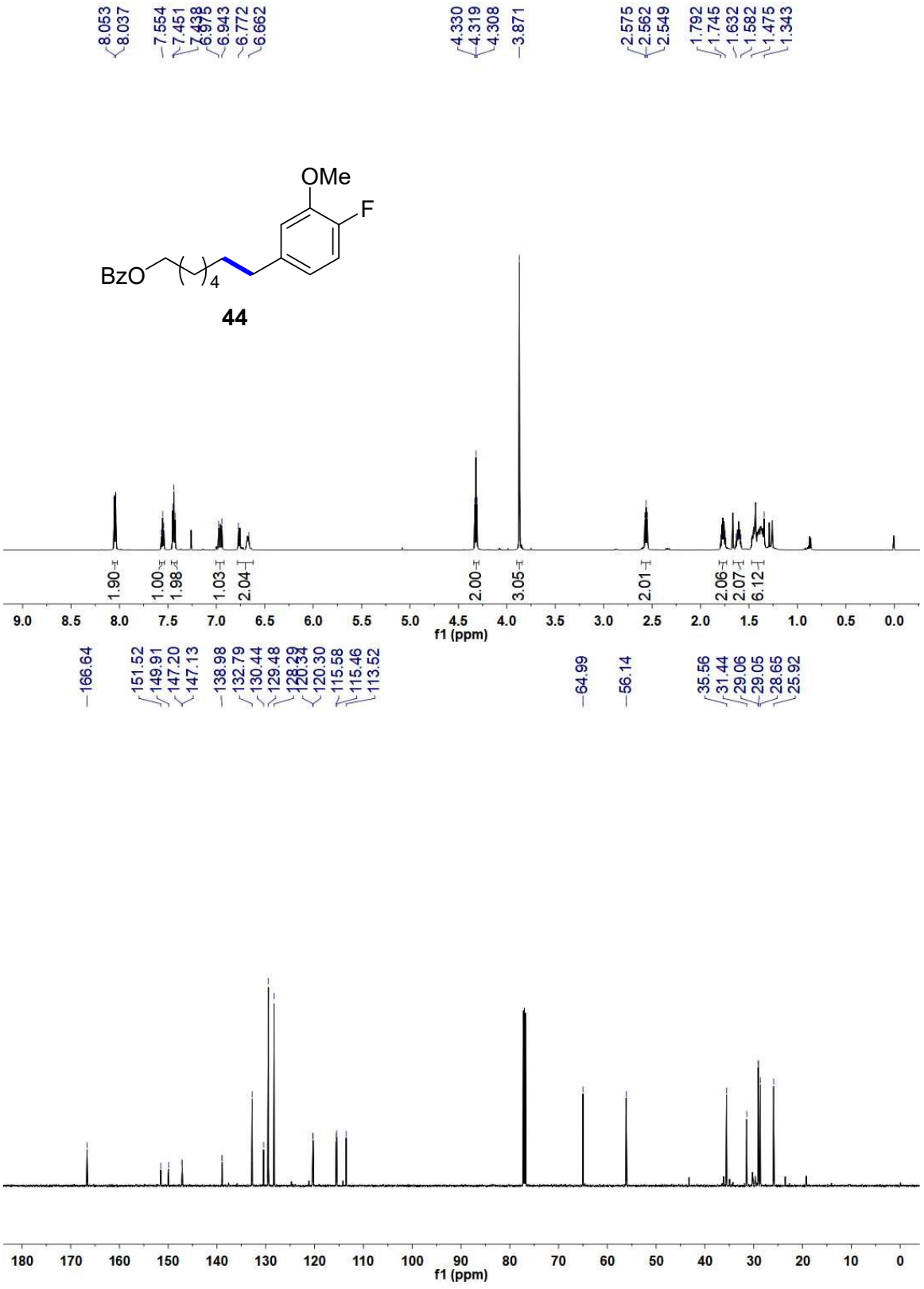

NO2
BzO
4

43

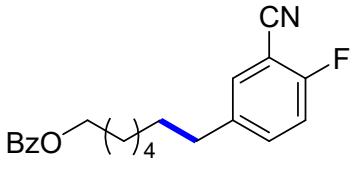

3.78
0.95
0.94
2.93
2.00
1.96
2.01
2.01
6.04
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


166.66
148.30
144.64
134.68
132.82
130.44
129.50
129.08
128.31
123.17
120.90
64.96
35.51
30.98
29.02
28.98
28.65
25.91

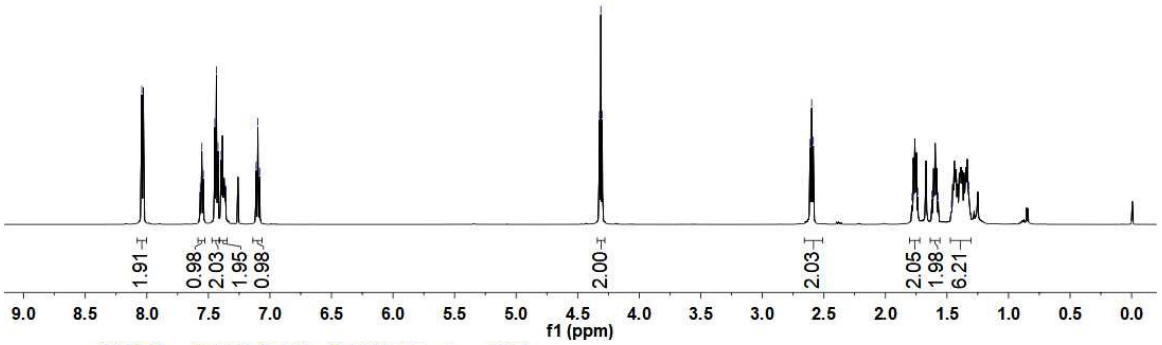

180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

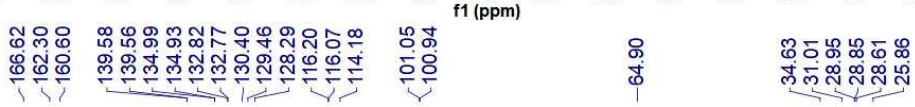

8.053
8.037
7.554
7.451
7.438
6.975
6.943
6.772
6.662
4.330
4.319
4.308
3.871
2.575
2.562
2.549
1.792
1.745
1.632
1.582
1.475
1.343
OMe
F
BzO
4
44
1.90
1.00
1.98
1.03
2.04
2.00
3.05
2.01
2.06
2.07
6.12
f1 (ppm)
166.64
151.52
149.91
147.20
147.13
138.98
132.79
130.44
129.48
128.29
128.34
120.30
115.58
115.46
113.52
64.99
56.14
35.56
31.44
29.06
29.05
28.65
25.92
f1 (ppm)

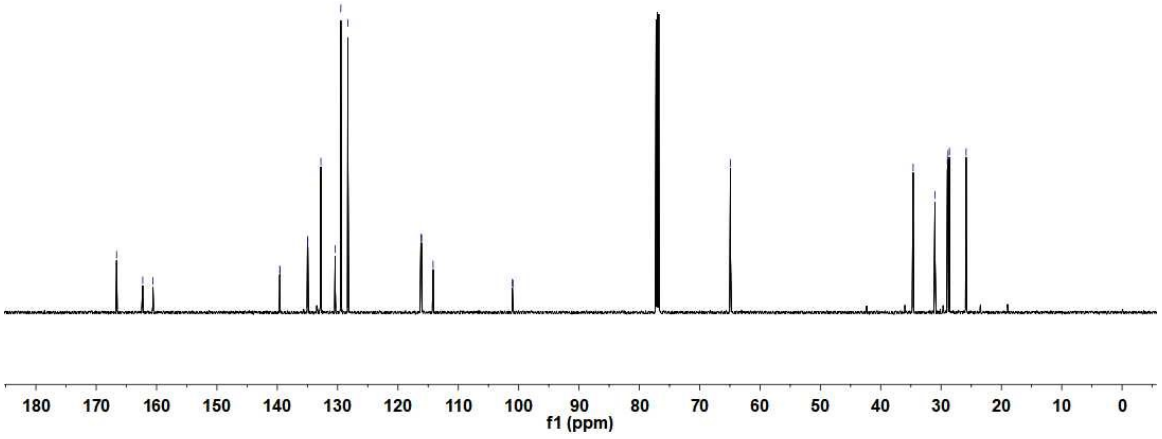

8.041
8.027
7.566
7.553
7.541
7.448
7.435
7.422
7.395
7.360
7.112
7.097
7.083
4.323
4.312
4.301
2.612
2.599
2.586
1.784
1.737
1.621
1.571
1.464
1.323

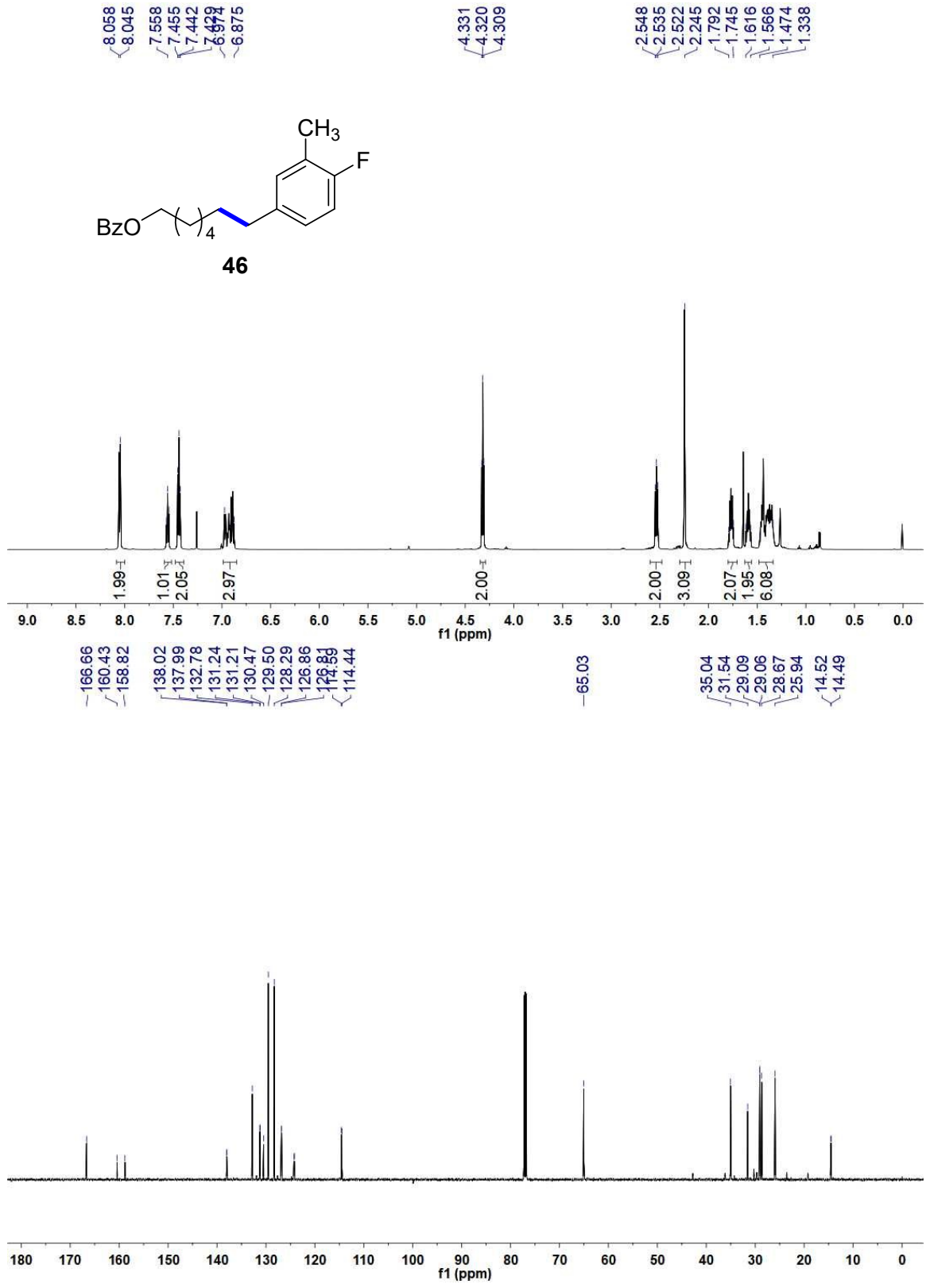

CN
F
BzO
4

45

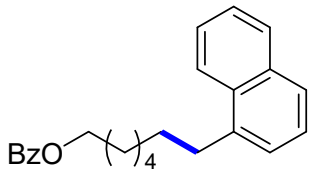

1.91
0.98
2.03
1.95
0.98
2.00
2.03
2.05
1.98
6.21
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


166.62
162.30
160.60
139.58
139.56
134.99
134.93
132.82
132.77
130.40
129.46
128.29
116.20
116.07
114.18
101.05
100.94
64.90
34.63
31.01
28.95
28.85
28.61
25.86

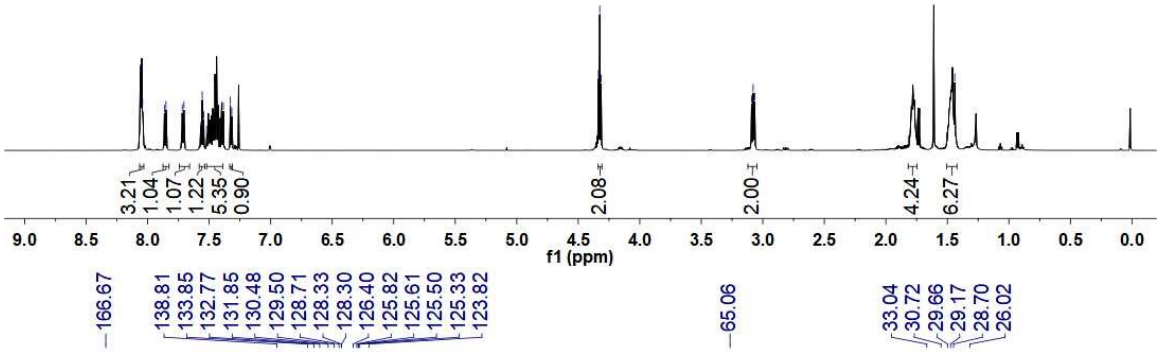

180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

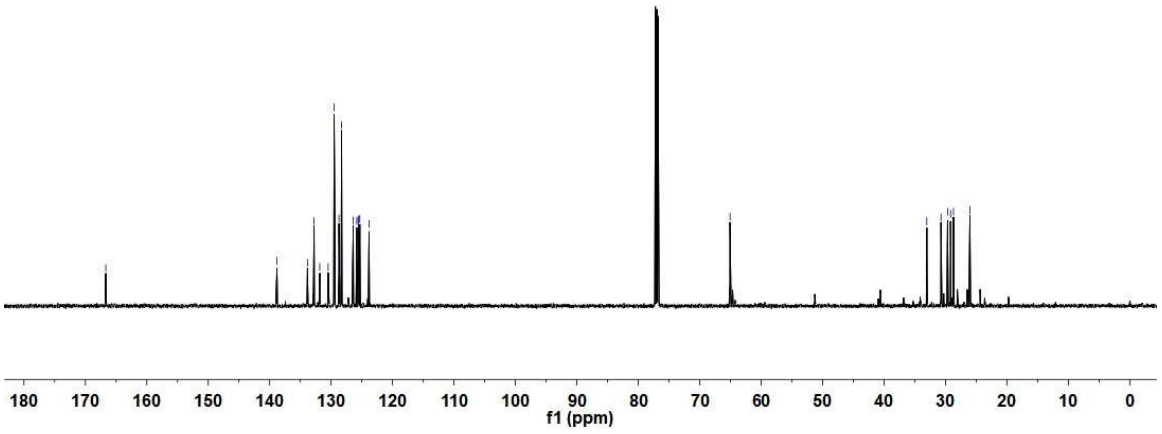

8.058
8.045
7.558
7.455
7.442
6.875
4.331
4.320
4.309
2.548
2.535
2.522
2.245
1.792
1.745
1.616
1.566
1.474
1.338
CH3
F
BzO
4
46
1.99
1.01
2.05
2.97
2.00
2.00
3.09
2.07
1.95
6.08
f1 (ppm)
166.66
160.43
158.82
138.02
137.99
132.78
131.24
131.21
130.47
129.50
128.29
126.86
114.44
65.03
35.04
31.54
29.09
29.06
28.67
25.94
14.52
14.49
f1 (ppm)

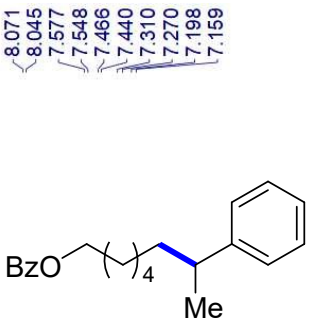

8.061
8.041
7.864
7.851
7.719
7.705
7.567
7.557
7.544
7.521
7.385
7.328
7.316
4.336
4.325
4.314
3.092
3.079
3.066
1.818
1.752
1.506
1.440


BzO
4

47


3.21
1.04
1.07
1.22
5.35
0.90
2.08
2.00
4.24
6.27
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)
166.67
138.81
133.85
132.77
131.85
130.48
129.50
128.71
128.33
128.30
126.40
125.82
125.61
125.50
125.33
123.82
65.06
33.04
30.72
29.66
29.17
28.70
26.02

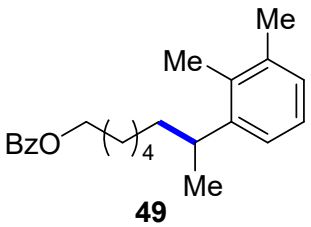

180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


BzO
4
Me

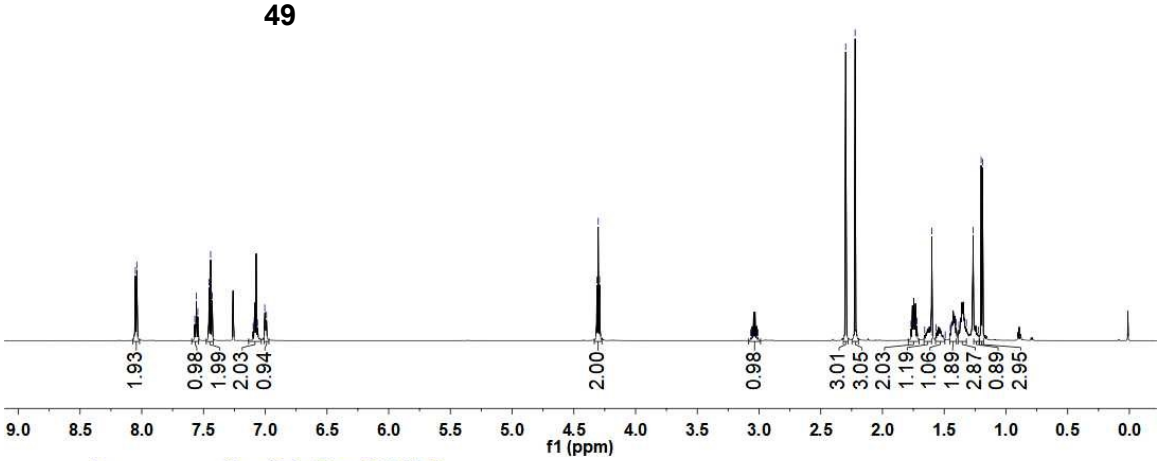
48

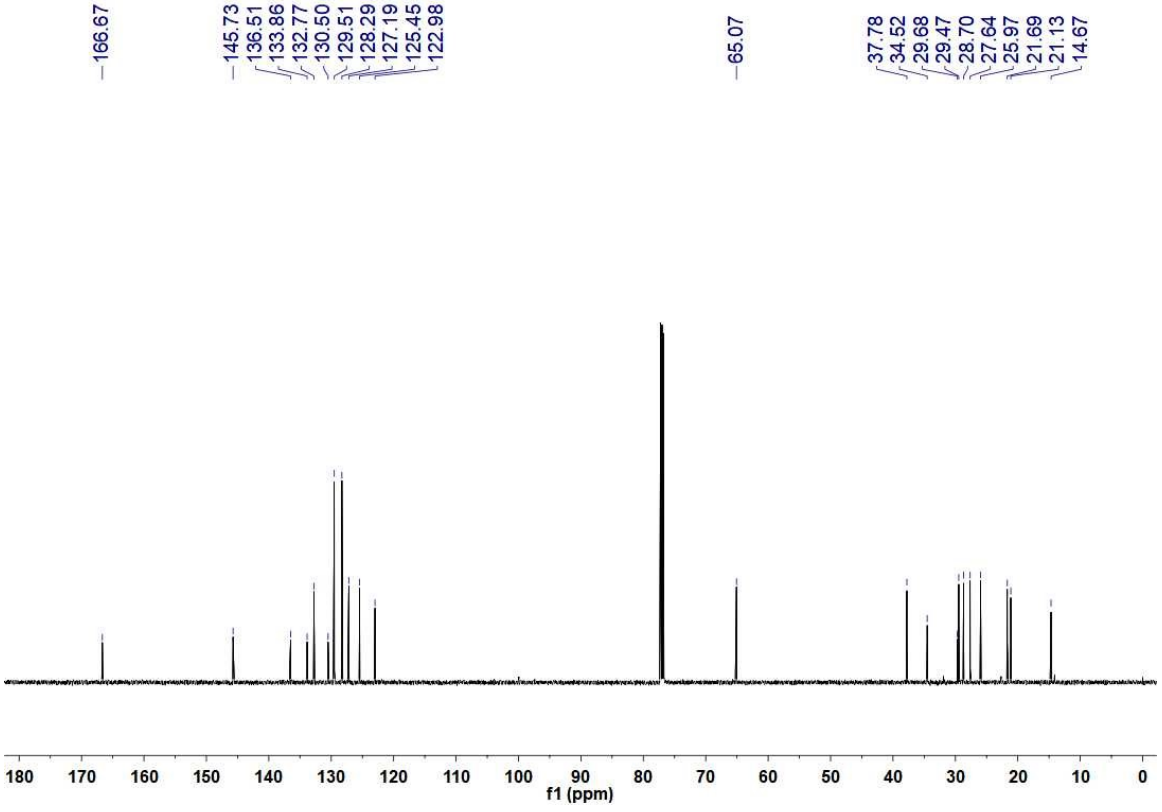
8.071
8.045
7.577
7.548
7.466
7.440
7.310
7.270
7.198
7.159
4.358
4.252
2.724
2.657
1.804
1.686
1.633
1.531
1.428
1.194
2.00
1.02
2.06
2.08
3.10
2.15
1.04
2.04
1.93
9.22
f1 (ppm)
166.64
147.75
132.75
130.48
129.49
128.28
128.24
126.93
125.74
65.04
39.88
38.28
29.30
28.65
27.54
25.91
22.31
f1 (ppm)


8.052
8.040
8.038
7.571
7.558
7.546
7.455
7.442
7.429
7.097
7.063
7.004
6.989
4.314
4.303
4.291
3.067
3.009
2.298
2.221
1.769
1.721
1.601
1.567
1.451
1.402
1.381
1.320
1.266
1.223
1.201


Me
Me
BzO
4
Me

49


1.93
0.98
1.99
2.03
0.94
2.00
0.98
3.01
3.05
2.03
1.19
1.06
1.89
2.87
0.89
2.95
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)


166.67
145.73
136.51
133.86
132.77
130.50
129.51
128.29
127.19
125.45
122.98
65.07
37.78
34.52
29.68
29.47
28.70
27.64
25.97
21.69
21.13
14.67
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)