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Supporting Information

Photoinduced Copper-Catalyzed Asymmetric Decarboxylative Alkynylation with Terminal Alkynes

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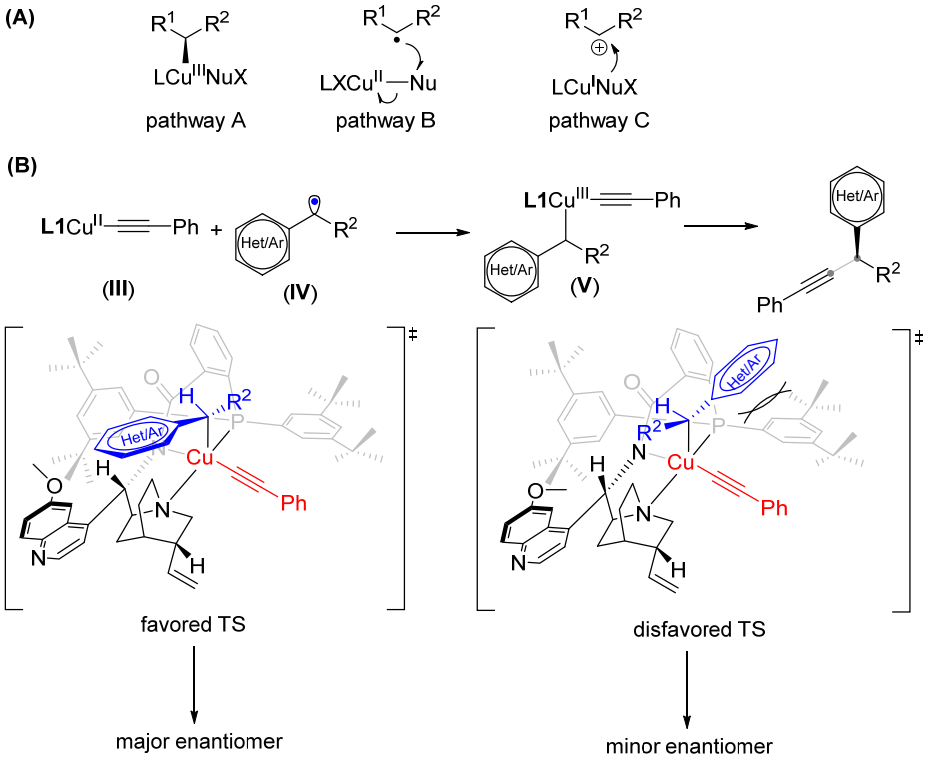
anie_202006317_sm_miscellaneous_information.pdf

Contents

Scheme S1. Proposed model for asymmetric induction.



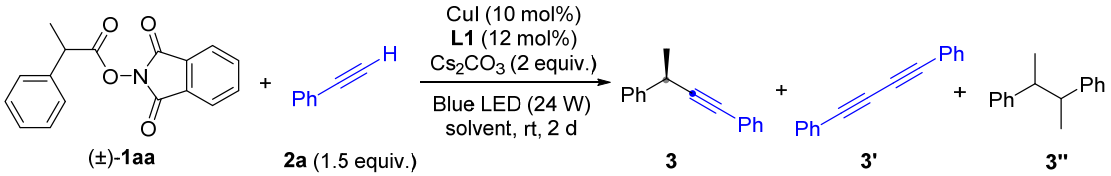
As for the copper-catalyzed radical C(sp^3)–Nu bond formation, there are mainly three possible pathways between $Cu^{II}Nu$ and the alkyl radical intermediate: (1) the formation of a Cu^{III} species between $Cu^{II}Nu$ and the alkyl radical intermediate, followed by subsequent reductive elimination (pathway A in Scheme S1A); (2) outer-sphere radical substitution (pathway B in Scheme S1A); (3) oxidation of the alkyl radical intermediate to a carbocation intermediate followed by nucleophilic trapping (pathway C in Scheme S1A). At this stage, we have no clear evidence favoring any of these three pathways. Nonetheless, we speculate that the reaction probably proceeds via the formation of Cu^{III} species **V** and subsequent reductive elimination (Scheme S1B). Based on this assumption, we have deduced transition states (TS) that lead to the desired stereochemistry and its mirror image, respectively (Scheme S1B). The unfavored transition state leading to the *S* product involves the clash between the relatively large (hetero)aryl group in substrate and the bulky phosphine moiety in ligand and thus, is unfavored. This result is consistent with the observed stereochemistry (*R* product). The investigation on the proposed formation of Cu^{III} species is still ongoing in our laboratory and the results will be disclosed in due report.

1. General information

Reagents were used as received from commercial suppliers without further purification, unless otherwise stated. CuI was purchased from Sigma-Aldrich. Anhydrous trifluorotoluene ($PhCF_3$) was purchased from Beijing J&K Scientific Ltd. and was used directly without further purification. NMR spectra were recorded for ^1H NMR (400 MHz), ^{13}C NMR (100 MHz) and ^{19}F NMR (376 MHz) using TMS as an internal standard and Bruker AV 400 as an instrument. The following abbreviations were used to describe peak patterns where appropriate: singlet (s), doublet (d), triplet (t), multiplet (m). High-resolution mass spectroscopy (HRMS) were obtained using Bruker Apex IV RTMS. Enantiomeric excess (ee) was determined by Agilent high-performance liquid chromatography (HPLC) with a Hatachi detector (at appropriate wavelength).

2. Screening of reaction conditions

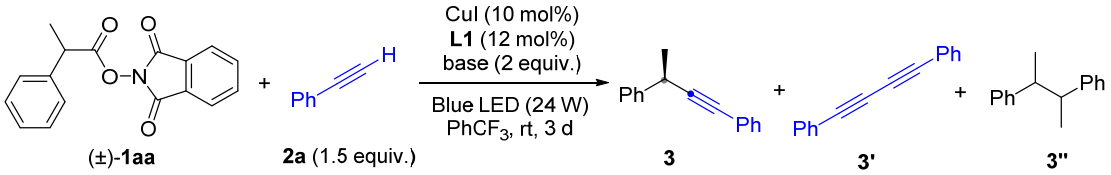
Table S1 Screening of different solvents[a]



Entry	Solvent	Yield of **3**	Yield of **3'**	Yield of **3''**	ee of **3**
1	DMF	< 5%	~30%	9%	NA
2	MeCN	10%	~30%	6%	86%
3	Et_2O	ND	~30%	8%	NA
4	THF	9%	~20%	9%	80%
5	fluorobenzene	13%	~30%	16%	92%
6	**trifluorotoluene**	**20%**	**~30%**	**13%**	**92%**
7	hexafluorobenzene	5%	~20%	18%	46%
8	EtOAc	ND	~10%	< 5%	NA
9	CH_2Cl_2	14%	~30%	11%	82%

[a] Reaction conditions: (±)-**1aa** (0.050 mmol), **2a** (1.5 equiv.), CuI (10 mol%), **L1** (12 mol%), and Cs_2CO_3 (2.0 equiv.) in anhydrous solvent (0.50 mL) at rt under irradiation of blue LED (24 W) for 2 d under argon. Yields of **3** and **3′′** were based on ^1H NMR analysis of the crude product using CH_2Br_2 as an internal standard. Yield of **3′** was the isolated yield. Ee value was determined by HPLC analysis. [b] ND = not detected. [c] NA = not applicable. In most cases, 2-phenylpropanoic acid via the hydrolysis of **1aa** could be detected.

Table S2 Screening of different bases[a]

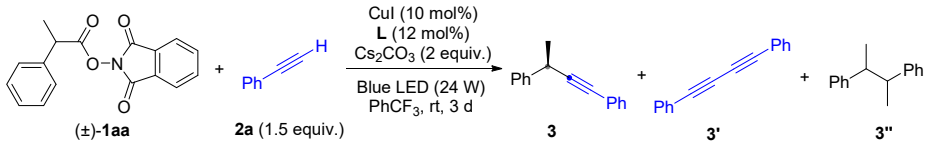


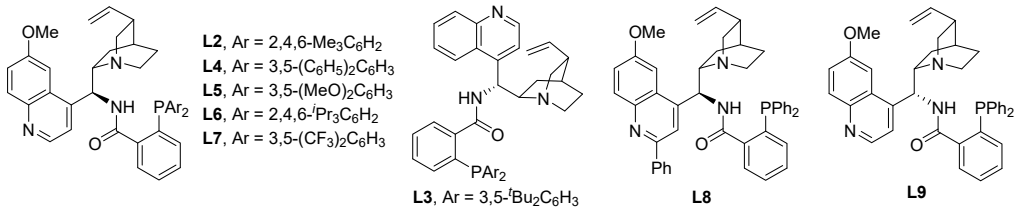
(±)-**1aa** **2a** (1.5 equiv.) **3** **3'** **3"**

Entry	Base	Yield of **3**	Yield of **3'**	Yield of **3"**	ee of **3**
1[b]	Cs_2CO_3	20%	~30%	13%	92%
2	**Cs_2CO_3**	**21%**	**~30%**	**12%**	**92%**
3	K_3PO_4	13%	~10%	5%	92%
4	K_2HPO_4	ND	< 5%	< 5%	NA
5	CsOAc	ND	< 5%	< 5%	NA
6	Et_3N	ND	< 5%	< 5%	NA
7	pyridine	ND	< 5%	< 5%	NA

[a] Reaction conditions: (±)-**1aa** (0.050 mmol), **2a** (1.5 equiv.), CuI (10 mol%), **L1** (12 mol%), and base (2.0 equiv.) in $PhCF_3$ (0.50 mL) at rt under irradiation of blue LED (24 W) for 3 d under argon. Yields of **3** and **3″** were based on ^1H NMR analysis of the crude product using CH_2Br_2 as an internal standard. Yield of **3′** was the isolated yield. Ee value was determined by HPLC analysis. [b] Reaction time: 2 d.

Table S3 Screening of different ligands[a]

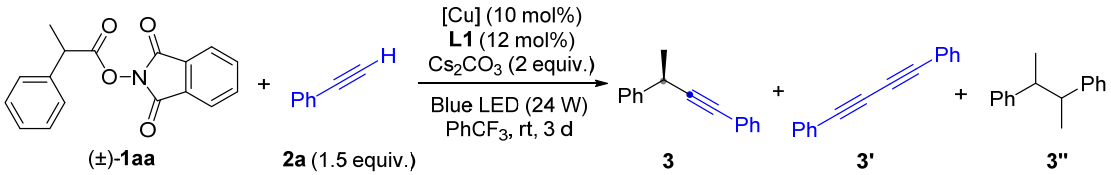




Entry	L	Yield of **3**	Yield of **3'**	Yield of **3''**	ee of **3**
1	**L1**	**21%**	**~30%**	**12%**	**92%**
2	**L2**	< 5%	~10%	< 5%	NA
3	**L3**	21%	~20%	6%	-72%
4	**L4**	6%	~20%	7%	70%
5	**L5**	15%	~30%	16%	76%
6	**L6**	< 5%	< 5%	< 5%	NA
7	**L7**	< 5%	~10%	< 5%	NA
8	**L8**	17%	~30%	14%	58%
9	**L9**	18%	~10%	< 5%	-48%

[a] Reaction conditions: (±)-**1aa** (0.050 mmol), **2a** (1.5 equiv.), CuI (10 mol%), **L** (12 mol%), and Cs_2CO_3 (2.0 equiv.) in $PhCF_3$ (0.50 mL) at rt under irradiation of blue LED (24 W) for 3 d under argon. Yields of **3** and **3′′** were based on ^1H NMR analysis of the crude product using CH_2Br_2 as an internal standard. Yield of **3′** was the isolated yield. Ee value was determined by HPLC analysis. In most cases, 2-phenylpropanoic acid via the hydrolysis of **1aa** could be detected.

Table S4. Screening of copper salts[a]



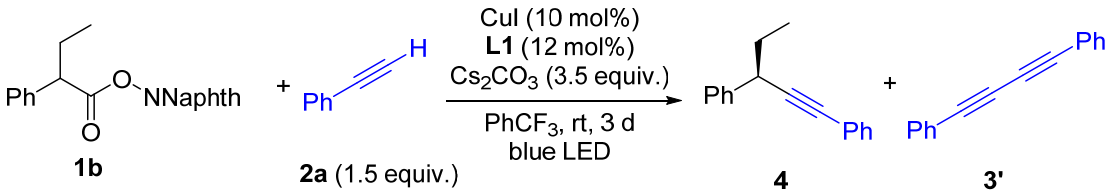
(±)-**1aa** **2a** (1.5 equiv.) **3** **3'** **3"**

Entry	[Cu] salt	Yield of **3**	Yield of **3'**	Yield of **3"**	ee of **3**
1	**CuI**	**21%**	**~30%**	**12%**	**92%**
2	CuCl	18%	~20%	5%	92%
3	CuSCN	19%	~20%	7%	92%
4	$Cu(MeCN)_4PF_6$	17%	~20%	7%	92%
5	CuTc	9%	~30%	14%	72%
6	$Cu(PPh_3)Br$	ND	~10%	6%	NA
7	$CuCl_2$	ND	~20%	13%	NA

[a] Reaction conditions: (±)-**1aa** (0.050 mmol), **2a** (1.5 equiv.), [Cu] salt (10 mol%), **L1** (12 mol%), and Cs_2CO_3 (2.0 equiv.) in $PhCF_3$ (0.50 mL) at rt under irradiation of blue LED (24 W) for 3 d under argon. Yield of **3** and **3″** were based on ^1H NMR analysis of the crude product using CH_2Br_2 as an internal standard. Yield of **3′** was the isolated yield. Ee value was determined by HPLC analysis. In most cases, 2-phenylpropanoic acid via the hydrolysis of **1aa** could be detected.

3. Control experiments

Table S5. Variation of reaction parameters[a]



Entry	Variation	Yield of **4**	Yield of **3′**	ee of **4**
1[b]	No light	11%	0%	97%
2	No CuI	0%	0%	NA
3	No **L1**	6%	~10%	NA
4	No Cs_2CO_3	0%	0%	NA

[a] Reaction conditions: **1b** (0.050 mmol), **2a** (1.5 equiv.), CuI (10 mol%), **L1** (12 mol%), and Cs_2CO_3 (3.5 equiv.) in $PhCF_3$ (1 mL) at rt under irradiation of blue LED (24 W) for 3 d under argon. Yield of **4** was based on ^1H NMR analysis of the crude product using CH_2Br_2 as an internal standard. Yield of **3′** was the isolated yield. Ee value was determined by HPLC analysis. [b] The reaction was stirred at rt for 3 d. and then was stirred at reflux for 2 d.

4. Stern-Volmer luminescence quenching experiments

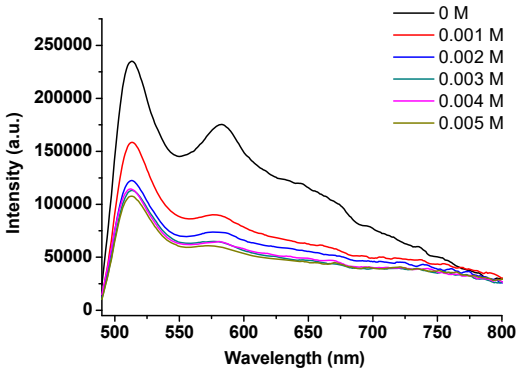


Figure S1a. Cu(I)-phenylacetylide emission quenching by **1b**.

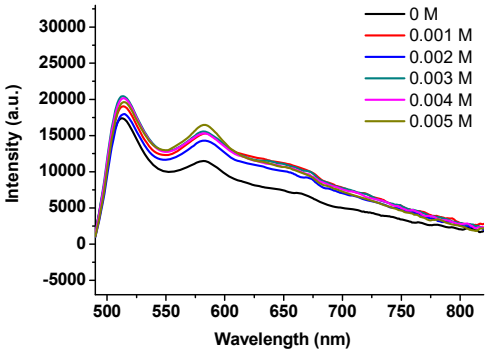


Figure S1b. Cu(I)-phenylacetylide emission quenching by ethynylbenzene (**2a**).

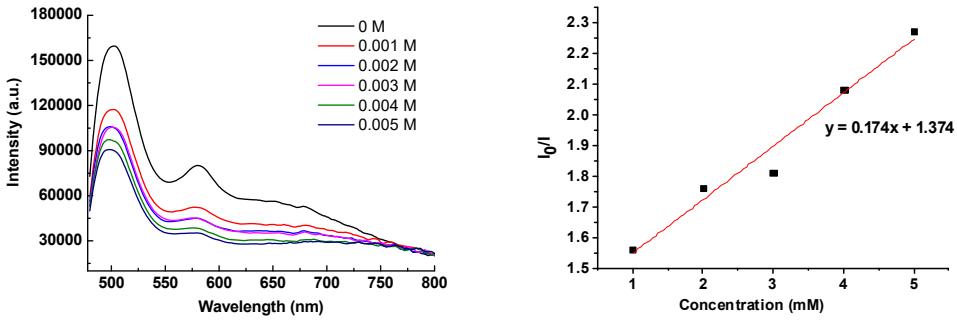


Figure S1c. Cu(I)-phenylacetylide emission quenching by **1aa**.

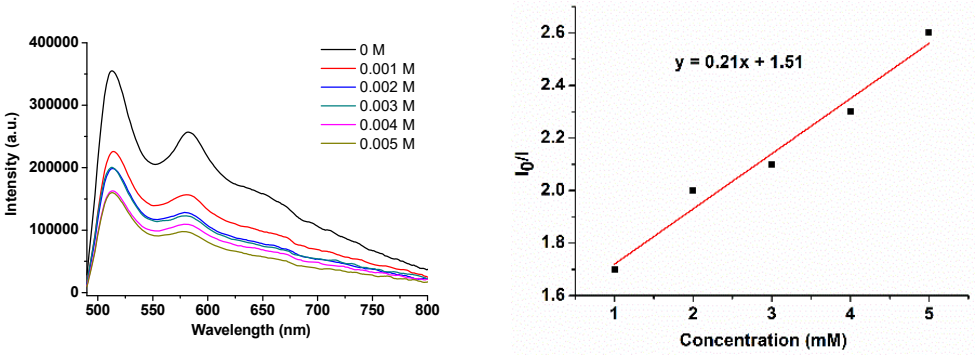


Figure S1d. Cu(I)-phenylacetylide emission quenching by **1ab**.

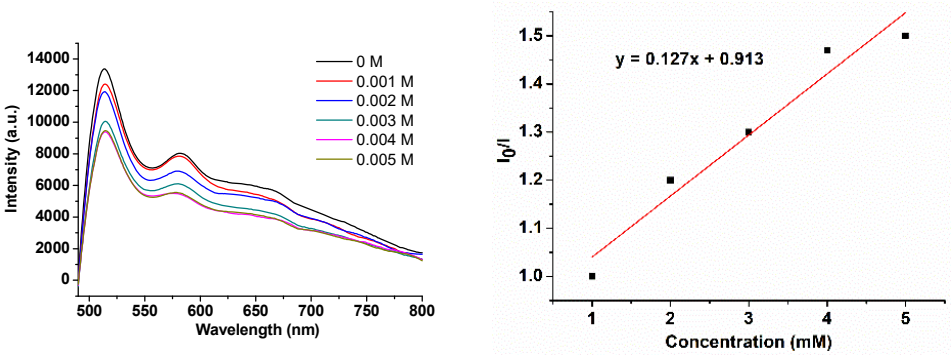


Figure S1e. Cu(I)-phenylacetylide emission quenching by **1ac**.

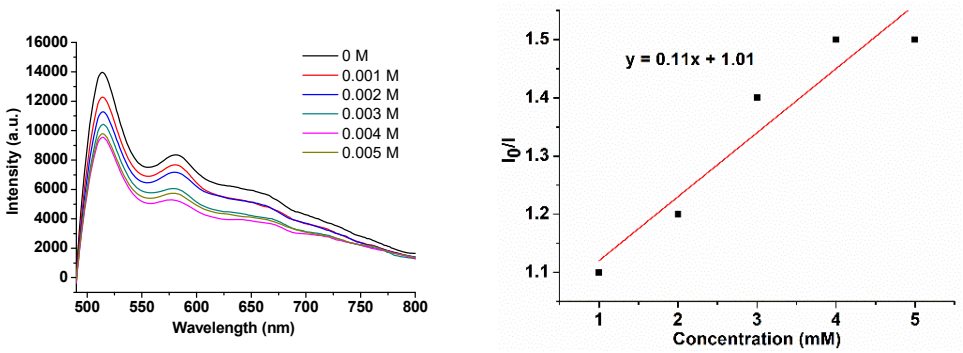


Figure S1f. Cu(I)-phenylacetylide emission quenching by **1ad**.

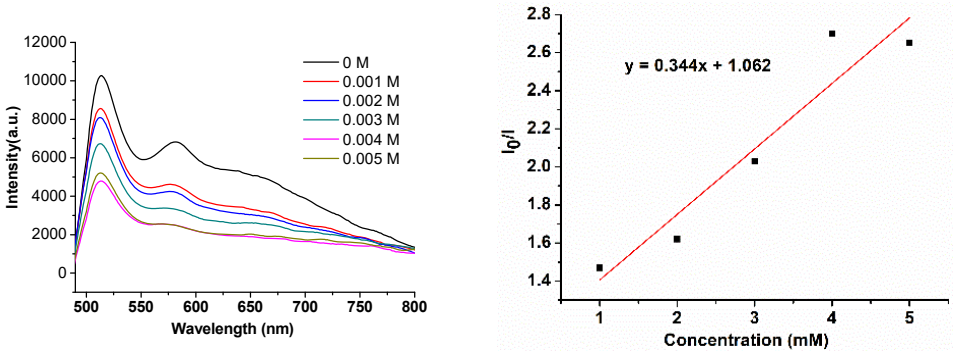


Figure S1g. Cu(I)-phenylacetylide emission quenching by **1ae**.

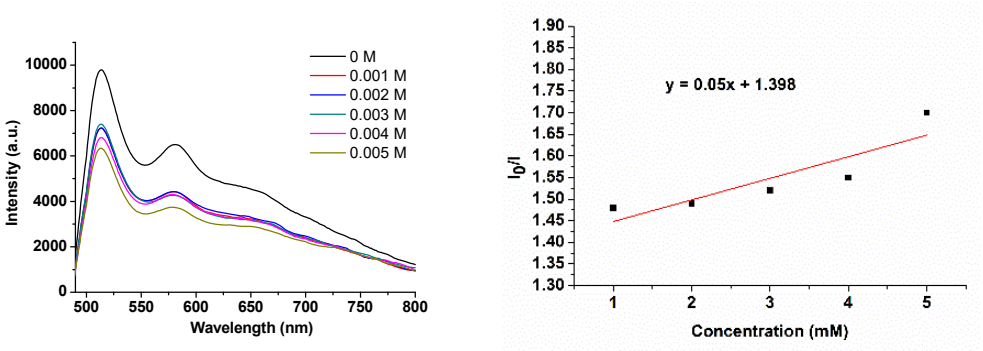


Figure S1h. Cu(I)-phenylacetylide emission quenching by **1af**.

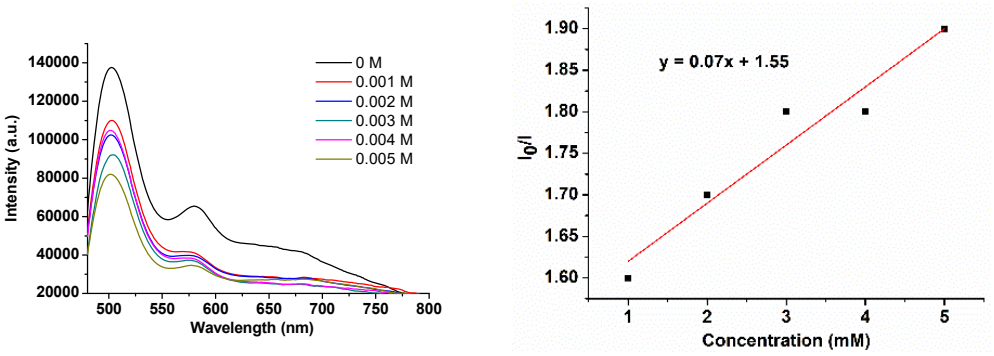


Figure S1i. Cu(I)-phenylacetylide emission quenching by **1ag**.

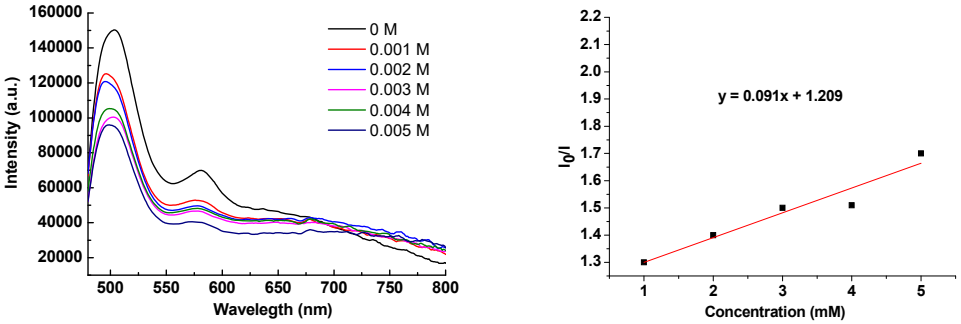


Figure S1j. Cu(I)-phenylacetylide emission quenching by **1ah**.

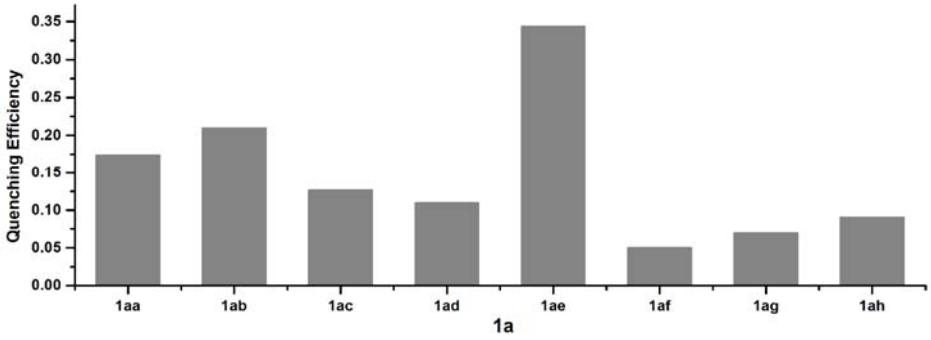


Figure S1k. Comparison of quenching efficiency with **1aa**–**1ah**.

5. Cyclic voltammetry experiments

Cyclic voltammetry experiment was performed using a CH Instruments Electrochemical Workstation model PalmSens4. The electrochemical cell was equipped with a glassy carbon working electrode, a Pt mesh counter electrode, and a $Ag/AgNO_3$ (10 mM $AgNO_3$ in MeCN) reference electrode. A solution of **1b** in MeCN (0.001 M) was tested with 0.1 M Bu_4NPF_6 as the supporting electrolyte and ferrocene was using as an internal standard. Scan rate = 0.1 V/s, 2 sweep segments, a sample interval of 0.001 V.

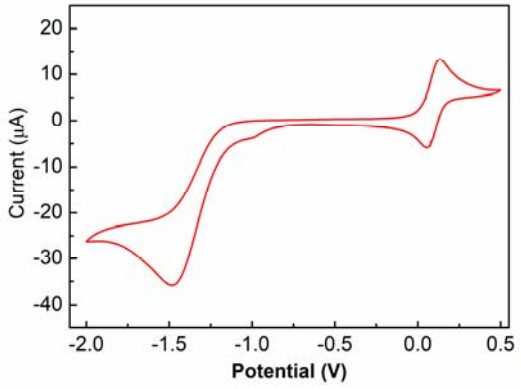
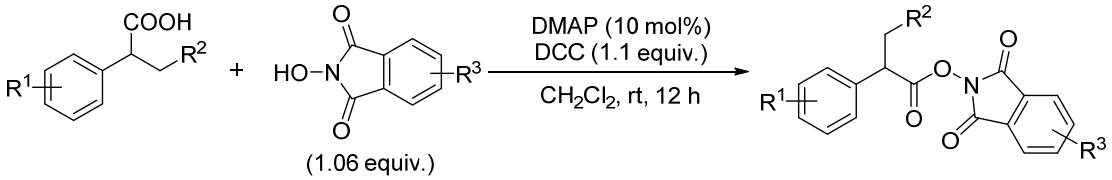


Figure S1. Cyclic voltammogram of **1b** in MeCN. $E_p = -1.567$ V vs. Fc/Fc^+. E_p (vs. SCE) = –1.567 V + 0.393 V = –1.174 V.

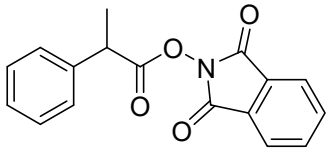
6. The synthesis of *N*-hydroxyphthalimide esters

General procedure 1



To a solution of alkyl carboxylic acid (1.0 equiv.), *N*,*N*-dimethylpyridin-4-amine (DMAP, 10 mol%) and *N*-hydroxyphthalimide or its analogues (1.06 equiv.) in dry CH_2Cl_2 (0.1 M) was added a solution of *N*,*N*-dicyclohexylcarbodiimide (DCC, 1.1 equiv.) in CH_2Cl_2 (0.4 M) under an ice-water bath. Then, the reaction mixture was stirred for 12 h at room temperature. After the completion of reaction, the organic solvent was removed by rotary evaporator under vacuum and the residue was purified by flash column chromatography on silica gel to afford the pure products.[1]

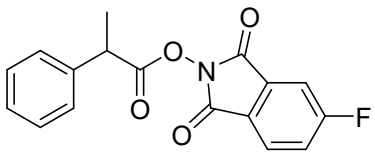
1,3-Dioxoisoindolin-2-yl 2-phenylpropanoate (1aa)



According to **General procedure 1** with 2-phenylpropanoic acid (300.4 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxyisoindoline-1,3-dione (345.8 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **1aa** as a colorless solid (442.9 mg, 75% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.87-7.85 (m, 2H), 7.79-7.75 (m, 2H), 7.42-7.38 (m, 4H), 7.36-7.31 (m, 1H), 4.13 (q, J = 7.2 Hz, 1H), 1.68 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.8, 161.8, 138.3, 134.7, 128.9, 128.7, 127.8, 127.5, 123.9, 42.9, 19.0. The NMR spectra were in accord with that reported in literature.[1]

5-Fluoro-1,3-dioxoisoindolin-2-yl 2-phenylpropanoate (1ab)

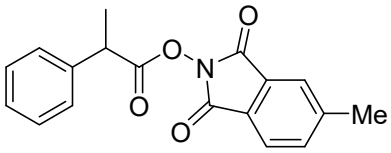


According to **General procedure 1** with 2-phenylpropanoic acid (412.2 mg, 2.7

mmol, 1.0 equiv.) and 5-fluoro-2-hydroxyisoindoline-1,3-dione (522.0 mg, 2.9 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **1ab** as a colorless solid (609.0 mg, 72% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.89-7.86 (m, 1H), 7.56-7.53 (m, 1H), 7.46-7.43 (m, 1H), 7.42-7.38 (m, 4H), 7.36-7.31 (m, 1H), 4.12 (q, J = 7.2 Hz, 1H), 1.67 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.7, 166.6 (d, J = 257.2 Hz), 160.6, 138.2, 131.7 (d, J = 9.5 Hz), 128.9, 127.8, 127.5, 126.6 (d, J = 9.4 Hz), 124.7 (d, J = 3.2 Hz), 121.8 (d, J = 23.4 Hz), 111.9 (d, J = 25.0 Hz), 42.9, 18.9; HRMS (ESI): decomposed to $C_8H_4FNO_3$, *m/z* calcd for $C_8H_3FNO_3$ $[M-H]^-$: 180.0102, found: 180.0095.

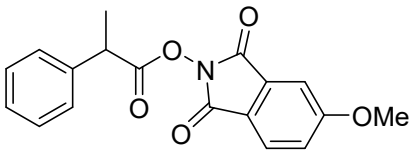
5-Methyl-1,3-dioxoisoindolin-2-yl 2-phenylpropanoate (1ac)



According to **General procedure 1** with 2-phenylpropanoic acid (300.4 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-5-methylisoindoline-1,3-dione (375.6 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/4) to yield the product **1ac** as a colorless solid (494.9 mg, 80% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.73 (d, J = 7.6 Hz, 1H), 7.66 (s, 1H), 7.55 (d, J = 7.6 Hz, 1H), 7.42-7.37 (m, 4H), 7.36-7.30 (m, 1H), 4.12 (q J = 7.1 Hz, 1H), 2.51 (s, 3H), 1.67 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.8, 162.0, 146.2, 138.4, 135.2, 129.2, 128.9, 127.8, 127.6, 126.2, 124.4, 123.9, 42.9, 22.1, 19.0; HRMS (ESI): *m/z* calcd for $C_{18}H_{16}NO_4$ $[M+H]^+$: 310.1074, found: 310.1071.

5-Methoxy-1,3-dioxoisoindolin-2-yl 2-phenylpropanoate (1ad)

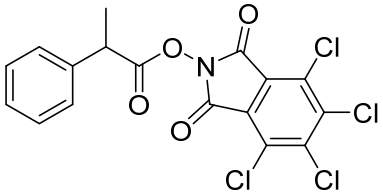


According to **General procedure 1** with 2-phenylpropanoic acid (300.4 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-5-methoxyisoindoline-1,3-dione (409.5 mg, 2.12

mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **1ad** as a colorless solid (455.4 mg, 70% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.76 (d, J = 8.4 Hz, 1H), 7.42-7.37 (m, 4H), 7.35-7.30 (m, 2H), 7.19 (dd, J = 8.4, 2.4 Hz, 1H), 4.11 (q, J = 7.2 Hz, 1H), 3.92 (s, 3H), 1.67 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.9, 165.1, 161.8, 138.4, 131.4, 128.9, 127.7, 127.5, 125.8, 120.6, 120.2, 108.9, 56.1, 42.9, 19.0; HRMS (ESI): *m/z* calcd for $C_{18}H_{16}NO_5$ $[M+H]^+$: 326.1023, found: 326.1019.

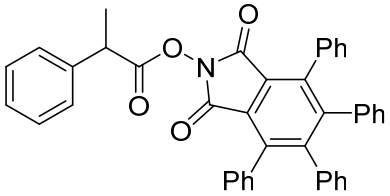
4,5,6,7-Tetrachloro-1,3-dioxoisoindolin-2-yl 2-phenylpropanoate (1ae)



According to **General procedure 1** with 2-phenylpropanoic acid (300.4 mg, 2.0 mmol, 1.0 equiv.) and 4,5,6,7-tetrachloro-2-hydroxyisoindoline-1,3-dione (637.9 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **1ae** as a colorless solid (563.0 mg, 65% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.42-7.37 (m, 4H), 7.35-7.31 (m, 1H), 4.12 (q, J = 7.2 Hz, 1H), 1.67 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.3, 157.4, 141.0, 137.9, 130.4, 129.0, 127.9, 127.5, 124.7, 42.9, 18.9; HRMS (ESI): decomposed to $C_8HCl_4NO_3$, *m/z* calcd for $C_8Cl_4NO_3$ $[M-H]^-$: 297.8638, found: 297.8639.

1,3-Dioxo-4,5,6,7-tetraphenylisoindolin-2-yl 2-phenylpropanoate (1af)

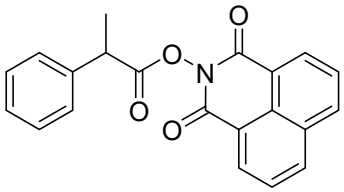


According to **General procedure 1** with 2-phenylpropanoic acid (758.4 mg, 5.1 mmol, 1.0 equiv.) and 2-hydroxy-4,5,6,7-tetraphenylisoindoline-1,3-dione (2.5 g, 5.4 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column

chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **1af** as a colorless solid (2.2 g, 71% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.32-7.31 (m, 4H), 7.27-7.24 (m, 1H), 7.19-7.18 (m, 6H), 7.11 (s, 4H), 6.90-6.88 (m, 6H), 6.74 (s, 4H), 4.00 (q, J = 7.2 Hz, 1H), 1.60 (d, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.6, 148.5, 140.1, 138.2, 137.7, 135.0, 130.6, 129.8, 128.8, 127.6, 127.59, 127.55, 127.4, 127.0, 126.4, 125.1, 42.9, 19.0; HRMS (ESI): *m/z* calcd for $C_{41}H_{30}NO_4$ $[M+H]^+$: 600.2169, found: 600.2164.

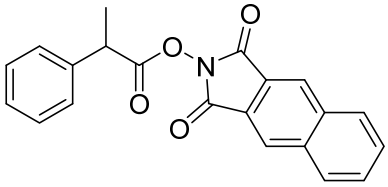
1,3-Dioxo-1*H*-benzo[*de*]isoquinolin-2(3*H*)-yl 2-phenylpropanoate (1ag)



According to **General procedure 1** with 2-phenylpropanoic acid (300.4 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*de*]isoquinoline-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **1ag** as a colorless solid (497.3 mg, 72% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.61-8.55 (m, 2H), 8.25 (d, J = 8.0 Hz, 2H), 7.76 (q, J = 8.0 Hz, 2H), 7.51 (d, J = 7.6 Hz, 2H), 7.43 (t, J = 7.6 Hz, 2H), 7.34 (t, J = 7.2 Hz, 1H), 4.24 (q, J = 7.2 Hz, 1H), 1.76 (d, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.6, 159.6, 159.4, 138.7, 135.0, 134.9, 131.9, 131.8, 128.8, 127.8, 127.7, 127.6, 127.1, 122.3, 43.2, 19.0; HRMS (ESI): *m/z* calcd for $C_{21}H_{16}NO_4$ $[M+H]^+$: 346.1074, found: 346.1070.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylpropanoate (1ah)

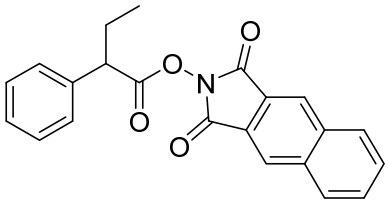


According to **General procedure 1** with 2-phenylpropanoic acid (1.3 g, 8.8 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (2.0 g, 9.3 mmol, 1.06

equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **1ah** as a colorless solid (2.1 g, 70% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.07-8.03 (m, 2H), 7.74-7.70 (m, 2H), 7.46-7.39 (m, 4H), 7.36-7.32 (m, 1H), 4.16 (q, J = 7.1 Hz, 1H), 1.70 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.6, 161.4, 138.4, 135.4, 130.4, 129.6, 128.9, 127.8, 127.6, 125.7, 124.4, 43.0, 19.0; HRMS (ESI): *m/z* calcd for $C_{21}H_{16}NO_4$ $[M+H]^+$: 346.1074, found: 346.1070.

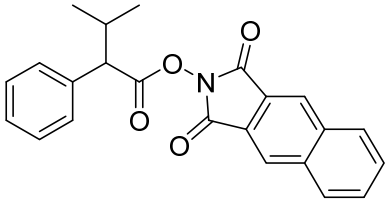
1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate (1b)



According to **General procedure 1** with 2-phenylbutanoic acid (328.4 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **1b** as a colorless solid (503.1 mg, 70% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.07-8.03 (m, 2H), 7.74-7.70 (m, 2H), 7.44-7.38 (m, 4H), 7.36-7.31 (m, 1H), 3.89 (t, J = 7.6 Hz, 1H), 2.33-2.22 (m, 1H), 2.04-1.93 (m, 1H), 1.06 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.1, 161.4, 136.8, 135.4, 130.4, 129.6, 128.8, 128.1, 127.8, 125.7, 124.4, 50.5, 27.2, 11.9; HRMS (ESI): *m/z* calcd for $C_{22}H_{18}NO_4$ $[M+H]^+$: 360.1230, found: 360.1228.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 3-methyl-2-phenylbutanoate (S5)

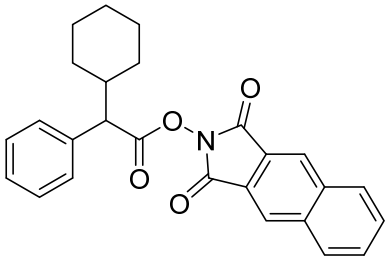


According to **General procedure 1** with 3-methyl-2-phenylbutanoic acid (356.5 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg,

2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **S5** as a colorless solid (470.5 mg, 63% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.34 (s, 2H), 8.06-8.04 (m, 2H), 7.74-7.70 (m, 2H), 7.43-7.31 (m, 5H), 3.61 (d, J = 9.6 Hz, 1H), 2.53-2.40 (m, 1H), 1.25 (d, J = 6.8 Hz, 3H), 0.85 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.9, 161.4, 136.0, 135.4, 130.4, 129.6, 128.7, 128.6, 127.9, 125.7, 124.4, 56.6, 32.4, 21.2, 20.2; HRMS (ESI): *m/z* calcd for $C_{23}H_{20}NO_4$ $[M+H]^+$: 374.1387, found: 374.1388.

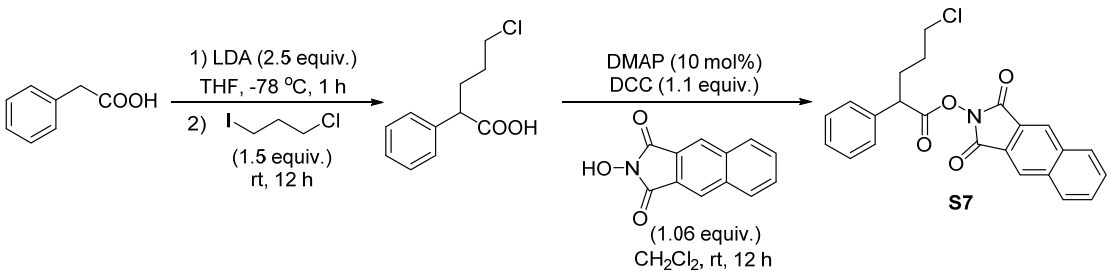
1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-cyclohexyl-2-phenylacetate (S6)



According to **General procedure 1** with 2-cyclohexyl-2-phenylacetic acid (436.6 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S6** as a colorless solid (504.4 mg, 61% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.33 (s, 2H), 8.06-8.04 (m, 2H), 7.73-7.70 (m, 2H), 7.42-7.31 (m, 5H), 3.67 (d, J = 9.6 Hz, 1H), 2.16-2.09 (m, 2H), 1.86-1.83 (m, 1H), 1.68-1.66 (m, 2H), 1.47-1.44 (m, 1H), 1.37-1.17 (m, 4H), 0.93-0.85 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.9, 161.4, 135.6, 135.4, 130.4, 129.6, 128.7, 127.8, 125.7, 124.4, 55.6, 41.5, 31.6, 30.4, 26.2, 26.0, 25.9; HRMS (ESI): *m/z* calcd for $C_{26}H_{24}NO_4$ $[M+H]^+$: 414.1700, found: 414.1701.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 5-chloro-2-phenylpentanoate (S7)

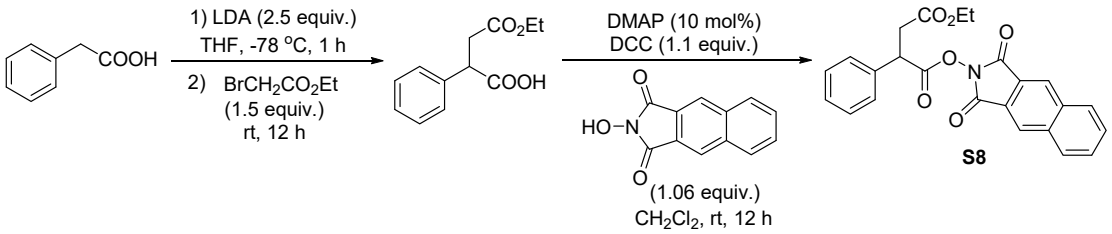


To a stirred solution of LiN(*i*Pr)$_2$ (LDA, 7.5 mL, 15 mmol, 2.5 equiv., 2.0 M in THF) in dry THF (20 mL) was added dropwise the solution of 2-phenylacetic acid (6 mmol, 1 equiv.) in dry THF (15 mL) under Ar at -78 °C. The reaction mixture was stirred at 0 °C for 1 h and cooled to -78 °C again. Then, 1-chloro-3-iodopropane (1.84 g, 9 mmol) was added and the reaction mixture was stirred for 12 h at room temperature. After the completion of reaction, the reaction was quenched with aqueous HCl (1 M). The reaction mixture was extracted with CH_2Cl_2 (3 × 10 mL). The combined organic layers were washed with saturated brine (2 × 30 mL) and dried with over anhydrous $MgSO_4$. The organic solvent was removed by rotary evaporator under vacuum to yield 5-chloro-2-phenylpentanoic acid which was used directly without further purification.

According to **General procedure 1** with 5-chloro-2-phenylpentanoic acid (425.3 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **S7** as a colorless solid (571.0 mg, 70% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.34 (s, 2H), 8.06-8.03 (m, 2H), 7.74-7.70 (m, 2H), 7.44-7.33 (m, 5H), 4.01 (t, J = 7.6 Hz, 1H), 3.65-3.54 (m, 2H), 2.41-2.32 (m, 1H), 2.20-2.11 (m, 1H), 2.03-1.82 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.8, 161.3, 136.4, 135.4, 130.4, 129.7, 129.0, 128.1, 128.0, 125.8, 124.3, 48.2, 44.3, 31.1, 30.0; HRMS (ESI): *m/z* calcd for $C_{23}H_{19}ClNO_4$ $[M+H]^+$: 408.0997, found: 408.0997.

1-(1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl) 4-ethyl 2-phenylsuccinate (S8)

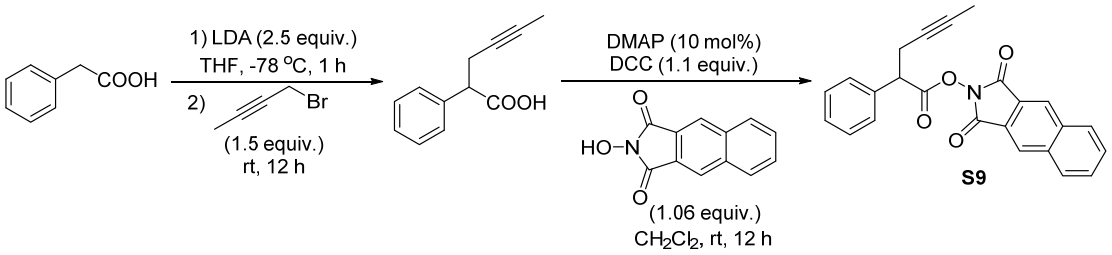


The synthetic procedure of 4-ethoxy-4-oxo-2-phenylbutanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 4-ethoxy-4-oxo-2-phenylbutanoic acid (444.5 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S8** as a colorless solid (542.6 mg, 65% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.34 (s, 2H), 8.05-8.04 (m, 2H), 7.72-7.70 (m, 2H), 7.44-7.36 (m, 5H), 4.55 (t, J = 7.6 Hz, 1H), 4.20 (q, J = 6.8 Hz, 2H), 3.31-3.25 (m, 1H), 2.90-2.85 (m, 1H), 1.26 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.2, 169.4, 161.1, 135.6, 135.4, 130.4, 129.6, 129.1, 128.3 128.0, 125.7, 124.3, 61.2, 45.0, 38.2, 14.1; HRMS (ESI): *m/z* calcd for $C_{24}H_{20}NO_6$ $[M+H]^+$: 418.1285, found: 418.1285.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylhex-4-ynoate (S9)

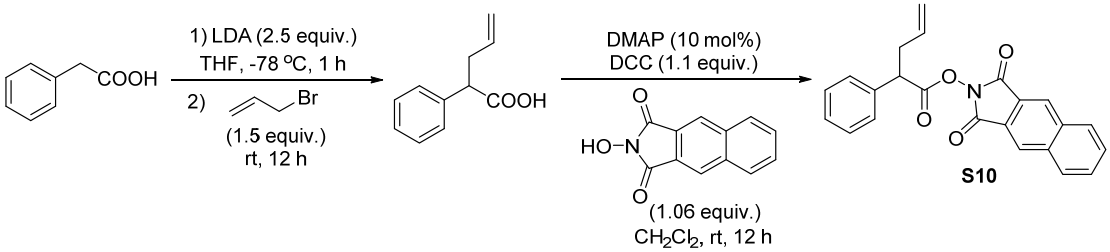


The synthetic procedure of 2-phenylhex-4-ynoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-phenylhex-4-ynoic acid (376.5 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S9** as a colorless solid (460.1 mg, 60% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.07-8.03 (m, 2H), 7.74-7.70 (m, 2H), 7.46-7.34 (m, 5H), 4.20 (t, J = 7.6 Hz, 1H), 3.05-2.97 (m, 1H), 2.77-2.69 (m, 1H), 1.81 (t, J = 2.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.1, 161.2, 135.8, 135.4, 130.4, 129.6, 128.9, 128.2, 127.9, 125.7, 124.3, 78.8, 74.8, 48.8, 24.0, 3.5; HRMS (ESI): *m/z* calcd for $C_{24}H_{18}NO_4$ $[M+H]^+$: 384.1230, found: 384.1230.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylpent-4-enoate (S10)

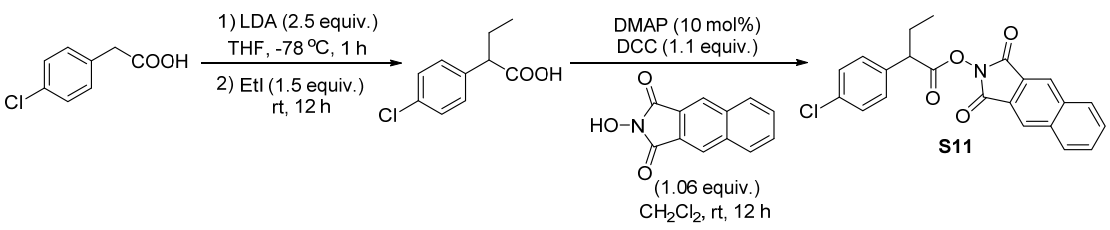


The synthetic procedure of 2-phenylpent-4-enoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-phenylpent-4-enoic acid (352.4 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S10** as a colorless solid (453.1 mg, 61% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.34 (s, 2H), 8.06-8.04 (m, 2H), 7.74-7.70 (m, 2H), 7.44-7.32 (m, 5H), 5.89-5.78 (m, 1H), 5.20-5.12 (m, 2H), 4.07 (t, J = 7.6 Hz, 1H), 3.02-2.95 (m, 1H), 2.74-2.67 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.6, 161.3, 136.3, 135.4, 133.9, 130.4, 129.6, 128.9, 128.1, 128.0, 125.7, 124.4, 118.1, 48.7, 37.8; HRMS (ESI): *m/z* calcd for $C_{23}H_{18}NO_4$ $[M+H]^+$: 372.1230, found: 372.1231.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(4-chlorophenyl)butanoate (S11)

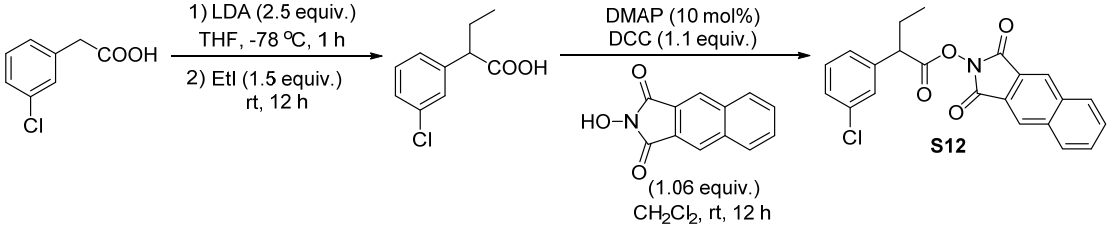


The synthetic procedure of 2-(4-chlorophenyl)butanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(4-chlorophenyl)butanoic acid (397.2 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S11** as a colorless solid (590.7 mg, 75% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.06-8.04 (m, 2H), 7.74-7.71 (m, 2H), 7.39-7.34 (m, 4H), 3.86 (t, J = 7.6 Hz, 1H), 2.31-2.20 (m, 1H), 2.01-1.90 (m, 1H), 1.05 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.8, 161.3, 135.4, 135.3, 133.8, 130.4, 129.7, 129.5, 129.0, 125.8, 124.3, 49.9, 27.2, 11.8; HRMS (ESI): *m/z* calcd for $C_{22}H_{17}ClNO_4$ $[M+H]^+$: 394.0841, found: 394.0839.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(3-chlorophenyl)butanoate (S12)

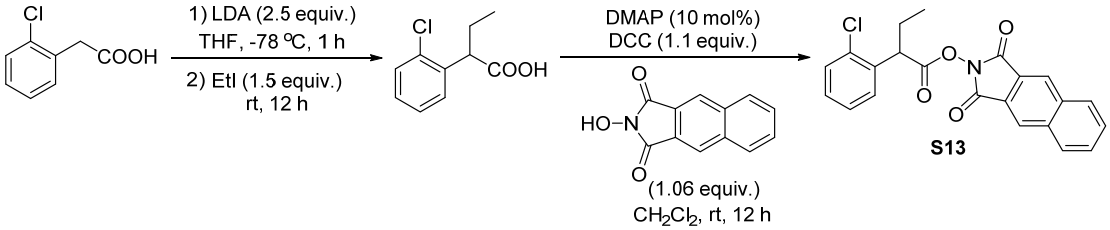


The synthetic procedure of 2-(3-chlorophenyl)butanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(3-chlorophenyl)butanoic acid (397.2 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S12** as a colorless solid (551.4 mg, 70% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.07-8.04 (m, 2H), 7.74-7.70 (m, 2H), 7.43 (s, 1H), 7.36-7.30 (m, 3H), 3.86 (t, J = 7.6 Hz, 1H), 2.32-2.21 (m, 1H), 2.03-1.92 (m, 1H), 1.07 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.6, 161.3, 138.7, 135.5, 134.7, 130.4, 130.1, 129.7, 128.4, 128.1, 126.3, 125.8, 124.4, 50.2, 27.2, 11.8; HRMS (ESI): *m/z* calcd for $C_{22}H_{17}ClNO_4$ $[M+H]^+$: 394.0841, found: 394.0841.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(2-chlorophenyl)butanoate (S13)

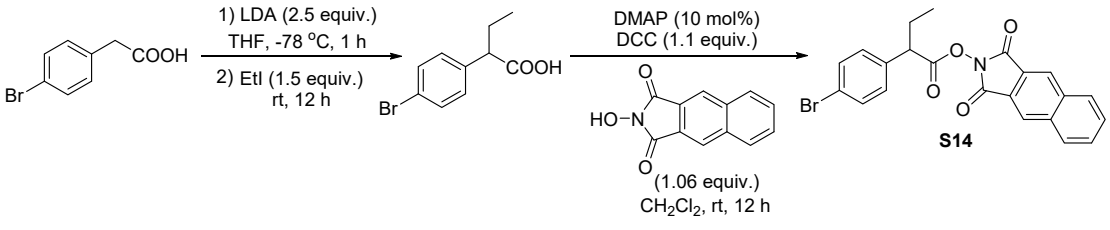


The synthetic procedure of 2-(2-chlorophenyl)butanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(2-chlorophenyl)butanoic acid (397.2 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **S13** as a colorless solid (496.2 mg, 63% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.06-8.03 (m, 2H), 7.74-7.70 (m, 2H), 7.52 (dd, J = 7.6, 1.6 Hz, 1H), 7.45 (dd, J = 8.0, 1.6 Hz, 1H), 7.34 (td, J = 7.6, 1.2 Hz, 1H), 7.29-7.25 (m, 1H), 4.54 (t, J = 7.4 Hz, 1H), 2.30-2.19 (m, 1H), 2.05-1.94 (m, 1H), 1.08 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.7, 161.3, 135.5, 134.8, 134.1, 130.4, 129.8, 129.7, 129.0, 128.8, 127.3, 125.7, 124.4, 46.4, 26.5, 11.7; HRMS (ESI): *m/z* calcd for $C_{22}H_{17}ClNO_4$ $[M+H]^+$: 394.0841, found: 394.0840.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(4-bromophenyl)butanoate (S14)



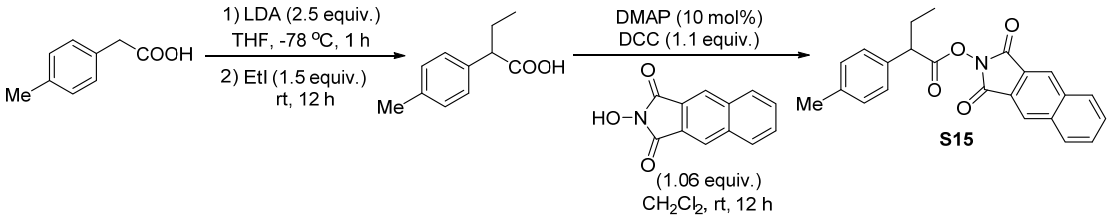
The synthetic procedure of 2-(4-bromophenyl)butanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(4-bromophenyl)butanoic acid (486.1 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg,

2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S14** as a colorless solid (622.4 mg, 71% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.07-8.04 (m, 2H), 7.73-7.71 (m, 2H), 7.53 (d, J = 8.4 Hz, 2H), 7.30 (d, J = 8.4 Hz, 2H), 3.85 (t, J = 7.6 Hz, 1H), 2.31-2.20 (m, 1H), 2.01-1.90 (m, 1H), 1.05 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.7, 161.3, 135.9, 135.5, 132.0, 130.4, 129.8, 129.7, 125.8, 124.3, 121.9, 50.0, 27.2, 11.8; HRMS (ESI): *m/z* calcd for $C_{22}H_{17}BrNO_4$ $[M+H]^+$: 438.0335, found: 438.0335.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(*p*-tolyl)butanoate (S15)

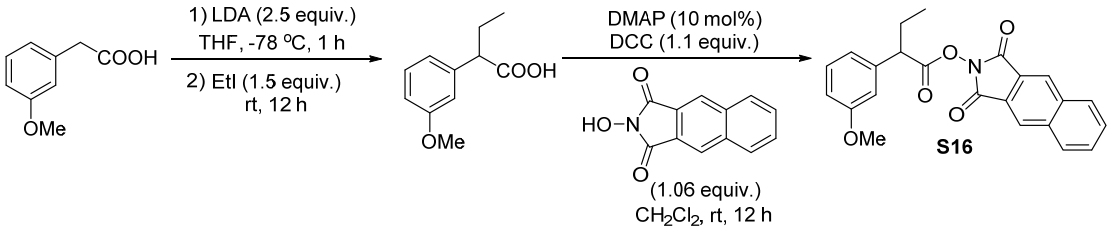


The synthetic procedure of 2-(*p*-tolyl)butanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(*p*-tolyl)butanoic acid (356.3 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **S15** as a colorless solid (560.1 mg, 75% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.34 (s, 2H), 8.06-8.04 (m, 2H), 7.74-7.70 (m, 2H), 7.31 (d, J = 8.0 Hz, 2H), 7.21 (d, J = 8.0 Hz, 2H), 3.85 (t, J = 7.6 Hz, 1H), 2.36 (s, 3H), 2.31-2.20 (m, 1H), 2.02-1.91 (m, 1H), 1.05 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.3, 161.4, 137.5, 135.4, 133.9, 130.4, 129.6, 129.5, 127.9, 125.7, 124.4, 50.1, 27.2, 21.1, 11.9; HRMS (ESI): *m/z* calcd for $C_{23}H_{20}NO_4$ $[M+H]^+$: 374.1387, found: 374.1386.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(3-methoxyphenyl)butanoate (S16)

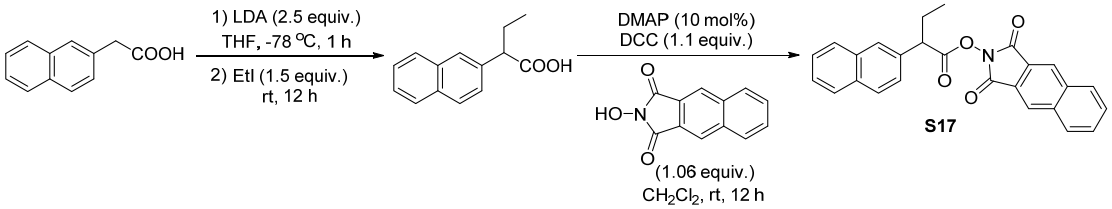


The synthetic procedure of 2-(3-methoxyphenyl)butanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(3-methoxyphenyl)butanoic acid (388.5 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S16** as a colorless solid (599.7 mg, 77% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.07-8.03 (m, 2H), 7.74-7.70 (m, 2H), 7.31 (t, J = 7.8 Hz, 1H), 7.01-6.99 (m, 2H), 6.89-6.86 (m, 1H), 3.89-3.85 (m, 4H), 2.31-2.21 (m, 1H), 2.04-1.93 (m, 1H), 1.07 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.0, 161.4, 159.9, 138.3, 135.4, 130.4, 129.7, 129.6, 125.7, 124.4, 120.5, 113.5, 55.3, 50.5, 27.2, 11.9; HRMS (ESI): *m/z* calcd for $C_{23}H_{20}NO_5$ $[M+H]^+$: 390.1336, found: 390.1332.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(naphthalen-2-yl)butanoate (S17)

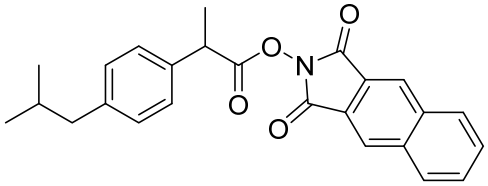


The synthetic procedure of 2-(naphthalen-2-yl)butanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(naphthalen-2-yl)butanoic acid (428.5 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S17** as a colorless solid (573.2 mg, 70% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.34 (s, 2H), 8.05-8.03 (m, 2H), 7.91-7.83 (m, 4H), 7.73-7.69 (m, 2H), 7.57-7.47 (m, 3H), 4.07 (t, J = 7.6 Hz, 1H), 2.43-2.32 (m, 1H), 2.15-2.04 (m, 1H), 1.10 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.1, 161.4, 135.4, 134.3, 133.4, 132.9, 130.4, 129.6, 128.6, 128.0, 127.7, 127.3, 126.3, 126.1, 125.71, 125.69, 124.4, 50.7, 27.2, 11.9; HRMS (ESI): *m/z* calcd for $C_{26}H_{20}NO_4$ $[M+H]^+$: 410.1387, found: 410.1388.

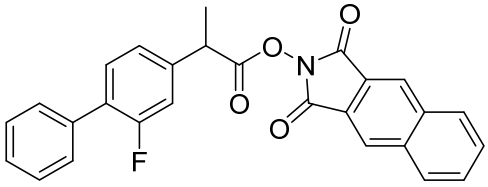
1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(4-isobutylphenyl)propanoate (S18)



According to **General procedure 1** with ibuprofen (309.4 mg, 1.5 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (339.0 mg, 1.59 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S18** as a colorless solid (439.6 mg, 73% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.06-8.03 (m, 2H), 7.74-7.70 (m, 2H), 7.34 (d, J = 8.4 Hz, 2H), 7.18 (d, J = 8.0 Hz, 2H), 4.13 (q, J = 7.1 Hz, 1H), 2.49 (d, J = 7.2 Hz, 2H), 1.93-1.83 (m, 1H), 1.69 (d, J = 7.2 Hz, 3H), 0.92 (d, J = 6.8 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.8, 161.4, 141.2, 135.6, 135.4, 130.4, 129.62, 129.60, 127.3, 125.7, 124.4, 45.1, 42.7, 30.1, 22.4, 19.0; HRMS (ESI): *m/z* calcd for $C_{25}H_{24}NO_4$ $[M+H]^+$: 402.1700, found: 402.1701.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(2-fluoro-[1,1'-biphenyl]-4-yl)propanoate (S19)

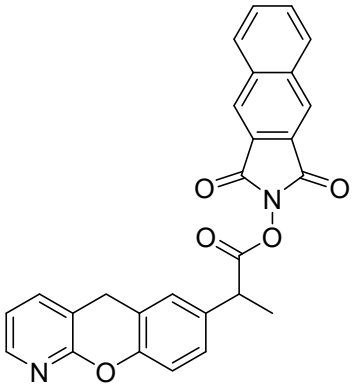


According to **General procedure 1** with flurbiprofen acid (488.5 mg, 2.0 mmol, 1.0

equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **S19** as a colorless solid (536.1 mg, 61% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.37 (s, 2H), 8.08-8.05 (m, 2H), 7.75-7.71 (m, 2H), 7.57 (d, J = 7.6 Hz, 2H), 7.51-7.44 (m, 3H), 7.40-7.36 (m, 1H), 7.32-7.29 (m, 2H), 4.20 (q, J = 7.2 Hz, 1H), 1.75 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.2, 161.3, 159.8 (d, J = 247.4 Hz), 139.5 (d, J = 7.7 Hz), 135.4, 135.3, 131.2 (d, J = 3.9 Hz), 130.4, 129.7, 129.0 (d, J = 2.9 Hz), 128.6, 128.4, 127.7, 125.8, 124.3, 123.6 (d, J = 3.4 Hz), 115.5 (d, J = 24.0 Hz), 42.5, 19.0; ^{19}F NMR (376 MHz, $CDCl_3$) δ: -116.9; HRMS (ESI): *m/z* calcd for $C_{27}H_{19}FNO_4$ $[M+H]^+$: 440.1293, found: 440.1288.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(5*H*-chromeno[2,3-*b*]pyridin-7-yl)propanoate (S20)

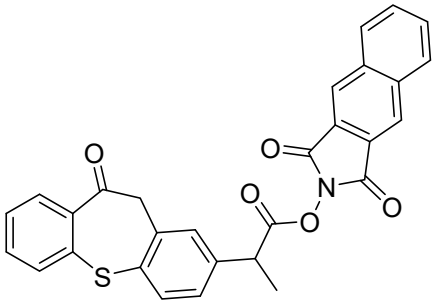


According to **General procedure 1** with pranoprofen (510.5 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/dichloromethane = 1/30) to yield the product **S20** as a colorless solid (504.5 mg, 56% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.36 (s, 2H), 8.18 (d, J = 4.0 Hz, 1H), 8.07-8.04 (m, 2H), 7.74-7.70 (m, 2H), 7.55 (d, J = 6.4 Hz, 1H), 7.29-7.27 (m, 2H), 7.20 (d, J = 8.0 Hz, 1H), 7.06-7.03 (m, 1H), 4.16-4.10 (m, 3H), 1.69 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.6, 161.4, 158.3, 151.2, 146.7, 138.4, 135.4, 133.7, 130.4,

129.7, 127.7, 127.4, 125.8, 124.3, 119.9, 119.86, 117.6, 115.3, 42.3, 28.1, 19.1; HRMS (ESI): *m/z* calcd for $C_{27}H_{19}N_2O_5$ $[M+H]^+$: 451.1288, found: 451.1285.

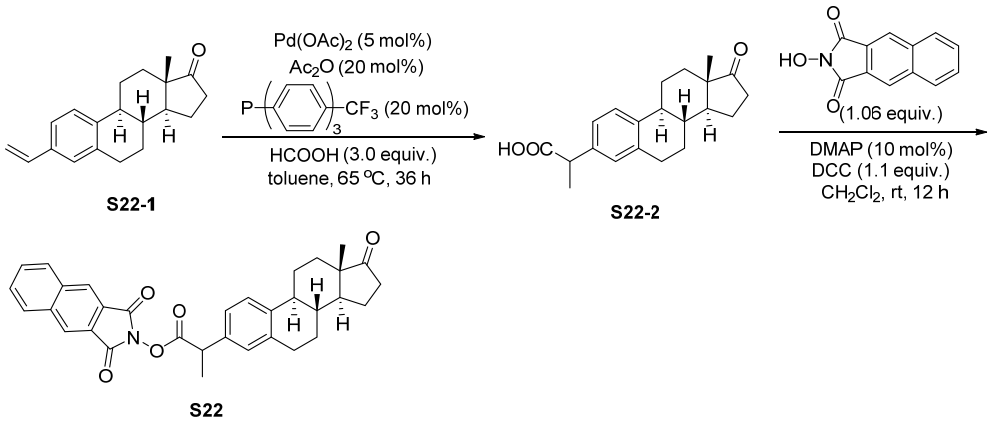
1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(10-oxo-10,11-dihydrodibenzo[*b*,*f*]thiepin-2-yl)propanoate (S21)



According to **General procedure 1** with zaltoprofen (596.7 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/dichloromethane = 1/50) to yield the product **S21** as a colorless solid (572.5 mg, 58% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.25 (s, 2H), 8.17 (d, J = 7.6 Hz, 1H), 7.97-7.95 (m, 2H), 7.67-7.63 (m, 3H), 7.57-7.53 (m, 2H), 7.39 (td, J = 7.4, 0.8 Hz, 1H), 7.31-7.26 (m, 2H), 4.40-4.34 (m, 2H), 4.16 (q, J = 7.2 Hz, 1H), 1.67 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 191.0, 170.0, 161.1, 140.4, 139.8, 138.1, 135.9, 135.2, 133.9, 132.4, 131.6, 131.4, 130.7, 130.2, 129.5, 128.6, 126.7, 126.3, 125.6, 124.0, 50.9, 42.5, 18.9; HRMS (ESI): *m/z* calcd for $C_{29}H_{20}NO_5S$ $[M+H]^+$: 494.1057, found: 494.1057.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-((8*R*,9*S*,13*S*,14*S*)-13-methyl-17-oxo-7,8,9,11,12,13,14,15,16,17-decahydro-6*H*-cyclopenta[α]phenanthren-3-yl)propanoate (S22)

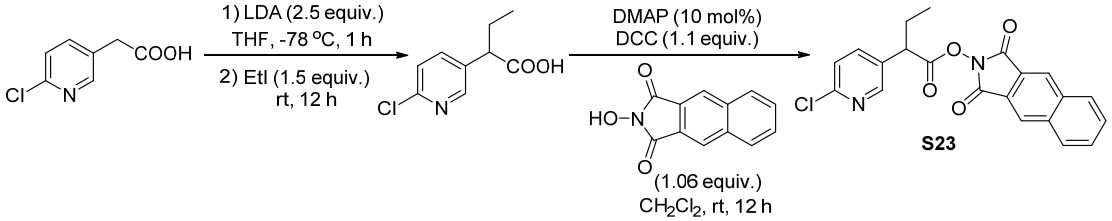


To a mixture of $Pd(OAc)_2$ (56 mg, 0.25 mmol, 5 mol%), tri[4-(trifluoromethyl)phenyl]phosphane (466 mg, 1.0 mmol, 0.2 equiv.), and toluene (5.0 mL) in a vial (50.0 mL) were added (8*R*,9*S*,13*S*,14*S*)-13-methyl-3-vinyl-6,7,8,9,11,12,13,14,15,16-decahydro-17*H*-cyclopenta[α]phenanthren-17-one **S22-1** (1.40 g, 5.0 mmol, 1.0 equiv.) which was synthesized according to the literature[2], HCOOH (0.69 g, 15 mmol, 3.0 equiv.), and Ac_2O (0.102 g, 1.0 mmol, 0.2 equiv.). The vial was purged with argon to remove the air and tightly sealed with a septum cap. The reaction mixture was stirred at 65 °C for 48 h, and then cooled to room temperature. The reaction mixture was diluted with CH_2Cl_2 (30 mL), and transferred into a separatory funnel, followed by the addition of 1 M NaOH (30 mL). The mixture was washed with CH_2Cl_2 (3 × 20 mL) with vigorous shaking. The aqueous layer was acidified with 3 M HCl (15 mL) and extracted with CH_2Cl_2 (3 × 30 mL). The combined organic layers were dried over Na_2SO_4 and the organic solvent was removed by rotary evaporator under vacuum. The residue was purified by flash column chromatography on silica gel to give the product **S22-2** (0.65 g, 40% yield).[3]

According to **General procedure 1** with 2-((8*R*,9*S*,13*S*,14*S*)-13-methyl-17-oxo-7,8,9,11,12,13,14,15,16,17-decahydro-6*H*-cyclopenta[α]phenanthren-3-yl)propanoic acid **S22-2** (650.0 mg, 2.0 mmol, 1.2 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (360.0 mg, 1.7 mmol, 1.0 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/petroleum ether = 1/10) to yield the product **S22** as a pale yellow colorless solid (720.0 mg, 69% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.36 (s, 2H), 8.12-7.99 (m, 2H), 7.78-7.68 (m, 2H), 7.33 (d, J = 8.1 Hz, 1H), 7.21 (d, J = 8.4 Hz, 1H), 7.17 (s, 1H), 4.10 (q, J = 7.4 Hz, 1H), 3.04-2.89 (m, 3H), 2.51 (dd, J = 18.7, 8.6 Hz, 1H), 2.48-2.39 (m, 1H), 2.37-2.26 (m, 1H), 2.23-1.91 (m, 5H), 1.68 (d, J = 7.3 Hz, 4H), 1.57-1.40 (m, 3H), 0.92 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 220.9, 170.7, 161.4, 139.3, 137.1, 135.8, 135.4, 130.4, 129.7, 128.2, 128.1, 125.9, 125.7, 125.0, 124.8, 124.4, 50.5, 48.0, 44.3, 42.6, 38.0, 35.8, 31.6, 29.4, 26.5, 25.6, 21.6, 19.1, 13.8; HRMS (ESI) *m/z* calcd. for $C_{33}H_{32}NO_5$ $[M + H]^+$ 522.2275, found 522.2272.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(6-chloropyridin-3-yl)butanoate (S23)

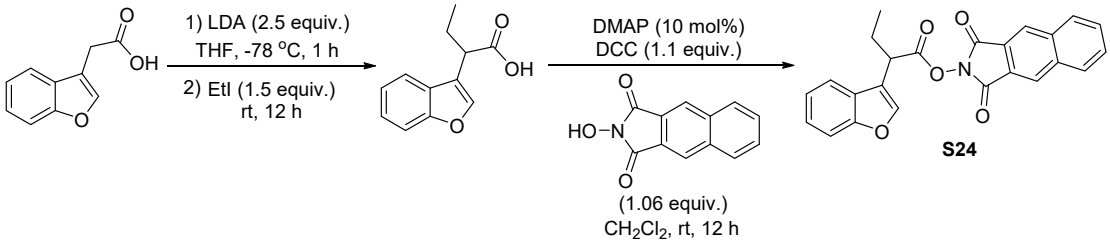


The synthetic procedure of 2-(6-chloropyridin-3-yl)butanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(6-chloropyridin-3-yl)butanoic acid (399.2 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 2/1) to yield the product **S23** as a colorless solid (497.5 mg, 63% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.42 (d, J = 2.4 Hz, 1H), 8.36 (s, 2H), 8.07-8.04 (m, 2H), 7.78 (dd, J = 8.4, 2.8 Hz, 1H), 7.75-7.71 (m, 2H), 7.39 (d, J = 8.4 Hz, 1H), 3.91 (t, J = 7.6 Hz, 1H), 2.35-2.24 (m, 1H), 2.03-1.92 (m, 1H), 1.07 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.3, 161.2, 151.2, 149.5, 138.1, 135.4, 131.6, 130.4, 129.8, 125.9, 124.6, 124.2, 47.3, 27.3, 11.7; HRMS (ESI): *m/z* calcd for $C_{21}H_{16}ClN_2O_4$ $[M+H]^+$: 395.0793, found: 395.0791.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(benzofuran-3-yl)butanoate (S24)

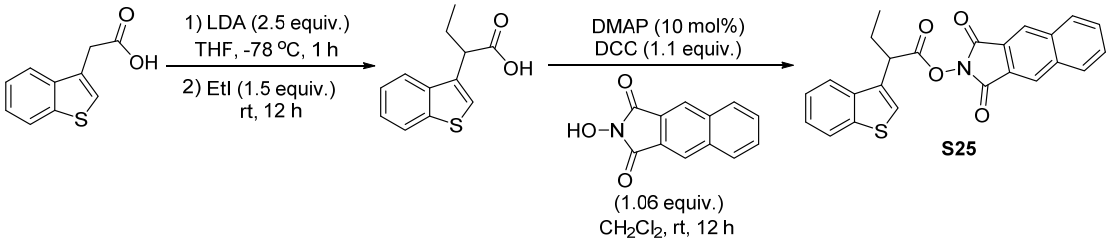


The synthetic procedure of 2-(benzofuran-3-yl)butanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(benzofuran-3-yl)butanoic acid (408.5 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **S24** as a colorless solid (519.2 mg, 65% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.36 (s, 2H), 8.07-8.05 (m, 2H), 7.77-7.71 (m, 4H), 7.52 (d, J = 8.0 Hz, 1H), 7.36-7.28 (m, 2H), 4.16 (t, J = 7.2 Hz, 1H), 2.38-2.18 (m, 2H), 1.17 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.6, 161.4, 155.4, 142.8, 135.4, 130.4, 129.7, 126.5, 125.8, 124.7, 124.3, 122.8, 120.0, 116.3, 111.7, 41.0, 25.9, 11.8; HRMS (ESI): *m/z* calcd for $C_{24}H_{18}NO_5$ $[M+H]^+$: 400.1179, found: 400.1178.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(benzo[*b*]thiophen-3-yl)butanoate (S25)

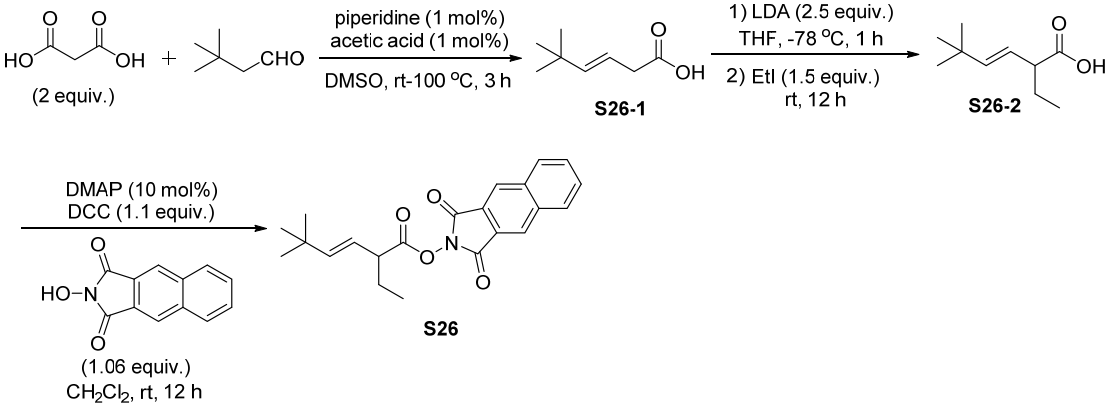


The synthetic procedure of 2-(benzo[*b*]thiophen-3-yl)butanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(benzo[*b*]thiophen-3-yl)butanoic acid (440.6 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S25** as a colorless solid (523.5 mg, 63% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.06-8.03 (m, 2H), 7.92-7.89 (m, 2H), 7.74-7.70 (m, 2H), 7.58 (s, 1H), 7.49-7.45 (m, 1H), 7.43-7.38 (m, 1H), 4.39-4.35 (m, 1H), 2.40-2.29 (m, 1H), 2.25-2.15 (m, 1H), 1.18 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.6, 161.4, 140.3, 137.8, 135.4, 131.0, 130.4, 129.7, 125.8, 124.6, 124.34, 124.3, 124.2, 123.0, 121.5, 44.2, 26.4, 12.0; HRMS (ESI): *m/z* calcd for $C_{24}H_{18}NO_4S$ $[M+H]^+$: 416.0951, found: 416.0950.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl (*E*)-2-ethyl-5,5-dimethylhex-3-enoate (S26)



Piperidine (25 μL, 0.25 mmol, 1 mol%) and acetic acid (15 μL, 0.25 mmol, 1 mol%) were added to a stirred solution of malonic acid (5 g, 50 mmol, 2 equiv.) and 3,3-dimethylbutanal (2.5 g, 25 mmol, 1 equiv.) in DMSO (20 mL) at room temperature. The reaction mixture was stirred for 20 min at room temperature and then was heated for 2 h at 100 °C. The reaction mixture was cooled to room temperature and water (60 mL) was added. Subsequently, the reaction mixture was extracted with diethyl ether (3 × 30 mL). The combined organic layers were washed with saturated brine (2 × 30 mL) and dried with over anhydrous $MgSO_4$. The organic solvent was removed by rotary evaporator under vacuum to afford the crude product **S26-1** without further purification.

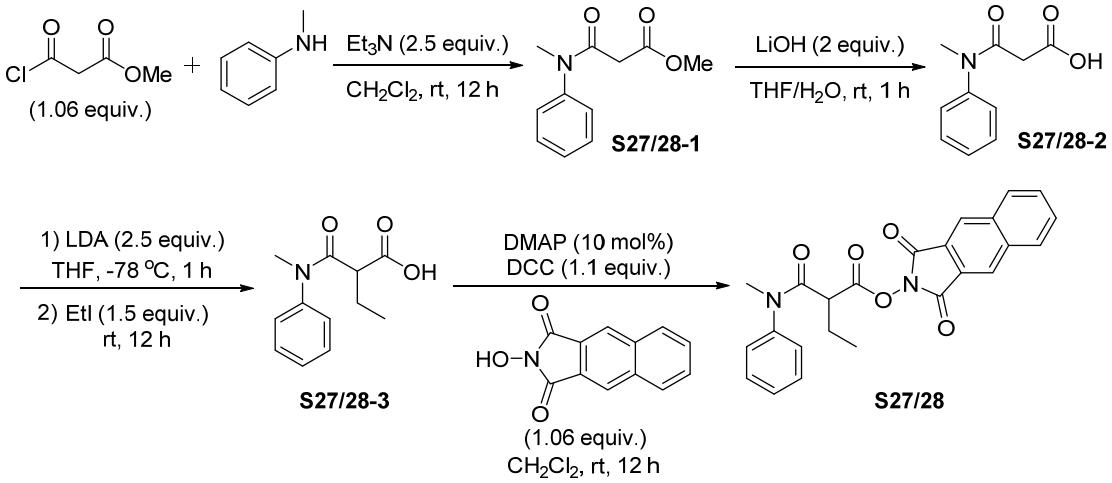
The synthetic procedure of (*E*)-2-ethyl-5,5-dimethylhex-3-enoic acid **S26-2** is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with (*E*)-2-ethyl-5,5-dimethylhex-3-enoic acid **S26-2** (510.6 mg, 3.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (678.0 mg, 3.18 mmol, 1.06 equiv.)

for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **S26** as a colorless solid (745.5 mg, 68% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.36 (s, 2H), 8.07-8.04 (m, 2H), 7.74-7.70 (m, 2H), 5.78 (d, J = 15.6 Hz, 1H), 5.43 (dd, J = 15.6, 8.4 Hz, 1H), 3.27 (q, J = 7.6 Hz, 1H), 2.04-1.93 (m, 1H), 1.80-1.69 (m, 1H), 1.07-1.04 (m, 12H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.6, 161.5, 146.3, 135.4, 130.4, 129.6, 125.7, 124.5, 120.2, 47.9, 33.3, 29.4, 26.2, 11.4; HRMS (ESI): *m/z* calcd for $C_{22}H_{24}NO_4$ $[M+H]^+$: 366.1700, found: 366.1697.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(methyl(phenyl)carbamoyl)butanoate (S27/28)



To a stirred solution of *N*-methylaniline (2.14 g, 20 mmol, 1 equiv.) and Et_3N (5.06 g, 50 mmol, 2.5 equiv.) in CH_2Cl_2 (80 mL) was added dropwise methyl 3-chloro-3-oxopropanoate (2.9 g, 21.2 mmol, 1.06 equiv.) at 0 °C. The reaction mixture was stirred for 12 h at room temperature and then was extracted with ethyl acetate (3 × 50 mL). The combined organic layers were washed with saturated brine (2 × 30 mL) and dried with over anhydrous $MgSO_4$. The organic solvent was removed by rotary evaporator under vacuum and the residue was purified by flash column chromatography on silica gel (ethyl acetate/petroleum ether = 1/2) to afford **S27/28-1** (3.15 g, 76% yield).

To a stirred solution of methyl 3-(methyl(phenyl)amino)-3-oxopropanoate **S27/28-1** (1.04 g, 5 mmol, 1 equiv.) in THF/H_2O (1/1 mL) was added LiOH (240 mg, 10 mmol,

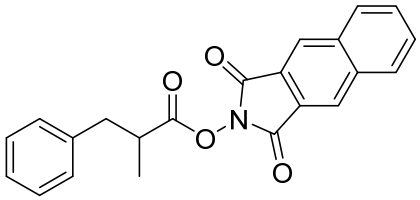
2 equiv.) at room temperature. The reaction mixture was stirred for 1 h at room temperature and then was extracted with ethyl acetate (3 × 20 mL). The combined organic layers were washed with saturated brine (2 × 10 mL) and dried with over anhydrous $MgSO_4$. The organic solvent was removed by rotary evaporator under vacuum and the residue was purified by flash column chromatography on silica gel (ethyl acetate/dichloromethane = 1/2) to afford **S27/28-2** (656.9 mg, 68% yield).

The synthetic procedure of 2-(methyl(phenyl)carbamoyl)butanoic acid **S27/28-3** is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(methyl(phenyl)carbamoyl)butanoic acid **S27/28-3** (553.0 mg, 2.5 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (565.0 mg, 2.65 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/dichloromethane = 1/50) to yield the product **S27/28** as a pale yellow solid (739.2 mg, 71% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.06-8.04 (m, 2H), 7.74-7.70 (m, 2H), 7.51 (t, J = 7.6 Hz, 2H), 7.42 (t, J = 7.4 Hz, 1H), 7.36 (d, J = 7.2 Hz, 2H), 3.61-3.58 (m, 1H), 3.39 (s, 3H), 2.22-2.13 (m, 1H), 2.10-2.01 (m, 1H), 0.98 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 166.3, 161.1, 142.9, 135.4, 130.4, 130.3, 129.7, 128.5, 127.7, 125.7, 124.3, 48.4, 38.0, 23.7, 11.8; HRMS (ESI): *m/z* calcd for $C_{24}H_{21}N_2O_5$ $[M+H]^+$: 417.1445, found: 417.1441.

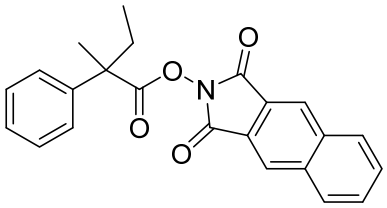
1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-methyl-3-phenylpropanoate (S29)



According to **General procedure 1** with 2-methyl-3-phenylpropanoic acid (328.4 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S29** as a colorless solid (524.7 mg, 73% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.37 (s, 2H), 8.08-8.04 (m, 2H), 7.75-7.71 (m, 2H), 7.37-7.33 (m, 2H), 7.29-7.25 (m, 3H), 3.30 (dd, J = 13.6, 6.0 Hz, 1H), 3.19-3.11 (m, 1H), 2.85 (dd, J = 13.6, 8.4 Hz, 1H), 1.36 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 172.0, 161.5, 138.0, 135.4, 130.4, 129.6, 129.2, 128.6, 126.7, 125.7, 124.4, 39.2, 38.9, 16.3; HRMS (ESI): *m/z* calcd for $C_{22}H_{18}NO_4$ $[M+H]^+$: 360.1230, found: 360.1228.

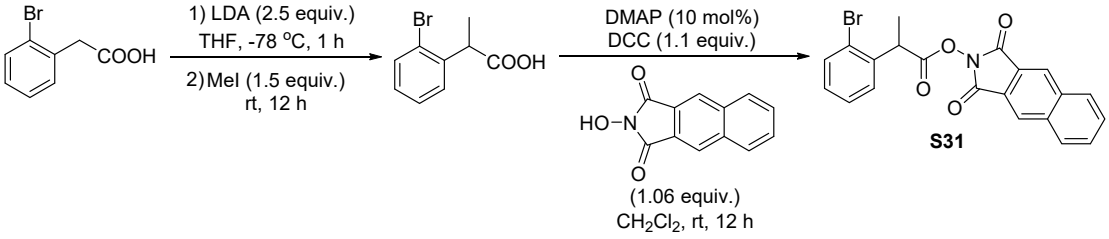
1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-methyl-2-phenylbutanoate (S30)



According to **General procedure 1** with 2-methyl-2-phenylbutanoic acid (445.6 mg, 2.5 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (565.0 mg, 2.65 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S30** as a colorless solid (653.5 mg, 70% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.08-8.04 (m, 2H), 7.74-7.70 (m, 2H), 7.51 (d, J = 7.6 Hz, 2H), 7.44 (t, J = 7.6 Hz, 2H), 7.33 (t, J = 7.2 Hz, 1H), 2.36-2.27 (m, 1H), 2.18-2.09 (m, 1H), 1.76 (s, 3H), 1.05 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 172.6, 161.5, 141.9, 135.4, 130.4, 129.6, 128.6, 127.3, 126.3, 125.6, 124.5, 50.7, 32.2, 23.3, 9.0; HRMS (ESI): *m/z* calcd for $C_{23}H_{20}NO_4$ $[M+H]^+$: 374.1387, found: 374.1387.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(2-bromophenyl)propanoate (S31)

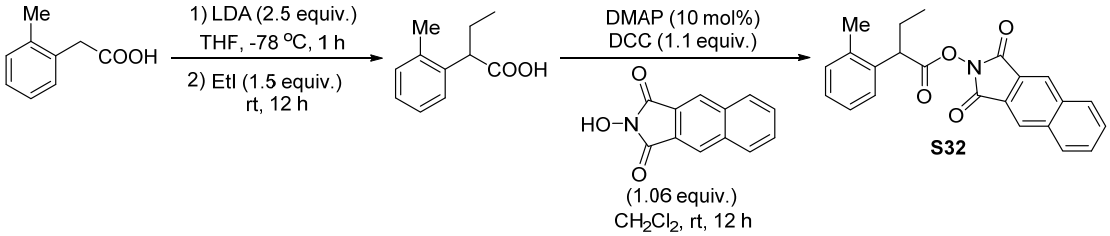


The synthetic procedure of 2-(2-bromophenyl)propanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(2-bromophenyl)propanoic acid (458.0 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S31** as a colorless solid (568.5 mg, 67% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.36 (s, 2H), 8.07-8.05 (m, 2H), 7.74-7.71 (m, 2H), 7.63 (dd, J = 8.0, 0.8 Hz, 1H), 7.52 (dd, J = 8.0, 1.6 Hz, 1H), 7.41 (td, J = 7.6, 1.2 Hz, 1H), 7.20 (td, J = 7.6, 1.6 Hz, 1H), 4.69 (q, J = 7.2 Hz, 1H), 1.67 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.2, 161.3, 138.1, 135.4, 133.1, 130.4, 129.7, 129.3, 128.6, 128.1, 125.8, 124.3, 124.1, 42.6, 18.0; HRMS (ESI): *m/z* calcd for $C_{21}H_{15}BrNO_4$ $[M+H]^+$: 424.0179, found: 424.0178.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(*o*-tolyl)butanoate (S32)



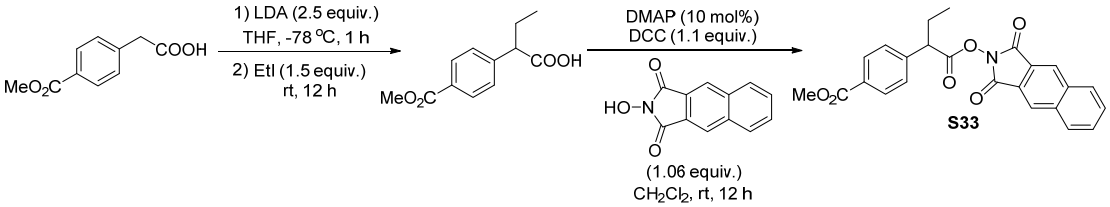
The synthetic procedure of 2-(*o*-tolyl)butanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(*o*-tolyl)butanoic acid (356.3 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **S32** as a colorless solid (522.8 mg, 70% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.33 (s, 2H), 8.05-8.02 (m, 2H), 7.73-7.69 (m, 2H), 7.41 (d, J = 7.2 Hz, 1H), 7.29-7.22 (m, 3H), 4.15 (t, J = 7.4 Hz, 1H), 2.48 (s, 3H), 2.34-2.23 (m, 1H), 2.02-1.91 (m, 1H), 1.08 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.4, 161.4, 136.2, 135.4, 135.3, 130.7, 130.4, 129.6, 127.6, 127.2, 126.6, 125.7, 124.4, 46.2, 26.5, 19.8, 12.0; HRMS (ESI): *m/z* calcd for $C_{23}H_{20}NO_4$ $[M+H]^+$:

374.1387, found: 374.1385.

Methyl 4-(1-((1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl)oxy)-1-oxobutan-2-yl)benzoate (S33)

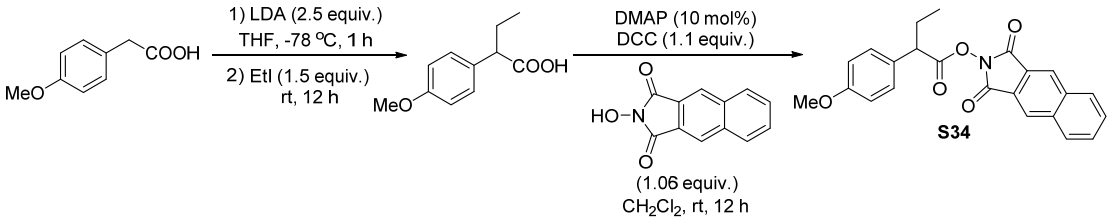


The synthetic procedure of 2-(4-(methoxycarbonyl)phenyl)butanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(4-(methoxycarbonyl)phenyl)butanoic acid (444.5 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **S33** as a colorless solid (542.6 mg, 65% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.10-8.03 (m, 4H), 7.74-7.70 (m, 2H), 7.50 (d, J = 8.4 Hz, 2H), 3.97-3.92 (m, 4H), 2.35-2.24 (m, 1H), 2.05-1.94 (m, 1H), 1.06 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.6, 166.7, 161.3, 141.9, 135.4, 130.4, 130.1, 129.74, 129.69, 128.2, 125.8, 124.3, 52.1, 50.4, 27.2, 11.8; HRMS (ESI): *m/z* calcd for $C_{24}H_{20}NO_6$ $[M+H]^+$: 418.1285, found: 418.1284.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(4-methoxyphenyl)butanoate (S34)



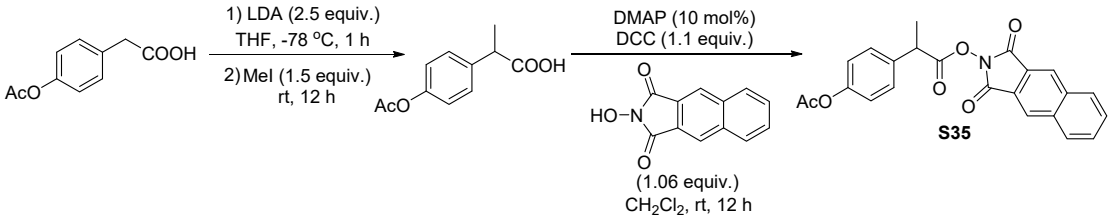
The synthetic procedure of 2-(4-methoxyphenyl)butanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(4-methoxyphenyl)butanoic acid (388.5

mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **S34** as a colorless solid (584.1 mg, 75% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.34 (s, 2H), 8.07-8.03 (m, 2H), 7.74-7.70 (m, 2H), 7.35-7.32 (m, 2H), 6.95-6.91 (m, 2H), 3.86-3.82 (m, 4H), 2.30-2.19 (m, 1H), 2.01-1.90 (m, 1H), 1.05 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.3, 161.4, 159.2, 135.4, 130.4, 129.6, 129.1, 128.9, 125.7, 124.4, 114.2, 55.2, 49.7, 27.2, 11.9; HRMS (ESI): *m/z* calcd for $C_{23}H_{20}NO_5$ $[M+H]^+$: 390.1336, found: 390.1333.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(4-acetoxyphenyl)propanoate (S35)



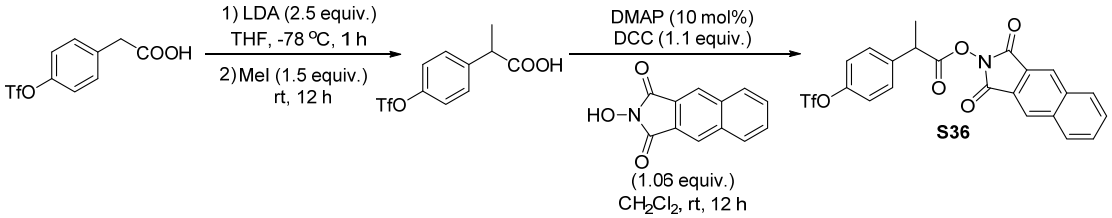
The synthetic procedure of 2-(4-acetoxyphenyl)propanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(4-acetoxyphenyl)propanoic acid (416.4 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **S35** as a colorless solid (492.1 mg, 61% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.34 (s, 2H), 8.06-8.04 (m, 2H), 7.74-7.71 (m, 2H), 7.45 (d, J = 8.8 Hz, 2H), 7.14 (d, J = 8.8 Hz, 2H), 4.16 (q, J = 7.2 Hz, 1H), 2.31 (s, 3H), 1.70 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.4, 169.3, 161.3, 150.2, 135.8, 135.4, 130.4, 129.7, 128.7, 125.7, 124.3, 122.0, 42.5, 21.1, 19.1; HRMS (ESI): *m/z* calcd for $C_{23}H_{18}NO_6$ $[M+H]^+$: 404.1129, found: 404.1125.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl

2-(4-(((trifluoromethyl)sulfonyl)oxy)phenyl)propanoate (S36)

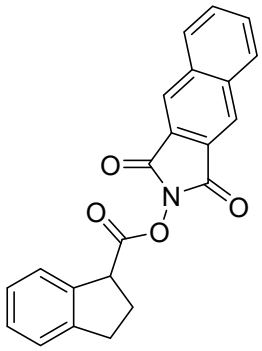


The synthetic procedure of 2-(4-(((trifluoromethyl)sulfonyl)oxy)phenyl)propanoic acid is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 2-(4-(((trifluoromethyl)sulfonyl)oxy)phenyl)propanoic acid (596.5 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **S36** as a colorless solid (542.8 mg, 55% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.36 (s, 2H), 8.07-8.05 (m, 2H), 7.75-7.72 (m, 2H), 7.54 (d, J = 8.8 Hz, 2H), 7.33 (d, J = 8.8 Hz, 2H), 4.20 (q, J = 7.2 Hz, 1H), 1.71 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.0, 161.3, 149.0, 138.9, 135.4, 130.4, 129.7, 129.6, 125.8, 124.2, 121.8, 118.7 (q, J = 318.8 Hz), 42.4, 19.0; ^{19}F NMR (376 MHz, $CDCl_3$) δ: -72.8; HRMS (ESI): *m/z* calcd for $C_{22}H_{15}F_3NO_7S$ $[M+H]^+$: 494.0516, found: 494.0516.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl
2,3-dihydro-1*H*-indene-1-carboxylate (S37)

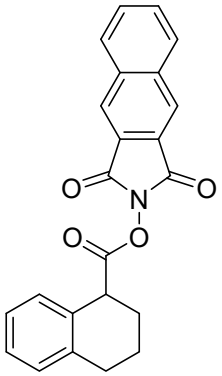


According to **General procedure 1** with 2,3-dihydro-1*H*-indene-1-carboxylic acid (324.4 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione

(452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **S37** as a colorless solid (464.6 mg, 65% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.37 (s, 2H), 8.07-8.05 (m, 2H), 7.74-7.72 (m, 2H), 7.68-7.66 (m, 1H), 7.32-7.29 (m, 3H), 4.46 (t, J = 7.8 Hz, 1H), 3.22-3.15 (m, 1H), 3.07-2.99 (m, 1H), 2.65-2.58 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.2, 161.5, 143.9, 138.7, 135.4, 130.4, 129.7, 128.2, 126.9, 125.8, 125.1, 124.7, 124.4, 47.5, 31.7, 29.3; HRMS (ESI): *m/z* calcd for $C_{22}H_{16}NO_4$ $[M+H]^+$: 358.1074, found: 358.1072.

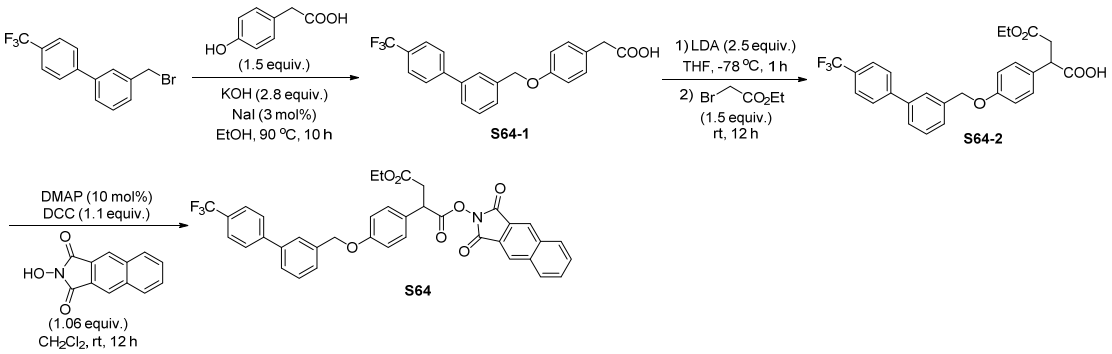
1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 1,2,3,4-tetrahydronaphthalene-1-carboxylate (S38)



According to **General procedure 1** with 1,2,3,4-tetrahydronaphthalene-1-carboxylic acid (352.4 mg, 2.0 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (452.0 mg, 2.12 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **S38** as a colorless solid (445.7 mg, 60% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.35 (s, 2H), 8.06-8.04 (m, 2H), 7.74-7.70 (m, 2H), 7.44-7.41 (m, 1H), 7.25-7.20 (m, 2H), 7.15-7.13 (m, 1H), 4.25 (t, J = 6.4 Hz, 1H), 2.95-2.78 (m, 2H), 2.41-2.25 (m, 2H), 2.15-2.06 (m, 1H), 1.93-1.84 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 171.0, 161.5, 137.2, 135.4, 131.1, 130.4, 129.6, 129.5, 127.5, 126.2, 125.7, 124.4, 42.6, 28.9, 27.1, 20.5; HRMS (ESI): *m/z* calcd for $C_{23}H_{18}NO_4$ $[M+H]^+$: 372.1230, found: 372.1228.

1-(1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl) 4-ethyl 2-(4-((4'-(trifluoromethyl)-[1,1'-biphenyl]-3-yl)methoxy)phenyl)succinate (S64)



To a stirred solution of 2-(4-hydroxyphenyl)acetic acid (228.2 mg, 1.5 mmol, 1.5 equiv.), KOH (160 mg, 2.8 mmol, 2.8 equiv.) and NaI (4.5 mg, 0.03 mmol, 3 mol%) in EtOH (10 mL) was added dropwise the solution of 3-(bromomethyl)-4'-(trifluoromethyl)-1,1'-biphenyl (315 mg, 1 mmol, 1 equiv.) in EtOH (10 mL). The reaction mixture was stirred at 90 °C for 10 h and then the pH of the reaction mixture was adjusted to 1~2 with 3.0 M HCl. The aqueous phase was extracted with CH_2Cl_2 (3 × 10 mL). The organic solvent was removed by rotary evaporator under vacuum and the residue was purified by flash column chromatography (ethyl acetate/dichloromethane = 1/2) on silica gel to afford the desired product S**64-1** (355.5 mg, 92% yield).

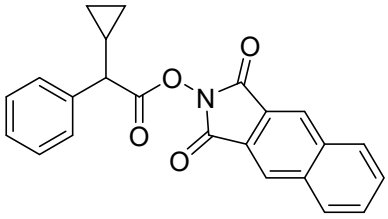
The synthetic procedure of 2-(4-((4'-(trifluoromethyl)-[1,1'-biphenyl]-3-yl)methoxy)phenyl)acetic acid S**64-2** (colorless oil, 84 mg, 46% yield) is the same as that of 5-chloro-2-phenylpentanoic acid (see compound **S7**).

According to **General procedure 1** with 4-ethoxy-4-oxo-2-(4-((4'-(trifluoromethyl)-[1,1'-biphenyl]-3-yl)methoxy)phenyl)butanoic acid S**64-2** (68.4 mg, 0.15 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (33 mg, 0.16 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 4/1) to yield the product **S64** as a colorless solid (49.3 mg, 51% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.34 (s, 2H), 8.06-8.04 (m, 2H), 7.74-7.68 (m, 7H), 7.58-7.56 (m, 1H), 7.53-7.45 (m, 2H), 7.38 (d, J = 8.4 Hz, 2H), 7.05 (d, J = 8.4 Hz,

2H), 5.15 (s, 2H), 4.53-4.49 (m, 1H), 4.23-4.16 (m, 2H), 3.29-3.23 (m, 1H), 2.89-2.83 (m, 1H), 1.26 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.3, 169.5, 161.2, 158.6, 144.4, 140.1, 137.7, 135.4, 130.4, 129.7, 129.3, 129.2, 128.1, 127.5, 127.2, 126.9, 126.3, 125.7 (q, J = 4.6 Hz), 124.3, 122.9 (q, J = 271.3 Hz), 115.4, 69.8, 61.2, 44.2, 38.3, 14.1; ^{19}F NMR (376 MHz, CDCl3) δ: -62.4; HRMS (ESI): *m/z* calcd for $C_{38}H_{28}F_3NO_7Na$ $[M+Na]^+$: 690.1710, found: 690.1707.

1,3-Dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-cyclopropyl-2-phenylacetate (1c)

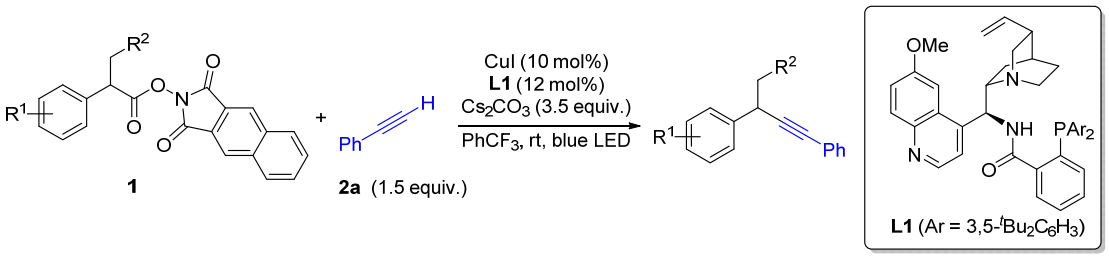


According to **General procedure 1** with 2-cyclopropyl-2-phenylacetic acid which was synthesized according to reference[4] (529.0 mg, 3.0 mmol, 1.0 equiv.,) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione (678.0 mg, 3.18 mmol, 1.06 equiv.) for 12 h, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1) to yield the product **1c** as a colorless solid (791.1 mg, 71% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.36 (s, 2H), 8.07-8.05 (m, 2H), 7.74-7.71 (m, 2H), 7.50 (d, J = 7.2 Hz, 2H), 7.42 (t, J = 7.4 Hz, 2H), 7.35 (t, J = 7.2 Hz, 1H), 3.33 (d, J = 9.6 Hz, 1H), 1.58-1.51 (m, 1H), 0.88-0.81 (m, 1H), 0.74-0.59 (m, 2H), 0.43-0.37 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.7, 161.4, 136.7, 135.4, 130.4, 129.6, 128.8, 128.0, 127.9, 125.7, 124.4, 53.3, 14.5, 4.8; HRMS (ESI): *m/z* calcd for $C_{23}H_{18}NO_4$ $[M+H]^+$: 372.1230, found: 372.1227.

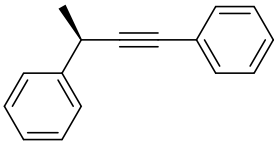
7. Asymmetric decarboxylative alkynylation: Scope of NHP-type esters

General procedure 2:



CuI (3.8 mg, 0.02 mmol, 10 mol%), **L1** (20.1 mg, 0.024 mmol, 12 mol%), Cs_2CO_3 (228.1 mg, 0.70 mmol, 3.5 equiv.), *N*-hydroxyphthalimide esters **1** (0.20 mmol, 1.0 equiv.) and anhydrous $PhCF_3$ (4.0 mL) were sequentially added to an oven-dried Schlenk tube equipped with a magnetic stir bar under argon atmosphere. Then, ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) was added to the mixture. The reaction mixture was stirred under the irradiation of a 24 W blue LED for 3 to 4 d at room temperature. After the completion of reaction, the reaction mixture was filtered and the precipitate was washed by EtOAc. The filtrate was removed by rotary evaporator under vacuum and the residue was purified by flash column chromatography on silica gel to afford the alkynylation product.

(*R*)-But-1-yne-1,3-diyldibenzene (3)



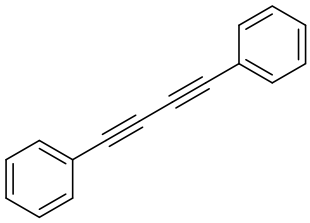
According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylpropanoate **1ah** (69.1 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **3** as a colorless oil (27.6 mg, 67% yield, 93% *ee*).

HPLC analysis: Chiralcel OJH (hexane/*i*-PrOH = 97/3, flow rate 0.8 mL/min, λ = 254 nm), t_R (minor) = 11.49 min, t_R (major) = 17.02 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.46-7.43 (m, 4H), 7.36-7.32 (m, 2H), 7.30-7.22 (m, 4H), 3.98 (q, J = 7.2 Hz, 1H), 1.58 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$)

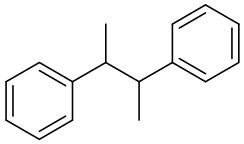
δ: 143.3, 131.6, 128.5, 128.2, 127.7, 126.9, 126.6, 123.7, 92.6, 82.4, 32.5, 24.5. The NMR spectra were in accord with that reported in literature.[5]

1,4-Diphenylbuta-1,3-diyne (3′)



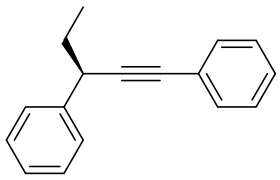
Colorless solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.54-7.52 (m, 4H), 7.40-7.32 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 132.5, 129.2, 128.4, 121.8, 81.5, 73.9. The NMR spectra were in accord with that reported in literature.[6]

Butane-2,3-diyldibenzene (3′′)



Colorless solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.32-7.29 (m, 2H), 7.21 (d, J = 7.2 Hz, 3H), 7.17-7.14 (m, 2H), 7.10-7.06 (m, 1H), 7.01-6.99 (m, 2H), 2.96-2.91 (m, 1H), 2.81-2.78 (m, 1H), 1.27 (d, J = 6.8 Hz, 3H), 1.02 (d, J = 6.0 Hz, 3H). The NMR spectra were in accord with that reported in literature.[7]

(*R*)-Pent-1-yne-1,3-diyldibenzene (4)



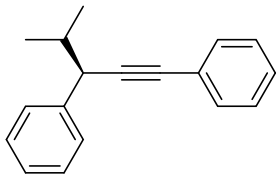
According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (71.9 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **4** as a colorless oil (33.9 mg, 77% yield, 97% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 1.0 mL/min, λ =

254 nm), t_R (minor) = 11.58 min, t_R (major) = 17.07 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.46-7.41 (m, 4H), 7.35-7.22 (m, 6H), 3.79 (t, J = 7.0 Hz, 1H), 1.90-1.82 (m, 2H), 1.06 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 142.0, 131.6, 128.4, 128.2, 127.7, 127.5, 126.6, 123.8, 91.4, 83.4, 39.9, 31.7, 11.8. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-(4-Methylpent-1-yne-1,3-diyl)dibenzene (5)

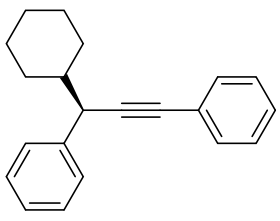


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 3-methyl-2-phenylbutanoate **S5** (74.7 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3.5 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **5** as a colorless oil (29.1 mg, 62% yield, 99% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 8.39 min, t_R (major) = 9.02 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.47-7.45 (m, 2H), 7.40 (d, J = 7.2 Hz, 2H), 7.34-7.22 (m, 6H), 3.73 (d, J = 6.0 Hz, 1H), 2.09-2.01 (m, 1H), 1.04 (d, J = 6.4 Hz, 3H), 0.99 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.0, 131.6, 128.19, 128.16, 127.7, 126.6, 123.9, 90.2, 84.2, 45.7, 35.2, 21.3, 18.7. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-(3-Cyclohexylprop-1-yne-1,3-diyl)dibenzene (6)



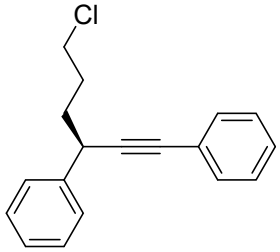
According to **General procedure 2** with

1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-cyclohexyl-2-phenylacetate **S6** (82.7 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3.5 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **6** as a colorless oil (35.7 mg, 65% yield, 99% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 9.88 min, t_R (major) = 11.73 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.46-7.44 (m, 2H), 7.38 (d, J = 7.2 Hz, 2H), 7.34-7.22 (m, 6H), 3.69 (d, J = 6.4 Hz, 1H), 1.88-1.86 (m, 1H), 1.73-1.65 (m, 5H), 1.21-1.14 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 140.8, 131.6, 128.3,128.2, 128.1, 127.6, 126.5, 124.0, 90.8, 84.0, 45.1, 44.6, 31.7, 29.5, 26.4, 26.3, 26.2. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-(6-Chlorohex-1-yne-1,3-diyl)dibenzene (7)

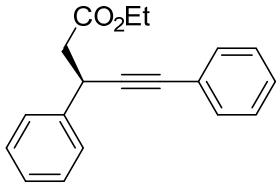


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 5-chloro-2-phenylpentanoate **S7** (81.6 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **7** as a colorless oil (33.3 mg, 62% yield, 96% *ee*).

HPLC analysis: Chiralcel OJH (hexane/*i*-PrOH = 99/1, flow rate 0.7 mL/min, λ = 254 nm), t_R (major) = 15.48 min, t_R (minor) = 20.72 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.46-7.42 (m, 4H), 7.37-7.24 (m, 6H), 3.89 (s, 1H), 3.58 (s, 2H), 2.03-1.96 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.5, 131.6, 128.6, 128.2, 127.9, 127.4, 126.9, 123.5, 90.6, 83.8, 44.7, 37.7, 35.7, 30.3; HRMS (ESI): *m/z* calcd for $C_{18}H_{18}Cl$ $[M+H]^+$: 269.1092, found: 269.1091.

Ethyl (*R*)-3,5-diphenylpent-4-ynoate (8)

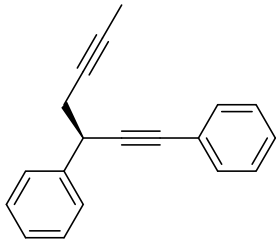


According to **General procedure 2** with 1-(1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl) 4-ethyl 2-phenylsuccinate **S8** (83.5 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **8** as a colorless oil (17.8 mg, 32% yield, 93% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 97/3, flow rate 0.7 mL/min, λ = 240 nm), t_R (major) = 8.01 min, t_R (minor) = 12.96 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.47-7.41 (m, 4H), 7.35 (t, J = 7.6 Hz, 2H), 7.29-7.25 (m, 4H), 4.38 (t, J = 7.6 Hz, 1H), 4.18-4.13 (m, 2H), 2.90 (dd, J = 15.2, 8.4 Hz, 1H), 2.80 (dd, J = 15.2, 7.2 Hz, 1H), 1.23 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.9, 140.5, 131.7, 128.7, 128.2, 128.0, 127.5, 127.2, 123.3, 89.8, 83.5, 60.7, 43.4, 34.8, 14.2. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-Hepta-1,5-diyne-1,3-diyldibenzene (9)

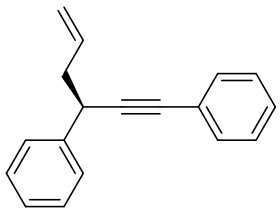


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylhex-4-ynoate **S9** (76.7 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **9** as a colorless oil (24.9 mg, 51% yield, 90% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99/1, flow rate 0.7 mL/min, λ = 254 nm), t_R (major) = 6.53 min, t_R (minor) = 7.43 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.47-7.46 (m, 4H), 7.35 (t, J = 7.4 Hz, 2H), 7.30-7.25 (m, 4H), 4.01 (t, J = 7.0 Hz, 1H), 2.75-2.61 (m, 2H), 1.78 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 140.7, 131.7, 128.4, 128.2, 127.9, 127.6, 127.1, 123.5, 90.5, 83.6, 77.9, 76.3, 38.4, 28.8, 3.5; HRMS (ESI): *m/z* calcd for $C_{19}H_{17}$ $[M+H]^+$: 245.1325, found: 245.1323.

(*R*)-Hex-5-en-1-yne-1,3-diyldibenzene (10)

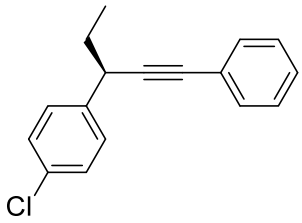


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylpent-4-enoate **S10** (74.3 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **10** as a colorless oil (24.6 mg, 53% yield, 96% *ee*).

HPLC analysis: Chiralcel ADH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 7.16 min, t_R (major) = 7.89 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.45-7.42 (m, 4H), 7.34 (t, J = 7.4 Hz, 2H), 7.30-7.23 (m, 4H), 5.97-5.87 (m, 1H), 5.13-5.06 (m, 2H), 3.92 (t, J = 7.0 Hz, 1H), 2.59 (t, J = 7.0 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.4, 135.4, 131.6, 128.5, 128.2, 127.8, 127.6, 126.8, 123.7, 117.1, 90.9, 83.8, 42.8, 38.5. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-1-Chloro-4-(1-phenylpent-1-yn-3-yl)benzene (11)

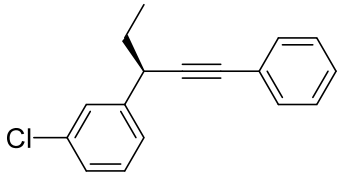


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(4-chlorophenyl)butanoate **S11** (78.8 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **11** as a colorless oil (32.6 mg, 64% yield, 96% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 230 nm), t_R (minor) = 7.79 min, t_R (major) = 11.23 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.47-7.43 (m, 2H), 7.37-7.35 (m, 2H), 7.32-7.29 (m, 5H), 3.78 (t, J = 6.8 Hz, 1H), 1.91-1.80 (m, 2H), 1.05 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 140.5, 132.4, 131.6, 128.9, 128.5, 128.2, 127.9, 123.6, 90.8, 83.7, 39.4, 31.5, 11.7; HRMS (ESI): *m/z* calcd for $C_{17}H_{16}Cl$ $[M+H]^+$: 255.0935, found: 255.0935.

(*R*)-1-Chloro-3-(1-phenylpent-1-yn-3-yl)benzene (12)

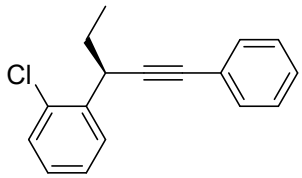


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(3-chlorophenyl)butanoate **S12** (78.8 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **12** as a colorless oil (33.1 mg, 65% yield, 95% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 8.10 min, t_R (major) = 9.62 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.46-7.41 (m, 3H), 7.31-7.28 (m, 4H), 7.26-7.20 (m, 2H), 3.77 (t, J = 7.0 Hz, 1H), 1.91-1.80 (m, 2H), 1.05 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 144.0, 134.2, 131.7, 129.6, 128.2, 127.9, 127.7, 126.9, 125.8, 123.5, 90.5, 83.8, 39.6, 31.5, 11.7; HRMS (ESI): *m/z* calcd for $C_{17}H_{16}Cl$ $[M+H]^+$: 255.0935, found: 255.0933.

(*S*)-1-Chloro-2-(1-phenylpent-1-yn-3-yl)benzene (13)

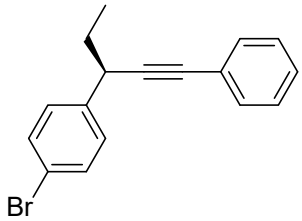


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(2-chlorophenyl)butanoate **S13** (78.8 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **13** as a colorless oil (31.1 mg, 61% yield, 98% *ee*).

HPLC analysis: Chiralcel OJH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (major) = 14.63 min, t_R (minor) = 17.31 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.70 (dd, J = 7.6, 1.6 Hz, 1H), 7.47-7.44 (m, 2H), 7.36-7.25 (m, 5H), 7.18 (td, J = 7.6, 1.6 Hz, 1H), 4.33-4.29 (m, 1H), 1.97-1.87 (m, 1H), 1.82-1.71 (m, 1H), 1.10 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 139.5, 132.8, 131.7, 129.5, 129.4, 128.2, 127.9, 127.8, 127.0, 123.6, 90.7, 83.4, 36.7, 29.8, 11.8; HRMS (ESI): *m/z* calcd for $C_{17}H_{16}Cl$ $[M+H]^+$: 255.0935, found: 255.0933.

(*R*)-1-Bromo-4-(1-phenylpent-1-yn-3-yl)benzene (14)



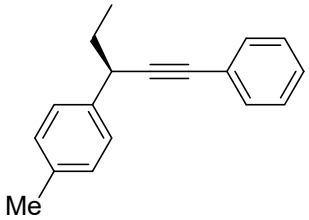
According to **General procedure 2** with

1,3-dioxo-1,3-dihydro-2H-benzo[f]isoindol-2-yl 2-(4-bromophenyl)butanoate **S14** (87.7 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **14** as a colorless oil (37.7 mg, 63% yield, 96% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 8.71 min, t_R (major) = 13.70 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.49-7.43 (m, 4H), 7.34-7.28 (m, 5H), 3.76 (t, J = 7.0 Hz, 1H), 1.91-1.80 (m, 2H), 1.06 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.0, 131.6, 131.5, 129.3, 128.2, 127.9, 123.5, 120.4, 90.7, 83.7, 39.4, 31.5, 11.7. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-1-Methyl-4-(1-phenylpent-1-yn-3-yl)benzene (15)

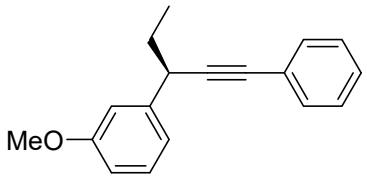


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(*p*-tolyl)butanoate **S15** (74.7 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **15** as a colorless oil (38.0 mg, 81% yield, 94% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 6.69 min, t_R (major) = 8.58 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.48-7.45 (m, 2H), 7.34-7.28 (m, 5H), 7.17 (d, J = 8.0 Hz, 2H), 3.77 (t, J = 7.0 Hz, 1H), 2.36 (s, 3H), 1.93-1.82 (m, 2H), 1.08 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 139.0, 136.2, 131.6, 129.1, 128.2, 127.6, 127.4, 123.9, 91.7, 83.2, 39.6, 31.7, 21.0, 11.8. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-1-Methoxy-3-(1-phenylpent-1-yn-3-yl)benzene (16)

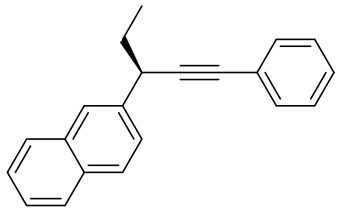


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(3-methoxyphenyl)butanoate **S16** (77.9 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **16** as a colorless oil (35.0 mg, 70% yield, 96% *ee*).

HPLC analysis: Chiralcel AD (hexane/*i*-PrOH = 97/3, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 10.55 min, t_R (major) = 11.78 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.45-7.43 (m, 2H), 7.30-7.23 (m, 4H), 7.00 (d, J = 6.8 Hz, 2H), 6.80-6.77 (m, 1H), 3.81 (s, 3H), 3.76 (t, J = 6.8 Hz, 1H), 1.92-1.81 (m, 2H), 1.06 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 159.7, 143.6, 131.6, 129.3, 128.2, 127.7, 123.8, 120.0, 113.5, 111.9, 91.3, 83.4, 55.2, 40.0, 31.5, 11.8. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-2-(1-Phenylpent-1-yn-3-yl)naphthalene (17)



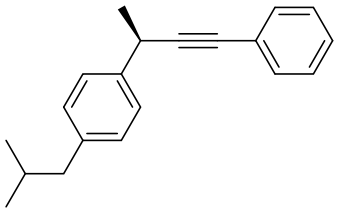
According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(naphthalen-2-yl)butanoate **S17** (81.9 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3.5 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **17** as a colorless oil (32.4 mg, 60% yield, 95% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99/1, flow rate 0.5 mL/min, λ =

254 nm), t_R (minor) = 11.11 min, t_R (major) = 12.40 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.89-7.84 (m, 4H), 7.58-7.45 (m, 5H), 7.36-7.31 (m, 3H), 3.98 (t, J = 7.0 Hz, 1H), 2.04-1.93 (m, 2H), 1.11 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 139.4, 133.5, 132.5, 131.7, 128.2, 128.1, 127.8, 127.7, 127.6, 126.0, 125.97, 125.5, 123.8, 91.4, 83.6, 40.1, 31.4, 11.9. HRMS (ESI): *m/z* calcd for $C_{21}H_{19}$ $[M+H]^+$: 271.1481, found: 271.1478.

(*R*)-1-Isobutyl-4-(4-phenylbut-3-yn-2-yl)benzene (18)

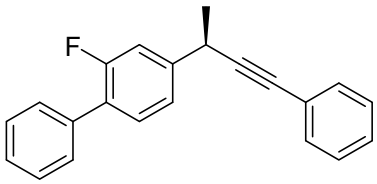


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(4-isobutylphenyl)propanoate **S18** (80.3 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.3 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **18** as a colorless oil (36.2 mg, 69% yield, 91% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 8.05 min, t_R (major) = 10.63 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.47-7.45 (m, 2H), 7.37 (d, J = 8.0 Hz, 2H), 7.33-7.29 (m, 3H), 7.13 (d, J = 7.6 Hz, 2H), 3.98 (q, J = 7.1 Hz, 1H), 2.48 (d, J = 7.2 Hz, 2H), 1.93-1.83 (m, 1H), 1.59 (d, J = 7.2 Hz, 3H), 0.93 (d, J = 6.8 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 140.5, 140.0, 131.6, 129.3, 128.2, 127.7, 126.6, 123.8, 92.9, 82.2, 45.0, 32.1, 30.2, 24.5, 22.4; HRMS (ESI): *m/z* calcd for $C_{20}H_{23}$ $[M+H]^+$: 263.1794, found: 263.1792.

(*R*)-2-Fluoro-4-(4-phenylbut-3-yn-2-yl)-1,1'-biphenyl (19)

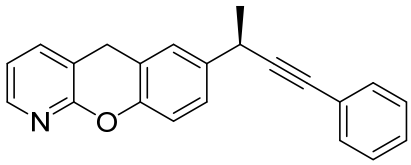


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(2-fluoro-[1,1'-biphenyl]-4-yl)propanoate **S19** (87.9 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.3 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **19** as a colorless oil (30.6 mg, 51% yield, 90% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 95/5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 6.85 min, t_R (major) = 7.42 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.55 (d, J = 7.6 Hz, 2H), 7.48-7.41 (m, 5H), 7.39-7.27 (m, 6H), 4.02 (q, J = 7.1 Hz, 1H), 1.62 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 159.7 (d, J = 246.5 Hz), 144.8 (d, J = 7.5 Hz), 135.7, 131.6, 130.8 (d, J = 3.9 Hz), 129.0 (d, J = 2.7 Hz), 128.4, 128.2, 127.9, 127.6, 123.4, 122.9 (d, J = 3.1 Hz), 114.8, 114.6, 91.7, 82.9, 32.0, 24.2; ^{19}F NMR (376 MHz, $CDCl_3$) δ: -117.8; HRMS (ESI): *m/z* calcd for $C_{22}H_{18}F$ $[M+H]^+$: 301.1387, found: 301.1385.

(*R*)-7-(4-Phenylbut-3-yn-2-yl)-5*H*-chromeno[2,3-*b*]pyridine (20)



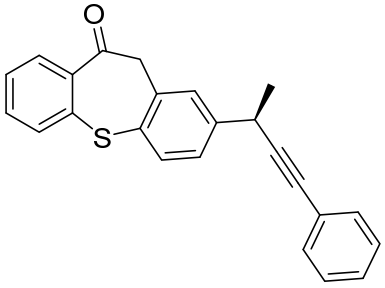
According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(5*H*-chromeno[2,3-*b*]pyridin-7-yl)propanoate **S20** (90.1 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.3 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 4/1) to yield the product **20** as a colorless oil (39.2 mg, 63% yield, 98% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 7.13 min, t_R (major) = 8.24 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.16 (d, J = 4.0 Hz, 1H), 7.53 (d, J = 7.2 Hz, 1H), 7.46-7.43 (m, 2H), 7.31-7.27 (m, 4H), 7.25 (s, 1H), 7.13 (d, J = 8.4 Hz, 1H), 7.03-7.00 (m, 1H), 4.11 (s, 2H), 3.95 (q, J = 7.2 Hz, 1H), 1.57 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 158.4, 150.3, 146.6, 138.7, 138.4, 131.6, 128.2, 127.8,

126.8, 126.6, 123.6, 119.7, 119.4, 117.2, 115.4, 92.4, 82.5, 31.8, 28.2, 24.5; HRMS (ESI): *m/z* calcd for $C_{22}H_{18}NO$ $[M+H]^+$: 312.1383, found: 312.1381.

(*R*)-2-(4-Phenylbut-3-yn-2-yl)dibenzo[*b*,*f*]thiepin-10(11*H*)-one (21)

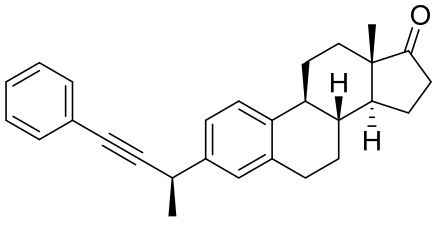


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(10-oxo-10,11-dihydrodibenzo[*b*,*f*]thiepin-2-yl)propanoate **S21** (98.7 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.3 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/petroleum ether = 1/50) to yield the product **21** as a colorless oil (28.4 mg, 40% yield, 88% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99/1, flow rate 0.7 mL/min, λ = 240 nm), t_R (major) = 16.74 min, t_R (minor) = 19.45 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.21 (d, J = 8.0 Hz, 1H), 7.63-7.60 (m, 2H), 7.52 (s, 1H), 7.44-7.41 (m, 3H), 7.33-7.29 (m, 5H), 4.43-4.35 (m, 2H), 3.98 (q, J = 7.2 Hz, 1H), 1.56 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 191.5, 145.6, 140.4, 137.8, 136.2, 132.7, 132.5, 131.6, 131.5, 131.45, 130.8, 128.2, 128.0, 127.9, 126.8, 125.9, 123.4, 91.7, 82.9, 51.1, 32.2, 24.3; HRMS (ESI): *m/z* calcd for $C_{24}H_{19}OS$ $[M+H]^+$: 355.1151, found: 355.1149.

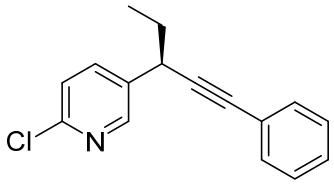
(8*R*,9*S*,13*S*,14*S*)-13-Methyl-3-((*R*)-4-phenylbut-3-yn-2-yl)-6,7,8,9,11,12,13,14,15,16-decahydro-17*H*-cyclopenta[*α*]phenanthren-17-one (22)



According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl (*S*)-2-((8*R*,9*S*,13*S*,14*S*)-13-methyl-17-oxo-7,8,9,11,12,13,14,15,16,17-decahydro-6*H*-cyclopenta[α]phenanthren-3-yl)propanoate **S22** (78.2 mg, 0.15 mmol, 1.0 equiv.), ethynylbenzene **2a** (23.0 mg, 0.225 mmol, 1.5 equiv.), CuI (5.7 mg, 0.03 mmol, 20 mol%) and **L1** (30.1 mg, 0.036 mmol, 24 mol%) for 3 d, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/petroleum ether = 1/2) to yield the product **22** as a colorless oil (24.7 mg, 43% yield, dr > 20:1). The diastereomeric ratio was determined by crude ^{1}H NMR spectroscopy.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.44-7.42 (m, 2H), 7.30-7.22 (m, 6H), 7.18 (s, 1H), 3.92 (q, J = 7.1 Hz, 1H), 2.95-2.92 (m, 2H), 2.54-2.41 (m, 2H), 2.32-2.27 (m, 1H), 2.17-1.94 (m, 4H), 1.66-1.45 (m, 9H), 0.91 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 220.9, 140.8, 138.1, 136.6, 131.6, 128.2, 127.7, 127.5, 125.6, 124.4, 123.8, 92.8, 82.1, 50.5, 48.0, 44.3, 38.1, 35.8, 32.0, 31.6, 29.5, 26.5, 25.7, 24.4, 21.6, 13.8. The NMR spectra were in accord with that reported in literature.[5]

(*S*)-2-Chloro-5-(1-phenylpent-1-yn-3-yl)pyridine (23)



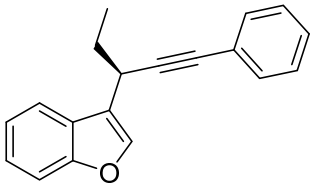
According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(6-chloropyridin-3-yl)butanoate **S23** (79.0 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **23** as a colorless oil (29.7 mg, 58% yield, 96% *ee*).

HPLC analysis: Chiralcel ASH (hexane/*i*-PrOH = 97/3, flow rate 0.7 mL/min, λ = 240 nm), t_R (minor) = 9.53 min, t_R (major) = 12.47 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.41 (d, J = 2.4 Hz, 1H), 7.74 (dd, J = 8.4, 2.8 Hz, 1H), 7.45-7.41 (m, 2H), 7.32-7.30 (m, 4H), 3.82 (t, J = 7.0 Hz, 1H), 1.90-1.82 (m, 2H), 1.07 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 149.8, 148.9, 138.0, 136.5,

131.6, 128.3, 128.1, 124.0, 123.1, 89.3, 84.3, 36.8, 31.3, 11.6; HRMS (ESI): *m/z* calcd for $C_{16}H_{15}ClN$ $[M+H]^+$: 256.0888, found: 256.0886.

(*S*)-3-(1-Phenylpent-1-yn-3-yl)benzofuran (24)

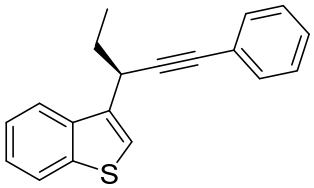


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(benzofuran-3-yl)butanoate **S24** (79.9 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **24** as a colorless oil (35.4 mg, 68% yield, 97% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 10.86 min, t_R (major) = 12.59 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.73 (d, J = 7.2 Hz, 1H), 7.61 (s, 1H), 7.50-7.43 (m, 3H), 7.32-7.23 (m, 5H), 4.00 (t, J = 6.8 Hz, 1H), 2.10-1.92 (m, 2H), 1.12 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 155.7, 141.8, 131.6, 128.2, 127.9, 126.7, 124.2, 123.5, 122.4, 120.8 120.1, 111.6, 90.0, 82.5, 30.0, 28.6, 11.7; HRMS (ESI): *m/z* calcd for $C_{19}H_{17}O$ $[M+H]^+$: 261.1274, found: 261.1272.

(*S*)-3-(1-Phenylpent-1-yn-3-yl)benzo[*b*]thiophene (25)



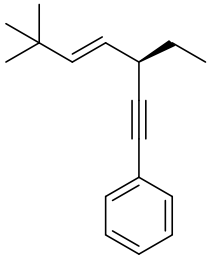
According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(benzo[*b*]thiophen-3-yl)butanoate **S25** (83.1 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **25** as a colorless oil (35.9 mg, 65%

yield, 97% *ee*).

HPLC analysis: Chiralcel OJH (hexane/*i*-PrOH = 99/1, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 18.24 min, t_R (major) = 20.50 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.92-7.86 (m, 2H), 7.44-7.24 (m, 8H), 4.19 (t, J = 6.6 Hz, 1H), 2.12-1.92 (m, 2H), 1.13 (td, J = 7.2, 1.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 140.9, 137.5, 136.0, 131.6, 128.2, 127.8, 124.2, 123.9, 123.6, 123.0, 122.7, 121.9, 90.5, 83.0, 34.1, 28.9, 11.9; HRMS (ESI): *m/z* calcd for $C_{19}H_{17}S$ $[M+H]^+$: 277.1045, found: 277.1046.

(*R*,*E*)-(3-Ethyl-6,6-dimethylhept-4-en-1-yn-1-yl)benzene (26)

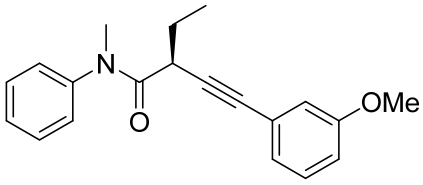


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl (*E*)-2-ethyl-5,5-dimethylhex-3-enoate **S26** (36.5 mg, 0.10 mmol, 1.0 equiv.), ethynylbenzene **2a** (15.3 mg, 0.15 mmol, 1.5 equiv.), CuI (3.8 mg, 0.02 mmol, 20 mol%) and **L1** (20.1 mg, 0.024 mmol, 24 mol%) in Et_2O (2 mL) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **26** as a colorless oil (9.5 mg, 42% yield, 77% *ee*).

HPLC analysis: Chiralcel OD3 (hexane/*i*-PrOH = 100/0, flow rate 0.5 mL/min, λ = 254 nm), t_R (minor) = 10.90 min, t_R (major) = 12.01 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.43-7.42 (m, 2H), 7.31-7.26 (m, 3H), 5.73 (d, J = 15.6 Hz, 1H), 5.32 (dd, J = 15.6, 6.8 Hz, 1H), 3.14 (q, J = 6.7 Hz, 1H), 1.66-1.60 (m, 2H), 1.04-1.00 (m, 12H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 142.4, 131.6, 128.1, 127.5, 124.3, 124.1, 91.7, 83.0, 36.6, 32.8, 29.7, 29.2, 11.4; HRMS (ESI): *m/z* calcd for $C_{17}H_{23}$ $[M+H]^+$: 227.1794, found: 227.1796.

(*S*)-2-Ethyl-4-(3-methoxyphenyl)-*N*-methyl-*N*-phenylbut-3-ynamide (27)

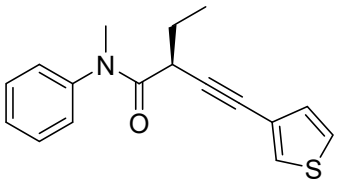


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(methyl(phenyl)carbamoyl)butanoate **S27/28** (41.6 mg, 0.10 mmol, 1.0 equiv.), 1-ethynyl-3-methoxybenzene **2b** (19.8 mg, 0.15 mmol, 1.5 equiv.), CuI (2.9 mg, 0.015 mmol, 15 mol%) and **L1** (15.1 mg, 0.018 mmol, 18 mol%) for 3 d, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/petroleum ether = 1:10) to yield the product **27** as a colorless oil (11.4 mg, 37% yield, 70% *ee*).

HPLC analysis: Chiralcel IG (hexane/*i*-PrOH = 95/5, flow rate 0.9 mL/min, λ = 254 nm), t_R (major) = 39.44 min, t_R (minor) = 46.02 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.45 (t, J = 7.4 Hz, 2H), 7.37 (t, J = 7.4 Hz, 1H), 7.31 (d, J = 7.6 Hz, 2H), 7.18 (t, J = 8.0 Hz, 1H), 6.98 (d, J = 7.6 Hz, 1H), 6.92 (s, 1H), 6.84 (dd, J = 8.4, 2.4 Hz, 1H), 3.79 (s, 3H), 3.32-3.26 (m, 4H), 1.95-1.78 (m, 2H), 0.93 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.1, 159.2, 143.5, 129.8, 129.1, 128.0, 127.5, 124.4, 124.3, 116.5, 114.5, 87.6, 82.3, 55.3, 37.9, 37.8, 26.1, 11.9; HRMS (ESI): *m/z* calcd for $C_{20}H_{22}NO_2$ $[M+H]^+$: 308.1645, found: 308.1641.

(*S*)-2-Ethyl-*N*-methyl-*N*-phenyl-4-(thiophen-3-yl)but-3-ynamide (28)



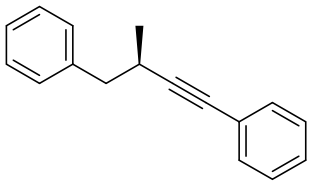
According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(methyl(phenyl)carbamoyl)butanoate **S27/28** (41.6 mg, 0.10 mmol, 1.0 equiv.), 3-ethynylthiophene **2c** (16.2 mg, 0.15 mmol, 1.5 equiv.), CuI (2.9 mg, 0.015 mmol, 15 mol%) and **L1** (15.1 mg, 0.018 mmol, 18 mol%) for 3 d, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/petroleum ether = 1:10)

to yield the product **28** as a colorless oil (8.8 mg, 31% yield, 76% *ee*).

HPLC analysis: Chiralcel IG (hexane/*i*-PrOH = 97/3, flow rate 0.9 mL/min, λ = 240 nm), t_R (minor) = 43.68 min, t_R (major) = 48.32 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.45 (t, J = 7.4 Hz, 2H), 7.39-7.37 (m, 2H), 7.30 (d, J = 7.6 Hz, 2H), 7.23-7.21 (m, 1H), 7.06 (d, J = 5.2 Hz, 1H), 3.32-3.26 (m, 4H), 1.93-1.77 (m, 2H), 0.91 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 170.1, 143.6, 130.0, 129.8, 128.3, 128.0, 127.5, 124.9, 122.3, 87.3, 77.5, 37.9, 37.8, 26.1, 11.9; HRMS (ESI): *m/z* calcd for $C_{17}H_{18}NOS$ $[M+H]^+$: 284.1104, found: 284.1101.

(*R*)-(3-Methylbut-1-yne-1,4-diyl)dibenzene (29)

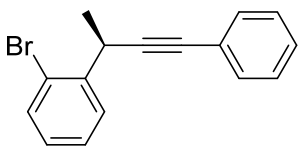


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-methyl-3-phenylpropanoate **S29** (71.9 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **29** as a colorless oil (22.5 mg, 51% yield, <5% *ee*).

HPLC analysis: Chiralcel OJH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 11.18 min, t_R (major) = 11.95 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.36-7.20 (m, 10H), 2.95-2.87 (m, 2H), 2.81-2.74 (m, 1H), 1.26 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 139.6, 131.5, 129.3, 128.1, 127.5, 126.3, 123.9, 94.1, 81.6, 43.2, 28.6, 20.6. The NMR spectra were in accord with that reported in literature.[8]

(*S*)-1-Bromo-2-(4-phenylbut-3-yn-2-yl)benzene (31)



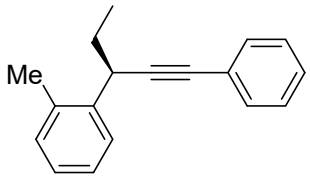
According to **General procedure 2** with

1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(2-bromophenyl)propanoate **S31** (84.9 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 4 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **31** as a colorless oil (29.7 mg, 52% yield, 97% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 240 nm), t_R (major) = 8.66 min, t_R (minor) = 9.32 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.76 (dd, J = 7.6, 1.6 Hz, 1H), 7.55 (dd, J = 8.0, 1.2 Hz, 1H), 7.47-7.44 (m, 2H), 7.36-7.29 (m, 4H), 7.12 (td, J = 7.6, 1.6 Hz, 1H), 4.43 (q, J = 6.9 Hz, 1H), 1.56 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 142.4, 132.8, 131.6, 128.8, 128.3, 128.2, 127.9, 127.9, 123.5, 123.0, 91.9, 82.5, 32.4, 23.1. The NMR spectra were in accord with that reported in literature.[5]

(*S*)-1-Methyl-2-(1-phenylpent-1-yn-3-yl)benzene (32)

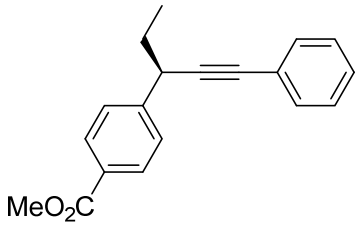


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(*o*-tolyl)butanoate **S32** (74.7 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 4 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **32** as a colorless oil (30.5 mg, 65% yield, 96% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (major) = 8.12 min, t_R (minor) = 8.74 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.58 (d, J = 7.2 Hz, 1H), 7.46-7.43 (m, 2H), 7.32-7.28 (m, 3H), 7.24-7.20 (m, 1H), 7.16-7.15 (m, 2H), 3.99-3.96 (m, 1H), 2.40 (s, 3H), 1.89-1.77 (m, 2H), 1.12 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 140.2, 134.9, 131.6, 130.4, 128.2, 127.6, 126.6, 126.2, 123.9, 91.9, 82.7, 36.5, 30.1, 19.2, 12.2. The NMR spectra were in accord with that reported in literature.[5]

Methyl (*R*)-4-(1-phenylpent-1-yn-3-yl)benzoate (33)

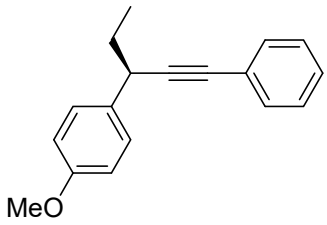


According to **General procedure 2** with methyl 4-(1-((1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl)oxy)-1-oxobutan-2-yl)benzoate **S33** (83.5 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **33** as a colorless oil (26.2 mg, 47% yield, 87% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 97/3, flow rate 0.7 mL/min, λ = 240 nm), t_R (minor) = 7.64 min, t_R (major) = 9.22 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.01 (d, J = 8.4 Hz, 2H), 7.49 (d, J = 8.4 Hz, 2H), 7.47-7.43 (m, 2H), 7.34-7.29 (m, 3H), 3.92 (s, 3H), 3.85 (t, J = 7.0 Hz, 1H), 1.93-1.82 (m, 2H), 1.05 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 167.0, 147.3, 131.6, 129.8, 128.6, 128.2, 127.9, 127.6, 123.5, 90.4, 83.9, 52.0, 39.9, 31.4, 11.7; HRMS (ESI): *m/z* calcd for $C_{19}H_{19}O_2$ $[M+H]^+$: 279.1380, found: 279.1380.

(*R*)-1-Methoxy-4-(1-phenylpent-1-yn-3-yl)benzene (34)



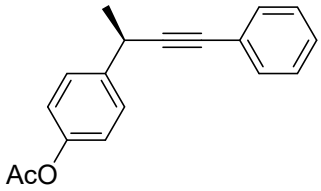
According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(4-methoxyphenyl)butanoate **S34** (77.9 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 4 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **34** as a colorless oil (35.5 mg, 71% yield, 88% *ee*).

HPLC analysis: Chiralcel AD (hexane/*i*-PrOH = 97/3, flow rate 0.7 mL/min, λ = 254

nm), t_R (minor) = 11.02 min, t_R (major) = 12.23 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.45-7.43 (m, 2H), 7.35-7.27 (m, 5H), 6.89-6.86 (m, 2H), 3.80 (s, 3H), 3.74 (t, J = 7.0 Hz, 1H), 1.87-1.79 (m, 2H), 1.04 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 158.3, 134.1, 131.6, 128.5, 128.2, 127.6, 123.9, 113.8, 91.81, 83.2, 55.3, 39.1, 31.7, 11.8; HRMS (ESI): *m/z* calcd for $C_{18}H_{19}O$ $[M+H]^+$: 251.1430, found: 251.1429.

(*R*)-4-(4-Phenylbut-3-yn-2-yl)phenyl acetate (35)

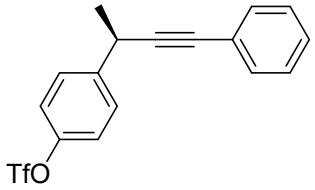


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(4-acetoxyphenyl)propanoate **S35** (80.7 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/2) to yield the product **35** as a colorless oil (18.5 mg, 35% yield, 93% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 97/3, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 9.43 min, t_R (major) = 10.12 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.47-7.41 (m, 4H), 7.31-7.27 (m, 3H), 7.07-7.04 (m, 2H), 3.98 (q, J = 7.1 Hz, 1H), 2.30 (s, 3H), 1.57 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 169.6, 149.3, 140.8, 131.6, 128.2, 128.0, 127.8, 123.6, 121.5, 92.3, 82.6, 32.0, 24.4, 21.1; HRMS (ESI): *m/z* calcd for $C_{18}H_{16}NaO_2$ $[M+Na]^+$: 287.1043, found: 287.1041.

(*R*)-4-(4-Phenylbut-3-yn-2-yl)phenyl trifluoromethanesulfonate (36)



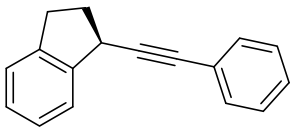
According to **General procedure 2** with

1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(4-(((trifluoromethyl)sulfonyl)oxy)phenyl)propanoate **S36** (98.7 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **36** as a colorless oil (21.3 mg, 30% yield, 93% *ee*).

HPLC analysis: Chiralcel IA (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 38.88 min, t_R (major) = 46.45 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.55-7.52 (m, 2H), 7.45-7.43 (m, 2H), 7.31-7.30 (m, 3H), 7.26-7.24 (m, 2H), 4.02 (q, J = 7.1 Hz, 1H), 1.59 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 148.2, 143.8, 131.6, 128.8, 128.3, 128.0, 123.2, 121.4, 118.7 (q, J = 318.8 Hz), 91.3, 83.2, 32.0, 24.4; ^{19}F NMR (376 MHz, $CDCl_3$) δ: -72.8; HRMS (ESI): *m/z* calcd for $C_{17}H_{14}F_3O_3S$ $[M+H]^+$: 355.0610, found: 355.0609.

(*S*)-1-(Phenylethynyl)-2,3-dihydro-1*H*-indene (37)

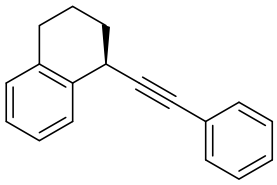


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2,3-dihydro-1*H*-indene-1-carboxylate **S37** (71.5 mg, 0.20 mmol, 1.0 equiv.), ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) and **L2** (16.7 mg, 0.024 mmol, 12 mol%) in Et_2O (4 mL) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **37** as a colorless oil (17.5 mg, 40% yield, 82% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 20.24 min, t_R (major) = 30.71 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.48-7.41 (m, 3H), 7.30-7.19 (m, 7H), 4.20 (t, J = 8.4 Hz, 1H), 3.06-2.99 (m, 1H), 2.95-2.87 (m, 1H), 2.62-2.55 (m, 1H), 2.25-2.15 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 143.6, 143.0, 131.7, 128.2, 127.7, 127.1, 126.6, 124.5, 124.3, 123.7, 91.5, 81.6, 36.8, 34.4, 31.5; HRMS (ESI): *m/z* calcd for $C_{17}H_{15}$ $[M+H]^+$: 219.1168, found: 219.1168.

(*S*)-1-(Phenylethynyl)-1,2,3,4-tetrahydronaphthalene (38)



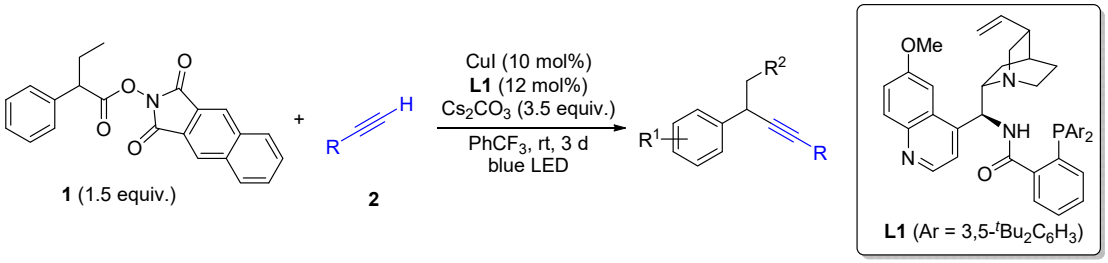
According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 1,2,3,4-tetrahydronaphthalene-1-carboxylate **S38** (74.3 mg, 0.20 mmol, 1.0 equiv.), ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) and **L2** (16.7 mg, 0.024 mmol, 12 mol%) in Et_2O (4 mL) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **38** as a colorless oil (19.1 mg, 41% yield, 67% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 15.28 min, t_R (major) = 18.84 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.55-7.53 (m, 1H), 7.43-7.39 (m, 2H), 7.29-7.25 (m, 3H), 7.20-7.13 (m, 2H), 7.10-7.08 (m, 1H), 4.01 (t, J = 6.6 Hz, 1H), 2.91-2.75 (m, 2H), 2.22-2.16 (m, 1H), 2.11-1.96 (m, 2H), 1.86-1.77 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 136.3, 136.2, 131.6, 129.2, 129.1, 128.1, 127.6, 126.5, 126.0, 123.8, 93.0, 81.4, 32.1, 30.3, 29.1, 21.3; HRMS (ESI): *m/z* calcd for $C_{18}H_{17}$ $[M+H]^+$: 233.1325, found: 233.1323.

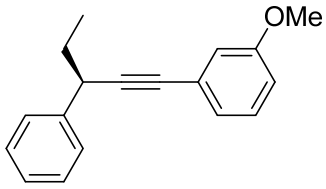
8. Asymmetric decarboxylative alkynylation: Scope of alkynes

General procedure 3:



CuI (3.8 mg, 0.02 mmol, 10 mol%), **L1** (20.1 mg, 0.024 mmol, 12 mol%), Cs_2CO_3 (228.1 mg, 0.70 mmol, 3.5 equiv.), *N*-hydroxyphthalimide esters **1** (0.30 mmol, 1.5 equiv.) and anhydrous $PhCF_3$ (4.0 mL) were sequentially added to an oven-dried Schlenk tube equipped with a magnetic stir bar under argon atmosphere. Then, alkyne **2** (0.20 mmol, 1.0 equiv.) was added to the mixture. The reaction mixture was stirred under the irradiation of a 24 W blue LED for 3 to 4 d at room temperature. After the completion of reaction, the reaction mixture was filtered and the precipitate was washed by EtOAc. The filtrate was removed by rotary evaporator under vacuum and the residue was purified by flash column chromatography on silica gel to afford the alkynylation product.

(*R*)-1-Methoxy-3-(3-phenylpent-1-yn-1-yl)benzene (39)



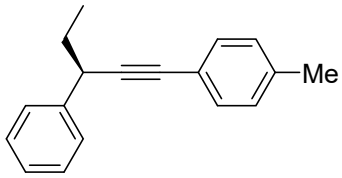
According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 1-ethynyl-3-methoxybenzene **2b** (26.4 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **39** as a colorless oil (36.1 mg, 72% yield, 97% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 26.49 min, t_R (major) = 33.84 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.43-7.41 (m, 2H), 7.36-7.32 (m, 2H), 7.27-7.18 (m,

2H), 7.06-7.04 (m, 1H), 6.98-6.97 (m, 1H), 6.86-6.83 (m, 1H), 3.79-3.77 (m, 4H), 1.92-1.81 (m, 2H), 1.05 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 159.3, 141.9, 129.2, 128.4, 127.5, 126.6, 124.8, 124.2, 116.5, 114.3, 91.3, 83.2, 55.2, 39.9, 31.6, 11.9. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-1-Methyl-4-(3-phenylpent-1-yn-1-yl)benzene (40)



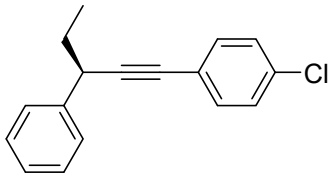
According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 1-ethynyl-4-methylbenzene **2d** (23.2 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **40** as a colorless oil (35.2 mg, 75% yield, 97% *ee*).

$[\alpha]_D^{25}$ = - 10.9 (*c* 0.73, CH_2Cl_2).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 14.83 min, t_R (major) = 18.13 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.43-7.41 (m, 2H), 7.35-7.31 (m, 4H), 7.26-7.21 (m, 1H), 7.10 (d, J = 7.6 Hz, 2H), 3.78 (t, J = 7.0 Hz, 1H), 2.33 (s, 3H), 1.91-1.80 (m, 2H), 1.05 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 142.1, 137.7, 131.5, 128.9, 128.4, 127.5, 126.6, 120.7, 90.6, 83.4, 39.9, 31.7, 21.4, 11.8. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-1-Chloro-4-(3-phenylpent-1-yn-1-yl)benzene (41)



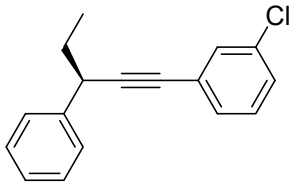
According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg,

0.30 mmol, 1.5 equiv.) and 1-chloro-4-ethynylbenzene **2e** (27.3 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **41** as a colorless oil (35.7 mg, 70% yield, 93% *ee*).

HPLC analysis: Chiralcel AD (hexane/*i*-PrOH = 100/0, flow rate 0.5 mL/min, λ = 254 nm), t_R (minor) = 12.33 min, t_R (major) = 13.79 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.41-7.32 (m, 6H), 7.29-7.23 (m, 3H), 3.77 (t, J = 7.0 Hz, 1H), 1.90-1.82 (m, 2H), 1.04 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.7, 133.6, 132.9, 128.49, 128.45, 127.5, 126.7, 122.3, 92.6, 82.2, 40.0, 31.5, 11.8. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-1-Chloro-3-(3-phenylpent-1-yn-1-yl)benzene (42)

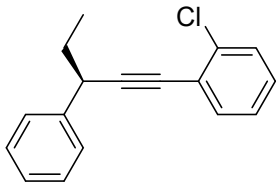


According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 1-chloro-3-ethynylbenzene **2f** (27.3 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **42** as a colorless oil (38.7 mg, 76% yield, 95% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 12.21 min, t_R (major) = 13.06 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.44-7.38 (m, 3H), 7.36-7.30 (m, 3H), 7.28-7.20 (m, 3H), 3.78 (t, J = 7.0 Hz, 1H), 1.92-1.81 (m, 2H), 1.05 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.6, 134.0, 131.5, 129.8, 129.4, 128.5, 128.0, 127.5, 126.8, 125.5, 92.9, 82.0, 39.9, 31.5, 11.8. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-1-Chloro-2-(3-phenylpent-1-yn-1-yl)benzene (43)

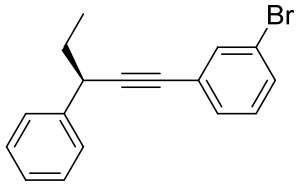


According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 1-chloro-2-ethynylbenzene **2g** (27.3 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **43** as a colorless oil (36.7 mg, 72% yield, 95% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 16.70 min, t_R (major) = 18.58 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.48-7.45 (m, 3H), 7.40-7.32 (m, 3H), 7.26-7.16 (m, 3H), 3.88-3.84 (m, 1H), 1.95-1.84 (m, 2H), 1.09 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.6, 136.0, 133.3, 129.1, 128.7, 128.4, 127.6, 126.7, 126.3, 123.7, 97.0, 80.3, 40.2, 31.7, 11.8. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-1-Bromo-3-(3-phenylpent-1-yn-1-yl)benzene (44)



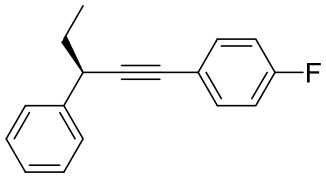
According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 1-bromo-3-ethynylbenzene **2h** (36.2 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **44** as a colorless oil (41.9 mg, 70% yield, 93% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 12.76 min, t_R (major) = 13.61 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.60-7.59 (m, 1H), 7.43-7.32 (m, 6H), 7.27-7.23 (m,

1H), 7.16 (t, J = 8.0 Hz, 1H), 3.77 (t, J = 7.0 Hz, 1H), 1.92-1.81 (m, 2H), 1.05 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.6, 134.4, 130.9, 130.2, 129.6, 128.5, 127.5, 126.8, 125.8, 122.0, 93.1, 81.9, 39.9, 31.5, 11.8. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-1-Fluoro-4-(3-phenylpent-1-yn-1-yl)benzene (45)

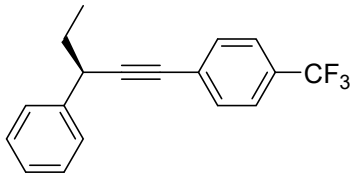


According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 1-ethynyl-4-fluorobenzene **2i** (24.0 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **45** as a colorless oil (35.7 mg, 75% yield, 94% *ee*).

HPLC analysis: Chiralcel OJH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 24.35 min, t_R (major) = 27.92 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.44-7.39 (m, 4H), 7.36-7.32 (m, 2H), 7.27-7.23 (m, 1H), 7.01-6.96 (m, 2H), 3.77 (t, J = 7.0 Hz, 1H), 1.91-1.80 (m, 2H), 1.05 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 162.2 (d, J = 247.0 Hz), 141.9, 133.4 (d, J = 8.1 Hz), 128.4, 127.5, 126.7, 119.9 (d, J = 3.5 Hz), 115.4 (d, J = 21.9 Hz), 91.1, 82.2, 39.9, 31.6, 11.8; ^{19}F NMR (376 MHz, $CDCl_3$) δ: -112.1. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-1-(3-Phenylpent-1-yn-1-yl)-4-(trifluoromethyl)benzene (46)



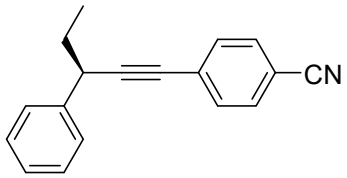
According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg,

0.30 mmol, 1.5 equiv.) and 1-ethynyl-4-(trifluoromethyl)benzene **2j** (34.0 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **46** as a colorless oil (46.1 mg, 80% yield, 96% *ee*).

HPLC analysis: Chiralcel IA (hexane/*i*-PrOH = 100/0, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 25.67 min, t_R (major) = 27.61 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.56-7.52 (m, 4H), 7.41-7.39 (m, 2H), 7.36-7.33 (m, 2H), 7.28-7.24 (m, 1H), 3.80 (t, J = 7.2 Hz, 1H), 1.93-1.83 (m, 2H), 1.06 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.5, 131.9, 129.5 (q, J = 32.3 Hz), 128.5, 127.7 (d, J = 1.4 Hz), 127.5, 126.8, 125.1 (q, J = 3.8 Hz), 124.0 (q, J = 270.5 Hz), 94.3, 82.2, 40.0, 31.5, 11.8; ^{19}F NMR (376 MHz, $CDCl_3$) δ: -62.7. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-4-(3-Phenylpent-1-yn-1-yl)benzonitrile (47)

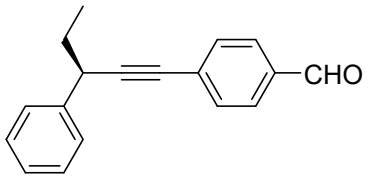


According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 4-ethynylbenzonitrile **2k** (25.4 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **47** as a colorless oil (34.8 mg, 71% yield, 95% *ee*).

HPLC analysis: Chiralcel ASH (hexane/*i*-PrOH = 95/5, flow rate 0.8 mL/min, λ = 254 nm), t_R (minor) = 9.30 min, t_R (major) = 11.43 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.58 (d, J = 8.4 Hz, 2H), 7.51 (d, J = 8.8 Hz, 2H), 7.40-7.33 (m, 4H), 7.28-7.25 (m, 1H), 3.80 (t, J = 7.0 Hz, 1H), 1.94-1.83 (m, 2H), 1.05 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.2, 132.2, 131.9, 128.8, 128.5, 127.4, 126.9, 118.6, 111.0, 96.6, 82.0, 40.0, 31.4, 11.8. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-4-(3-Phenylpent-1-yn-1-yl)benzaldehyde (48)

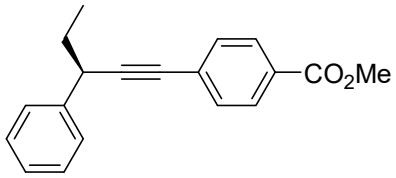


According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 4-ethynylbenzaldehyde **2l** (26.0 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **48** as a colorless oil (32.8 mg, 66% yield, 96% *ee*).

HPLC analysis: Chiralcel ASH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.3 mL/min, λ = 290 nm), t_R (minor) = 28.29 min, t_R (major) = 31.21 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 9.99 (s, 1H), 7.81 (d, J = 8.4 Hz, 2H), 7.58 (d, J = 8.4 Hz, 2H), 7.42-7.40 (m, 2H), 7.35 (t, J = 7.6 Hz, 2H), 7.28-7.24 (m, 1H), 3.82 (t, J = 7.0 Hz, 1H), 1.95-1.84 (m, 2H), 1.06 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 191.5, 141.4, 135.1, 132.2, 130.2, 129.5, 128.5, 127.5, 126.9, 96.2, 82.7, 40.1, 31.4, 11.8. The NMR spectra were in accord with that reported in literature.[5]

Methyl (*R*)-4-(3-phenylpent-1-yn-1-yl)benzoate (49)

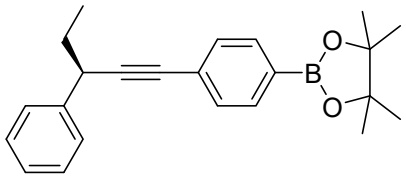


According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and methyl 4-ethynylbenzoate **2m** (32.0 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **49** as a colorless oil (39.0 mg, 70% yield, 93% *ee*).

HPLC analysis: Chiralcel IA (hexane/*i*-PrOH = 97/3, flow rate 0.5 mL/min, λ = 254 nm), t_R (minor) = 10.10 min, t_R (major) = 11.31 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.98-7.96 (m, 2H), 7.51-7.49 (m, 2H), 7.42-7.40 (m, 2H), 7.36-7.33 (m, 2H), 7.28-7.23 (m, 1H), 3.91 (s, 3H), 3.80 (t, J = 7.0 Hz, 1H), 1.92-1.84 (m, 2H), 1.06 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 166.7, 141.5, 131.6, 129.4, 129.0, 128.6, 128.5, 127.5, 126.8, 94.9, 82.7, 52.2, 40.1, 31.5, 11.8. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-4,4,5,5-Tetramethyl-2-(4-(3-phenylpent-1-yn-1-yl)phenyl)-1,3,2-dioxaborolan e (50)

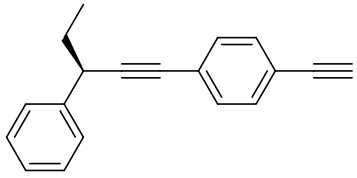


According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 2-(4-ethynylphenyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane **2n** (45.6 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/petroleum ether = 1/100) to yield the product **50** as a colorless oil (43.6 mg, 63% yield, 96% *ee*).

HPLC analysis: Chiralcel IA (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.2 mL/min, λ = 254 nm), t_R (minor) = 24.78 min, t_R (major) = 29.18 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.73 (d, J = 8.0 Hz, 2H), 7.45-7.40 (m, 4H), 7.35-7.32 (m, 2H), 7.26-7.22 (m, 1H), 3.79 (t, J = 7.0 Hz, 1H), 1.92-1.81 (m, 2H), 1.34 (s, 12H), 1.05 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.9, 134.5, 130.8, 128.4, 127.5, 126.7, 126.6, 92.9, 83.9, 83.5, 40.0, 31.6, 24.9, 11.8. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-1-Ethynyl-4-(3-phenylpent-1-yn-1-yl)benzene (51)

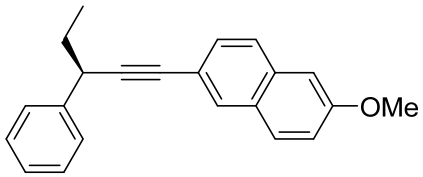


According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (71.9 mg, 0.20 mmol, 1.0 equiv.) and 1,4-diethynylbenzene **2o** (37.8 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **51** as a colorless oil (31.8 mg, 65% yield, 95% *ee*).

HPLC analysis: Chiralcel AD (hexane/*i*-PrOH = 97/3, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 6.16 min, t_R (major) = 7.61 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.43-7.37 (m, 6H), 7.35-7.32 (m, 2H), 7.27-7.23 (m, 1H), 3.79 (t, J = 7.0 Hz, 1H), 3.13 (s, 1H), 1.92-1.81 (m, 2H), 1.05 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.7, 131.9, 131.5, 128.5, 127.5, 126.7, 124.4, 121.3, 93.7, 83.3, 82.9, 78.5, 40.0, 31.5, 11.8. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-2-Methoxy-6-(3-phenylpent-1-yn-1-yl)naphthalene (52)



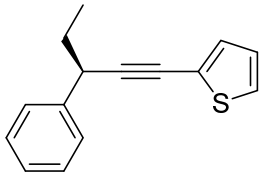
According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 2-ethynyl-6-methoxynaphthalene **2p** (36.4 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **52** as a colorless oil (43.9 mg, 73% yield, 95% *ee*).

HPLC analysis: Chiralcel OJH (hexane/*i*-PrOH = 97/3, flow rate 0.8 mL/min, λ = 254 nm), t_R (major) = 21.20 min, t_R (minor) = 31.44 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.88 (s, 1H), 7.65 (t, J = 8.6 Hz, 2H), 7.48-7.44 (m, 3H), 7.35 (t, J = 7.6 Hz, 2H), 7.27-7.23 (m, 1H), 7.14-7.08 (m, 2H), 3.90 (s, 3H), 3.82 (t, J = 7.0 Hz, 1H), 1.95-1.84 (m, 2H), 1.09 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 158.0, 142.1, 133.8, 131.0, 129.3, 129.1, 128.5, 128.4, 127.6, 126.6, 119.2, 118.8, 105.8, 91.0, 83.8, 55.3, 40.1, 31.7, 11.9. The NMR spectra were in accord with

that reported in literature.[5]

(*R*)-2-(3-Phenylpent-1-yn-1-yl)thiophene (53)

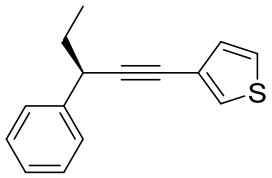


According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 2-ethynylthiophene **2q** (21.6 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **53** as a colorless oil (27.6 mg, 61% yield, 96% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 12.52 min, t_R (major) = 13.82 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.40-7.38 (m, 2H), 7.36-7.32 (m, 2H), 7.27-7.23 (m, 1H), 7.20-7.16 (m, 2H), 6.96-6.94 (m, 1H), 3.80 (t, J = 7.0 Hz, 1H), 1.92-1.81 (m, 2H), 1.04 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.6, 131.2, 128.4, 127.5, 126.8, 126.7, 126.2, 123.9, 95.4, 76.4, 40.2, 31.5, 11.9. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-3-(3-Phenylpent-1-yn-1-yl)thiophene (54)

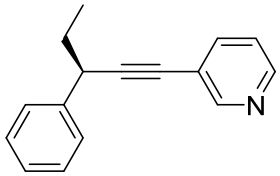


According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 3-ethynylthiophene **2c** (21.6 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **54** as a colorless oil (28.1 mg, 62% yield, 97% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 214 nm), t_R (minor) = 17.63 min, t_R (major) = 19.77 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.41-7.39 (m, 3H), 7.35-7.31 (m, 2H), 7.26-7.22 (m, 2H), 7.12-7.10 (m, 1H), 3.76 (t, J = 7.0 Hz, 1H), 1.91-1.80 (m, 2H), 1.04 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.9, 130.1, 128.4, 127.8, 127.5, 126.6, 125.0, 122.8, 91.0, 78.3, 40.0, 31.6, 11.8; HRMS (ESI): *m/z* calcd for $C_{15}H_{15}S$ $[M+H]^+$: 227.0889, found: 227.0888.

(*R*)-4-(3-Phenylpent-1-yn-1-yl)pyridine (55)

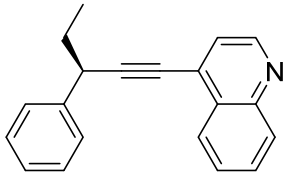


According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 3-ethynylpyridine **2r** (20.6 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/petroleum ether = 1/100) to yield the product **55** as a colorless oil (31.4 mg, 71% yield, 96% *ee*).

HPLC analysis: Chiralcel IA (hexane/*i*-PrOH = 97/3, flow rate 0.5 mL/min, λ = 254 nm), t_R (minor) = 12.91 min, t_R (major) = 14.98 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.68 (s, 1H), 8.51 (s, 1H), 7.73-7.70 (m, 1H), 7.42-7.39 (m, 2H), 7.37-7.33 (m, 2H), 7.28-7.21 (m, 2H), 3.80 (t, J = 7.0 Hz, 1H), 1.94-1.83 (m, 2H), 1.06 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 152.4, 148.1, 141.4, 138.5, 128.5, 127.5, 126.8, 122.9, 120.9 95.2, 80.0, 40.0, 31.4, 11.8; HRMS (ESI): *m/z* calcd for $C_{16}H_{16}N$ $[M+H]^+$: 222.1277, found: 222.1277.

(*R*)-4-(3-Phenylpent-1-yn-1-yl)quinoline (56)

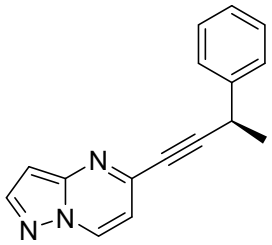


According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (107.8 mg, 0.30 mmol, 1.5 equiv.) and 4-ethynylquinoline **2s** (30.6 mg, 0.20 mmol, 1.0 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/petroleum ether = 1/30) to yield the product **56** as a colorless oil (35.3 mg, 65% yield, 95% *ee*).

HPLC analysis: Chiralcel OD3 (hexane/*i*-PrOH = 98/2, flow rate 0.3 mL/min, λ = 254 nm), t_R (major) = 30.42 min, t_R (minor) = 32.10 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.85 (d, J = 4.4 Hz, 1H), 8.29 (dd, J = 8.4, 0.8 Hz, 1H), 8.11 (d, J = 8.4 Hz, 1H), 7.76-7.71 (m, 1H), 7.62-7.58 (m, 1H), 7.50-7.47 (m, 3H), 7.41-7.37 (m, 2H), 7.32-7.27 (m, 1H), 3.97 (t, J = 7.0 Hz, 1H), 2.05-1.96 (m, 2H), 1.14 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 149.7, 148.0, 141.1, 130.3, 129.7, 128.6, 128.1, 127.5, 127.04, 126.96, 126.0, 123.8, 101.7, 79.3, 40.4, 31.5, 11.9. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-5-(3-Phenylbut-1-yn-1-yl)pyrazolo[1,5-*α*]pyrimidine (57)



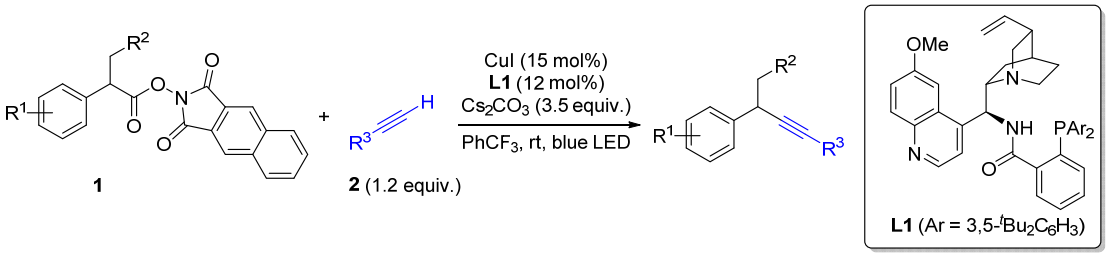
According to **General procedure 3** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylpropanoate **1ah** (51.8 mg, 0.15 mmol, 1.5 equiv.), 5-ethynylpyrazolo[1,5-*α*]pyrimidine **2t** which was synthesized according to the reference[3] (14.3 mg, 0.1 mmol, 1.0 equiv.), CuI (4.3 mg, 0.0225 mmol, 15 mol%) and **L1** (22.6 mg, 0.027 mmol, 18 mol%) for 4 d, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/petroleum ether = 1/2) to yield the product **57** as a colorless oil (11.1 mg, 45% yield, 93% *ee*).

HPLC analysis: Chiralcel AD3 (hexane/*i*-PrOH = 95/5, flow rate 0.3 mL/min, λ = 254 nm), t_R (minor) = 48.41 min, t_R (major) = 51.19 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.58 (d, J = 7.2 Hz, 1H), 8.12 (s, 1H), 7.44 (d, J = 7.6

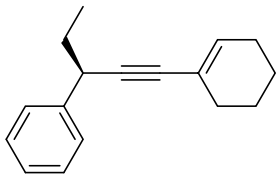
Hz, 2H), 7.36 (t, J = 7.4 Hz, 2H), 7.27 (t, J = 7.2 Hz, 1H), 6.85 (d, J = 7.2 Hz, 1H), 6.68 (s, 1H), 4.05 (q, J = 7.2 Hz, 1H), 1.64 (d, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 148.1, 145.6, 142.4, 141.8, 134.4, 128.7, 127.0, 126.9, 110.7, 97.2, 96.9, 81.0, 32.4, 23.7. The NMR spectra were in accord with that reported in literature.[5]

General procedure 4:



CuI (5.7 mg, 0.03 mmol, 15 mol%), **L1** (20.1 mg, 0.024 mmol, 12 mol%), Cs_2CO_3 (228.1 mg, 0.70 mmol, 3.5 equiv.), *N*-hydroxyphthalimide esters **1** (0.20 mmol, 1.0 equiv.) and anhydrous $PhCF_3$ (4.0 mL) were sequentially added to an oven-dried Schlenk tube equipped with a magnetic stir bar under argon atmosphere. Then, alkyne **2** (0.24 mmol, 1.2 equiv.) was added to the mixture. The reaction mixture was stirred under the irradiation of a 24 W blue LED for 4 d at room temperature. After the completion of reaction, the reaction mixture was filtered and the precipitate was washed by EtOAc. The filtrate was removed by rotary evaporator under vacuum and the residue was purified by flash column chromatography on silica gel to afford the alkynylation product.

(*R*)-(1-(Cyclohex-1-en-1-yl)pent-1-yn-3-yl)benzene (58)



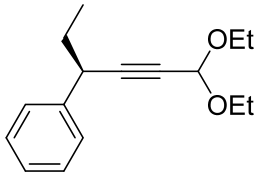
According to **General procedure 4** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (71.9 mg, 0.20 mmol, 1.0 equiv.) and 1-ethynylcyclohex-1-ene **2u** (25.5 mg, 0.24 mmol, 1.2 equiv.) for 4 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **58** as a colorless oil (14.8 mg, 33% yield, 97%

ee).

HPLC analysis: Chiralcel OD3 (hexane/*i*-PrOH = 100/0, flow rate 0.2 mL/min, λ = 214 nm), t_R (minor) = 31.14 min, t_R (major) = 38.85 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.37-7.30 (m, 4H), 7.22 (t, J = 7.0 Hz, 1H), 6.10-6.08 (m, 1H), 3.68 (t, J = 7.0 Hz, 1H), 2.17-2.15 (m, 2H), 2.12-2.09 (m, 2H), 1.84-1.72 (m, 2H), 1.68-1.56 (m, 4H), 1.00 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 142.4, 133.5, 128.3, 127.5, 126.4, 120.9, 88.5, 85.2, 39.8, 31.8, 29.6, 25.6, 22.4, 21.6, 11.8. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-(6,6-Diethoxyhex-4-yn-3-yl)benzene (59)

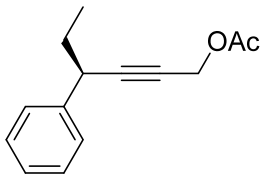


According to **General procedure 4** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (71.9 mg, 0.20 mmol, 1.0 equiv.) and 3,3-diethoxyprop-1-yne **2v** (30.8 mg, 0.24 mmol, 1.2 equiv.) for 4 d, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/petroleum ether = 1/50) to yield the product **59** as a colorless oil (24.1 mg, 49% yield, 97% *ee*).

HPLC analysis: Chiralcel OD3 (hexane/*i*-PrOH = 99/1, flow rate 0.3 mL/min, λ = 214 nm), t_R (major) = 20.31 min, t_R (minor) = 25.24 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.35-7.29 (m, 4H), 7.23 (t, J = 6.6 Hz, 1H), 5.34 (s, 1H), 3.81-3.72 (m, 2H), 3.65-3.56 (m, 3H), 1.84-1.77 (m, 2H), 1.26-1.22 (m, 6H), 0.99 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 141.2, 128.3, 127.5, 126.7, 91.5, 87.4, 78.5, 60.7, 60.6, 39.2, 31.2, 15.1, 11.7. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-4-Phenylhex-2-yn-1-yl acetate (60)

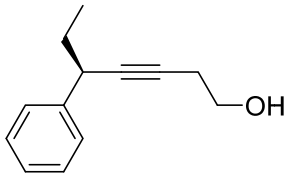


According to **General procedure 4** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (71.9 mg, 0.20 mmol, 1.0 equiv.) and prop-2-yn-1-yl acetate **2w** (23.5 mg, 0.24 mmol, 1.2 equiv.) for 4 d, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/petroleum ether = 1/50) to yield the product **60** as a colorless oil (22.1 mg, 51% yield, 95% *ee*).

HPLC analysis: Chiralcel OD3 (hexane/*i*-PrOH = 99/1, flow rate 0.3 mL/min, λ = 214 nm), t_R (major) = 29.92 min, t_R (minor) = 34.28 min.

^{1}H NMR (400 MHz, $CDCl_3$) *δ*: 7.33-7.29 (m, 4H), 7.26-7.21 (m, 1H), 4.74 (d, *J* = 2.0 Hz, 2H), 3.62-3.58 (m, 1H), 2.10 (s, 3H), 1.82-1.75 (m, 2H), 0.97 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ*: 170.4, 141.3, 128.4, 127.4, 126.7, 88.8, 52.8, 39.3, 31.2, 20.8, 11.7. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-5-Phenylhept-3-yn-1-ol (61)



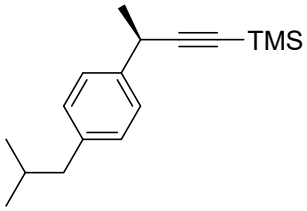
According to **General procedure 4** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (71.9 mg, 0.20 mmol, 1.0 equiv.) and but-3-yn-1-ol **2x** (16.8 mg, 0.24 mmol, 1.2 equiv.) for 4 d, the reaction mixture was purified by column chromatography on silica gel (ethyl acetate/petroleum ether = 1/10) to yield the product **61** as a colorless oil (11.3 mg, 30% yield, 97% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 95/5, flow rate 0.7 mL/min, λ = 214 nm), t_R (major) = 11.42 min, t_R (minor) = 12.69 min.

^{1}H NMR (400 MHz, $CDCl_3$) *δ*: 7.35-7.30 (m, 4H), 7.23 (t, *J* = 6.6 Hz, 1H), 3.72 (t, *J* = 5.8 Hz, 2H), 3.56 (t, *J* = 7.0 Hz, 1H), 2.52 (td, *J* = 6.2, 1.6 Hz, 2H), 1.87 (s, 1H),

1.82-1.70 (m, 2H), 0.98 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 142.3, 128.4, 127.4, 126.6, 84.1, 79.2, 61.4, 39.4, 31.6, 23.3, 11.8. The NMR spectra were in accord with that reported in literature.[5]

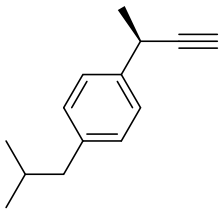
(*R*)-(3-(4-Isobutylphenyl)but-1-yn-1-yl)trimethylsilane (62)



According to **General procedure 4** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(4-isobutylphenyl)propanoate **1b** (80.3 mg, 0.20 mmol, 1.0 equiv.) and ethynyltrimethylsilane **2y** (23.6 mg, 0.24 mmol, 1.2 equiv.) for 4 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **62** as a colorless oil (25.8 mg, 50% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.28 (d, J = 8.0 Hz, 2H), 7.10 (d, J = 8.0 Hz, 2H), 3.77 (q, J = 7.2 Hz, 1H), 2.46 (d, J = 7.2 Hz, 2H), 1.91-1.80 (m, 1H), 1.47 (d, J = 7.2 Hz, 3H), 0.91 (d, J = 6.4 Hz, 6H), 0.19 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 140.2, 139.9, 129.2, 126.5, 109.8, 86.0, 45.0, 32.4, 30.2, 24.7, 22.40, 22.38, 0.2. The NMR spectra were in accord with that reported in literature.[5]

(*S*)-1-(But-3-yn-2-yl)-4-isobutylbenzene (62')

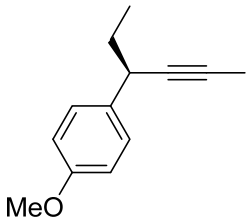


To a stirred solution of **62** (24.4 mg, 0.094 mmol, 1.0 equiv.) in MeOH (1.5 mL) was added K_2CO_3 (26 mg, 0.189 mmol, 2.0 equiv.) and the reaction mixture was stirred for 4 h. After completion of reaction, the mixture was concentrated under reduced pressure and purified by column chromatography (petroleum ether) to yield the desired product **62'** as a colorless oil (15.6 mg, 89% yield, 94% *ee*).

HPLC analysis: Chiralcel OD3 (hexane/*i*-PrOH = 100/0, flow rate 0.3 mL/min, λ = 214 nm), t_R (major) = 17.64 min, t_R (minor) = 22.26 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.30 (d, J = 8.0 Hz, 2H), 7.11 (d, J = 8.0 Hz, 2H), 3.78-3.72 (m, 1H), 2.46 (d, J = 7.2 Hz, 2H), 2.26 (d, J = 2.4 Hz, 1H), 1.90-1.80 (m, 1H), 1.51 (d, J = 7.2 Hz, 3H), 0.91 (d, J = 6.4 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 140.1, 139.8, 129.3, 126.5, 87.4, 69.9, 45.0, 31.2, 30.2, 24.2, 22.4. The NMR spectra were in accord with that reported in literature.[5]

(*R*)-1-(Hex-4-yn-3-yl)-4-methoxybenzene (63)



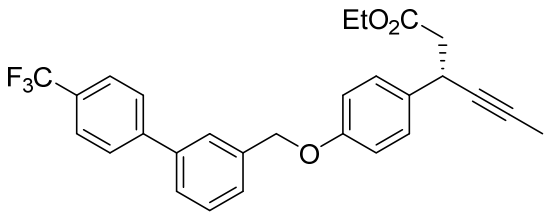
According to **General procedure 4** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-(4-methoxyphenyl)butanoate **S34** (39.0 mg, 0.10 mmol, 1.0 equiv.) and prop-1-yne **2z** (0.5 mL, 0.50 mmol, 5.0 equiv., 1.0 M in THF) for 4 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **63** as a colorless oil (10.9 mg, 58% yield, 93% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 230 nm), t_R (minor) = 11.31 min, t_R (major) = 17.02 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.26-7.24 (m, 2H), 6.85 (d, J = 8.4 Hz, 2H), 3.79 (s, 3H), 3.45 (t, J = 6.4 Hz, 1H), 1.86 (s, 3H), 1.74-1.67 (m, 2H), 0.95 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 158.2, 134.9, 128.4, 113.7, 81.1, 78.1, 55.3, 38.6, 31.7, 11.8, 3.6; HRMS (ESI): *m/z* calcd for $C_{13}H_{17}O$ $[M+H]^+$: 189.1274, found: 189.1273.

Ethyl

(*S*)-3-(4-((4'-(trifluoromethyl)-[1,1'-biphenyl]-3-yl)methoxy)phenyl)hex-4-ynoate (64)

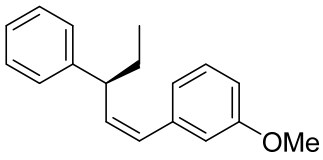


According to **General procedure 2** with 1-(1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl) 4-ethyl 2-(4-((4'-(trifluoromethyl)-[1,1'-biphenyl]-3-yl)methoxy)phenyl)succinate **S64** (66.8 mg, 0.1 mmol, 1.0 equiv.), prop-1-yne **2z** (0.5 mL, 0.5 mmol, 5.0 equiv., 1.0 M in THF), CuI (3.8 mg, 0.02 mmol, 20 mol%) and **L3** (19.3 mg, 0.024 mmol, 24 mol%) for 3 d, the reaction mixture was purified by column chromatography on silica gel (dichloromethane/petroleum ether = 1/1.5) to yield the product **64** as a colorless oil (12.6 mg, 27% yield, 76% *ee*).

HPLC analysis: Chiralcel IB (hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 10.55 min, t_R (major) = 11.62 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.70 (s, 4H), 7.65 (s, 1H), 7.56 (d, J = 7.2 Hz, 1H), 7.48 (d, J = 7.6 Hz, 2H), 7.30 (d, J = 8.4 Hz, 2H), 6.94 (d, J = 8.4 Hz, 2H), 5.12 (s, 2H), 4.16-4.06 (m, 3H), 2.77-2.71 (m, 1H), 2.67-2.61 (m, 1H), 1.82 (d, J = 2.4 Hz, 3H), 1.21 (t, J = 7.0 Hz, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ: -62.4. The NMR spectra were in accord with that reported in literature.[5]

(*S*,*Z*)-1-Methoxy-3-(3-phenylpent-1-en-1-yl)benzene (65)



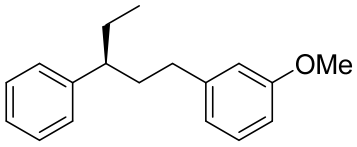
To a solution of IPrCuCl (7.3 mg, 0.015 mmol, 10 mol%), $Pd(OAc)_2$ (1.7 mg, 0.0075 mmol, 5 mol%), **L** (5.7 mg, 0.015 mmol, 10 mol%), NaO^{t}Bu (28.8 mg, 0.3 mmol, 2 equiv.), MeOH (24.0 mg, 0.75 mmol, 5 equiv.) and **39** (37.6 mg, 0.15 mmol, 1.0 equiv., 97% *ee*) in toluene (1.5 mL) was added TMDSO (1,1,3,3-tetramethyldisiloxane) (40.3 mg, 0.3 mmol, 2 equiv.) under argon atmosphere. Then, the reaction mixture was stirred at 60 °C for 4 h. Subsequently, the reaction mixture was filtered through a short plug of silica gel with EtOAc (3 × 10 mL). The

organic solvent was removed by rotary evaporator under vacuum and the residue was purified by flash column chromatography (petroleum ether) on silica gel to afford the product **65** as a colorless oil (30.7 mg, 81% yield, 97% *ee*).[9]

HPLC analysis: Chiralcel OJH (hexane/*i*-PrOH = 99/1, flow rate 1.0 mL/min, λ = 240 nm), t_R (minor) = 10.92 min, t_R (major) = 22.96 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.31 (t, J = 7.4 Hz, 2H), 7.25-7.18 (m, 4H), 6.83 (d, J = 7.6 Hz, 1H), 6.80-6.77 (m, 2H), 6.51 (d, J = 11.6 Hz, 1H), 5.88-5.82 (m, 1H), 3.75 (s, 3H), 3.73-3.68 (m, 1H), 1.80-1.66 (m, 2H), 0.84 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 159.4, 145.2, 138.9, 136.0, 129.1, 128.8, 128.5, 127.4, 126.1, 121.2, 113.9, 112.5, 55.1, 45.5, 30.7, 12.0; HRMS (ESI): *m/z* calcd for $C_{18}H_{21}O$ $[M+H]^+$: 253.1587, found: 253.1585.

(*S*)-1-Methoxy-3-(3-phenylpentyl)benzene (66)



To a solution of **39** (37.6 mg, 0.15 mmol, 1.0 equiv., 97% *ee*) in THF (2.5 mL) was added Pd/C (10.0 mg, 10% w/w Pd on carbon) under argon atmosphere. Subsequently, the reaction flask was evacuated and refilled with hydrogen through a balloon. The reaction mixture was stirred at room temperature under the hydrogen atmosphere for 4 h. Then, the reaction mixture was filtered and rinsed with EtOAc (3 × 20 mL). The filtrate was concentrated by rotary evaporator under vacuum and the residue was purified by column chromatography on silica gel (petroleum ether) to give the product **66** as a colorless oil (31.7 mg, 83% yield, 96% *ee*).

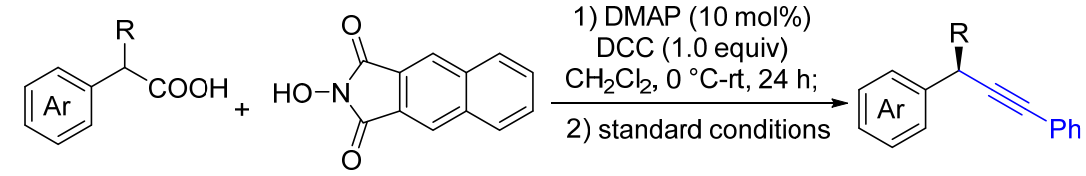
HPLC analysis: Chiralcel OJH (hexane/*i*-PrOH = 99/1, flow rate 1.0 mL/min, λ = 214 nm), t_R (minor) = 10.65 min, t_R (major) = 13.23 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.31 (t, J = 7.4 Hz, 2H), 7.24-7.14 (m, 4H), 6.71-6.69 (m, 2H), 6.65 (s, 1H), 3.77 (s, 3H), 2.48-2.38 (m, 3H), 2.02-1.83 (m, 2H), 1.74-1.66 (m, 1H), 1.61-1.54 (m, 1H), 0.76 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 159.5, 145.4, 144.3, 129.1, 128.3, 127.8, 125.9, 120.8, 114.1, 110.9, 55.1, 47.3, 38.0, 33.9, 29.8, 12.1; HRMS (ESI): *m/z* calcd for $C_{18}H_{23}O$ $[M+H]^+$: 255.1743, found:

255.1740.

9. Synthetic applications

9.1 One-pot synthesis



67a, R^1 = H, R^2 = Et
67b, R^1 = ^{t}Bu, R^2 = Me

68 (1 equiv.)

4, 61%, 97% ee
18, 55%, 90% ee

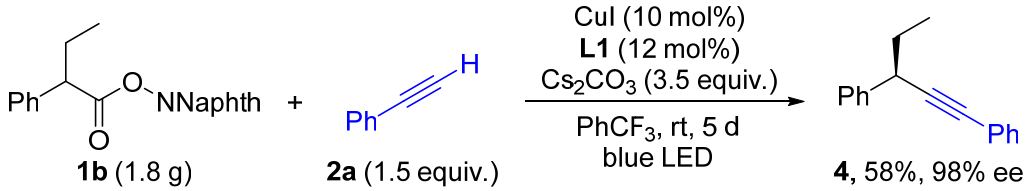
Step 1: According to **General procedure 1** with alkyl carboxylic acids **67a** and **67b** (0.20 mmol, 1.0 equiv.) and 2-hydroxy-1*H*-benzo[*f*]isoindole-1,3(2*H*)-dione **68** (42.6 mg, 0.20 mmol, 1.0 equiv.) for 24 h, the reaction mixture was filtrated through a pad of diatomite. The precipitate was washed with CH_2Cl_2 (3 × 50 mL). The filtrate was removed by rotary evaporator under vacuum to give the crude ester without further purification.

Step 2: According to **General procedure 2** with the crude ester (0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether) to yield the product **4** (colorless oil, 26.9 mg, 61% yield, 97% *ee*) and **18** (colorless oil, 28.9 mg, 55% yield, 90% *ee*), respectively.

HPLC analysis of **4**: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 11.48 min, t_R (major) = 16.96 min.

HPLC analysis of **18**: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 15.97 min, t_R (major) = 26.49 min.

9.2 Large-scale synthesis



1b (1.8 g)

2a (1.5 equiv.)

4, 58%, 98% ee

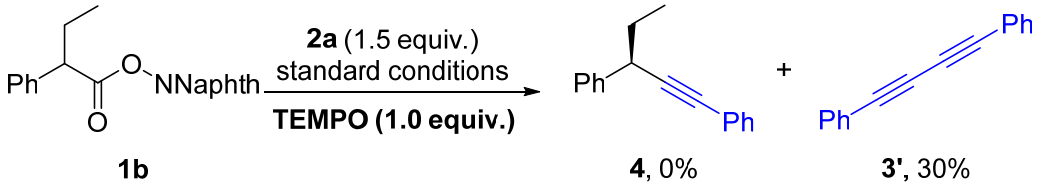
CuI (95.2 mg, 0.5 mmol, 10 mol%), **L1** (502 mg, 0.6 mmol, 12 mol%), Cs_2CO_3 (5.7 g, 17.5 mmol, 3.5 equiv.), 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (1.8 g, 5.0 mmol, 1.0 equiv.) and anhydrous $PhCF_3$ (100 mL) were sequentially added to an oven-dried flask equipped with a magnetic stir bar

under argon atmosphere. Then, ethynylbenzene **2a** (766.1 mg, 7.5 mmol, 1.5 equiv.) was added to the mixture. The reaction mixture was stirred under the irradiation of a 24 W blue LED for 5 d at room temperature. After the completion of reaction, the reaction mixture was filtered and the precipitate was washed by EtOAc (3 × 30 mL). The filtrate was removed by rotary evaporator under vacuum and the residue was purified by flash column chromatography on silica gel with petroleum ether to afford the product **4** as a colorless oil (638.9 mg, 58% yield, 98% *ee*).

HPLC analysis: Chiralcel ODH (hexane/*i*-PrOH = 99.5/0.5, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 11.16 min, t_R (major) = 16.35 min.

10. Mechanistic Study

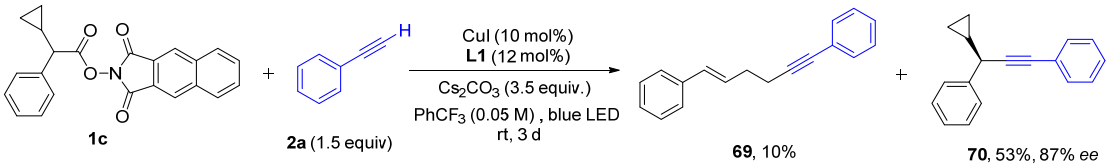
10.1 Radical-trapping experiment



1b **4**, 0% **3'**, 30%

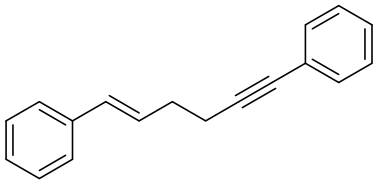
CuI (3.8 mg, 0.02 mmol, 10 mol%), **L1** (20.1 mg, 0.024 mmol, 12 mol%), Cs_2CO_3 (228.1 mg, 0.70 mmol, 3.5 equiv.), 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-phenylbutanoate **1b** (71.9 mg, 0.20 mmol, 1.0 equiv.), TEMPO (31.2 mg, 0.20 mmol 1.0 equiv.) and anhydrous $PhCF_3$ (4.0 mL) were sequentially added to an oven-dried Schlenk tube equipped with a magnetic stir bar under argon atmosphere. Then, ethynylbenzene **2a** (30.6 mg, 0.30 mmol, 1.5 equiv.) was added to the mixture. The reaction mixture was stirred under the irradiation of a 24 W blue LED for 3 d at room temperature. After the completion of reaction, the reaction mixture was filtered and the precipitate was washed by EtOAc. The filtrate was removed by rotary evaporator under vacuum and the residue was analyzed by ^1H NMR. **4** was not detected in the reaction mixture. Furthermore, **3'** was isolated as a colorless solid (9.1 mg, 30% yield) and 2-phenylbutanoic acid via the hydrolysis of **1b** could be detected.

10.2 Radical clock experiments



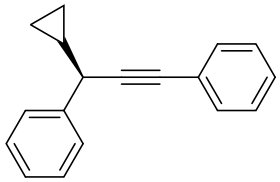
According to **General procedure 2** with 1,3-dioxo-1,3-dihydro-2*H*-benzo[*f*]isoindol-2-yl 2-cyclopropyl-2-phenylacetate **1c** (74.3 mg, 0.20 mmol, 1.0 equiv.) and ethynylbenzene **2a** (30.6 mg, 0.3 mmol, 1.5 equiv.) for 3 d, the reaction mixture was purified by column chromatography on silica gel (petroleum ether).

(*E*)-Hex-1-en-5-yne-1,6-diyldibenzene (69)



69 was isolated as a colorless oil (4.6 mg, 10% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.41-7.36 (m, 4H), 7.32-7.26 (m, 5H), 7.21 (t, J = 7.2 Hz, 1H), 6.50 (d, J = 16.0 Hz, 1H), 6.36-6.29 (m, 1H), 2.60-2.52 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 137.5, 131.6, 131.1, 128.8, 128.5, 128.2, 127.6, 127.1, 126.1, 123.9, 89.4, 81.2, 32.3, 19.8; HRMS (ESI): *m/z* calcd for $C_{18}H_{17}$ $[M+H]^+$: 233.1325, found: 233.1324.

(*R*)-(3-Cyclopropylprop-1-yne-1,3-diyl)dibenzene (70)



70 was isolated as a colorless oil (24.6 mg, 53% yield, 87% *ee*). HPLC analysis: Chiralcel OJH (hexane/*i*-PrOH = 99.5/0.5, flow rate 0.7 mL/min, λ = 254 nm), t_R (minor) = 22.39 min, t_R (major) = 26.84 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.51-7.49 (m, 2H), 7.46-7.43 (m, 2H), 7.38-7.35 (m, 2H), 7.31-7.27 (m, 4H), 3.70 (d, J = 6.4 Hz, 1H), 1.28-1.20 (m, 1H), 0.63-0.52 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 142.0, 131.7, 128.4, 128.2, 127.8, 127.5, 126.8, 123.6, 89.6, 83.2, 41.3, 17.5, 4.1, 3.1. The NMR spectra were in accord with that reported in literature.[3]

10.3 Stern-Volmer luminescence quenching experiments

Emission intensities were recorded using FLS-980 Spectrofluorometer equipped with MCP-PMT detector from Edinburgh Instruments for all experiments. The solution was prepared by adding Cu(I)-phenylacetylide, an appropriate amount of quencher, and $PhCF_3$ to a 5.0 mL of quartz cuvette. The concentration of Cu(I)-phenylacetylide was 5.0×10^{-3} M. The cuvette was sealed with a septum. After degassing with nitrogen for 30 min, the solution was irradiated at 466 nm, and emission was detected at 582 nm.

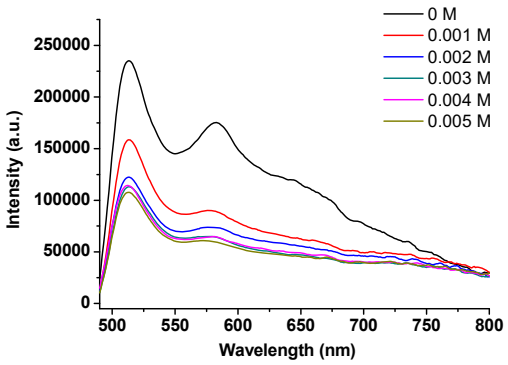


Figure S1a. Cu(I)-phenylacetylide emission quenching by **1b**.

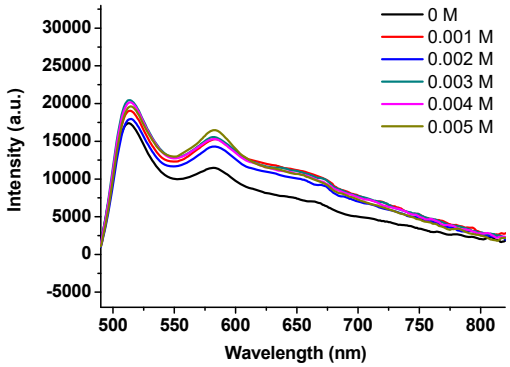


Figure S1b. Cu(I)-phenylacetylide emission quenching by ethynylbenzene (**2a**).

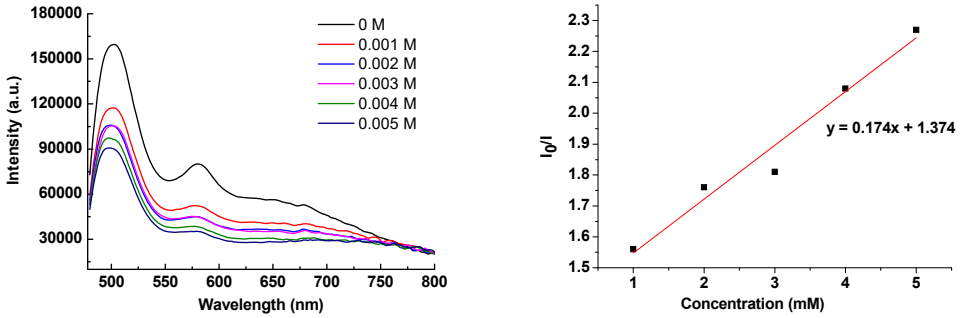


Figure S1c. Cu(I)-phenylacetylide emission quenching by **1aa**.

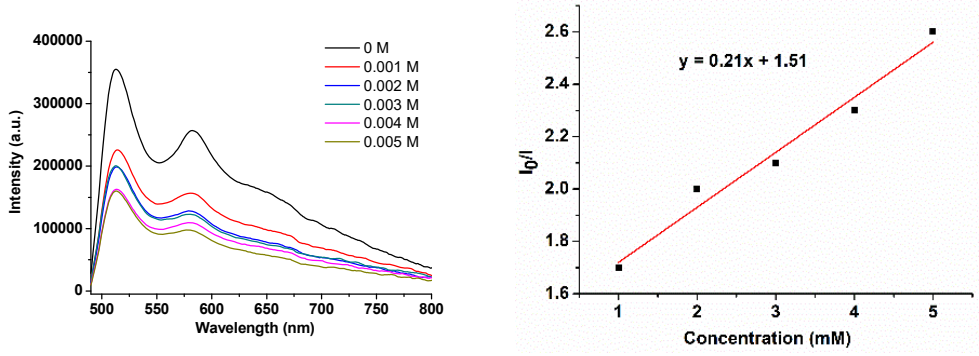


Figure S1d. Cu(I)-phenylacetylide emission quenching by **1ab**.

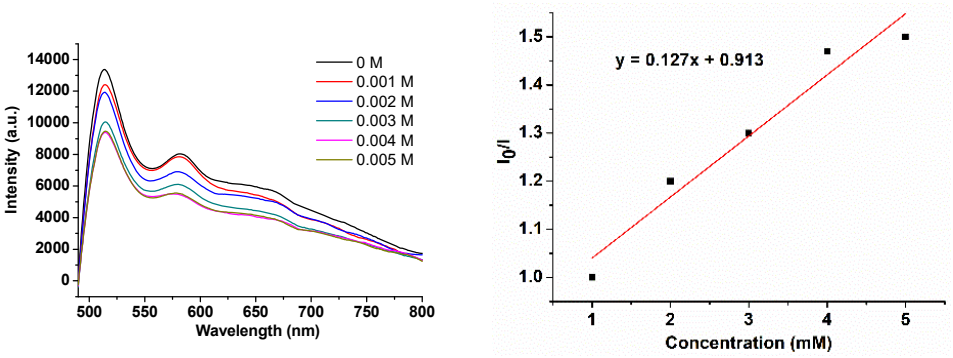


Figure S1e. Cu(I)-phenylacetylide emission quenching by **1ac**.

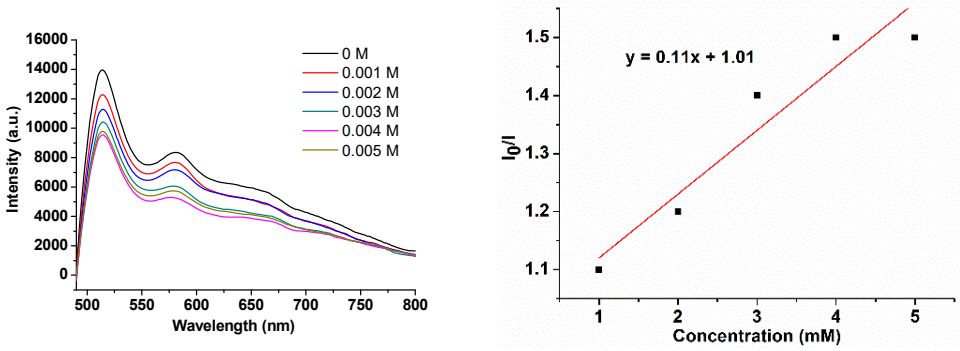


Figure S1f. Cu(I)-phenylacetylide emission quenching by **1ad**.

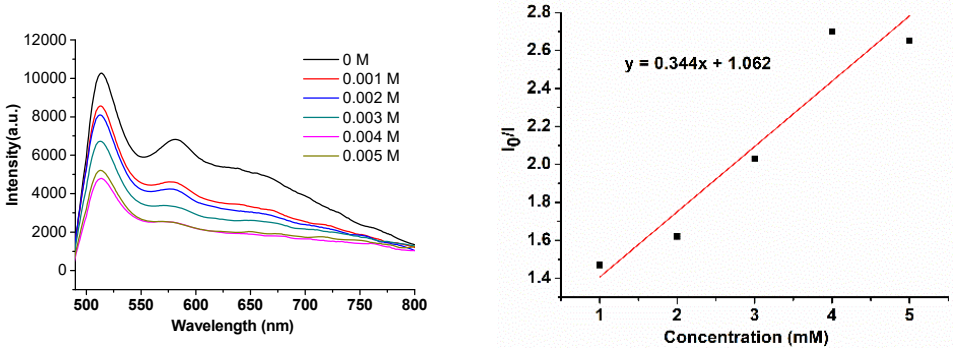


Figure S1g. Cu(I)-phenylacetylide emission quenching by **1ae**.

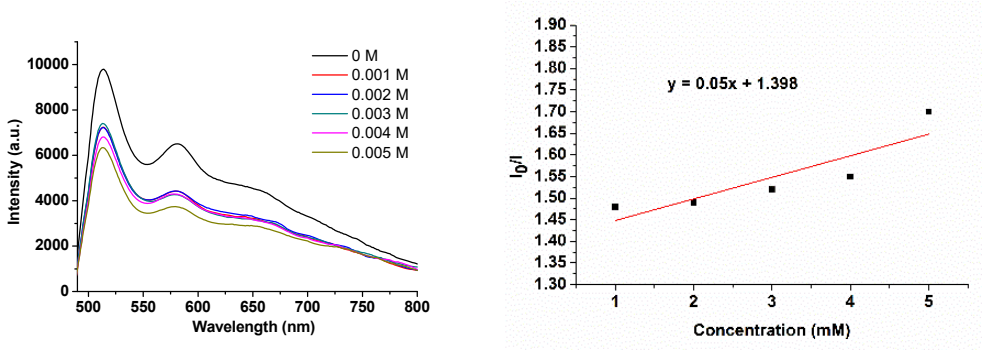


Figure S1h. Cu(I)-phenylacetylide emission quenching by **1af**.

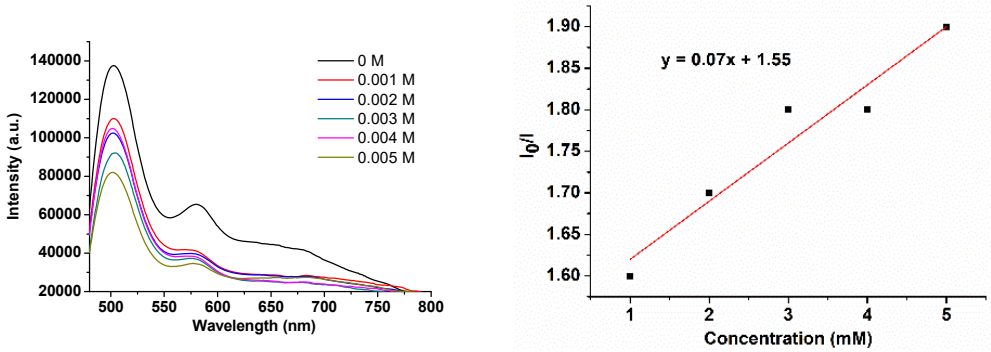


Figure S1i. Cu(I)-phenylacetylide emission quenching by **1ag**.

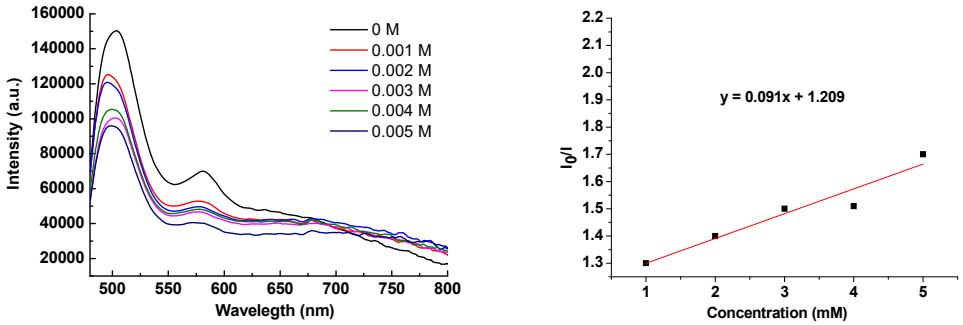


Figure S1j. Cu(I)-phenylacetylide emission quenching by **1ah**.

10.4 Cyclic voltammetry experiments

Cyclic voltammetry experiment was performed using a CH Instruments Electrochemical Workstation model PalmSens4. The electrochemical cell was equipped with a glassy carbon working electrode, a Pt mesh counter electrode, and a $Ag/AgNO_3$ (10 mM $AgNO_3$ in MeCN) reference electrode. A solution of **1b** in MeCN (0.001 M) was tested with 0.1 M Bu_4NPF_6 as the supporting electrolyte and ferrocene was using as an internal standard. Scan rate = 0.1 V/s, 2 sweep segments, a sample

interval of 0.001 V.

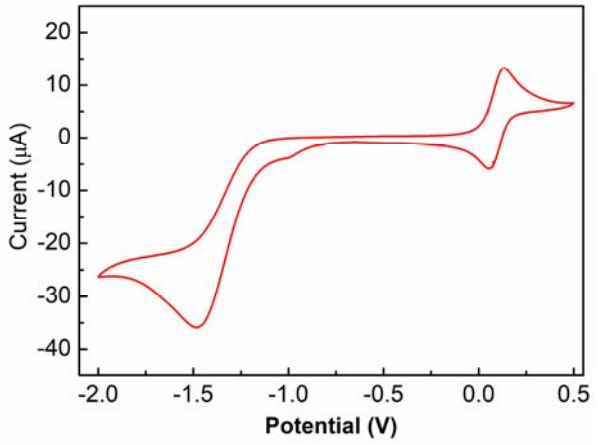


Figure S1. Cyclic voltammogram of **1b** in MeCN. E_p = −1.567 V vs. Fc/Fc^+. E_p (vs. SCE) = −1.567 V + 0.393 V = −1.174 V.

11. References

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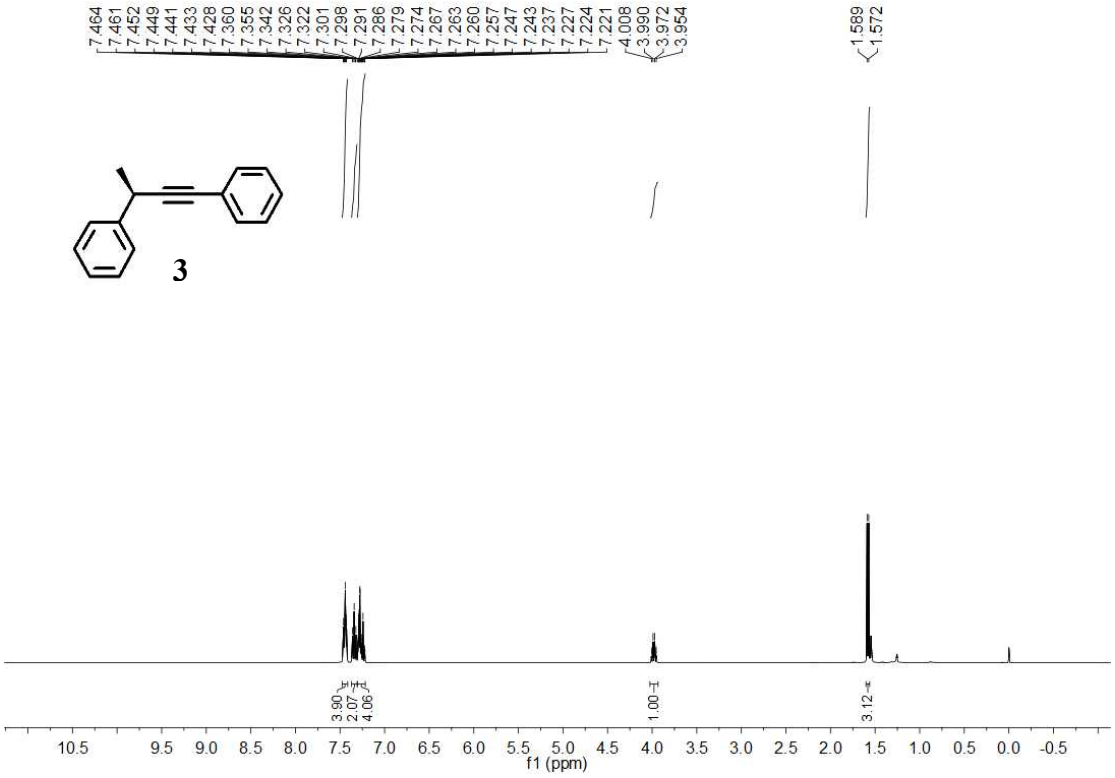
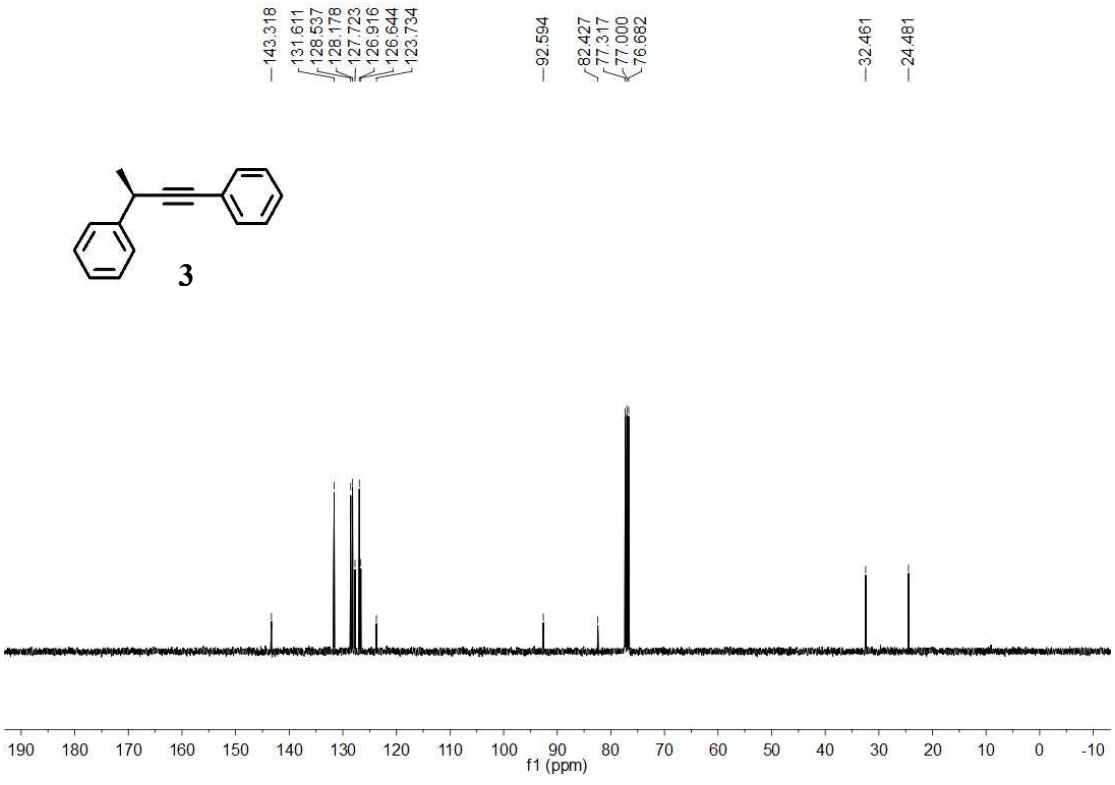
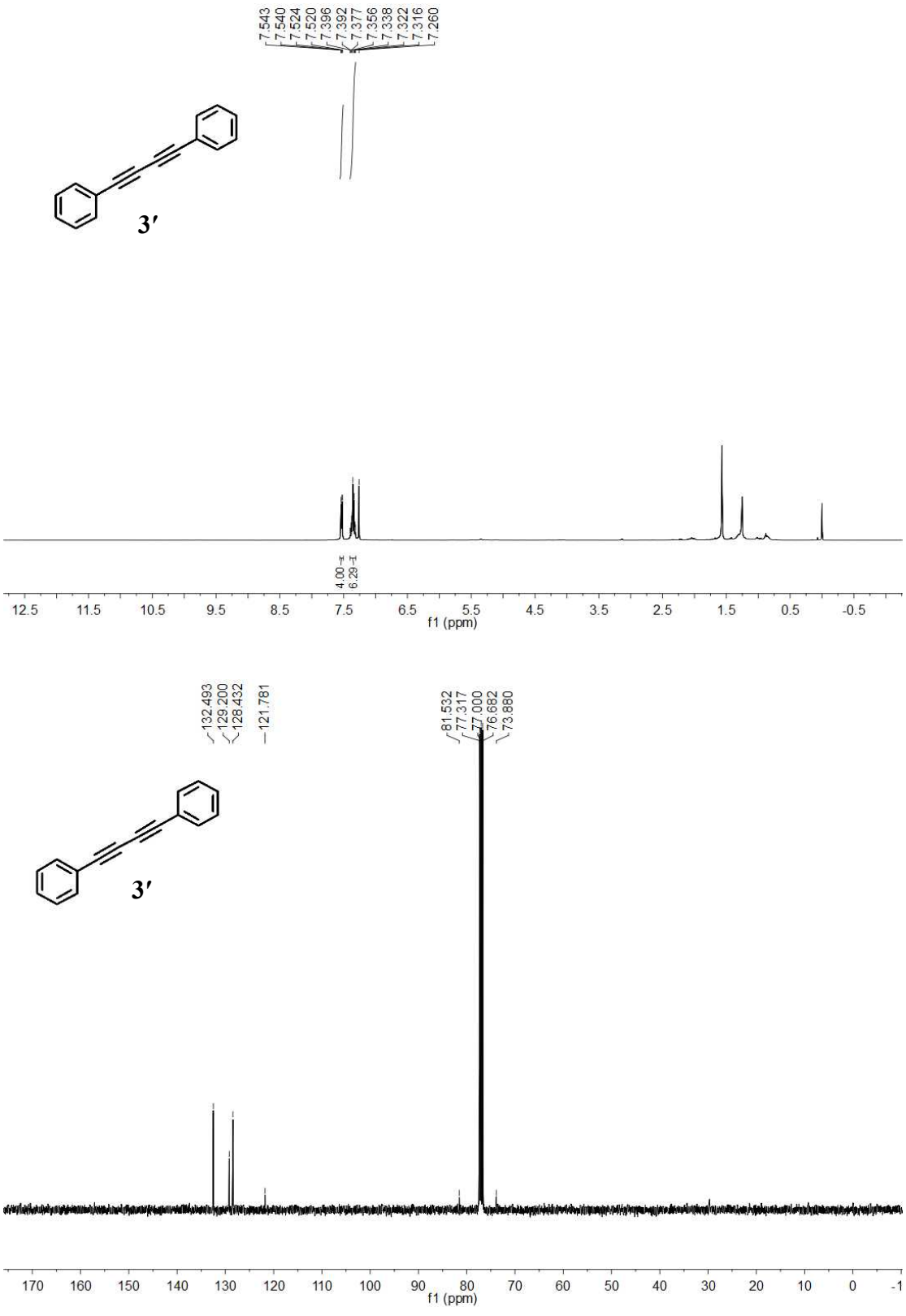
12. NMR Spectra



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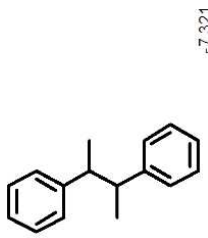
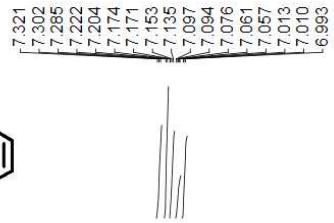
7.524
7.520
7.396
7.392
7.377
7.356
7.338
7.322
7.316
7.260
3′
4.00
6.29
12.5
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)
132.493
129.200
128.432
121.781
81.532
77.317
77.000
76.682
73.880
3′
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)



3″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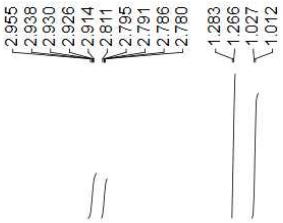
7.302
7.285
7.222
7.204
7.174
7.171
7.153
7.135
7.097
7.094
7.076
7.061
7.057
7.013
7.010
6.993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2.930
2.926
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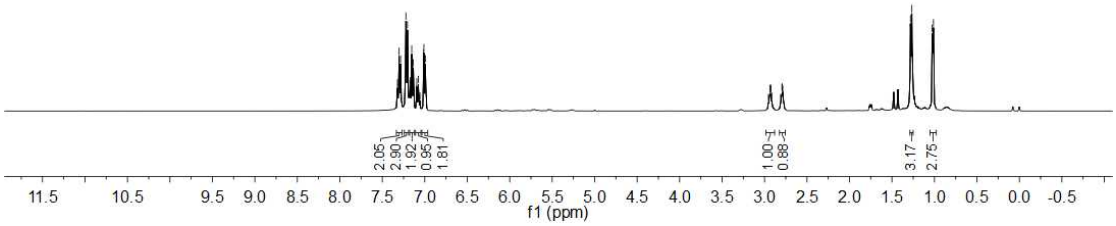
2.791
2.786
2.780
1.283
1.266
1.027
1.012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2.90
1.92
0.95
1.81
1.00
0.88
3.17
2.75
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


7.460
7.449
7.440
7.436
7.429
7.427
7.408
7.352
7.348
7.334
7.315
7.304
7.301
7.294
7.289
7.281
7.276
7.269
7.265
7.261
7.258
7.255
7.242
7.224
7.221
3.805
3.787
3.770
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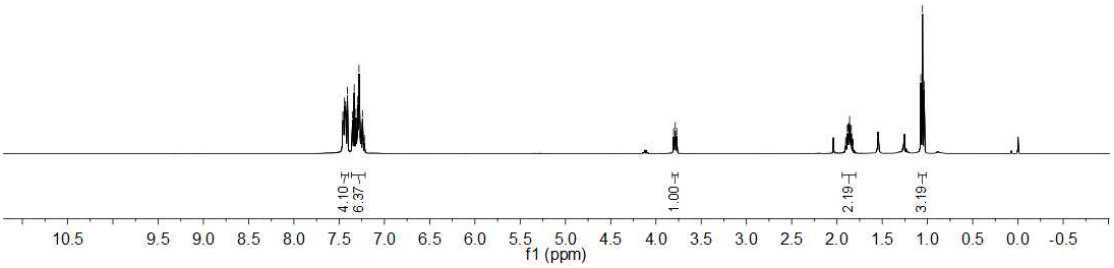
1.055
1.037

4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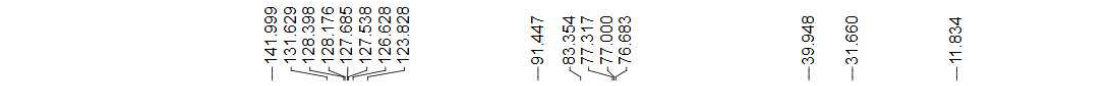
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128.398
128.176
127.685
127.538
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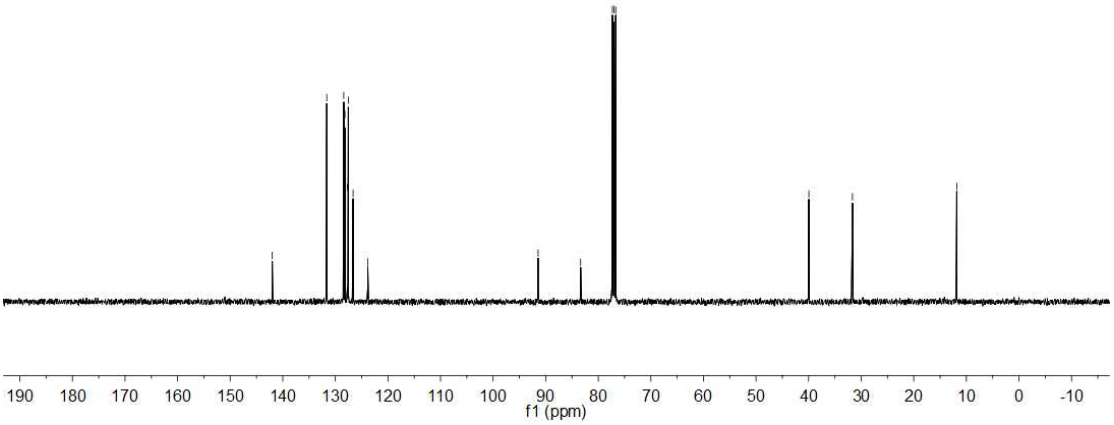
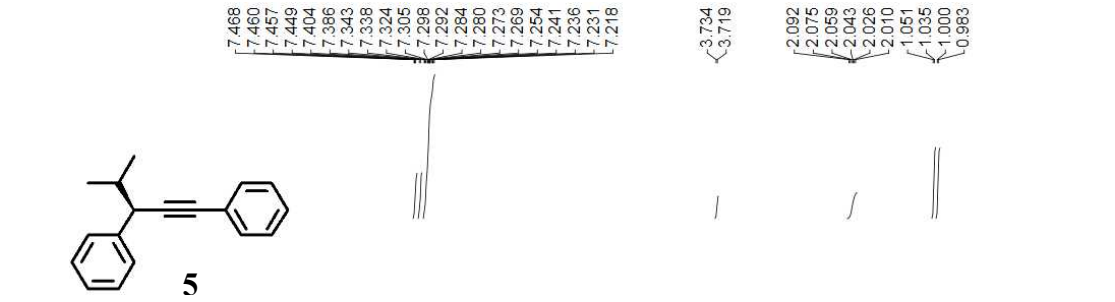
77.000
76.683
39.948
31.660
11.834

4


f1 (ppm)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7.449
7.404
7.386
7.343
7.338
7.324
7.305
7.298
7.292
7.284
7.280
7.273
7.269
7.254
7.241
7.236
7.231
7.218
3.734
3.719
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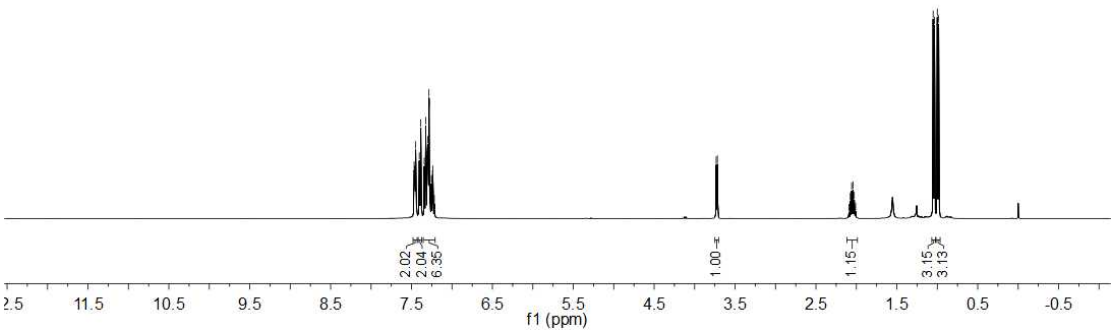
2.075
2.059
2.043
2.026
2.010
1.051
1.035
1.000
0.983

5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1.15
3.15
3.13
f1 (ppm)


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76.683
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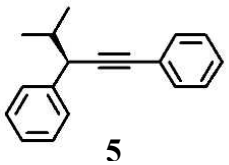
18.706



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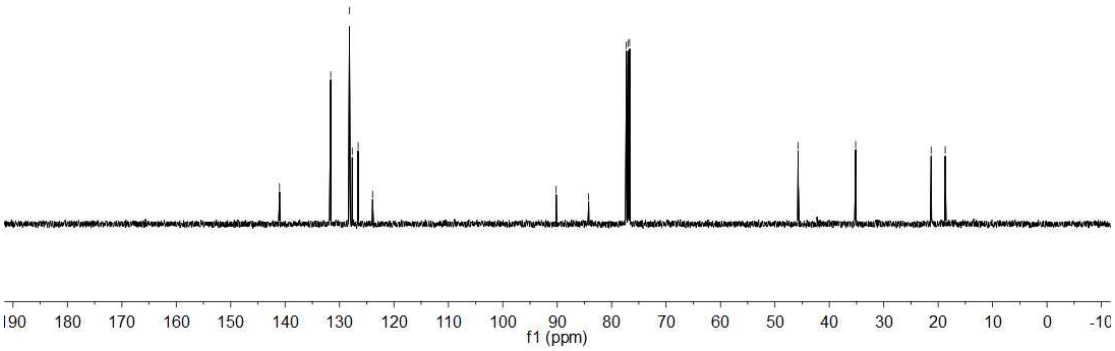
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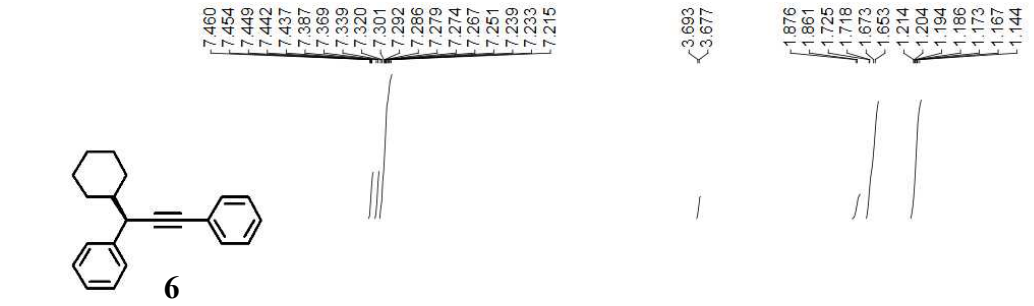
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7.279
7.274
7.267
7.251
7.239
7.233
7.215
3.693
3.677
1.876
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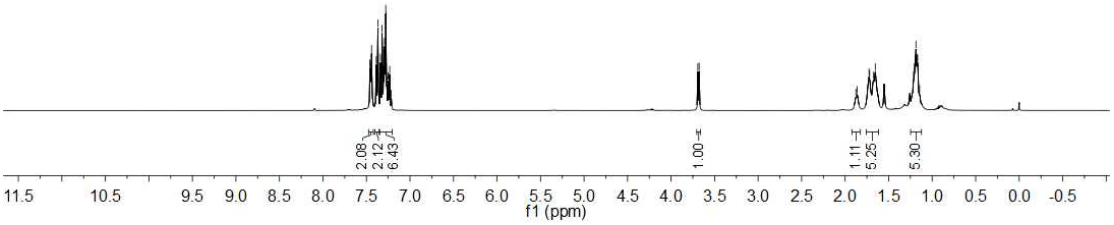
1.167
1.144

6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6.43
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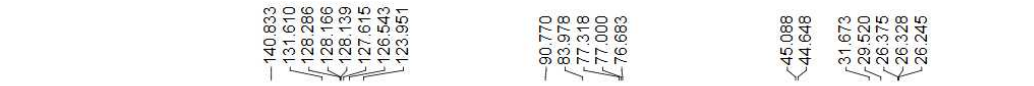
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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127.615
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77.000
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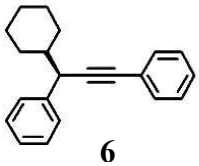
31.673
29.520
26.375
26.328
26.245



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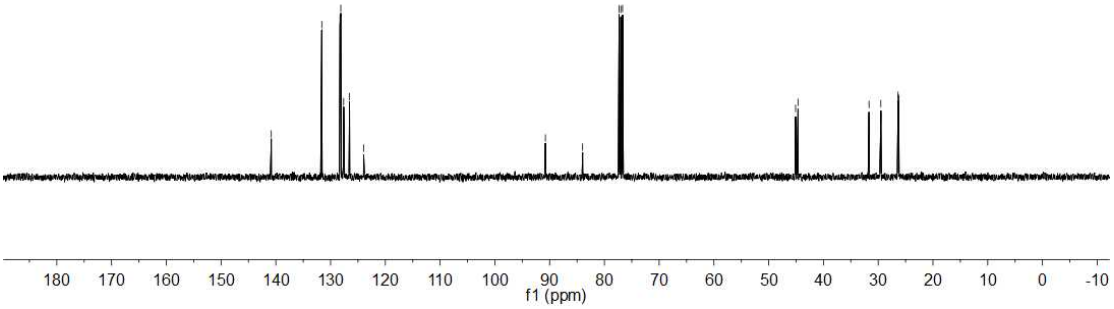
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170
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100
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80
70
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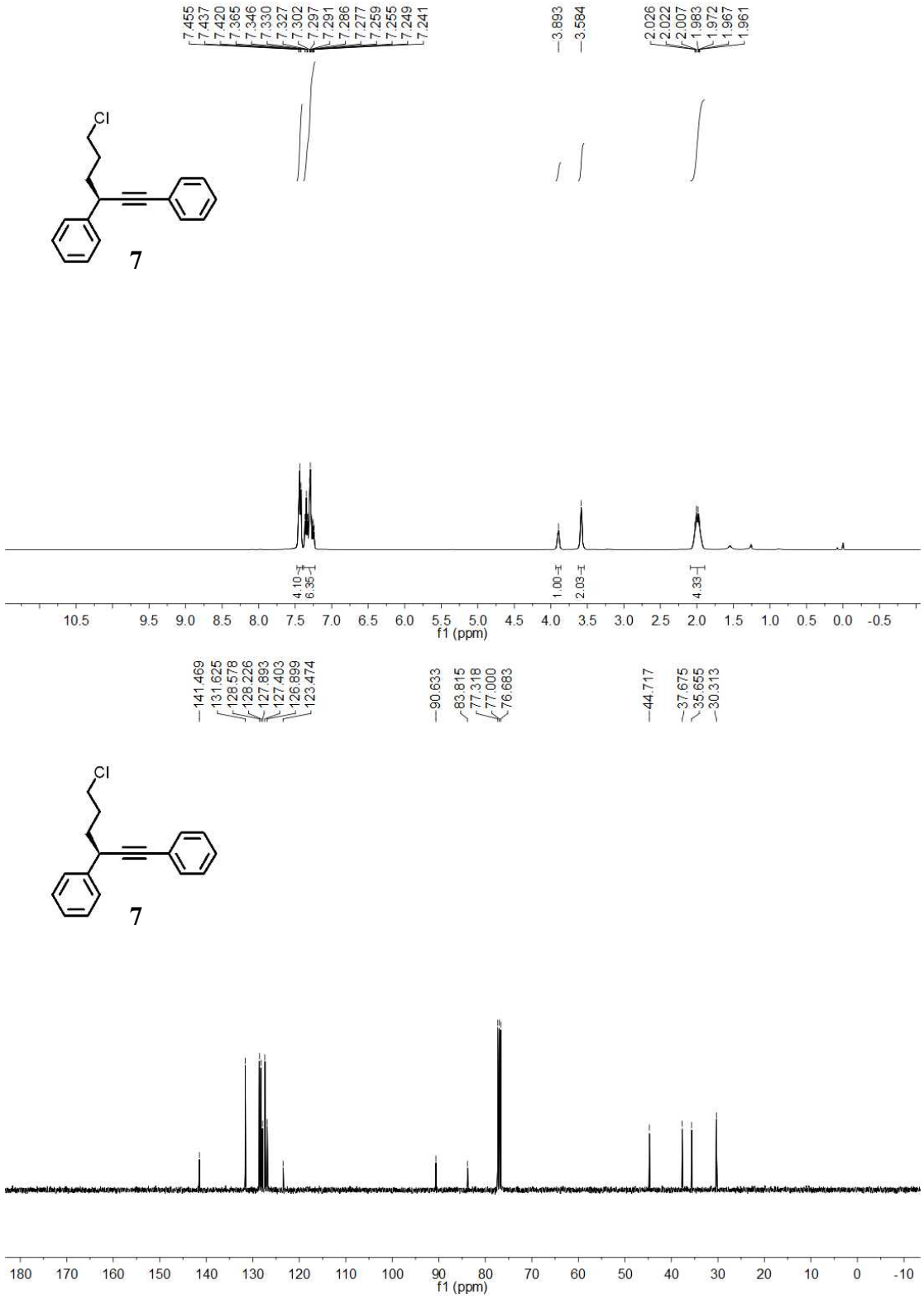
50
40
30
20
10
0
-10
f1 (ppm)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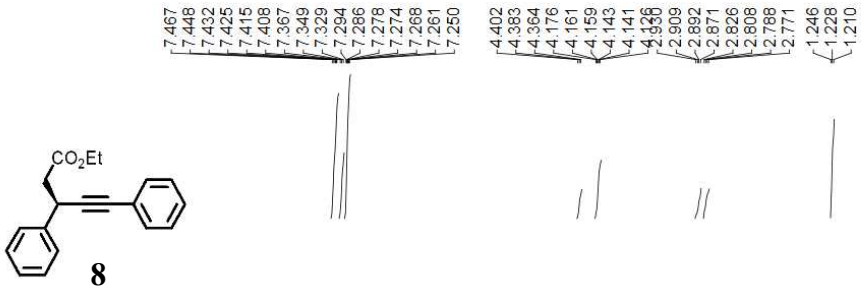
7.259
7.255
7.249
7.241
3.893
3.584
2.026
2.022
2.007
1.983
1.972
1.967
1.961
Cl
7
4.10
6.35
1.00
2.03
4.33
10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)
141.469
131.625
128.578
128.226
127.893
127.403
126.899
123.474
90.633
83.815
77.318
77.000
76.683
44.717
37.675
35.655
30.313
Cl
7
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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7.408
7.367
7.349
7.329
7.294
7.286
7.278
7.274
7.268
7.261
7.250
4.402
4.383
4.364
4.176
4.161
4.159
4.143
4.141
4.126
2.930
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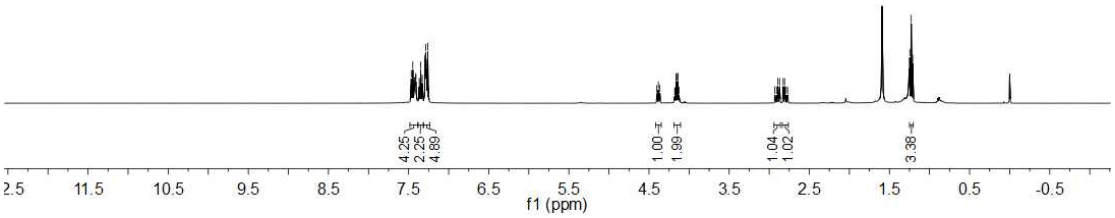
1.246
1.228
1.210

CO2Et

8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11.5
10.5
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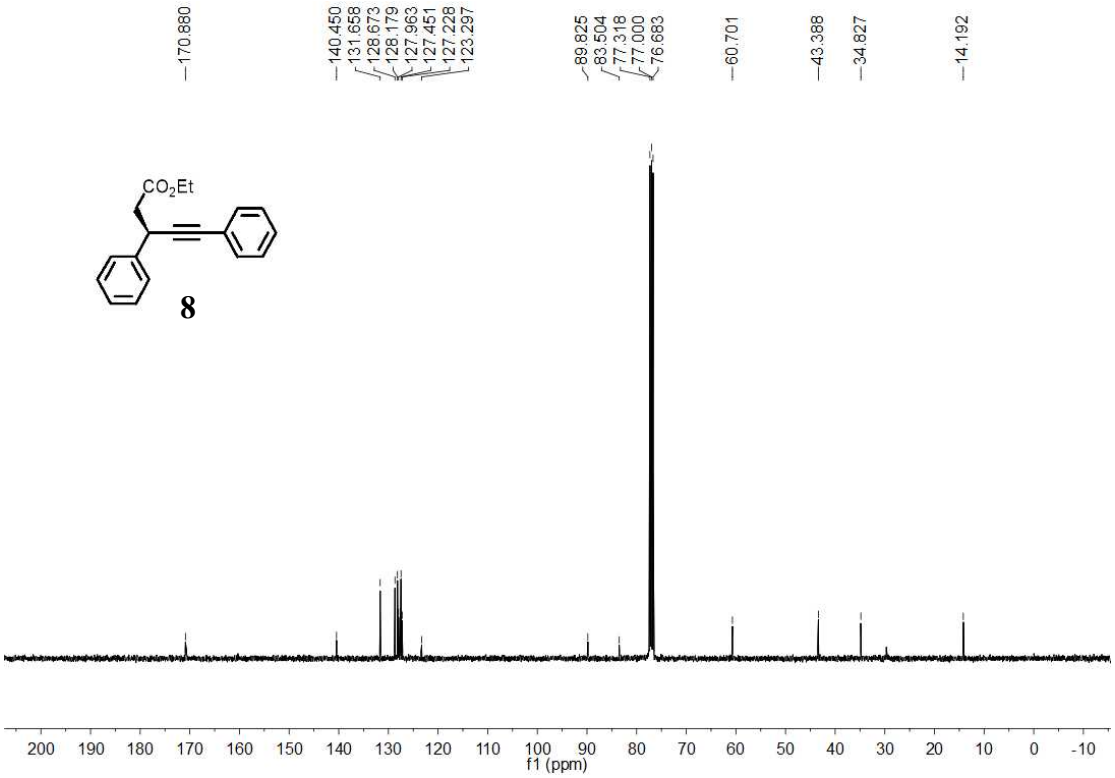
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)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127.228
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83.504
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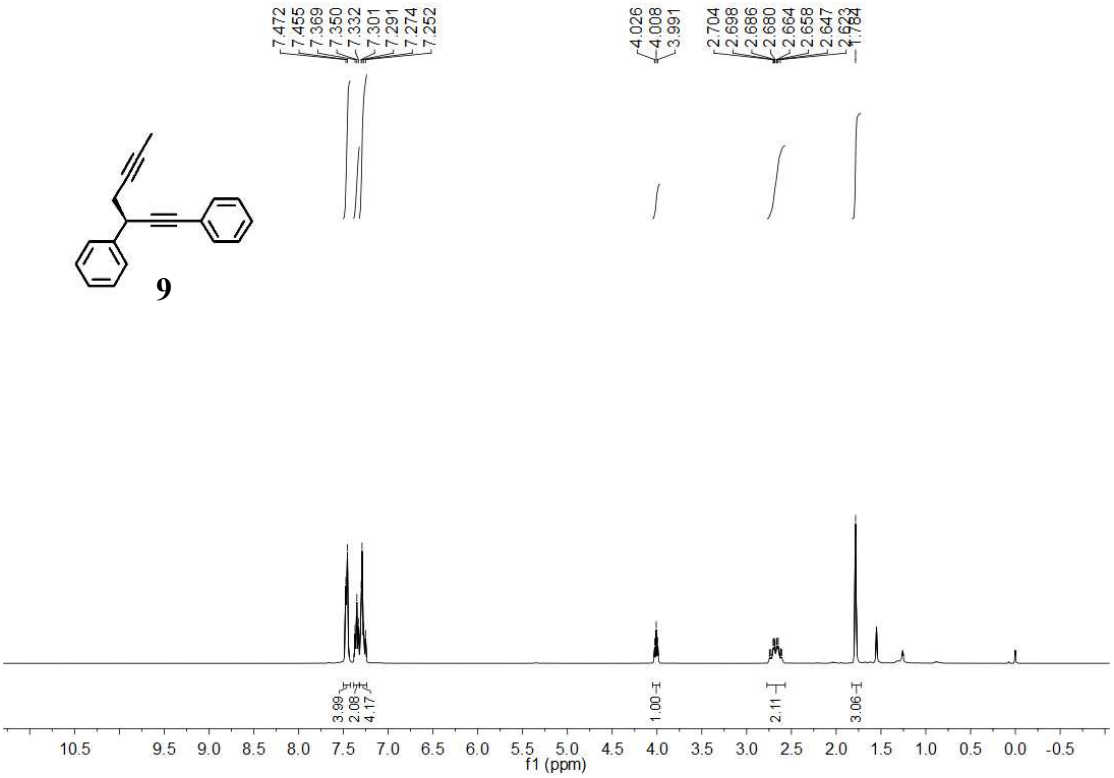
76.683
60.701
43.388
34.827
14.192
CO2Et
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

8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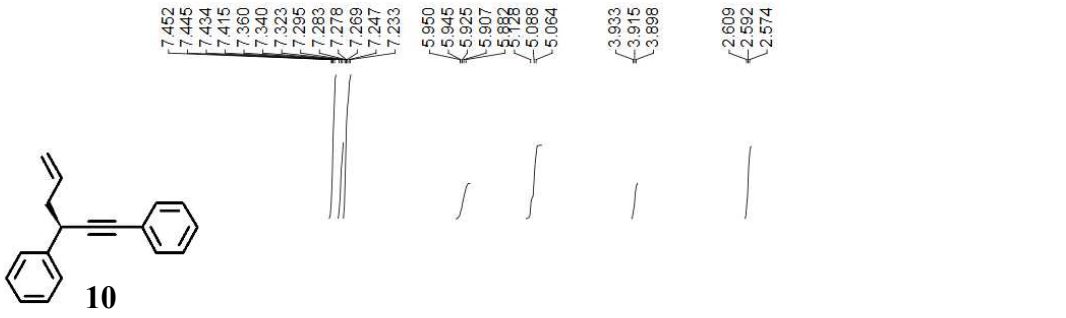
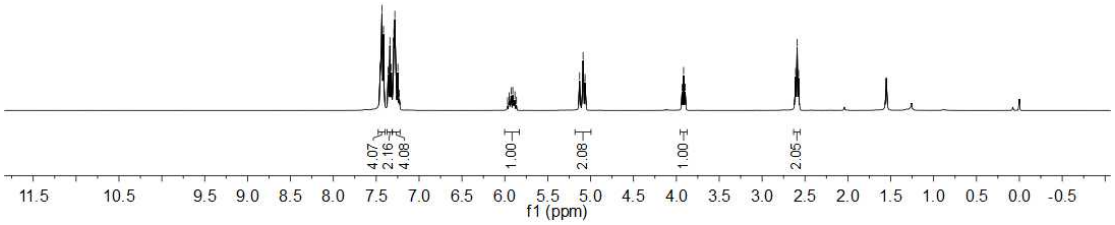
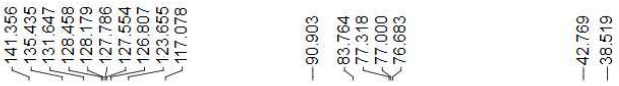
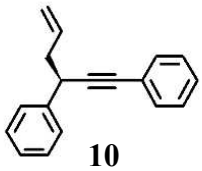
2.698
2.686
2.680
2.664
2.658
2.647
1.784
9
3.99
2.08
4.17
1.00
2.11
3.06
f1 (ppm)
140.685
131.709
128.404
128.167
127.864
127.612
127.110
123.540
90.471
83.615
77.931
77.317
77.000
76.682
76.296
38.394
28.821
3.536
9
f1 (ppm)


7.452
7.445
7.434
7.415
7.360
7.340
7.323
7.295
7.283
7.278
7.269
7.247
7.233
5.950
5.945
5.925
5.907
5.128
5.088
5.064
3.933
3.915
3.898
2.609
2.592
2.574

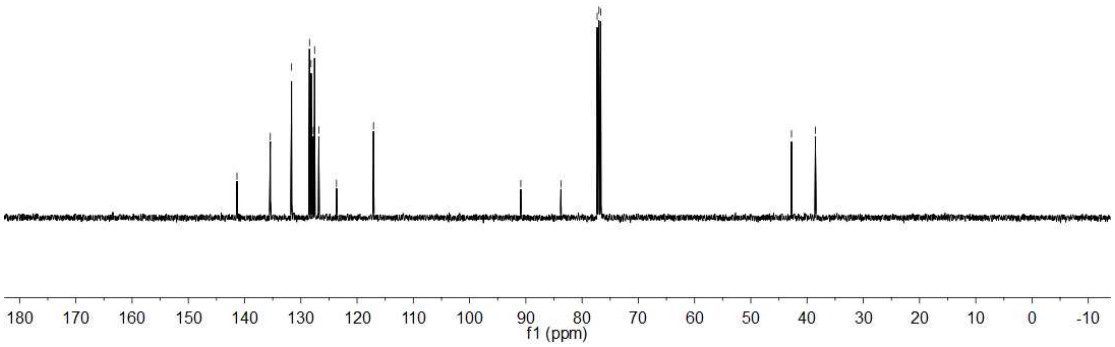
10

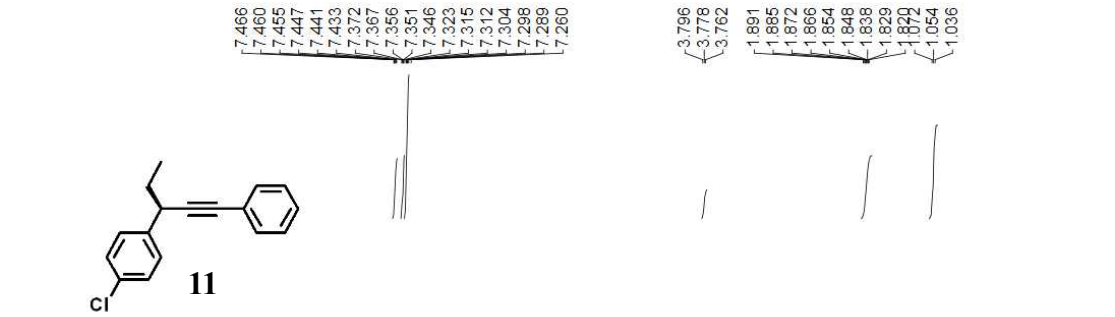

4.07
2.16
4.08
1.00
2.08
1.00
2.05
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


141.356
135.435
131.647
128.458
128.179
127.786
127.554
126.807
123.655
117.078
90.903
83.764
77.318
77.000
76.683
42.769
38.519

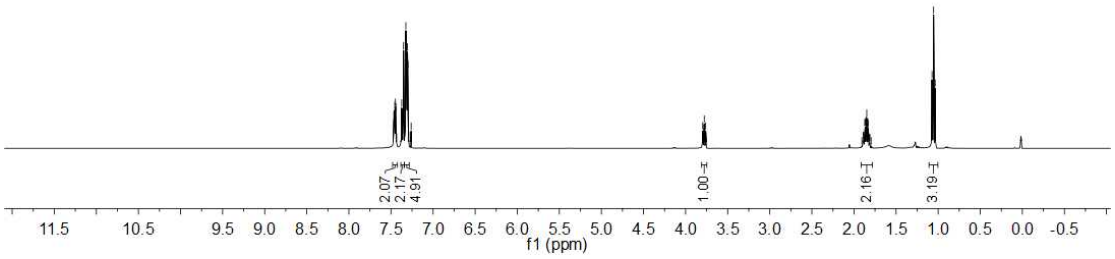


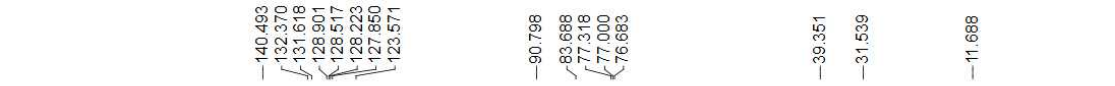
10

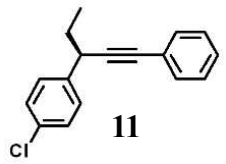

180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.466
7.460
7.455
7.447
7.441
7.433
7.372
7.367
7.356
7.351
7.346
7.323
7.315
7.312
7.304
7.298
7.289
7.260
3.796
3.778
3.762
1.891
1.885
1.872
1.866
1.854
1.848
1.838
1.829
1.820
1.072
1.054
1.036
Cl

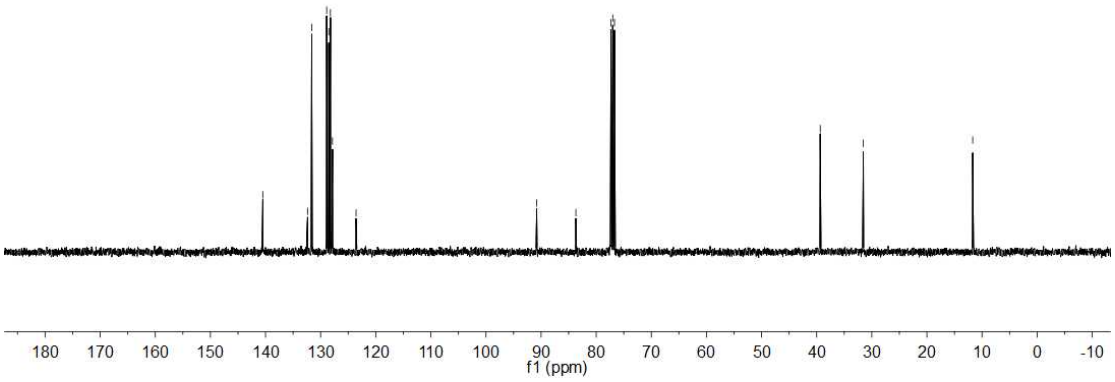
11

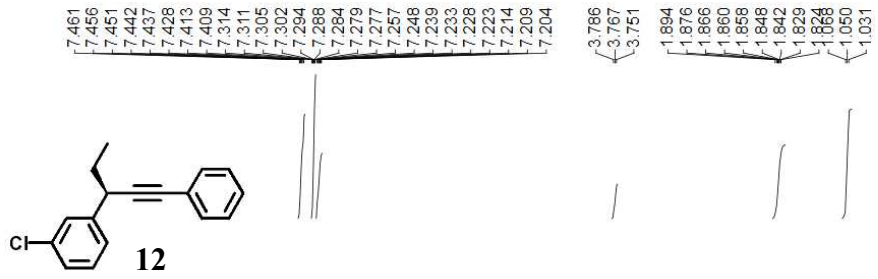

2.07
2.17
4.91
1.00
2.16
3.19
11.5 10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


140.493
132.370
131.618
128.901
128.517
128.223
127.850
123.571
90.798
83.688
77.318
77.000
76.683
39.351
31.539
11.688

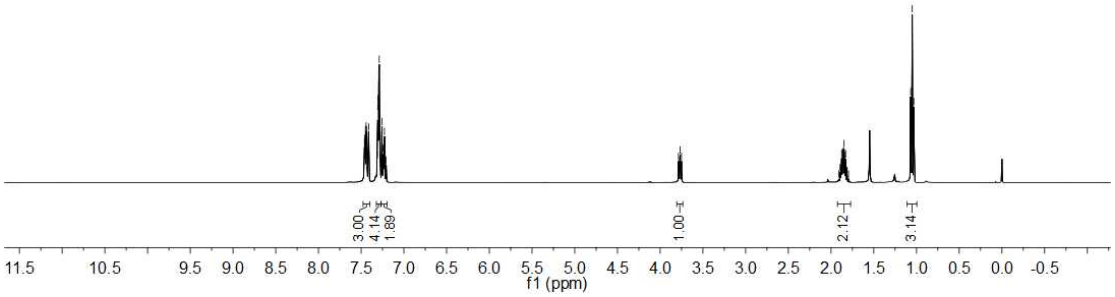

Cl

11

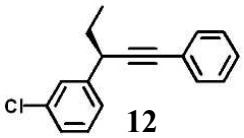

180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.461
7.456
7.451
7.442
7.437
7.428
7.413
7.409
7.314
7.311
7.305
7.302
7.294
7.288
7.284
7.279
7.277
7.257
7.248
7.239
7.233
7.228
7.223
7.214
7.209
7.204
3.786
3.767
3.751
1.894
1.876
1.866
1.860
1.858
1.848
1.842
1.829
1.824
1.050
1.031
Cl

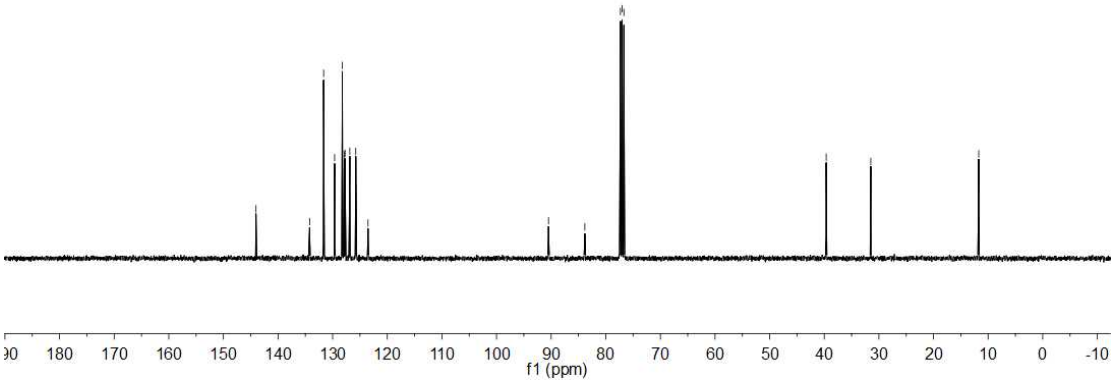
12

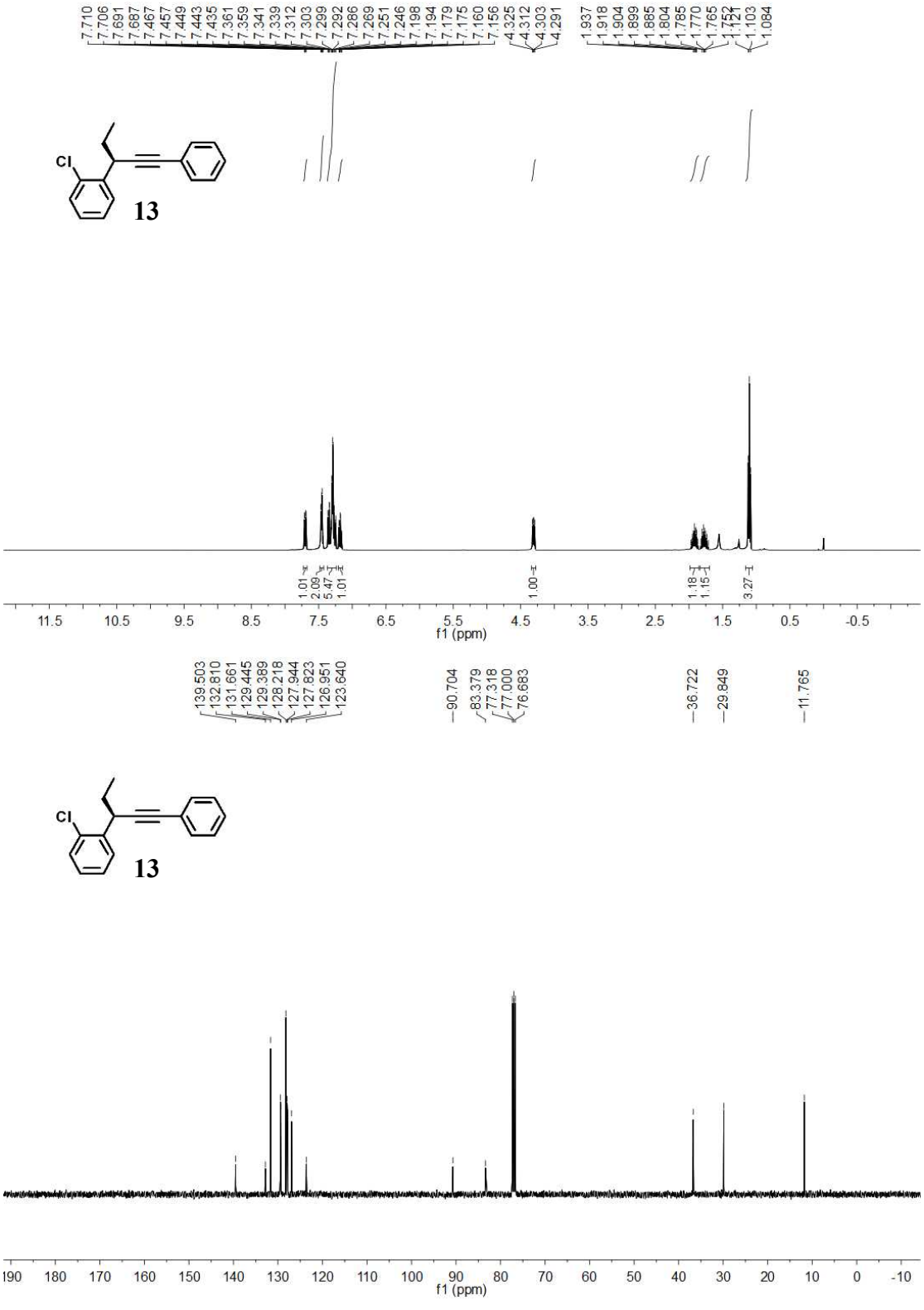

3.00
4.14
1.89
1.00
2.12
3.14
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

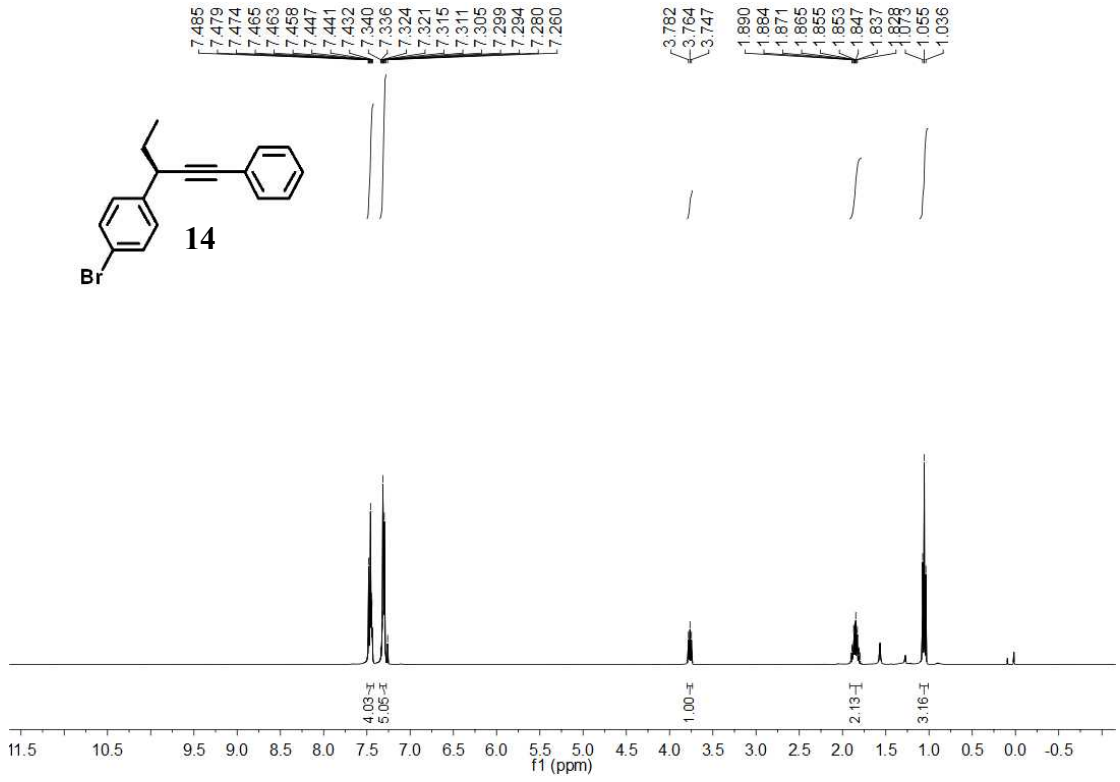

144.037
134.226
131.653
129.643
128.228
127.883
127.730
126.865
125.773
123.529
90.479
83.833
77.317
77.000
76.683
39.645
31.485
11.719

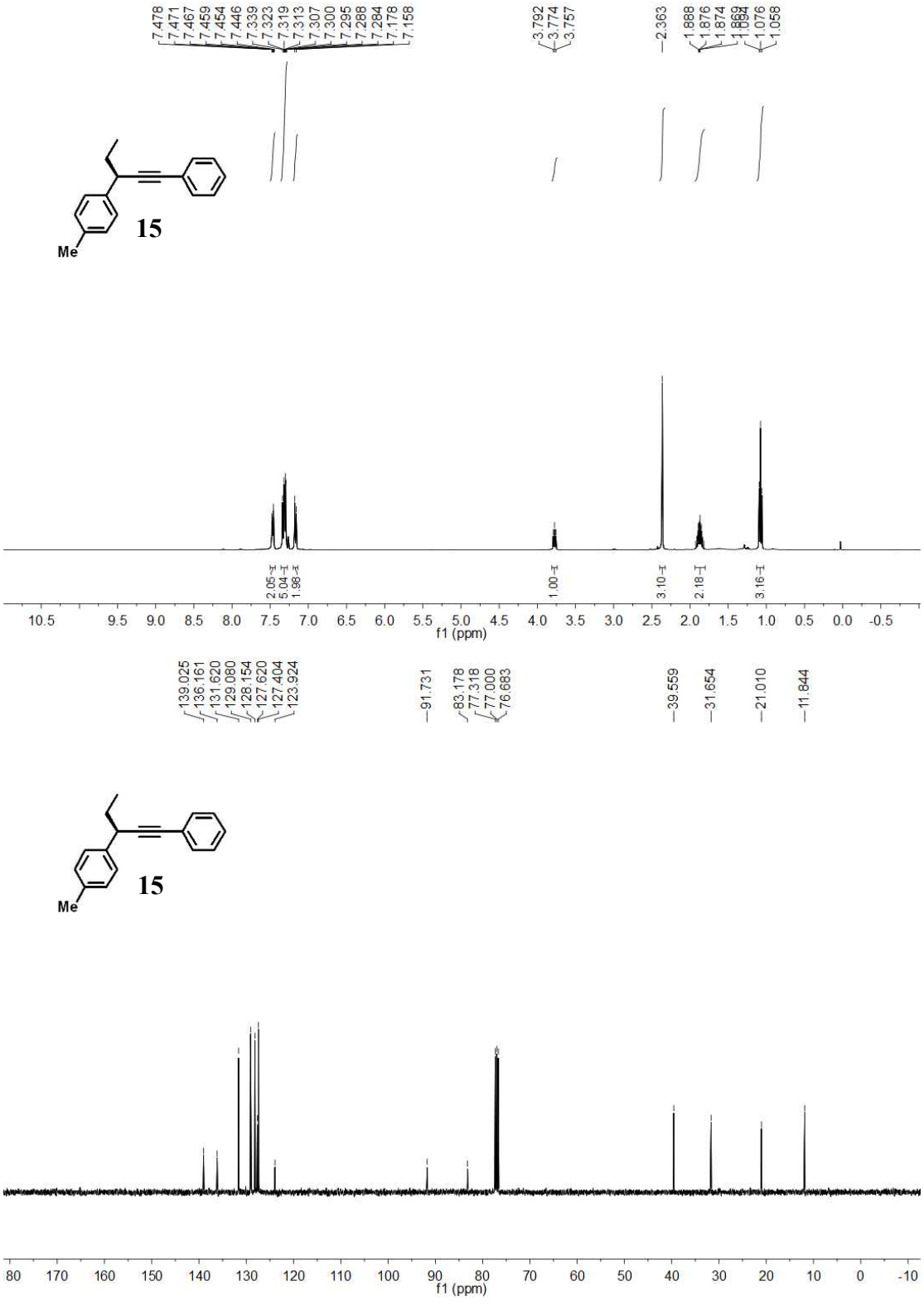

Cl

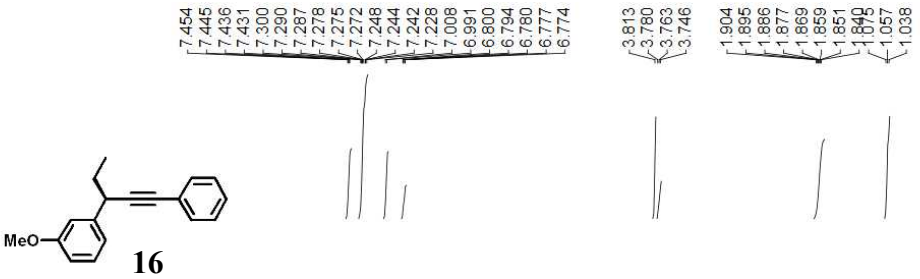
12


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

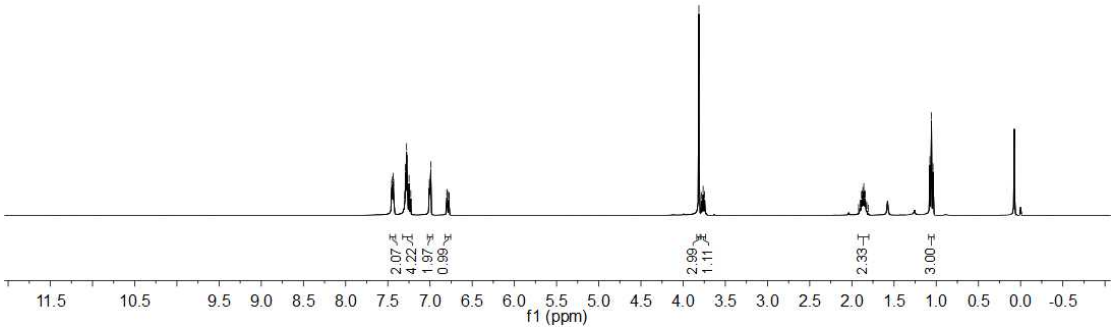

7.710
7.706
7.691
7.687
7.467
7.457
7.449
7.443
7.435
7.361
7.359
7.341
7.339
7.312
7.303
7.299
7.292
7.286
7.269
7.251
7.246
7.198
7.194
7.179
7.175
7.160
7.156
4.325
4.312
4.303
4.291
1.937
1.918
1.904
1.899
1.885
1.804
1.785
1.770
1.765
1.752
1.121
1.103
1.084
Cl
13
1.01
2.09
5.47
1.01
1.00
1.18
1.15
3.27
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)
139.503
132.810
131.661
129.445
129.389
128.218
127.944
127.823
126.951
123.640
90.704
83.379
77.318
77.000
76.683
36.722
29.849
11.765
Cl
13
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

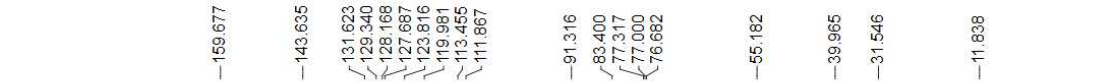

7.485
7.479
7.474
7.465
7.463
7.458
7.447
7.441
7.432
7.340
7.336
7.324
7.321
7.315
7.311
7.305
7.299
7.294
7.280
7.260
3.782
3.764
3.747
1.890
1.884
1.871
1.865
1.855
1.853
1.847
1.837
1.073
1.055
1.036
14
Br
4.03
5.05
1.00
2.13
3.16
f1 (ppm)
141.020
131.615
131.470
129.297
128.221
127.855
123.547
120.424
90.698
83.708
77.317
77.000
76.682
39.415
31.482
11.687
14
Br
f1 (ppm)

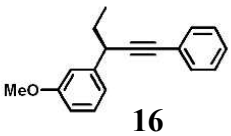

7.478
7.471
7.467
7.459
7.454
7.446
7.339
7.323
7.319
7.313
7.307
7.300
7.295
7.288
7.284
7.178
7.158
3.792
3.774
3.757
2.363
1.888
1.876
1.874
1.076
1.058
15
Me
2.05
5.04
1.98
1.00
3.10
2.18
3.16
f1 (ppm)
139.025
136.161
131.620
129.080
128.154
127.620
127.404
123.924
91.731
83.178
77.318
77.000
76.683
39.559
31.654
21.010
11.844
15
Me
f1 (ppm)


7.454
7.445
7.436
7.431
7.300
7.290
7.287
7.278
7.275
7.272
7.248
7.244
7.242
7.228
7.008
6.991
6.800
6.794
6.780
6.777
6.774
3.813
3.780
3.763
3.746
1.904
1.895
1.886
1.877
1.869
1.859
1.851
1.840
1.075
1.057
1.038
MeO

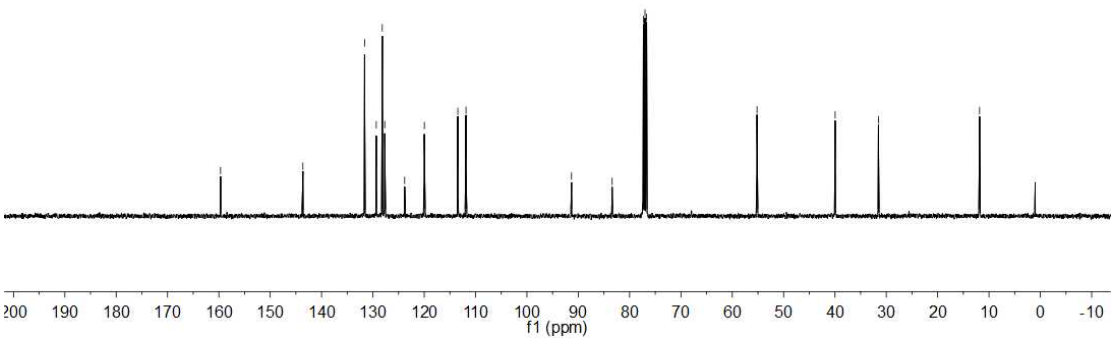
16

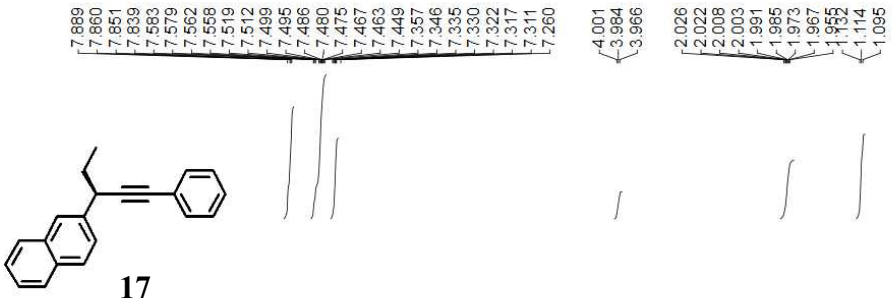

2.07
4.22
1.97
0.99
2.99
1.11
2.33
3.00
11.5 10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


159.677
143.635
131.623
129.340
128.168
127.687
123.816
119.981
113.455
111.867
91.316
83.400
77.317
77.000
76.682
55.182
39.965
31.546
11.838

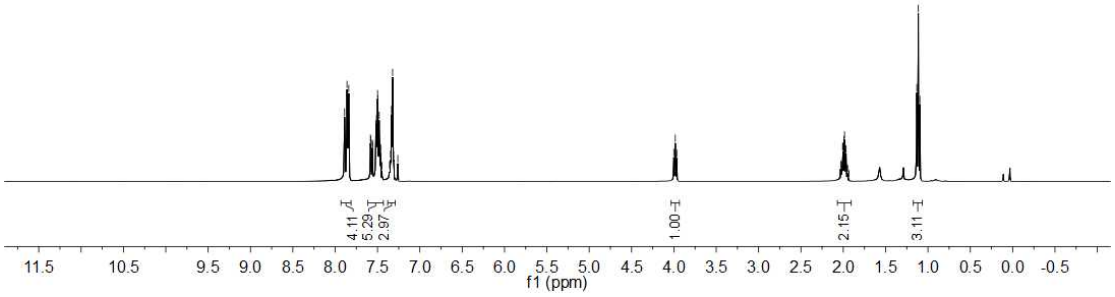

MeO

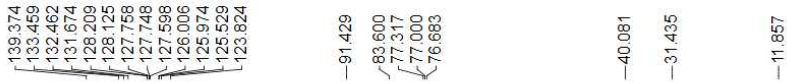
16

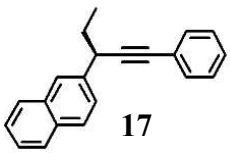

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.889
7.860
7.851
7.839
7.583
7.579
7.562
7.558
7.519
7.512
7.499
7.495
7.486
7.480
7.475
7.467
7.463
7.449
7.357
7.346
7.335
7.330
7.322
7.317
7.311
7.260
4.001
3.984
3.966
2.026
2.022
2.008
2.003
1.991
1.985
1.973
1.967
1.955
1.132
1.114
1.095

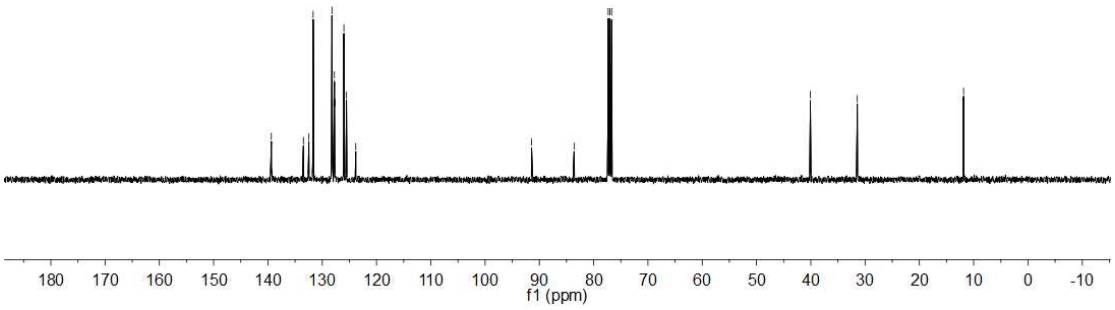
17

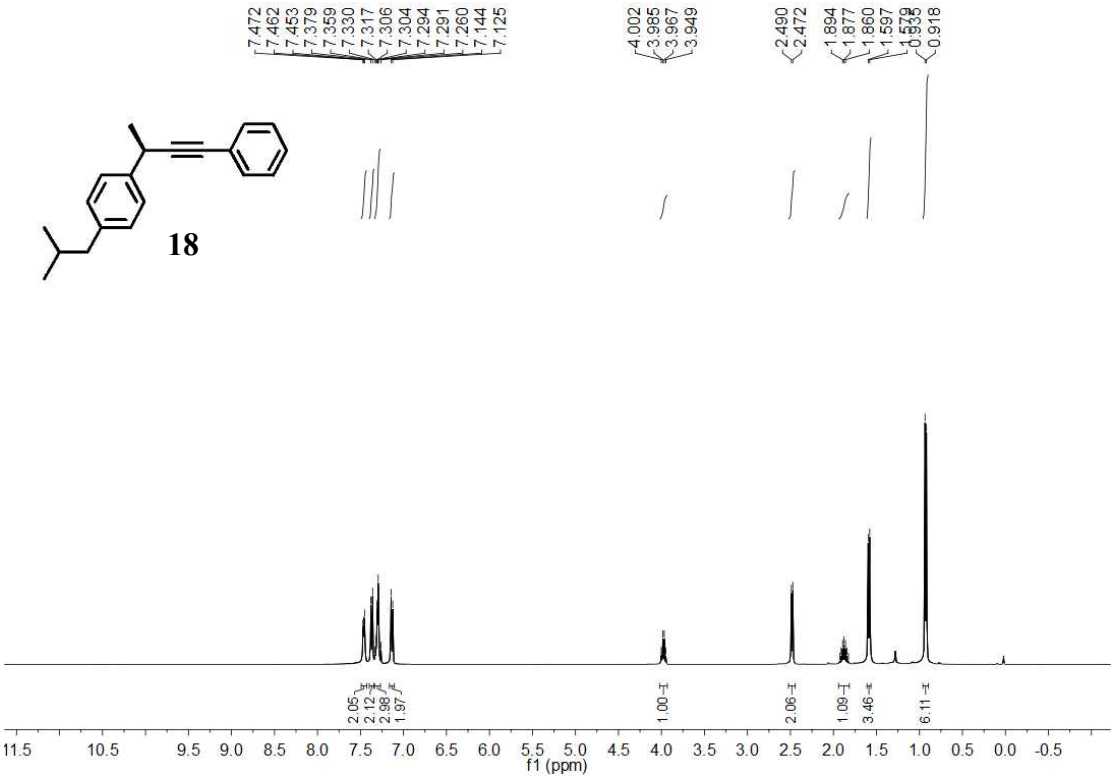

4.11
5.29
2.97
1.00
2.15
3.11
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

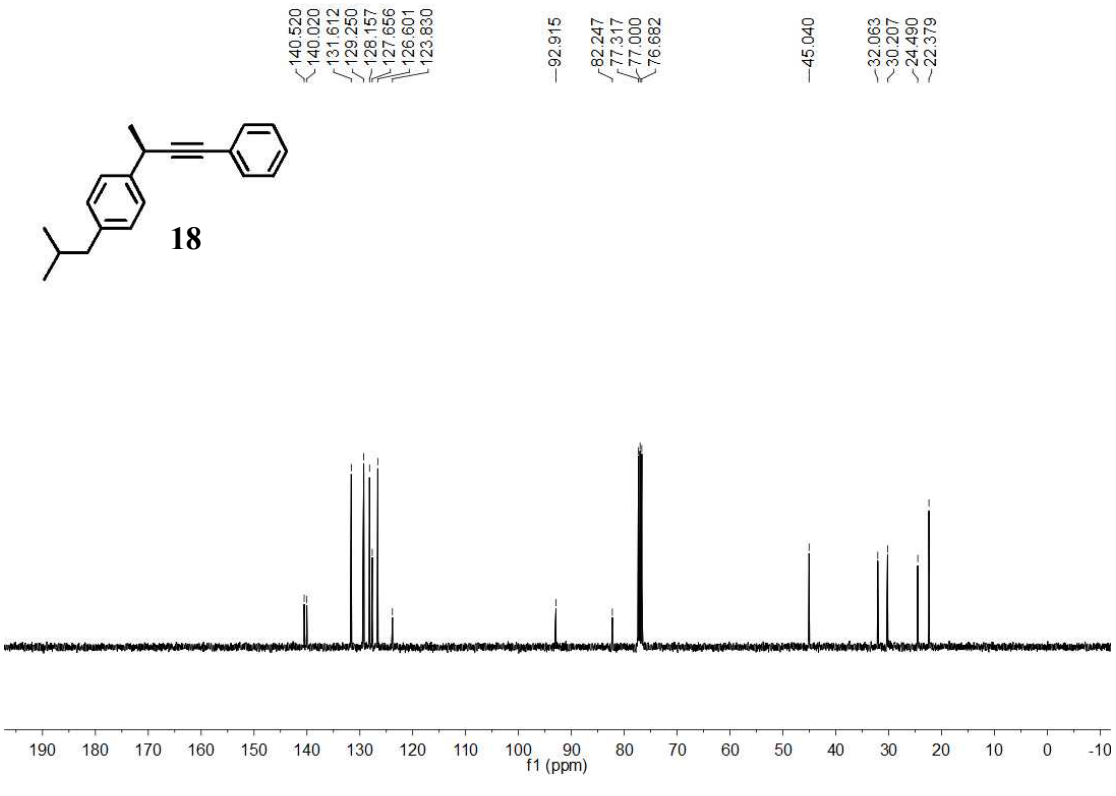

139.374
133.459
132.462
131.674
128.209
128.125
127.758
127.748
127.598
126.006
125.974
125.529
123.824
91.429
83.600
77.317
77.000
76.683
40.081
31.435
11.857

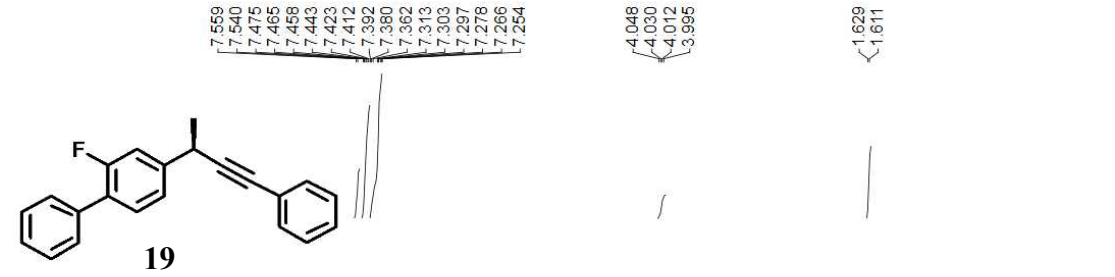


17

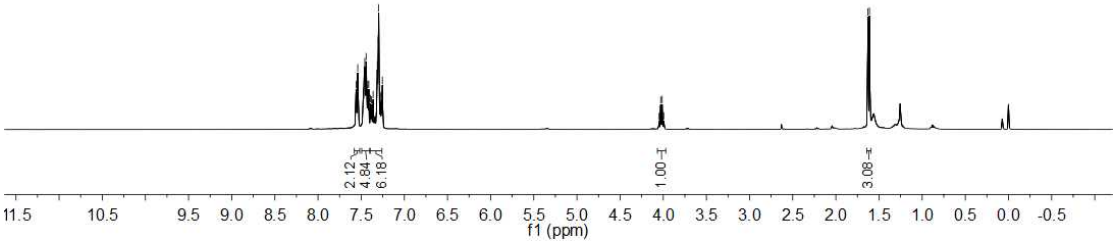

180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

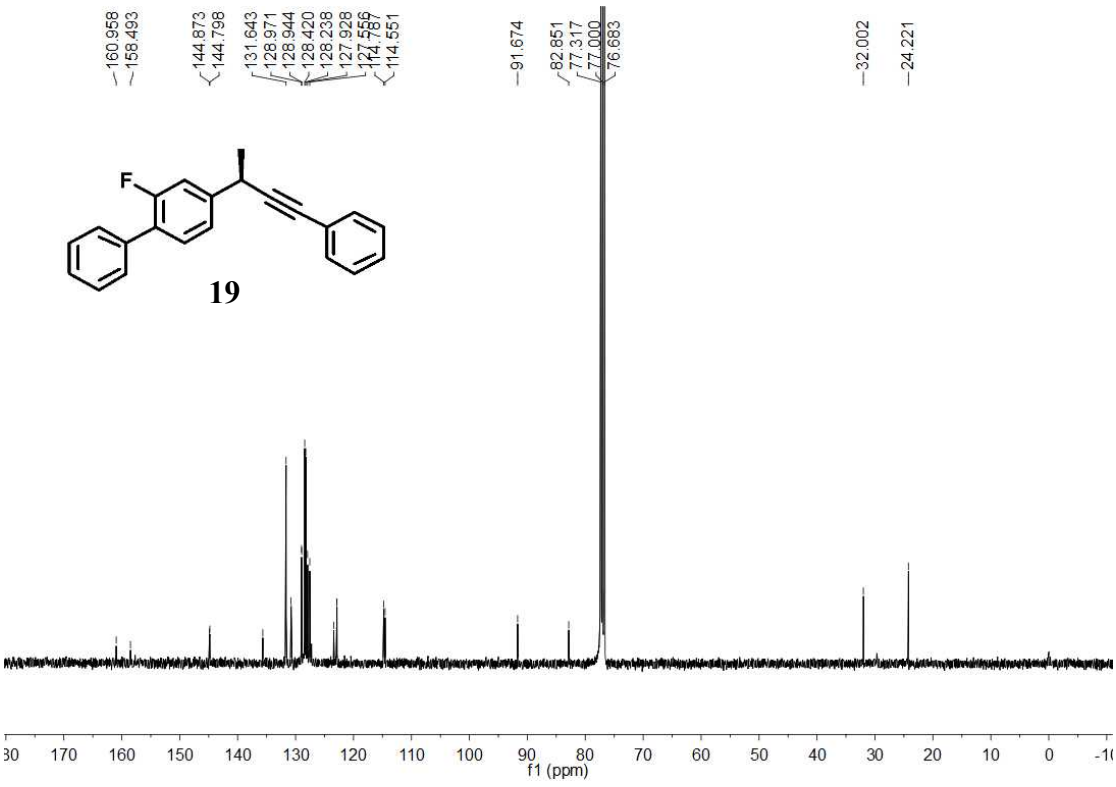

7.472
7.462
7.453
7.379
7.359
7.330
7.317
7.306
7.304
7.294
7.291
7.260
7.144
7.125
4.002
3.985
3.967
3.949
2.490
2.472
1.894
1.877
1.860
1.597
0.935
0.918
18
2.05
2.12
2.98
1.97
1.00
2.06
1.09
3.46
6.11
f1 (ppm)

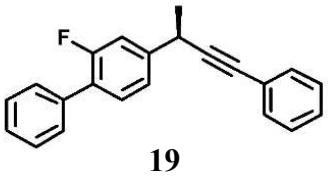

140.520
140.020
131.612
129.250
128.157
127.656
126.601
123.830
92.915
82.247
77.317
77.000
76.682
45.040
32.063
30.207
24.490
22.379
18
f1 (ppm)


7.559
7.540
7.475
7.465
7.458
7.443
7.423
7.412
7.392
7.380
7.362
7.313
7.303
7.297
7.278
7.266
7.254
4.048
4.030
4.012
3.995
1.629
1.611
F

19

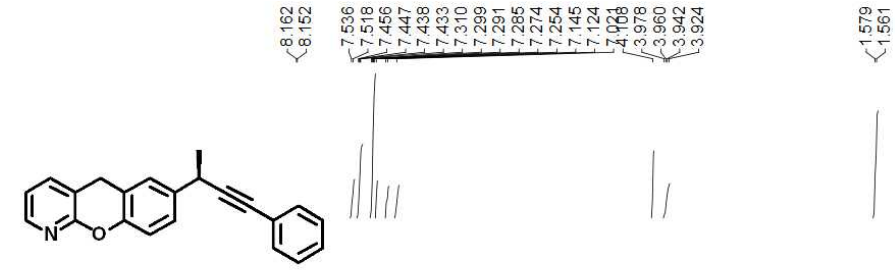

2.12
4.84
6.18
1.00
3.08
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

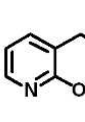

160.958
158.493
144.873
144.798
131.643
128.971
128.944
128.420
128.238
127.928
127.556
127.787
114.551
91.674
82.851
77.317
77.000
76.683
32.002
24.221
F
19
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


F

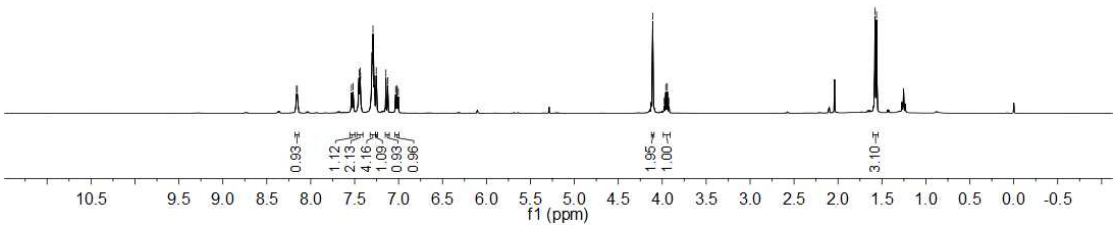
19

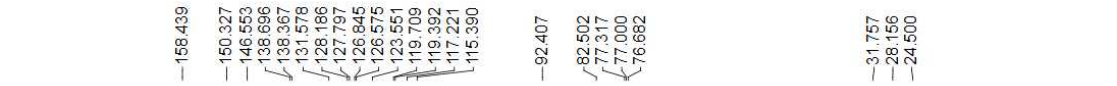
-117.813
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
f1 (ppm)
-120
-140
-160
-180
-200


8.162
8.152
7.536
7.518
7.456
7.447
7.438
7.433
7.310
7.299
7.291
7.285
7.274
7.254
7.145
7.124
4.008
3.978
3.960
3.942
3.924
1.579
1.561

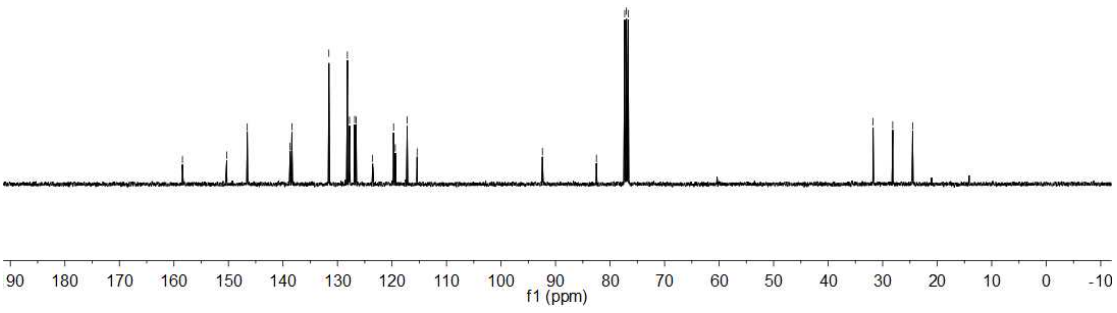


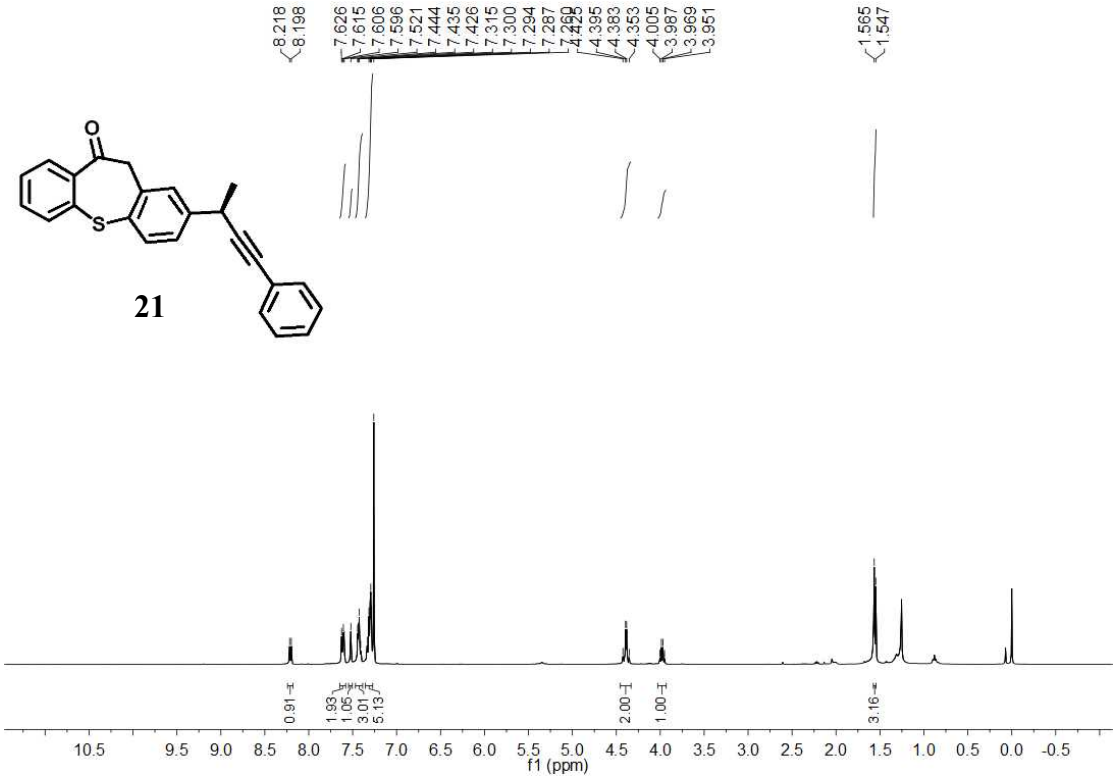
20


0.93
1.12
2.13
4.16
1.09
0.93
0.96
1.95
1.00
3.10
10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

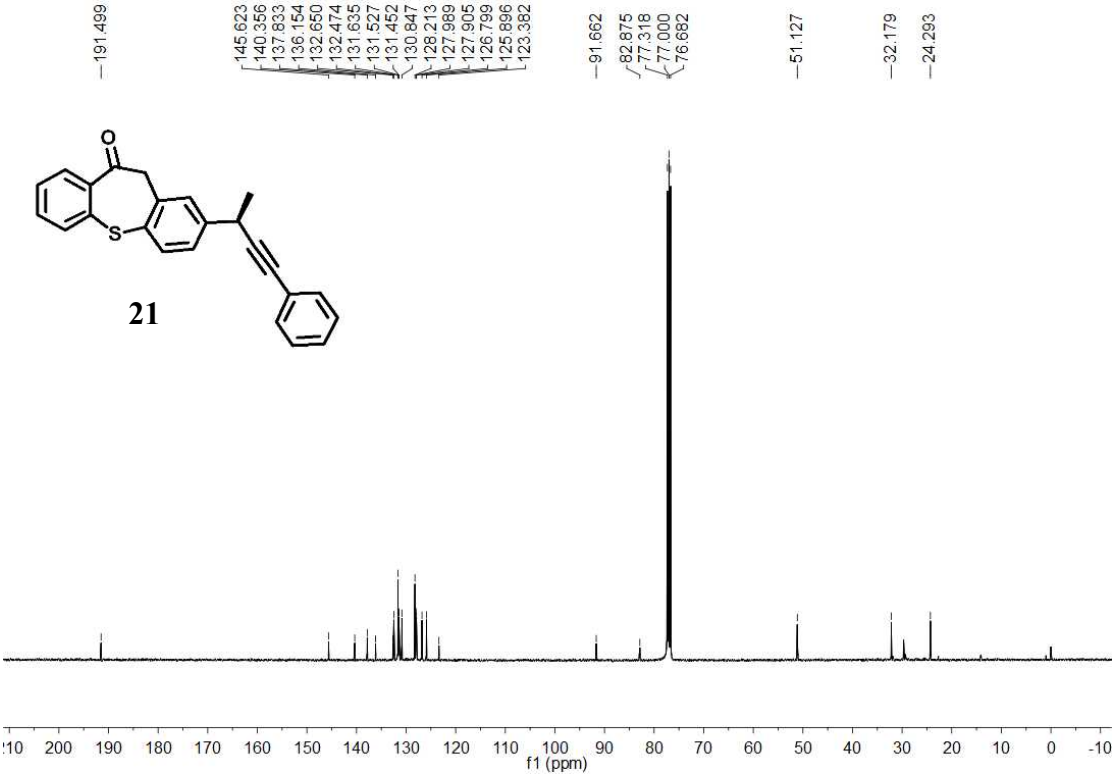

158.439
150.327
146.553
138.696
138.367
131.578
128.186
127.797
126.845
126.575
123.551
119.709
119.392
117.221
115.390
92.407
82.502
77.317
77.000
76.682
31.757
28.156
24.500

20

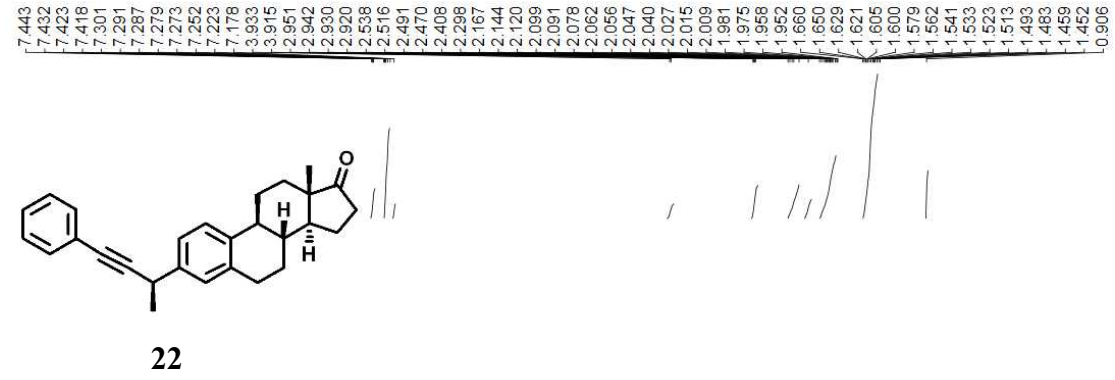

90 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


8.218
8.198
7.626
7.615
7.606
7.596
7.521
7.444
7.435
7.426
7.315
7.300
7.294
7.287
4.395
4.383
4.353
4.005
3.987
3.969
3.951
1.565
1.547
0.91
1.93
1.05
3.01
5.13
2.00
1.00
3.16
f1 (ppm)

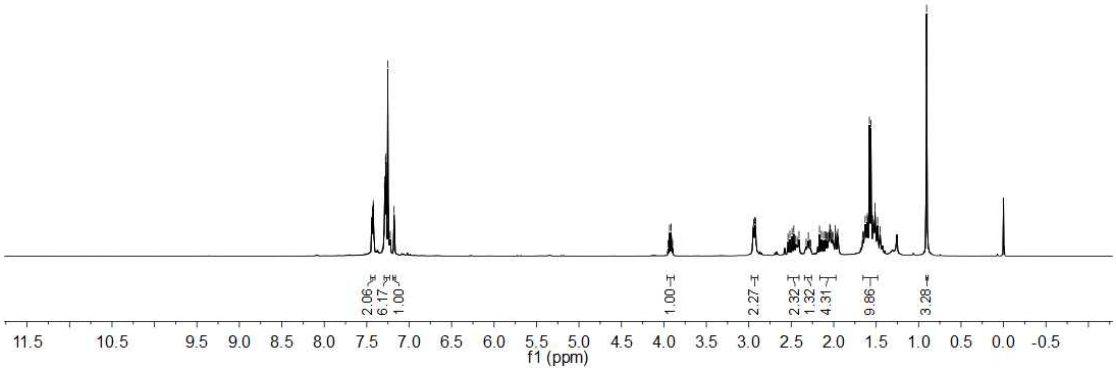
21

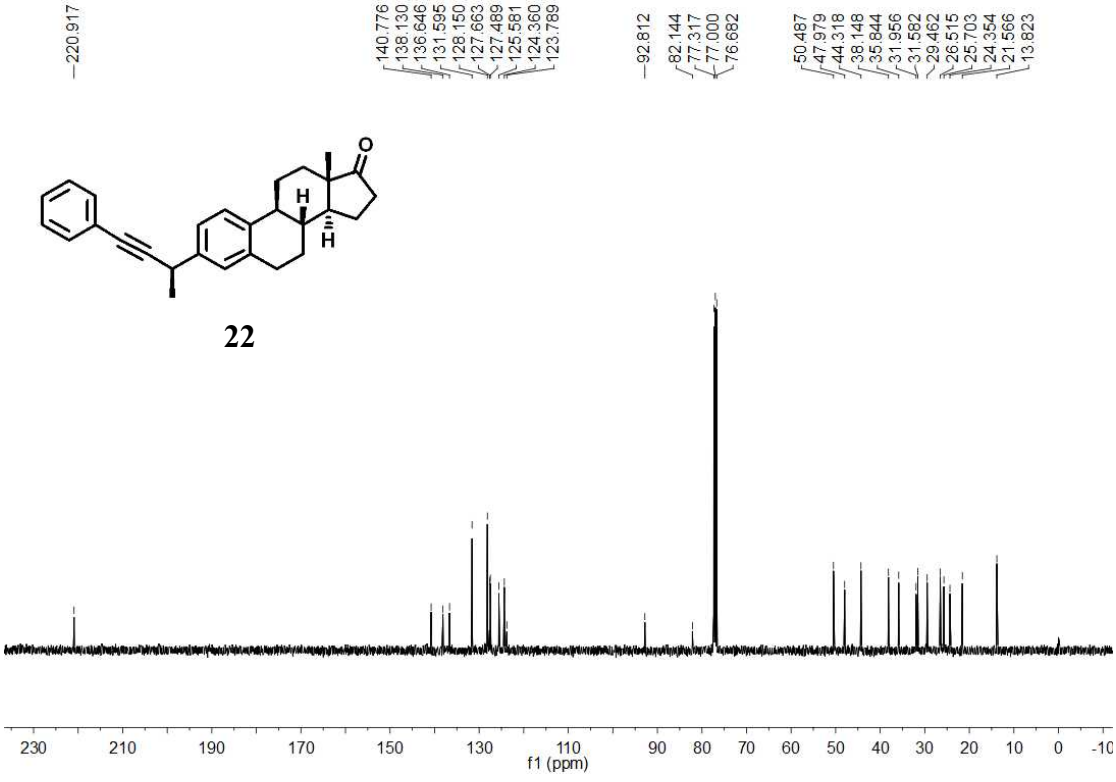

191.499
145.623
140.356
137.833
136.154
132.650
132.474
131.635
131.527
131.452
130.847
128.213
127.989
127.905
126.799
125.896
123.382
91.662
82.875
77.318
77.000
76.682
51.127
32.179
24.293
f1 (ppm)

21

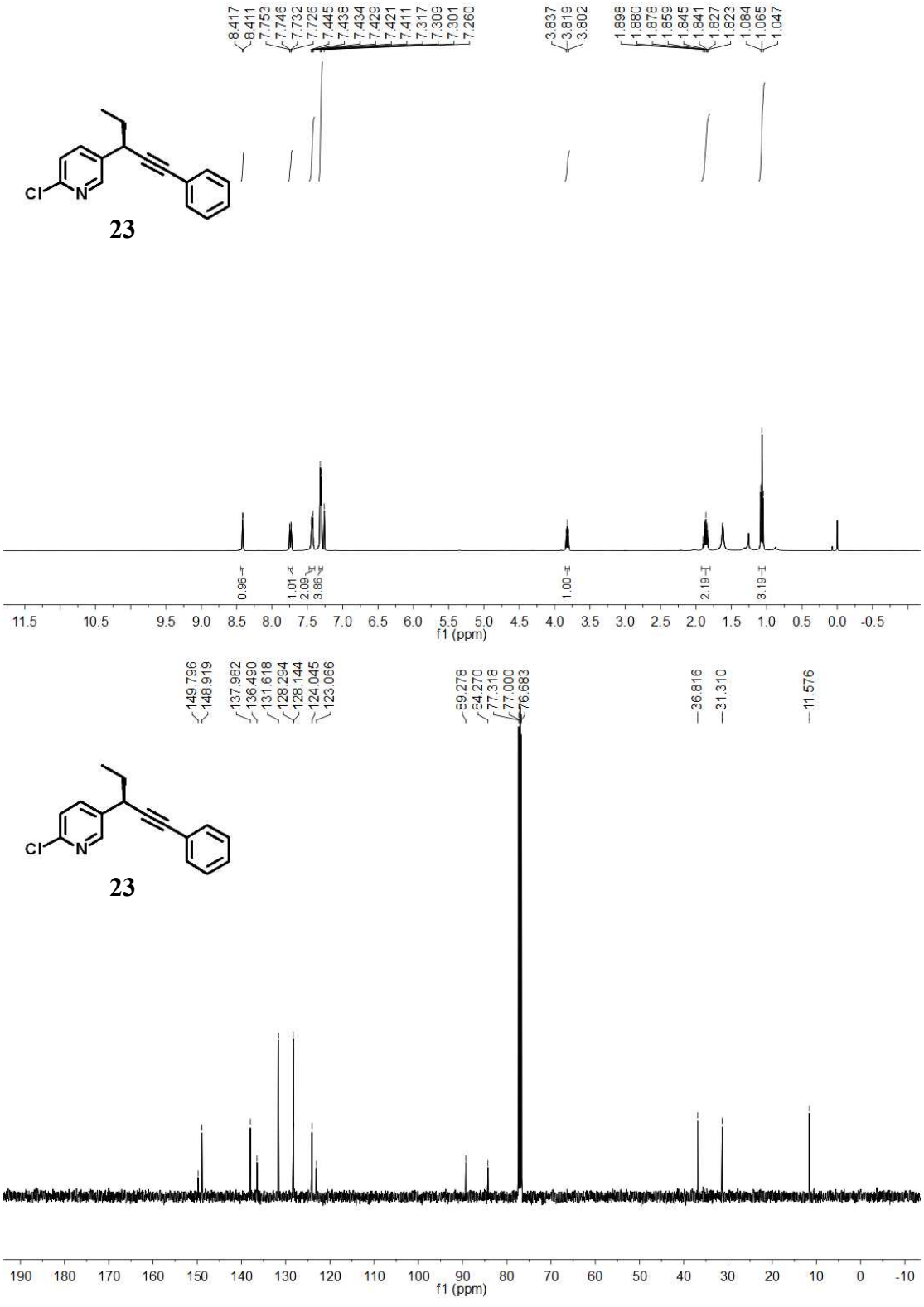

7.443
7.432
7.423
7.418
7.301
7.291
7.287
7.279
7.273
7.252
7.223
7.178
3.933
3.915
2.951
2.942
2.930
2.920
2.538
2.516
2.491
2.470
2.408
2.298
2.167
2.144
2.120
2.099
2.091
2.078
2.062
2.056
2.047
2.040
2.027
2.015
2.009
1.981
1.975
1.958
1.952
1.660
1.650
1.629
1.621
1.605
1.600
1.579
1.562
1.541
1.533
1.523
1.513
1.493
1.483
1.459
1.452
0.906
O
H
H

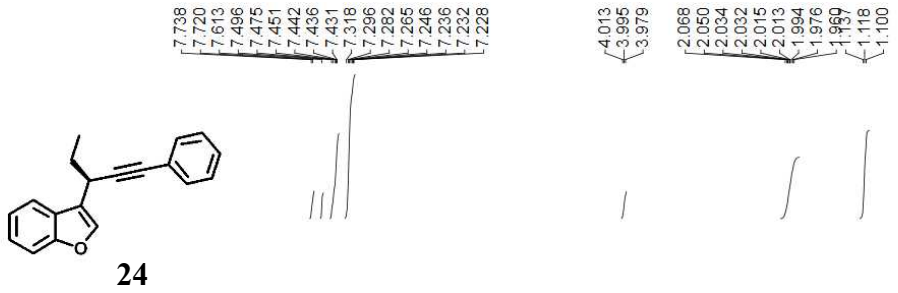
22


2.06
6.17
1.00
1.00
2.27
2.32
1.32
4.31
9.86
3.28
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

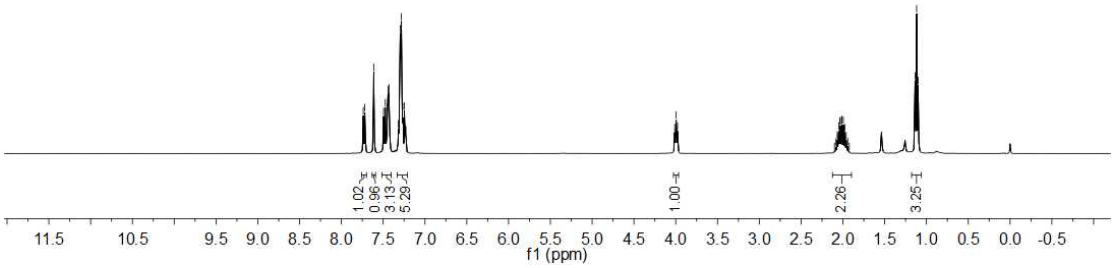

220.917
140.776
138.130
136.646
131.595
128.150
127.663
127.489
125.581
124.360
123.789
92.812
82.144
77.317
77.000
76.682
50.487
47.979
44.318
38.148
35.844
31.956
31.582
29.462
26.515
25.703
24.354
21.566
13.823
O
H
H
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

22

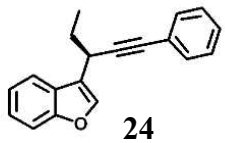

8.417
8.411
7.753
7.746
7.732
7.726
7.445
7.438
7.434
7.429
7.421
7.411
7.317
7.309
7.301
7.260
3.837
3.819
3.802
1.898
1.880
1.878
1.859
1.845
1.841
1.827
1.823
1.084
1.065
1.047
Cl
N
23
0.96
1.01
2.09
3.86
1.00
2.19
3.19
f1 (ppm)
149.796
148.919
137.982
136.490
131.618
128.294
128.144
124.045
123.066
89.278
84.270
77.318
77.000
76.683
36.816
31.310
11.576
Cl
N
23
f1 (ppm)


7.738
7.720
7.613
7.496
7.475
7.451
7.442
7.436
7.431
7.318
7.296
7.282
7.265
7.246
7.236
7.232
7.228
4.013
3.995
3.979
2.068
2.050
2.034
2.032
2.015
2.013
1.994
1.976
1.118
1.100

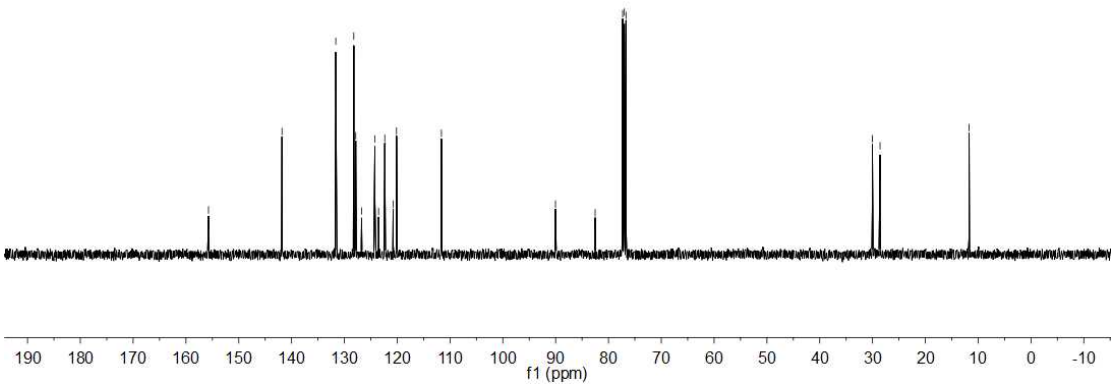
24

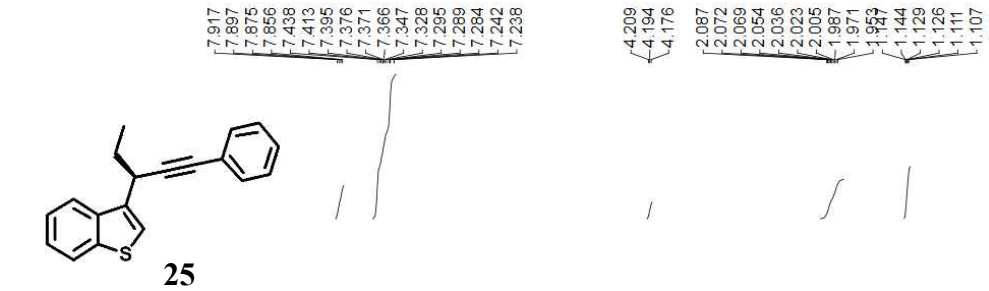

1.02
0.96
3.13
5.29
1.00
2.26
3.25
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


155.730
141.815
131.632
128.219
127.853
124.239
122.356
120.774
120.131
111.631
90.033
82.523
77.318
77.000
76.683
30.025
28.579
11.711

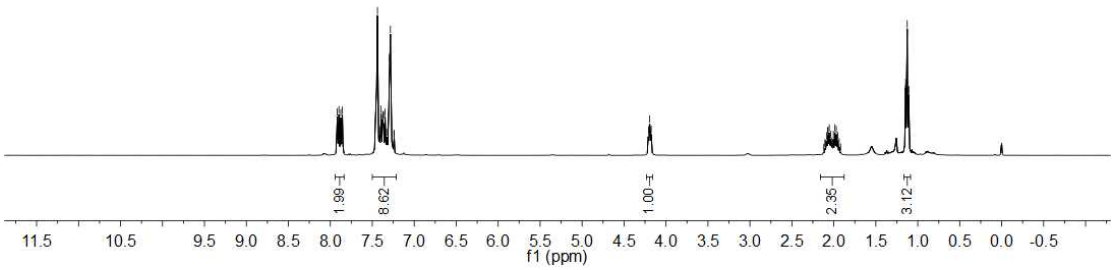


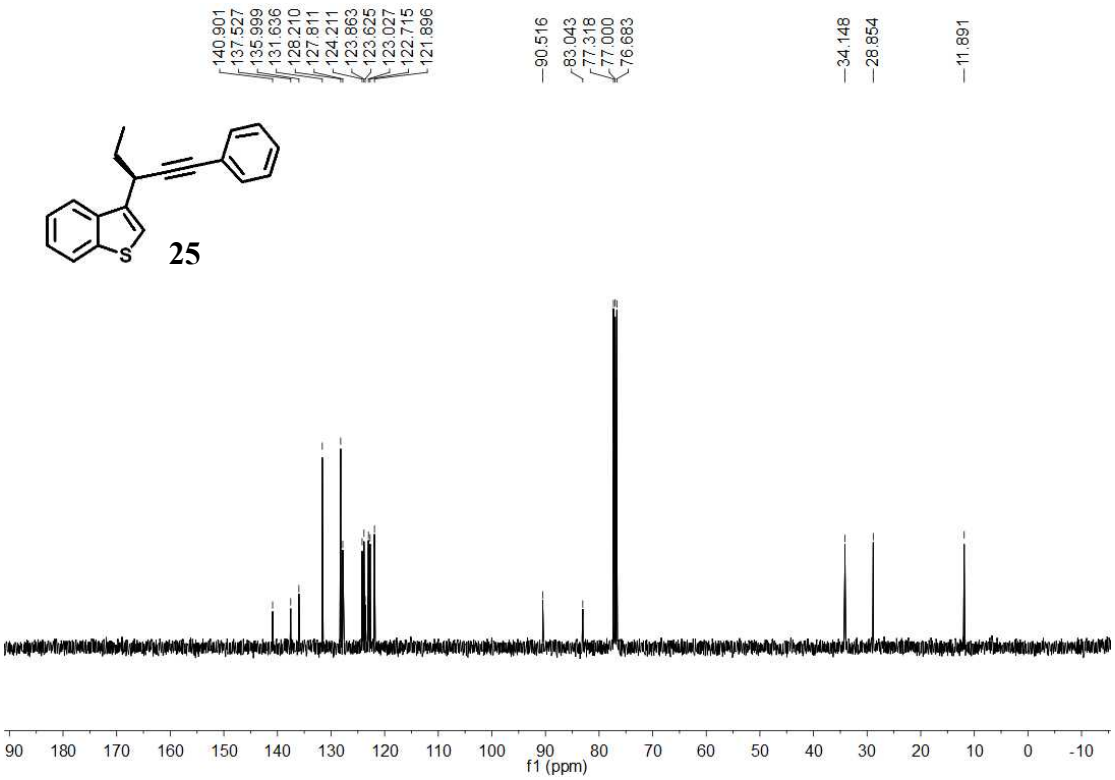
24


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

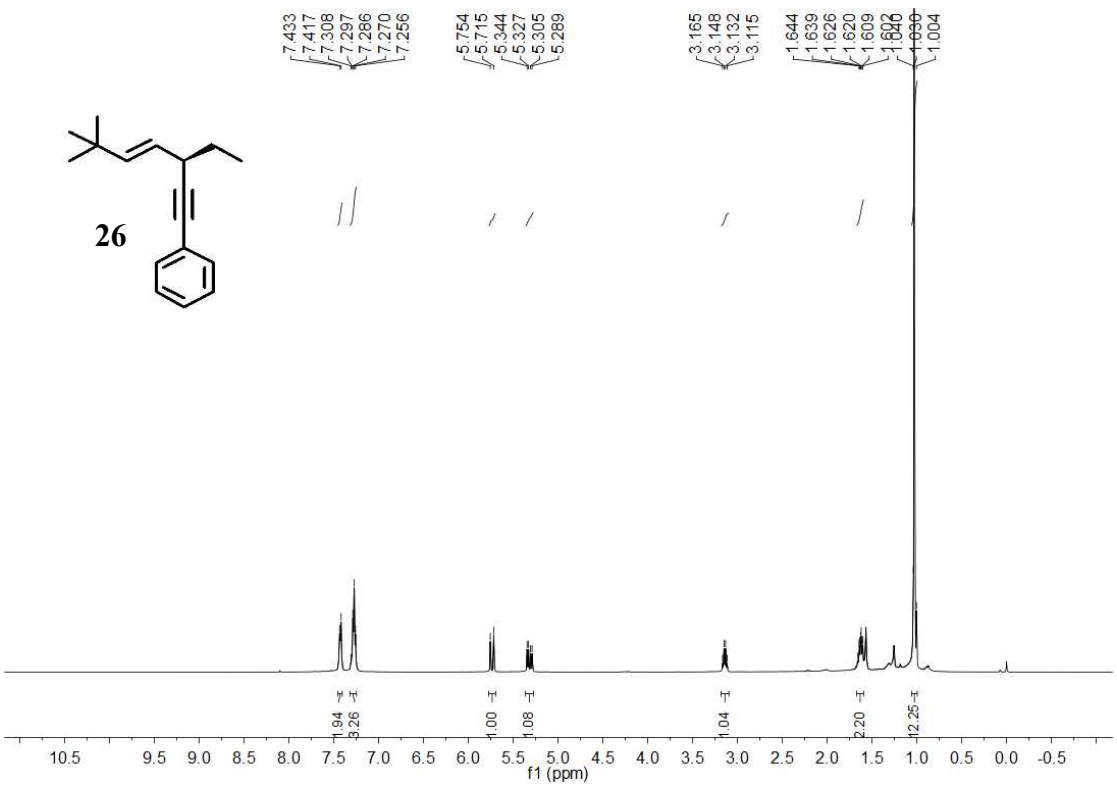

7.917
7.897
7.875
7.856
7.438
7.413
7.395
7.376
7.371
7.366
7.347
7.328
7.295
7.289
7.284
7.242
7.238
4.209
4.194
4.176
2.087
2.072
2.069
2.054
2.036
2.023
2.005
1.987
1.971
1.953
1.144
1.129
1.126
1.111
1.107

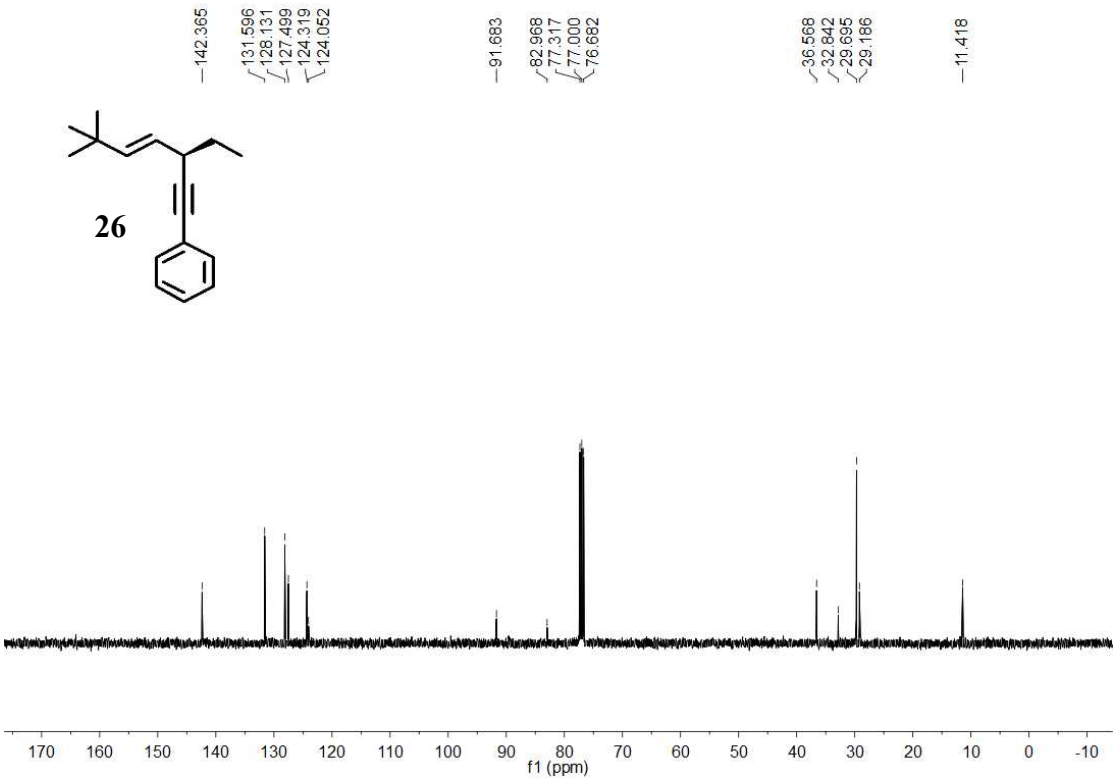
25

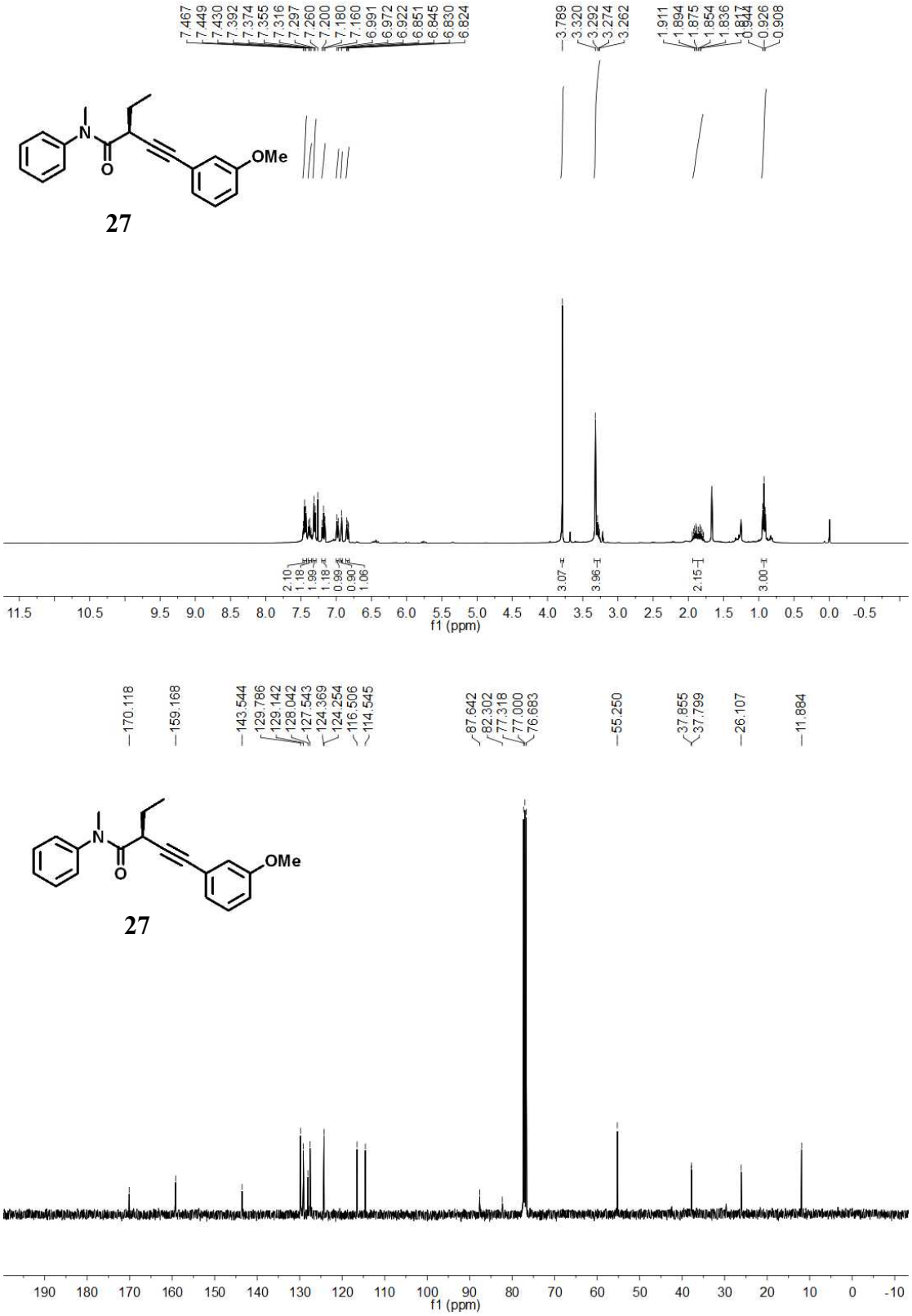

1.99
8.62
1.00
2.35
3.12
11.5 10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

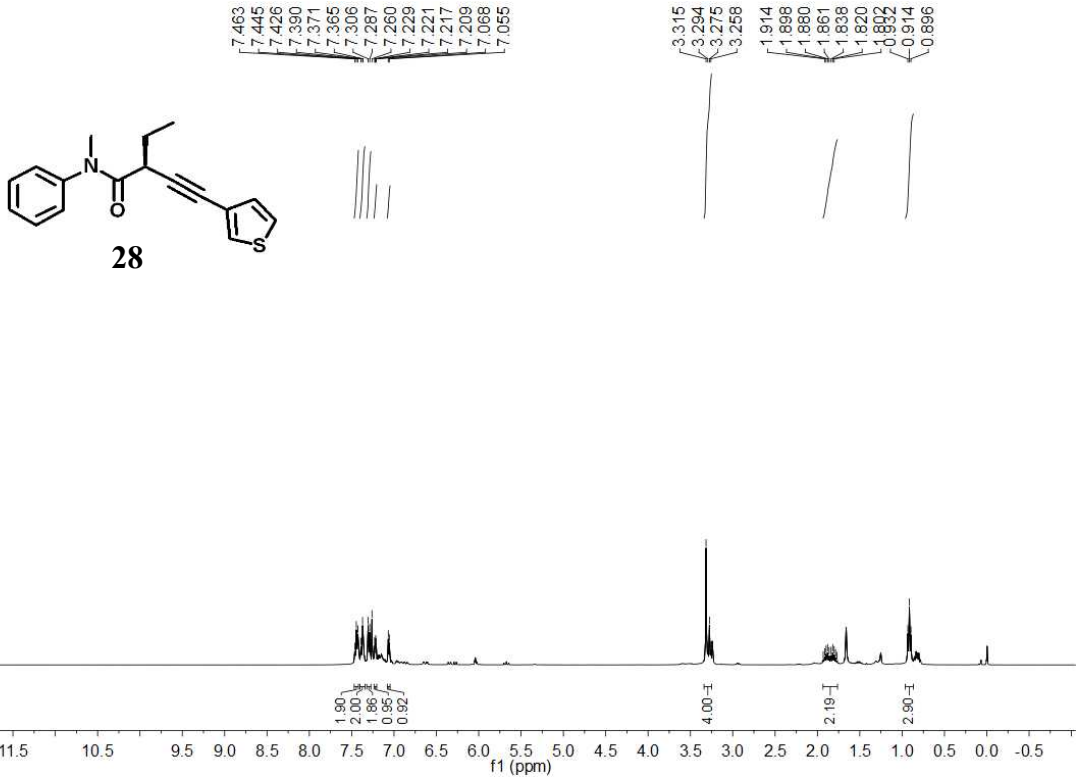

140.901
137.527
135.999
131.636
128.210
127.811
124.211
123.863
123.625
123.027
122.715
121.896
90.516
83.043
77.318
77.000
76.683
34.148
28.854
11.891
90 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

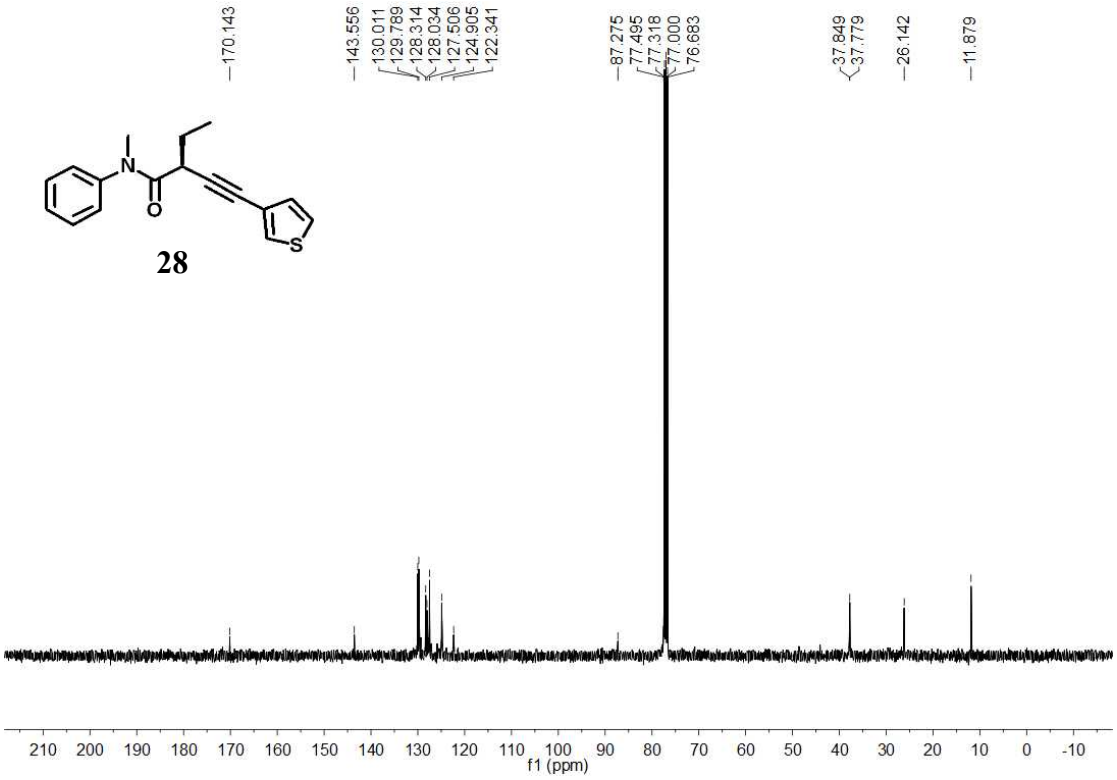
25

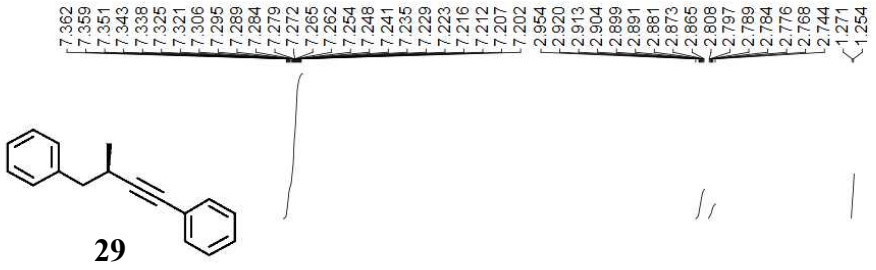

7.433
7.417
7.308
7.297
7.286
7.270
7.256
5.754
5.715
5.344
5.327
5.305
5.289
3.165
3.148
3.132
3.115
1.644
1.639
1.626
1.620
1.609
1.004
26
1.94
3.26
1.00
1.08
1.04
2.20
12.25
f1 (ppm)


142.365
131.596
128.131
127.499
124.319
124.052
91.683
82.968
77.317
77.000
76.682
36.568
32.842
29.695
29.186
11.418
26
f1 (ppm)

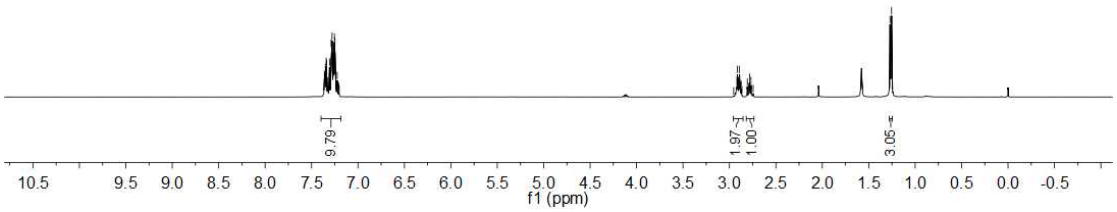

7.467
7.449
7.430
7.392
7.374
7.355
7.316
7.297
7.260
7.200
7.180
7.160
6.991
6.972
6.922
6.851
6.845
6.830
6.824
3.789
3.320
3.292
3.274
3.262
1.911
1.894
1.875
1.854
1.836
0.944
0.926
0.908
OMe
27
2.10
1.18
1.99
1.18
0.99
0.90
1.06
3.07
3.96
2.15
3.00
11.5 10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)
170.118
159.168
143.544
129.786
129.142
128.042
127.543
124.369
124.254
116.506
114.545
87.642
82.302
77.318
77.000
76.683
55.250
37.855
37.799
26.107
11.884
OMe
27
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.463
7.445
7.426
7.390
7.371
7.365
7.306
7.287
7.260
7.229
7.221
7.217
7.209
7.068
7.055
3.315
3.294
3.275
3.258
1.914
1.898
1.880
1.861
1.838
1.820
0.932
0.914
0.896
N
O
S
28
1.90
2.00
1.86
0.95
0.92
4.00
2.19
2.90
11.5 10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

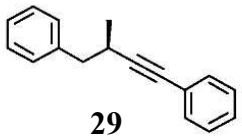

170.143
143.556
130.011
129.789
128.314
128.034
127.506
124.905
122.341
87.275
77.495
77.318
77.000
76.683
37.849
37.779
26.142
11.879
N
O
S
28
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.362
7.359
7.351
7.343
7.338
7.325
7.321
7.306
7.295
7.289
7.284
7.279
7.272
7.265
7.262
7.254
7.248
7.241
7.235
7.229
7.223
7.216
7.212
7.207
7.202
2.954
2.920
2.913
2.904
2.899
2.891
2.881
2.873
2.865
2.808
2.797
2.789
2.784
2.776
2.768
2.744
1.271
1.254

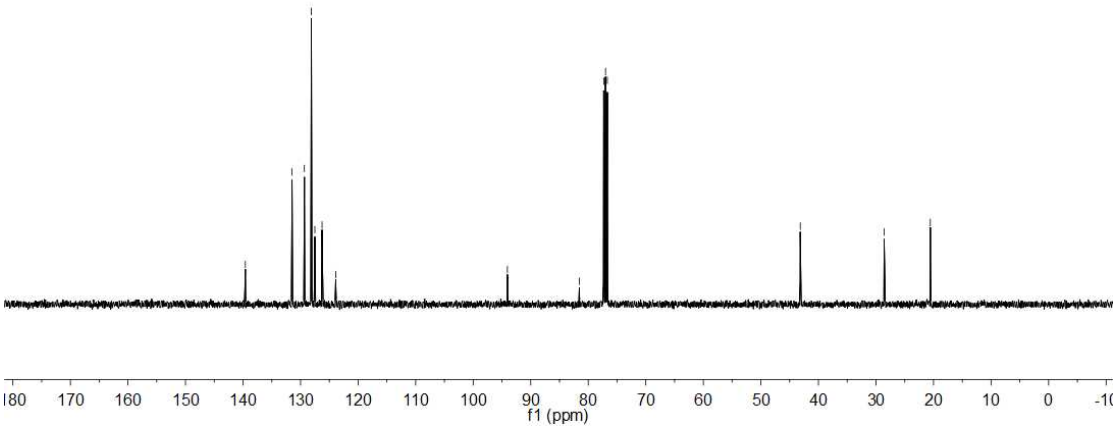
29

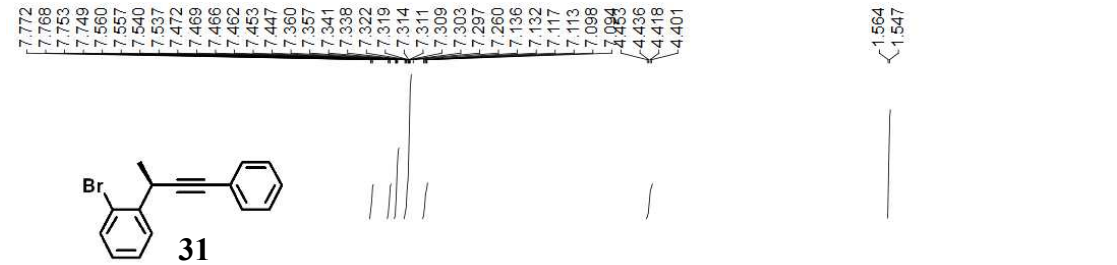

9.79
1.97
1.00
3.05
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


139.595
131.482
129.338
128.127
127.516
126.267
123.890
94.055
81.554
77.318
77.000
76.683
43.155
28.576
20.558

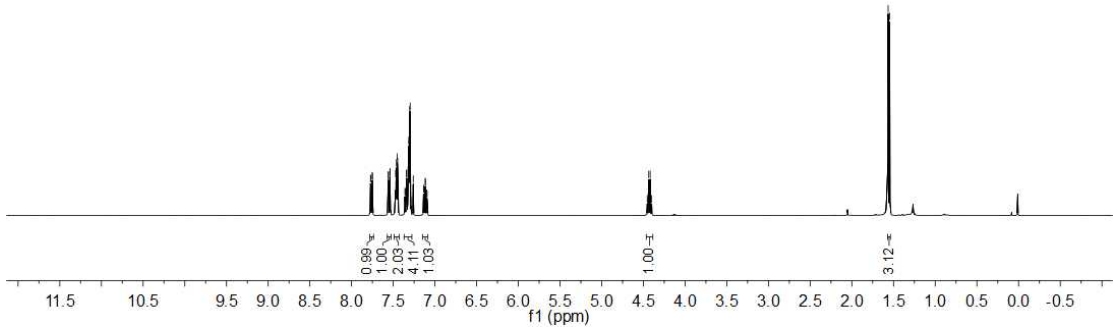


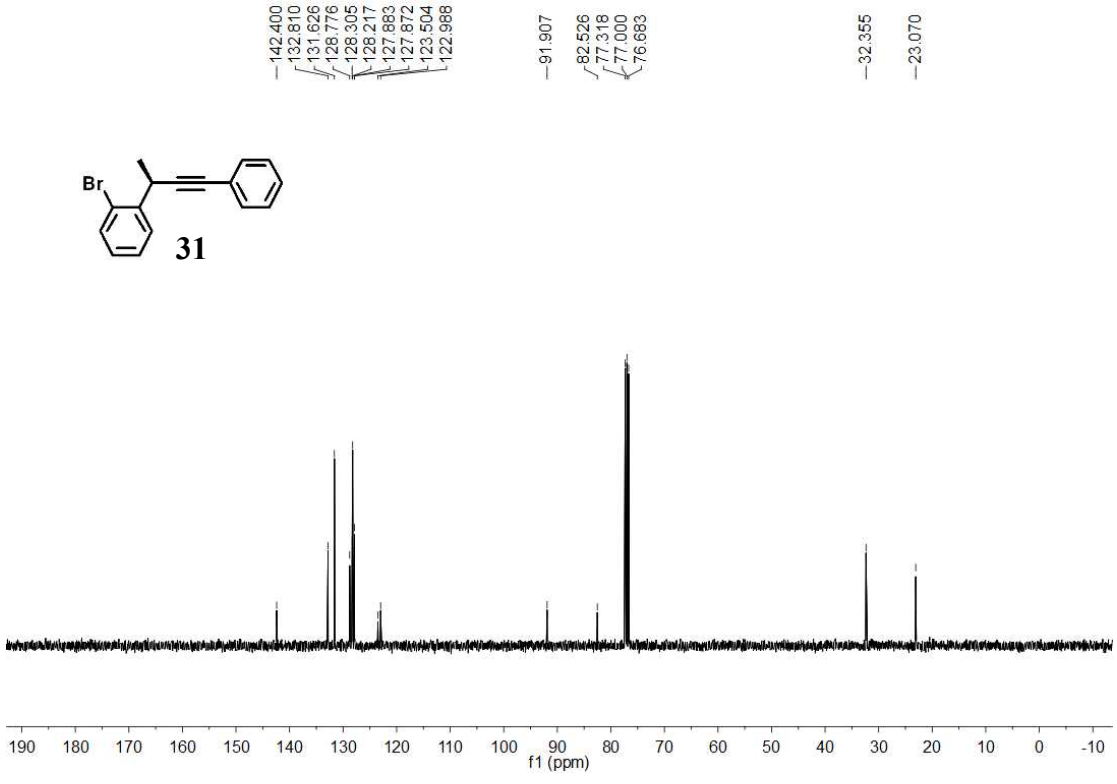
29


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

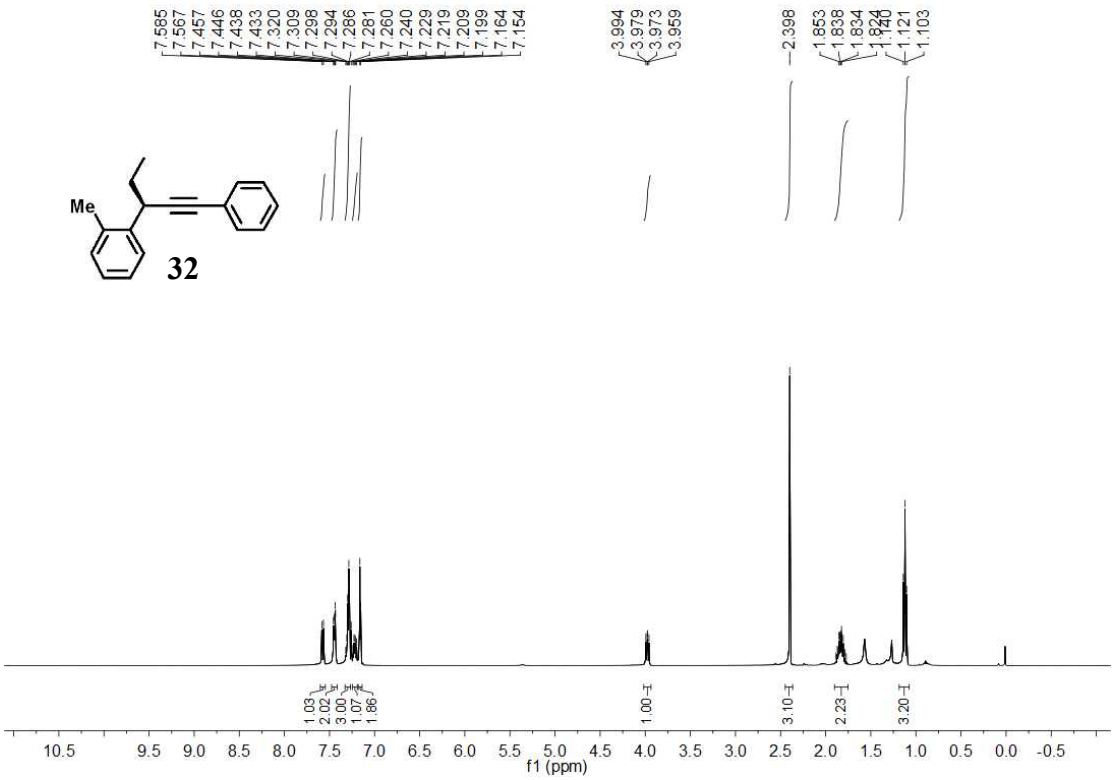

7.772
7.768
7.753
7.749
7.560
7.557
7.540
7.537
7.472
7.469
7.466
7.462
7.453
7.447
7.360
7.357
7.341
7.338
7.322
7.319
7.314
7.311
7.309
7.303
7.297
7.260
7.136
7.132
7.117
7.113
7.098
4.436
4.418
4.401
1.564
1.547
Br

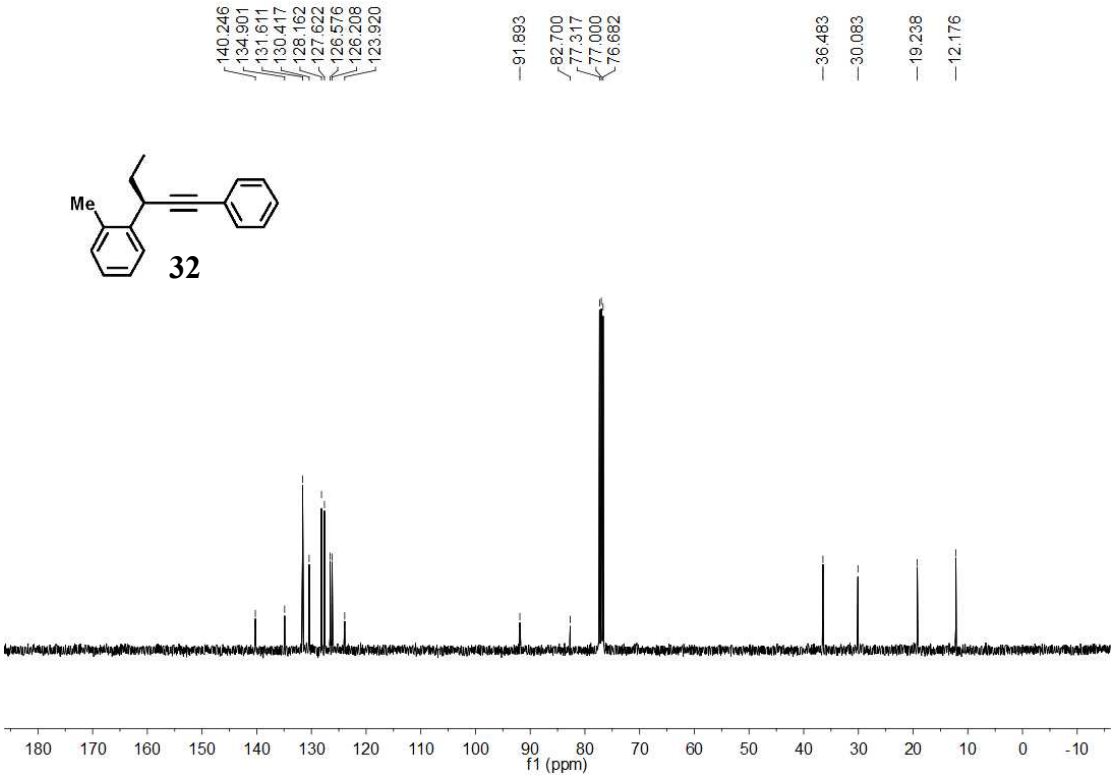
31

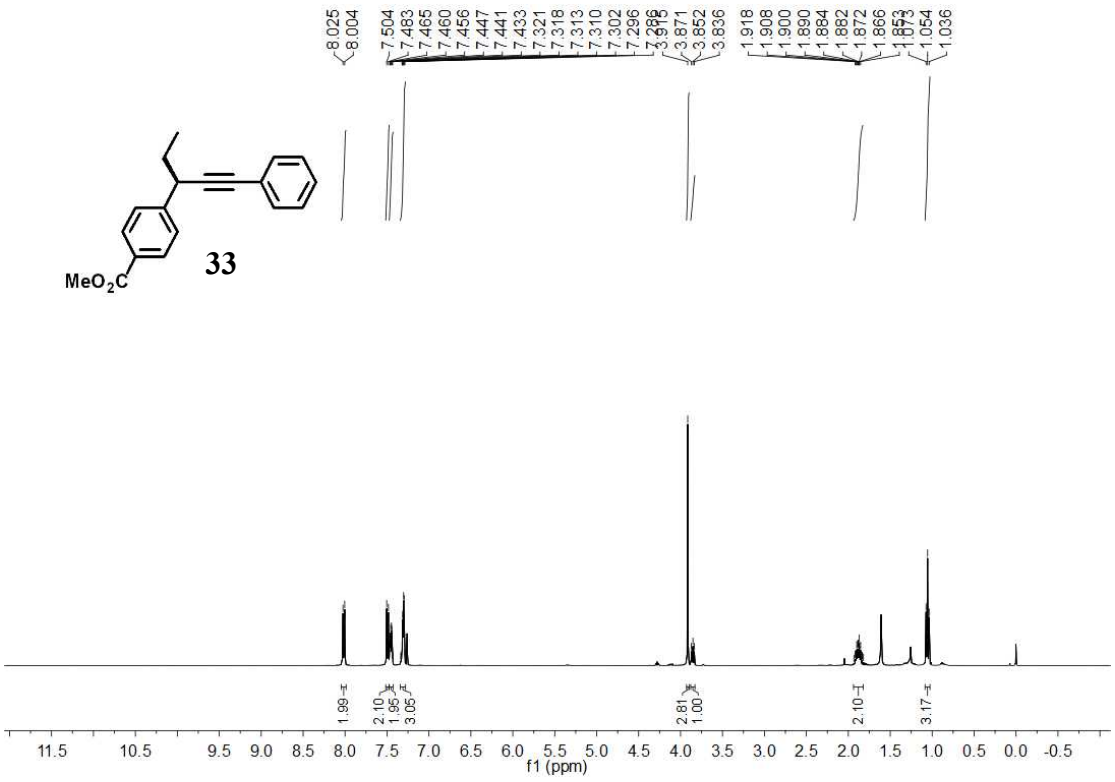

0.99
1.00
2.03
4.11
1.03
1.00
3.12
11.5 10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

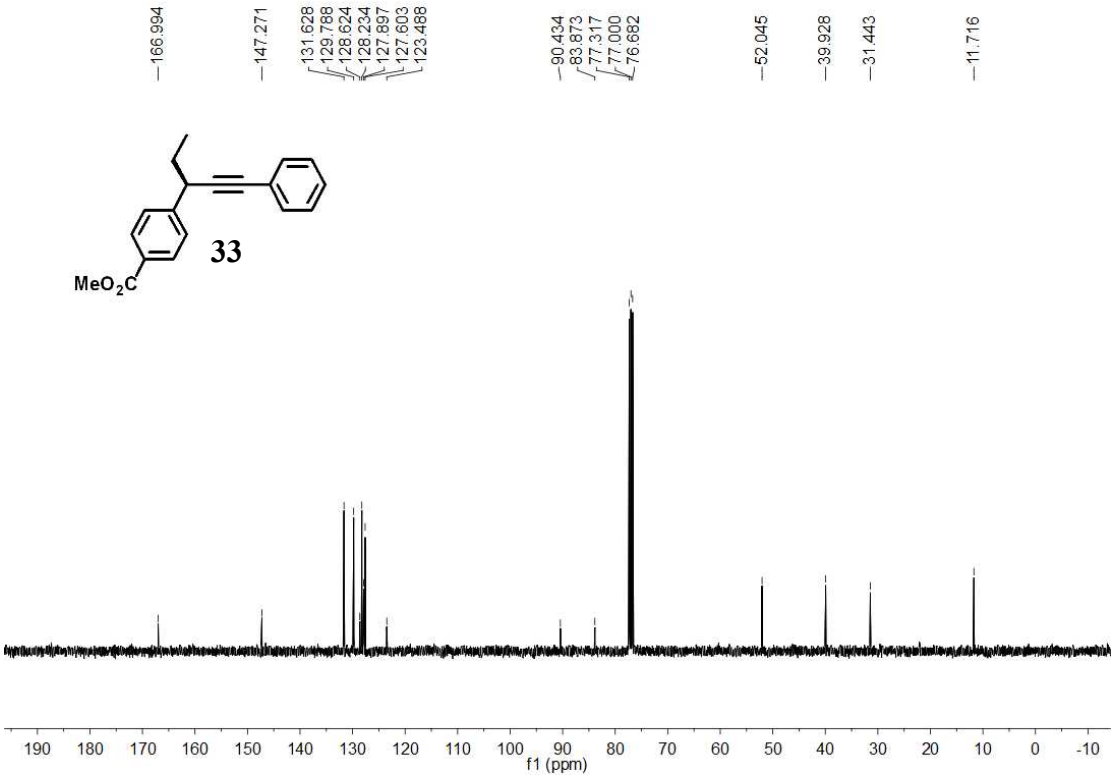

142.400
132.810
131.626
128.776
128.305
128.217
127.883
127.872
123.504
122.988
91.907
82.526
77.318
77.000
76.683
32.355
23.070
Br
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

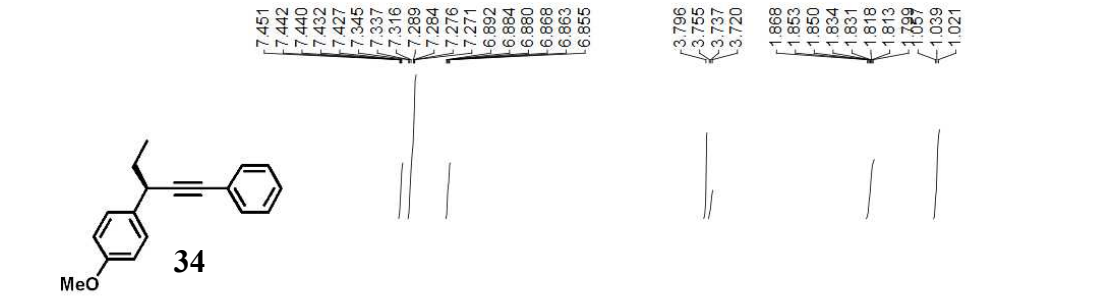
31

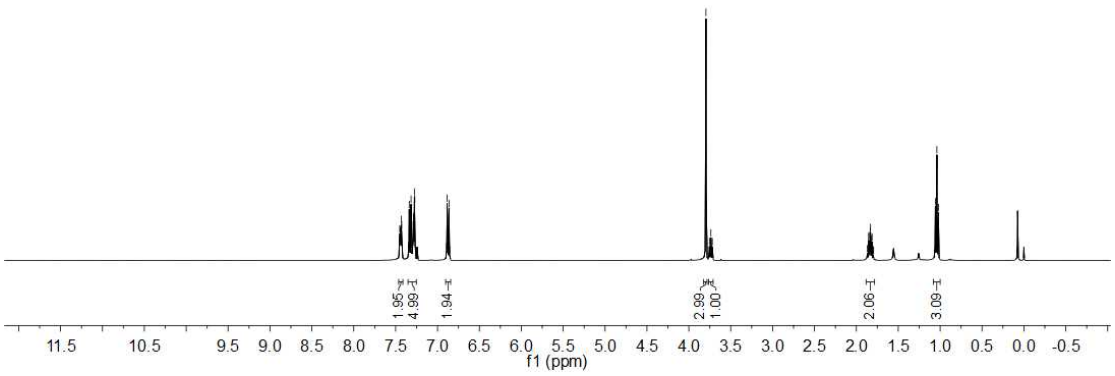

7.585
7.567
7.457
7.446
7.438
7.433
7.320
7.309
7.298
7.294
7.286
7.281
7.260
7.240
7.229
7.219
7.209
7.199
7.164
7.154
3.994
3.979
3.973
3.959
2.398
1.853
1.838
1.834
1.824
1.140
1.121
1.103
Me
32
1.03
2.02
3.00
1.07
1.86
1.00
3.10
2.23
3.20
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


140.246
134.901
131.611
130.417
128.162
127.622
126.576
126.208
123.920
91.893
82.700
77.317
77.000
76.682
36.483
30.083
19.238
12.176
Me
32
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

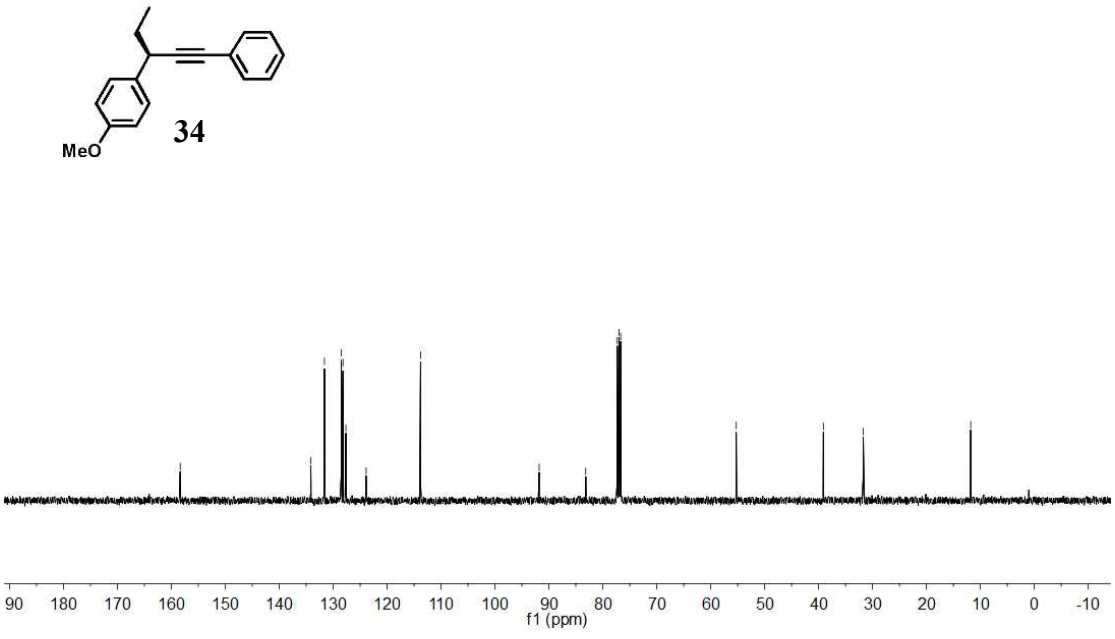

8.025
8.004
7.504
7.483
7.465
7.460
7.456
7.447
7.441
7.433
7.321
7.318
7.313
7.310
7.302
7.296
3.871
3.852
3.836
1.918
1.908
1.900
1.890
1.884
1.882
1.872
1.866
1.054
1.036
33
MeO2C
1.99
2.10
1.95
3.05
2.81
1.00
2.10
3.17
f1 (ppm)

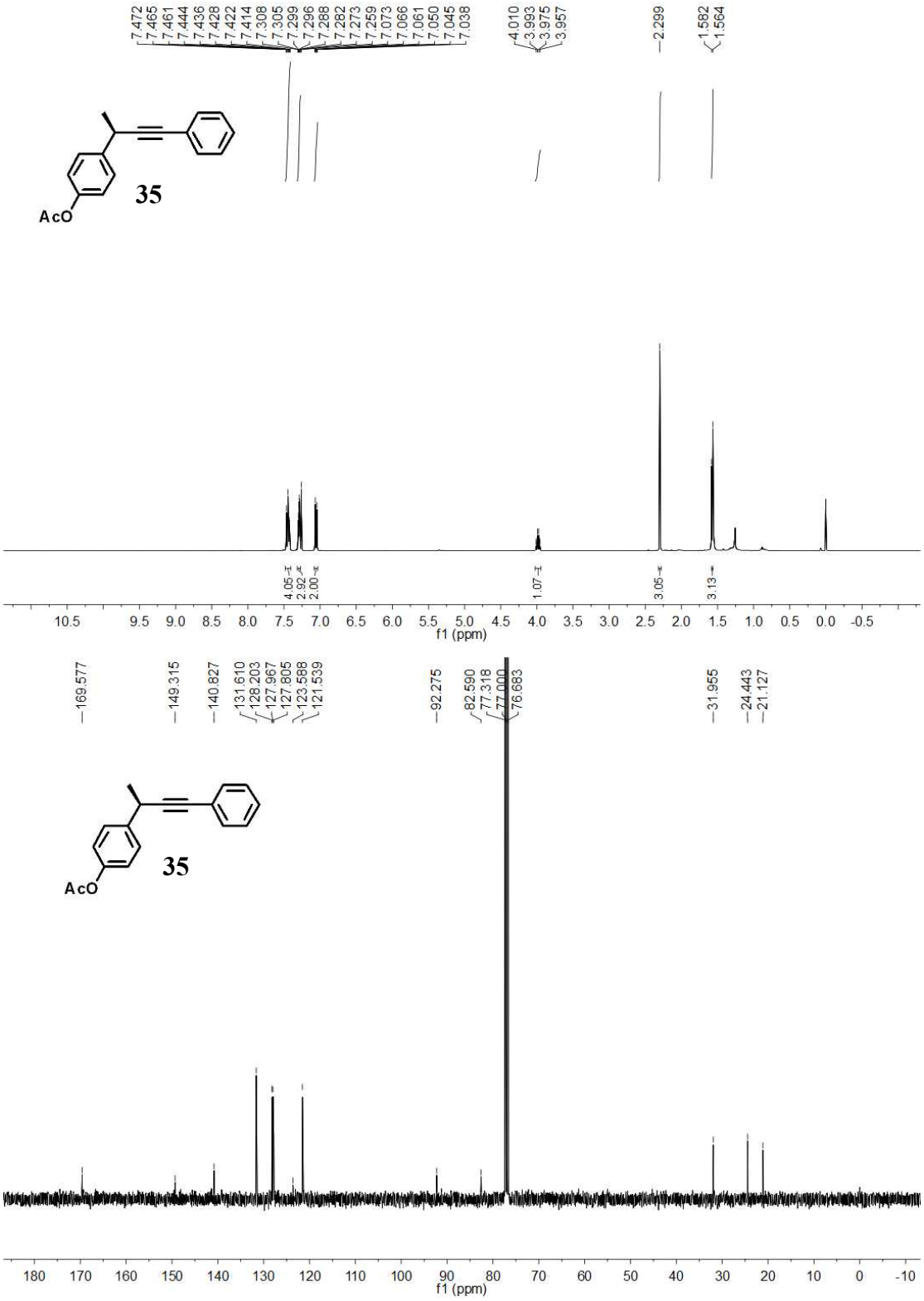

166.994
147.271
131.628
129.788
128.624
128.234
127.897
127.603
123.488
90.434
83.873
77.317
77.000
76.682
52.045
39.928
31.443
11.716
33
MeO2C
f1 (ppm)

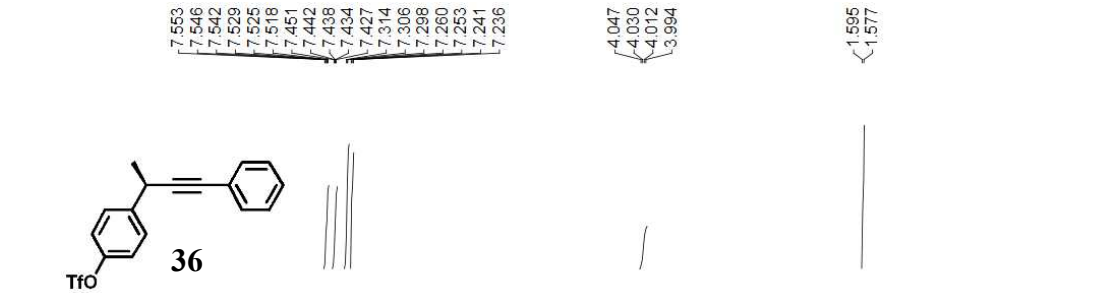

7.451
7.442
7.440
7.432
7.427
7.345
7.337
7.316
7.289
7.284
7.276
7.271
6.892
6.884
6.880
6.868
6.863
6.855
3.796
3.755
3.737
3.720
1.868
1.853
1.850
1.834
1.831
1.818
1.813
1.039
1.021
MeO
34

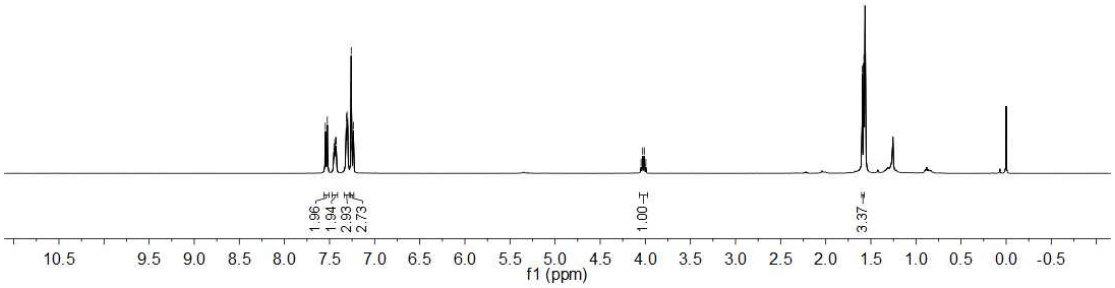

1.95
4.99
1.94
2.99
1.00
2.06
3.09
11.5 10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

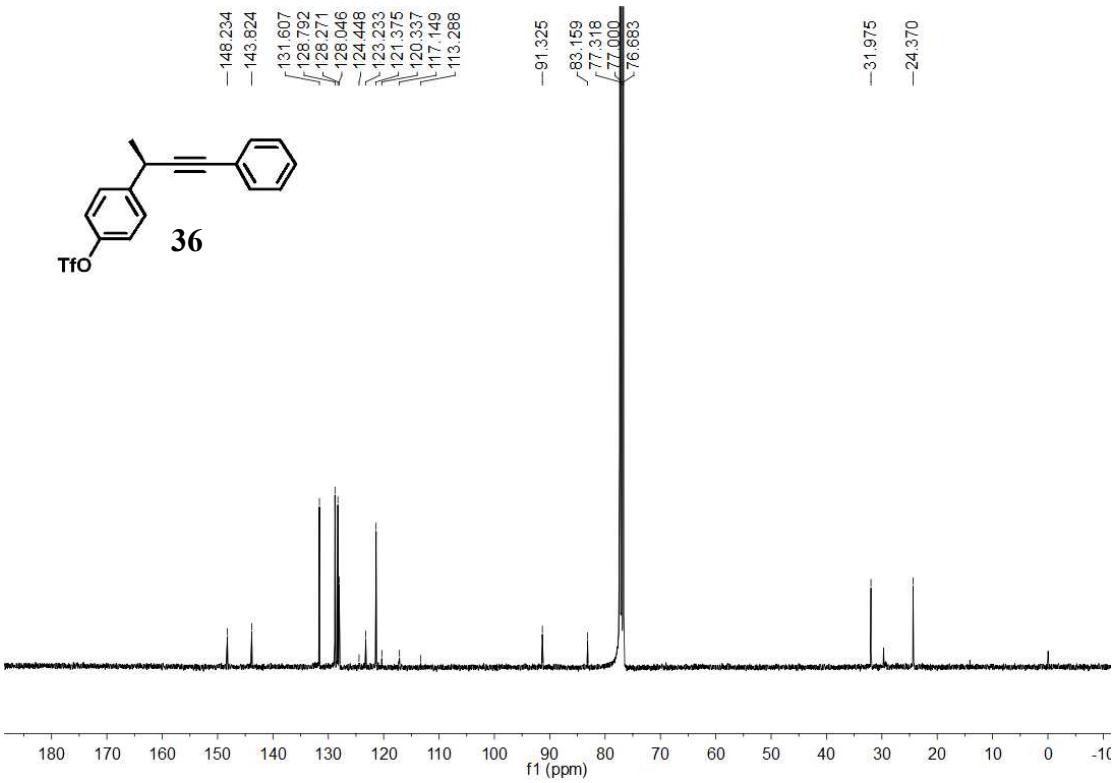

158.345
134.135
131.614
128.474
128.164
127.638
123.890
113.794
91.808
83.173
77.318
77.000
76.683
55.267
39.103
31.707
11.782

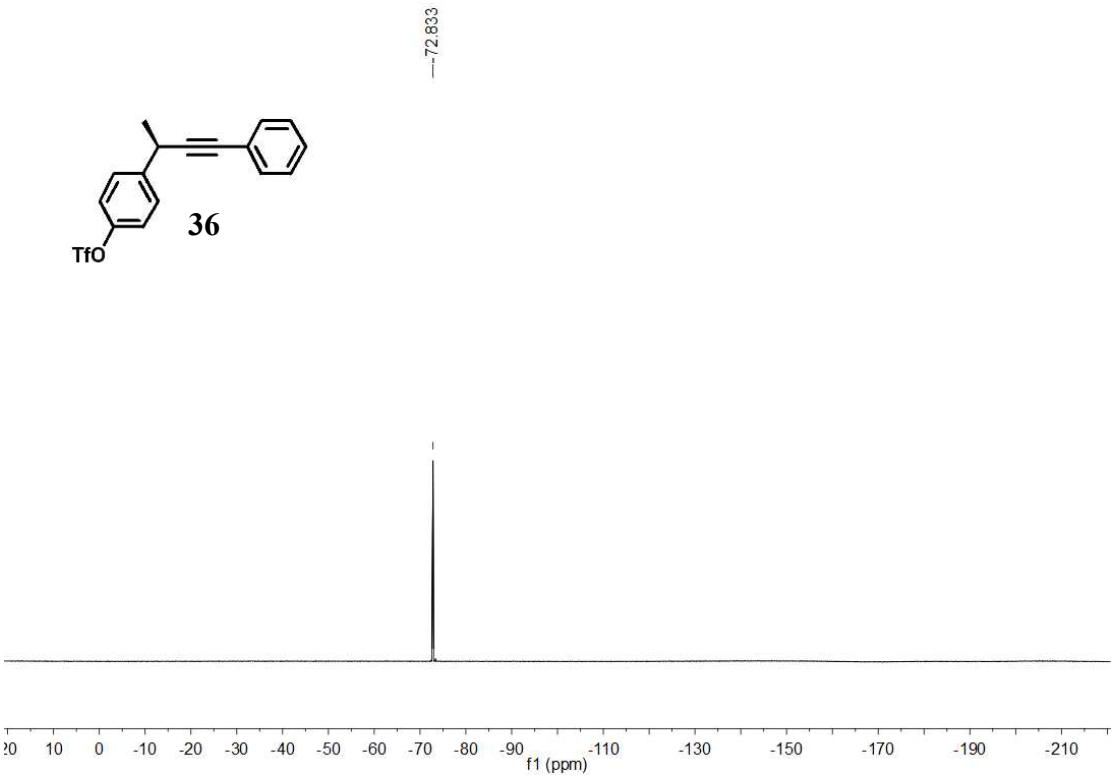

MeO
34
90 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

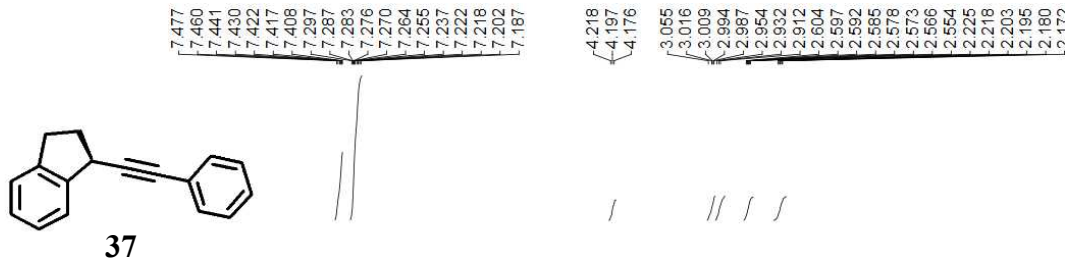

7.472
7.465
7.461
7.444
7.436
7.428
7.422
7.414
7.308
7.305
7.299
7.296
7.288
7.282
7.273
7.259
7.073
7.066
7.061
7.050
7.045
7.038
4.010
3.993
3.975
3.957
2.299
1.582
1.564
35
AcO
4.05
2.92
2.00
1.07
3.05
3.13
f1 (ppm)
169.577
149.315
140.827
131.610
128.203
127.967
127.805
123.588
121.539
92.275
82.590
77.318
77.000
76.683
31.955
24.443
21.127
35
AcO
f1 (ppm)


7.553
7.546
7.542
7.529
7.525
7.518
7.451
7.442
7.438
7.434
7.427
7.314
7.306
7.298
7.260
7.253
7.241
7.236
4.047
4.030
4.012
3.994
1.595
1.577
TfO
36

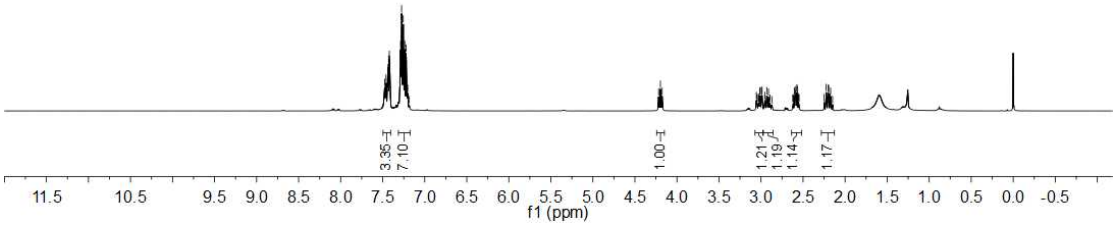

1.96
1.94
2.93
2.73
1.00
3.37
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

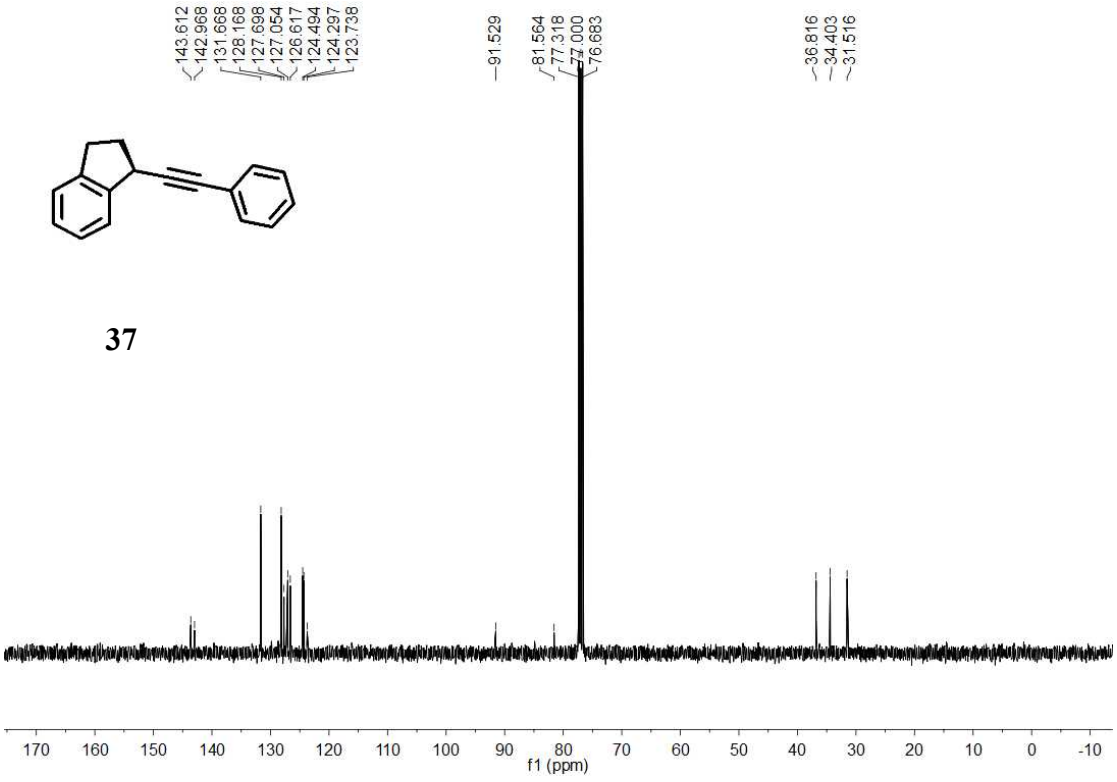

148.234
143.824
131.607
128.792
128.271
128.046
124.448
123.233
121.375
120.337
117.149
113.288
91.325
83.159
77.318
77.000
76.683
31.975
24.370
TfO
36
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


-72.833
TfO
36
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
-210
f1 (ppm)

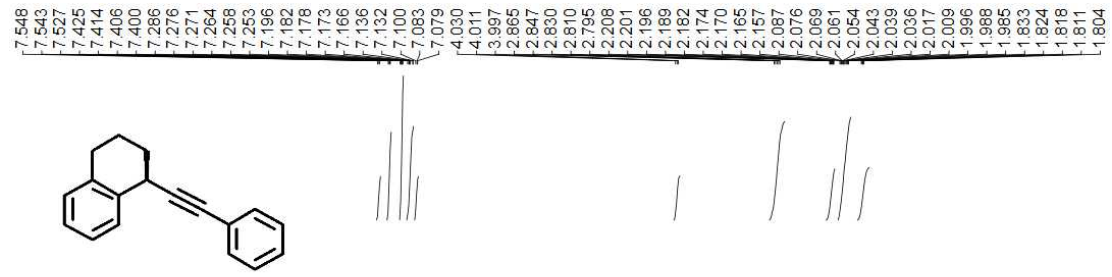

7.477
7.460
7.441
7.430
7.422
7.417
7.408
7.297
7.287
7.283
7.276
7.270
7.264
7.255
7.237
7.222
7.218
7.202
7.187
4.218
4.197
4.176
3.055
3.016
3.009
2.994
2.987
2.954
2.932
2.912
2.604
2.597
2.592
2.585
2.578
2.573
2.566
2.554
2.225
2.218
2.203
2.195
2.180

37

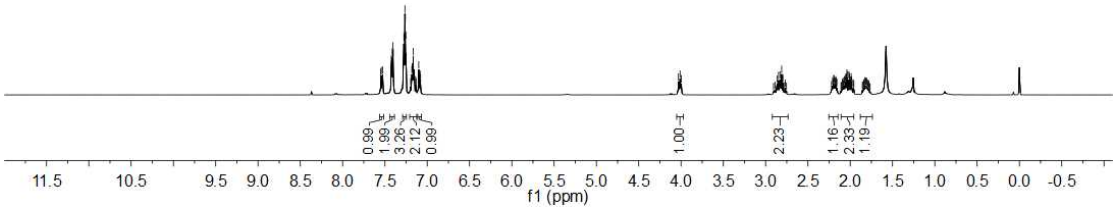

3.35
7.10
1.00
1.21
1.19
1.14
1.17
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

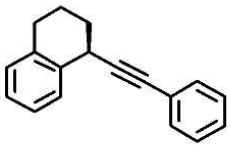

143.612
142.968
131.668
128.168
127.698
127.054
126.617
124.494
124.297
123.738
91.529
81.564
77.318
77.000
76.683
36.816
34.403
31.516
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

37

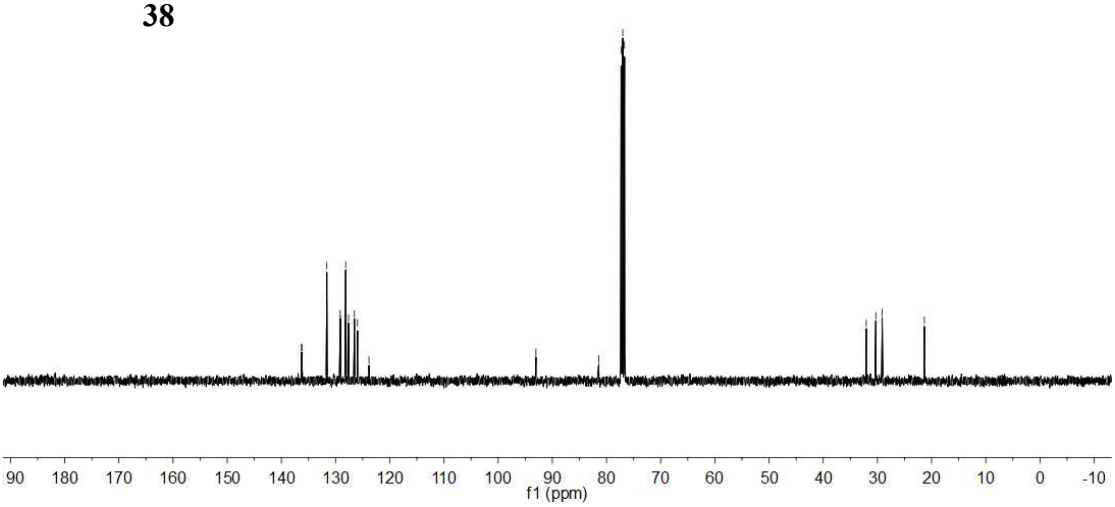


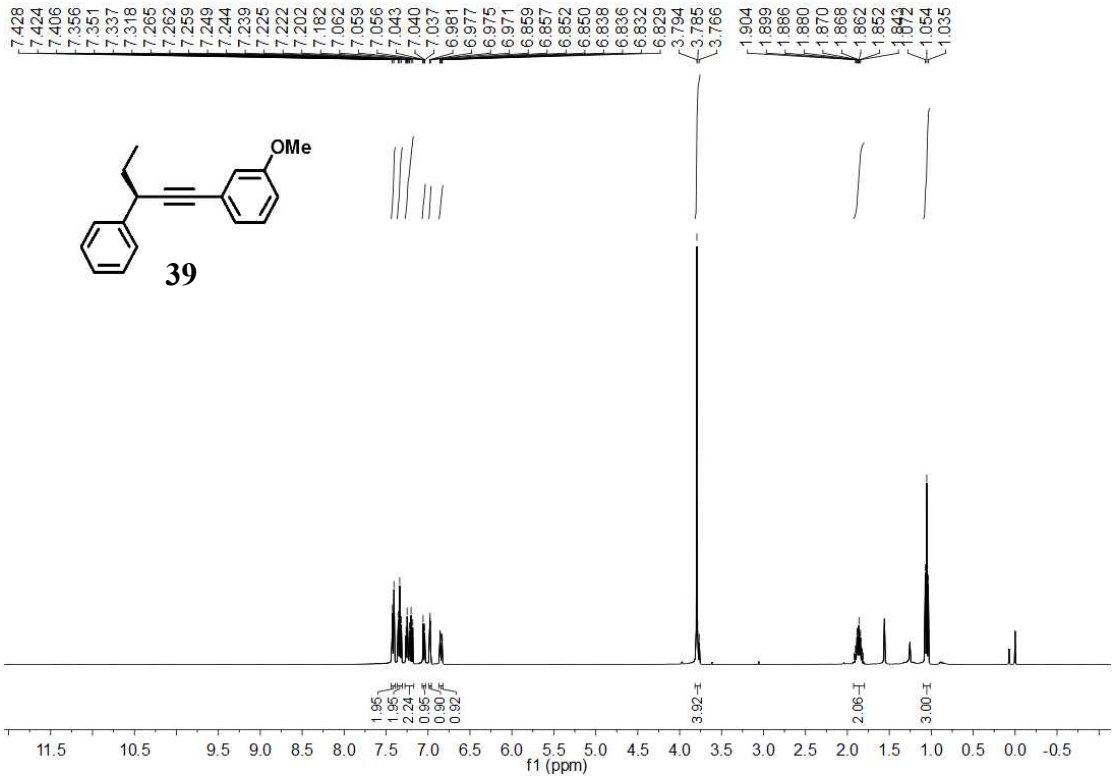
38





38

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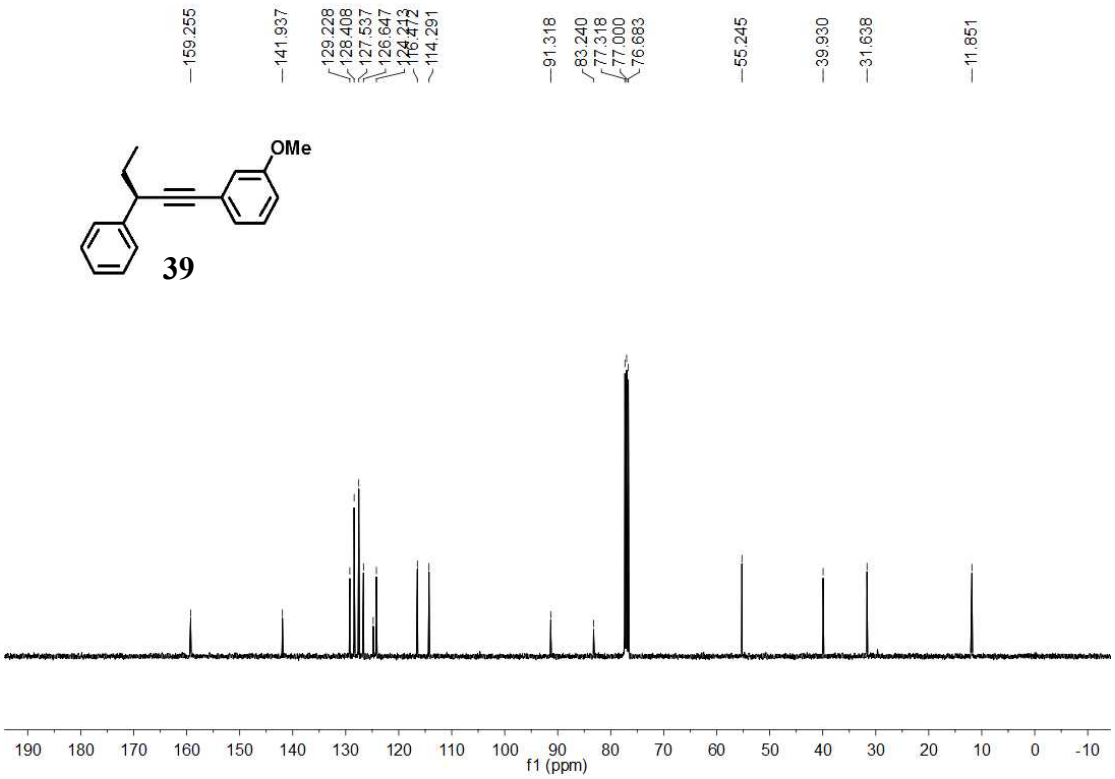
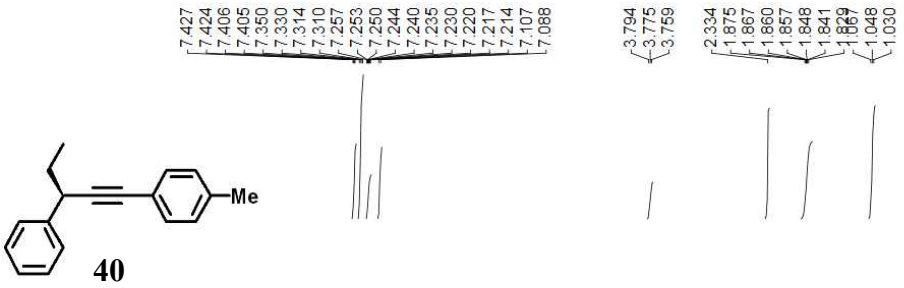
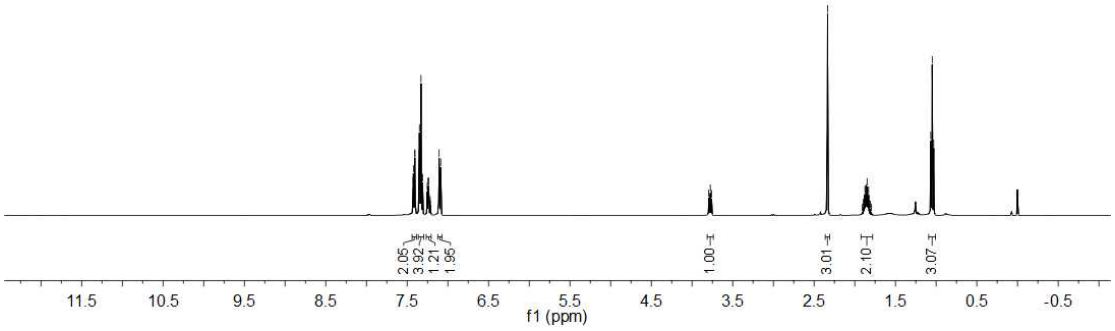
7.406
7.356
7.351
7.337
7.318
7.265
7.262
7.259
7.249
7.244
7.239
7.225
7.222
7.202
7.182
7.062
7.059
7.056
7.043
7.040
7.037
6.981
6.977
6.975
6.971
6.859
6.857
6.852
6.850
6.838
6.836
6.832
6.829
3.794
3.785
3.766
1.904
1.899
1.886
1.880
1.870
1.868
1.862
1.852
1.054
1.035
OMe
39
1.95
1.95
2.24
0.95
0.90
0.92
3.92
2.06
3.00
f1 (ppm)


159.255
141.937
129.228
128.408
127.537
126.647
124.213
116.472
114.291
91.318
83.240
77.318
77.000
76.683
55.245
39.930
31.638
11.851
OMe
39
f1 (ppm)


7.427
7.424
7.406
7.405
7.350
7.330
7.314
7.310
7.257
7.253
7.250
7.244
7.240
7.235
7.230
7.220
7.217
7.214
7.107
7.088
3.794
3.775
3.759
2.334
1.875
1.867
1.860
1.857
1.848
1.841
1.048
1.030
Me

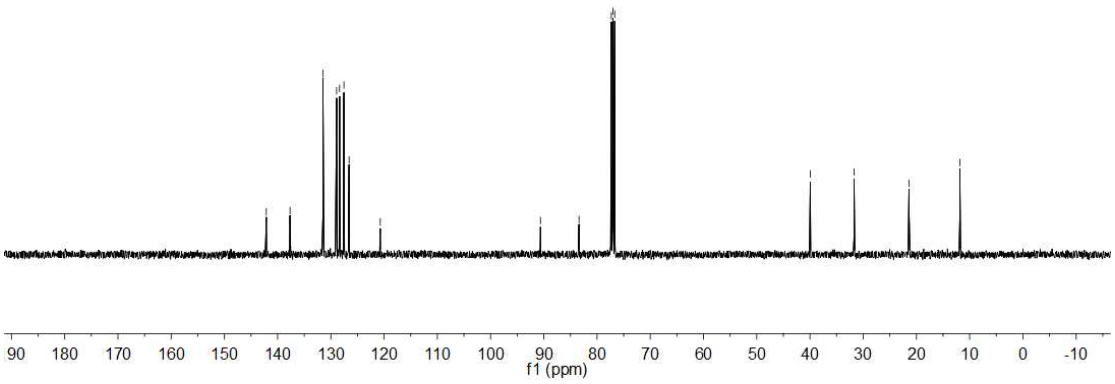
40

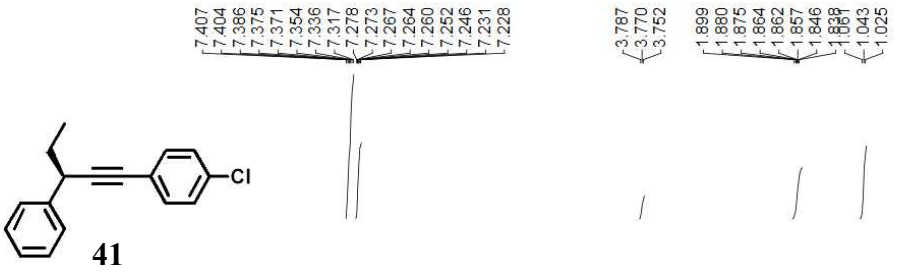

2.05
3.92
1.21
1.95
1.00
3.01
2.10
3.07
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)


142.134
137.669
131.488
128.923
128.366
127.543
126.577
120.724
90.616
83.383
77.318
77.000
76.683
39.946
31.709
21.404
11.842

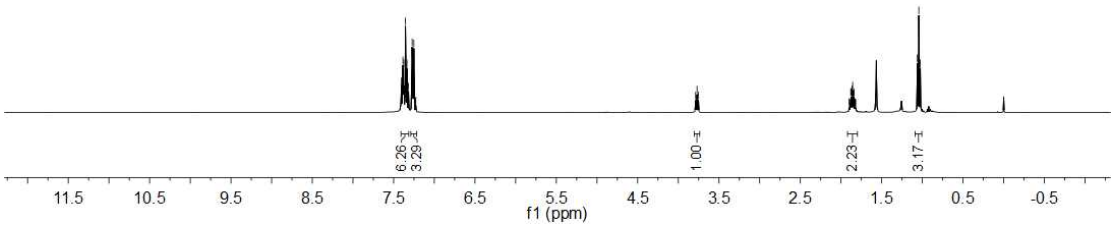

Me

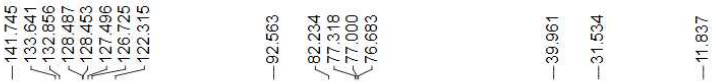
40

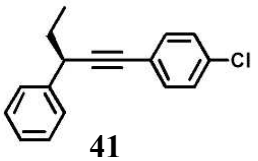

90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.407
7.404
7.386
7.375
7.371
7.354
7.336
7.317
7.278
7.273
7.267
7.264
7.260
7.252
7.246
7.231
7.228
3.787
3.770
3.752
1.899
1.880
1.875
1.864
1.862
1.857
1.846
1.043
1.025
Cl

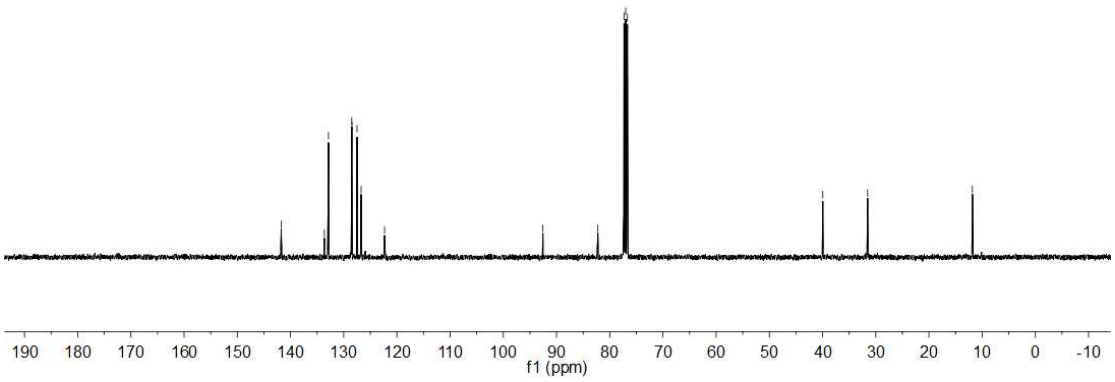
41

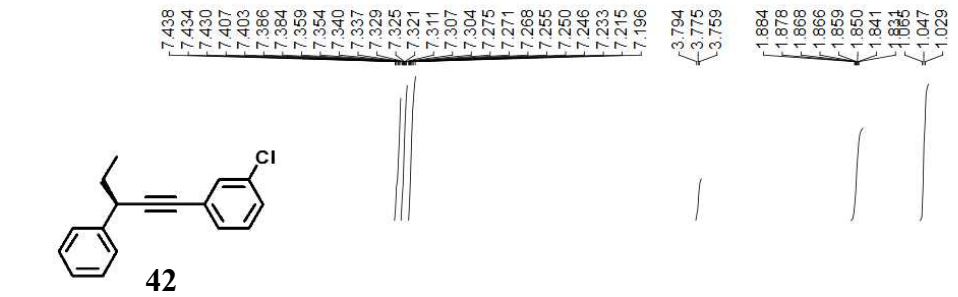

6.26
3.29
1.00
2.23
3.17
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)


141.745
133.641
132.856
128.487
128.453
127.496
126.725
122.315
92.563
82.234
77.318
77.000
76.683
39.961
31.534
11.837

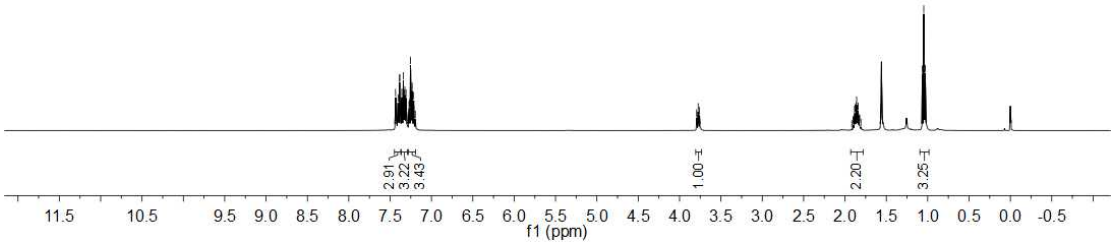

Cl

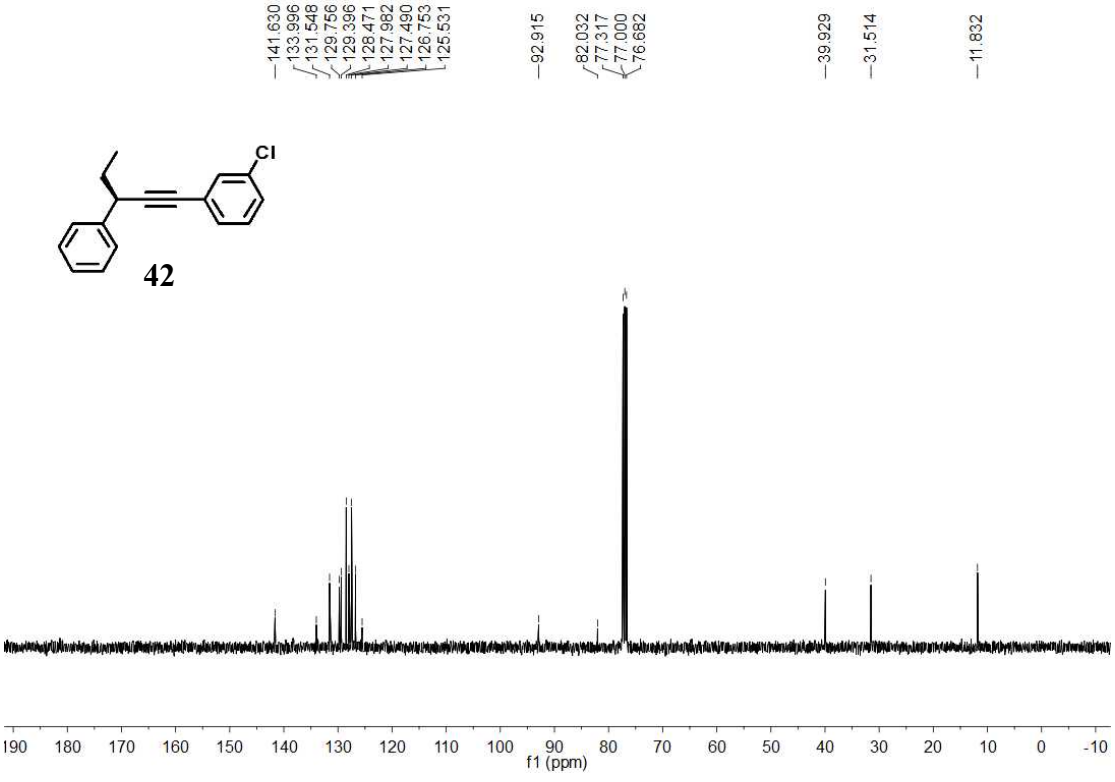
41


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

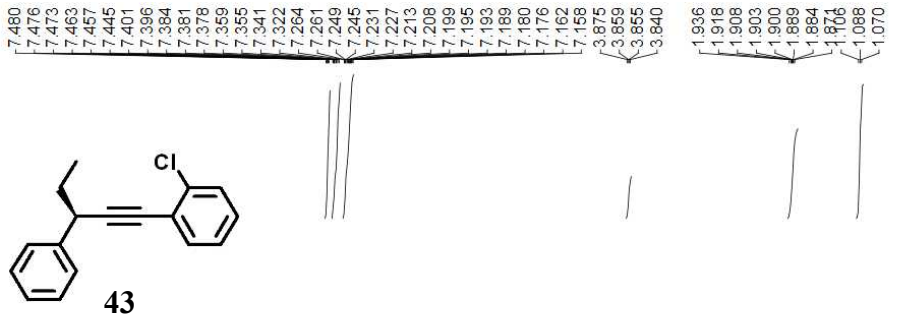

7.438
7.434
7.430
7.407
7.403
7.386
7.384
7.359
7.354
7.340
7.337
7.329
7.325
7.321
7.311
7.307
7.304
7.275
7.271
7.268
7.255
7.250
7.246
7.233
7.215
7.196
3.794
3.775
3.759
1.884
1.878
1.868
1.866
1.859
1.850
1.841
1.831
1.047
1.029
Cl

42

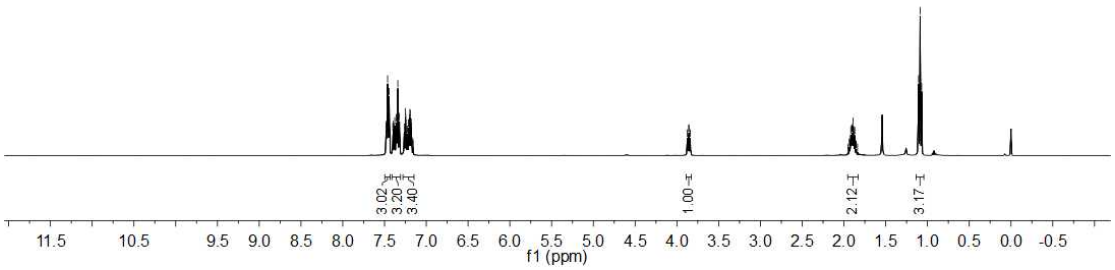

2.91
3.22
3.43
1.00
2.20
3.25
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


141.630
133.996
131.548
129.756
129.396
128.471
127.982
127.490
126.753
125.531
92.915
82.032
77.317
77.000
76.682
39.929
31.514
11.832
Cl
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

42


7.480
7.476
7.473
7.463
7.457
7.445
7.401
7.396
7.384
7.381
7.378
7.359
7.355
7.341
7.322
7.264
7.261
7.249
7.245
7.231
7.227
7.213
7.208
7.199
7.195
7.193
7.189
7.180
7.176
7.162
7.158
3.875
3.859
3.855
3.840
1.936
1.918
1.908
1.903
1.900
1.889
1.884
1.088
1.070
Cl

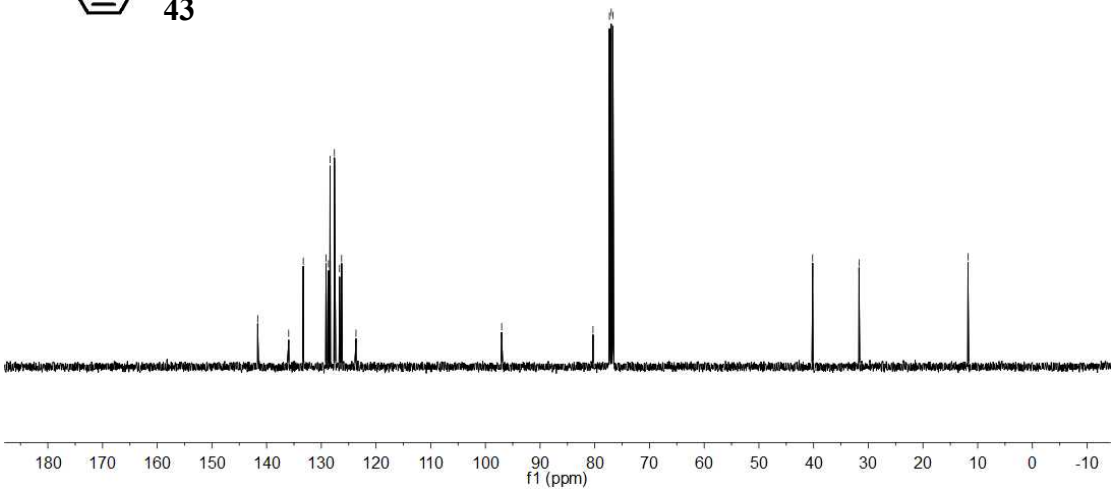
43


3.02
3.20
3.40
1.00
2.12
3.17
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


141.630
135.965
133.296
129.143
128.691
128.409
127.606
126.677
126.292
123.661
97.027
80.325
77.318
77.000
76.683
40.179
31.692
11.776

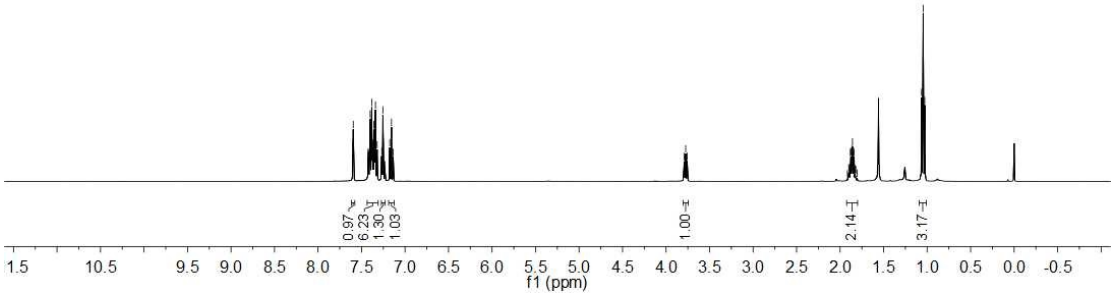

Cl

43

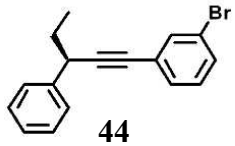

180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.599
7.595
7.591
7.426
7.423
7.421
7.419
7.404
7.401
7.383
7.374
7.371
7.368
7.358
7.352
7.349
7.340
7.321
7.271
7.268
7.264
7.255
7.250
7.244
7.235
7.232
7.229
7.176
7.156
7.136
3.793
3.774
3.758
1.901
1.895
1.883
1.876
1.866
1.864
1.858
1.848
1.046
1.027
Br

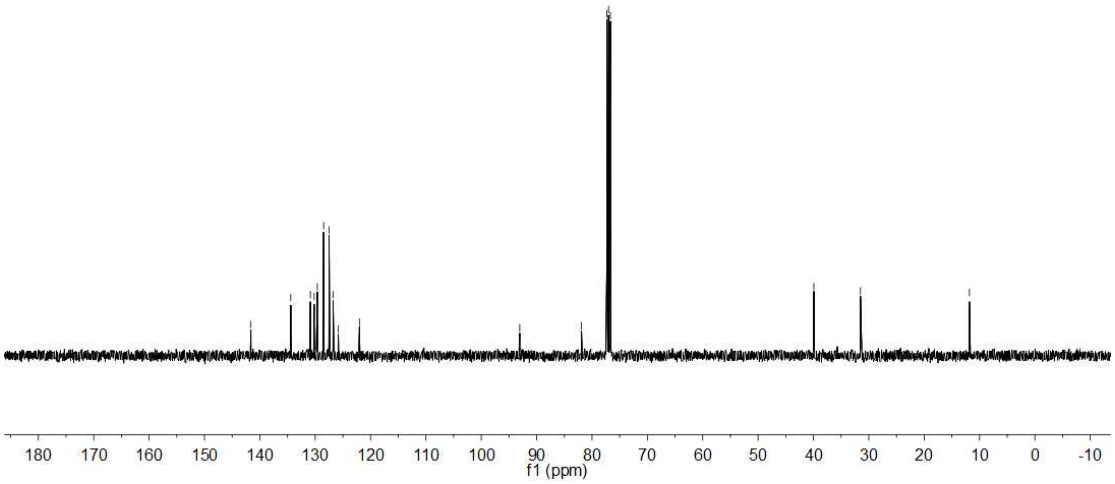
44

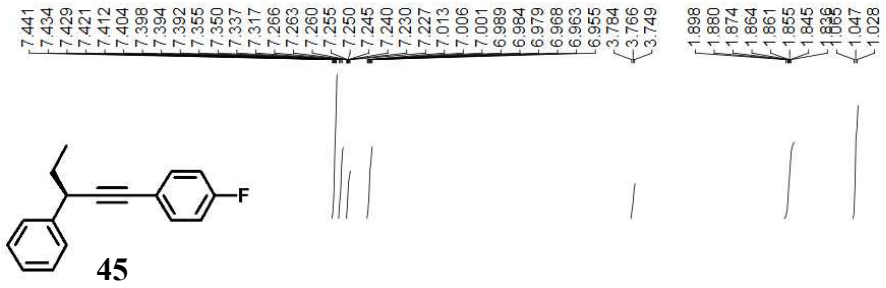

0.97
6.23
1.30
1.03
1.00
2.14
3.17
1.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


141.615
134.411
130.865
130.186
129.619
128.472
127.487
126.757
125.821
122.007
93.053
81.897
77.317
77.000
76.682
39.930
31.509
11.834

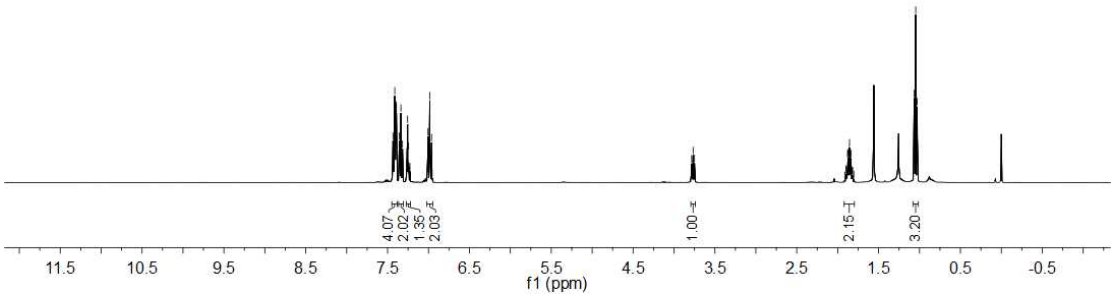

Br

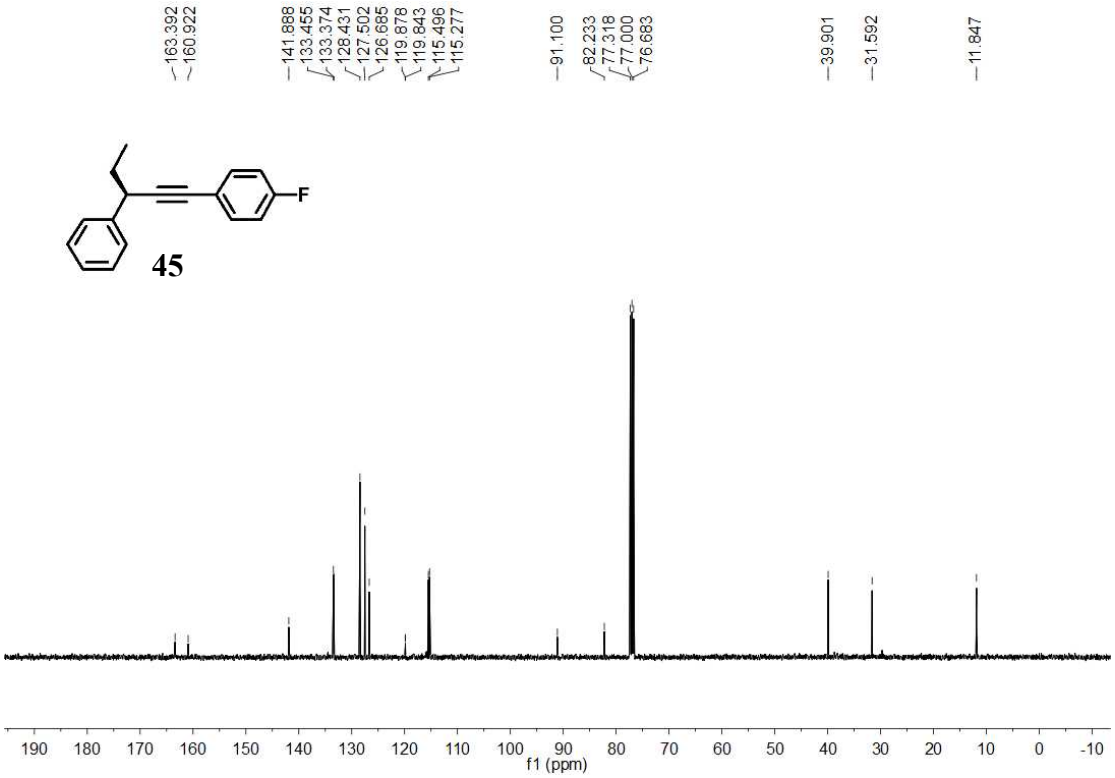
44


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

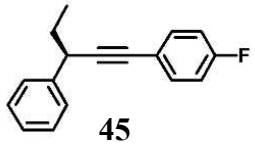

7.441
7.434
7.429
7.421
7.412
7.404
7.398
7.394
7.392
7.355
7.350
7.337
7.317
7.266
7.263
7.260
7.255
7.250
7.245
7.240
7.230
7.227
7.013
7.006
7.001
6.989
6.984
6.979
6.968
6.963
6.955
3.784
3.766
3.749
1.898
1.880
1.874
1.864
1.861
1.855
1.845
1.047
1.028
F

45


4.07
2.02
1.35
2.03
1.00
2.15
3.20
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

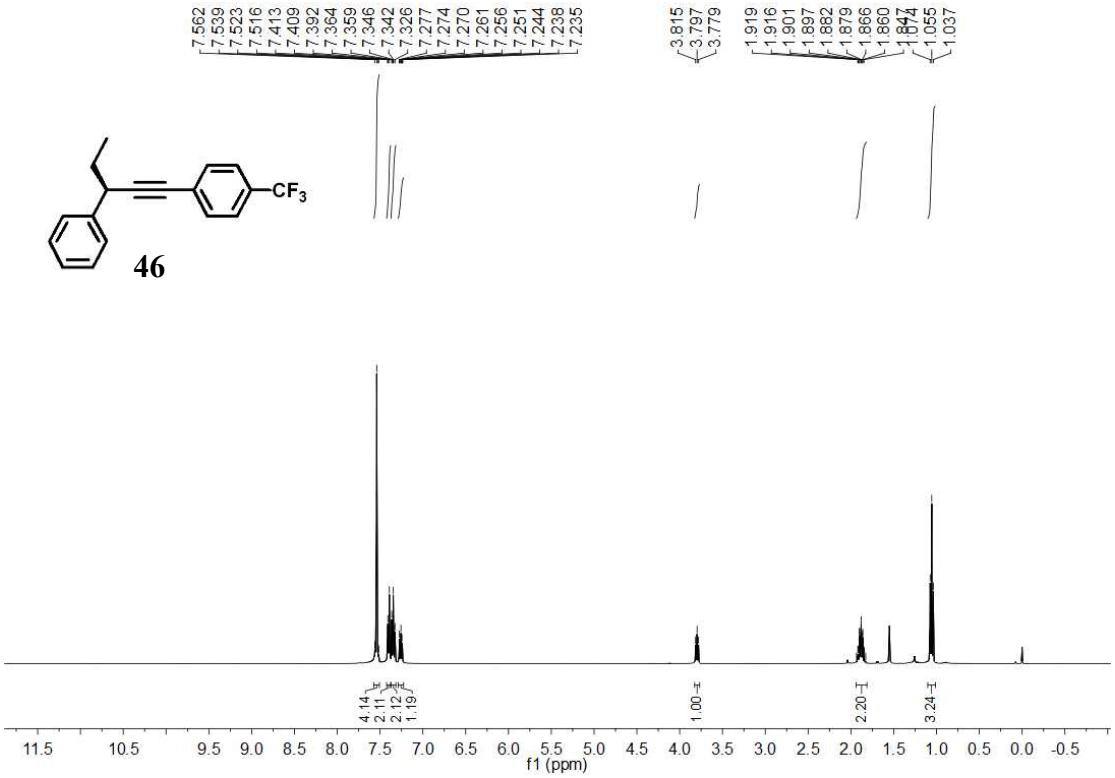

163.392
160.922
141.888
133.455
133.374
128.431
127.502
126.685
119.878
119.843
115.496
115.277
91.100
82.233
77.318
77.000
76.683
39.901
31.592
11.847
F
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

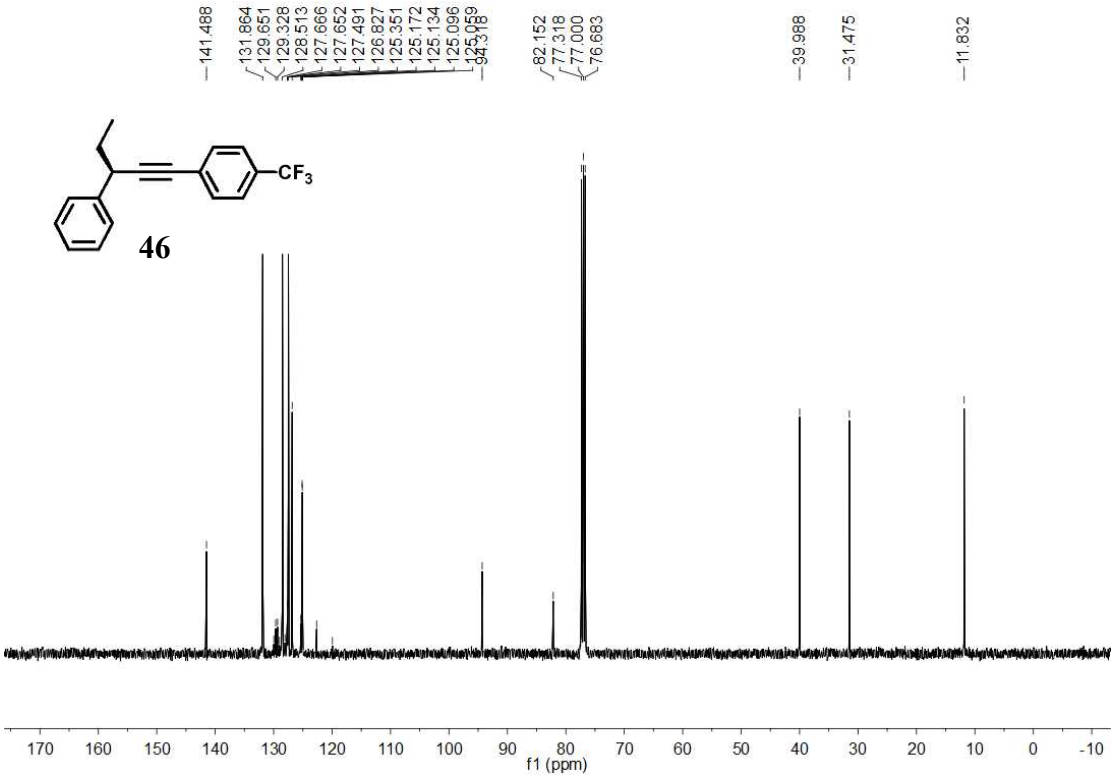
45

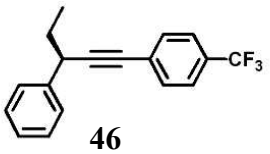

F

45

-112.068
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
f1 (ppm)
-120
-140
-160
-180
-200

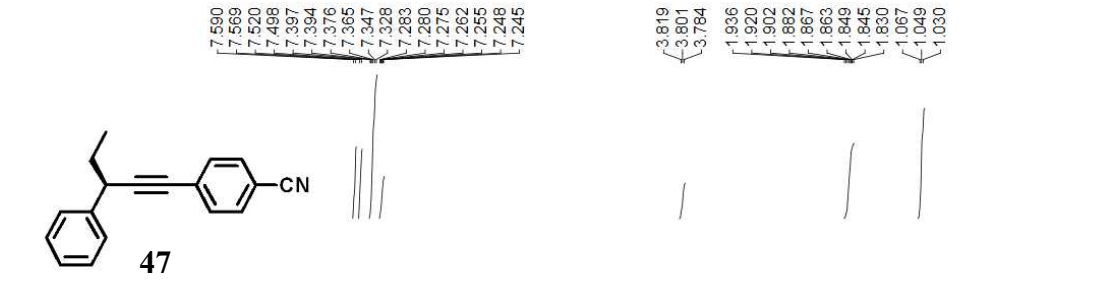

7.562
7.539
7.523
7.516
7.413
7.409
7.392
7.364
7.359
7.346
7.342
7.326
7.277
7.274
7.270
7.261
7.256
7.251
7.244
7.238
7.235
3.815
3.797
3.779
1.919
1.916
1.901
1.897
1.882
1.879
1.866
1.860
1.055
1.037
CF3
46
4.14
2.11
2.12
1.19
1.00
2.20
3.24
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


141.488
131.864
129.651
129.328
128.513
127.666
127.652
127.491
126.827
125.351
125.172
125.134
125.096
125.059
94.318
82.152
77.318
77.000
76.683
39.988
31.475
11.832
CF3
46
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

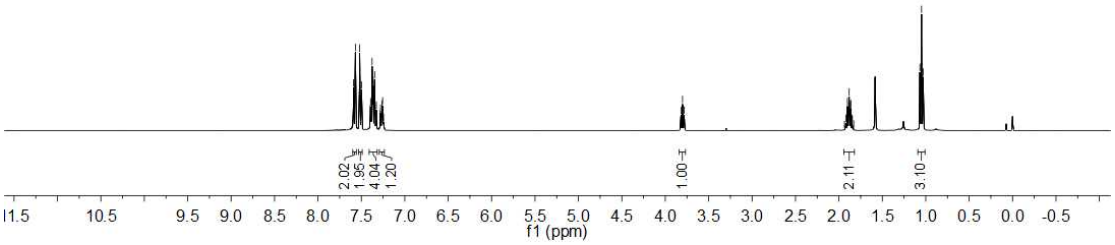

CF3

46

-62.731
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180
-200
f1 (ppm)


7.590
7.569
7.520
7.498
7.397
7.394
7.376
7.365
7.347
7.328
7.283
7.280
7.275
7.262
7.255
7.248
7.245
3.819
3.801
3.784
1.936
1.920
1.902
1.882
1.867
1.863
1.849
1.845
1.830
1.067
1.049
1.030
CN

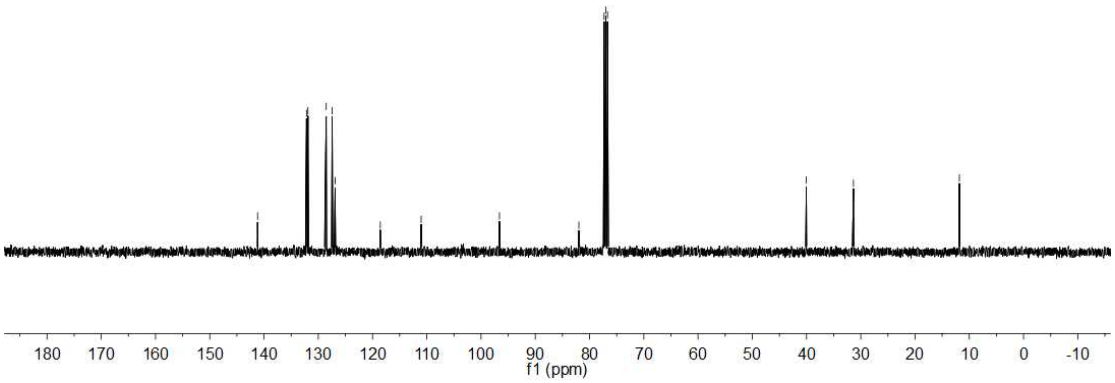
47

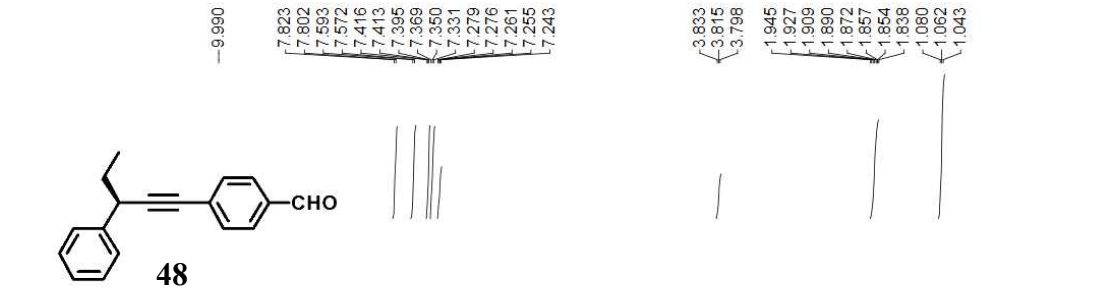

2.02
1.95
4.04
1.20
1.00
2.11
3.10
f1 (ppm)


141.188
132.170
131.907
128.544
127.442
111.036
96.604
81.963
77.317
77.000
76.682
40.039
31.352
11.828

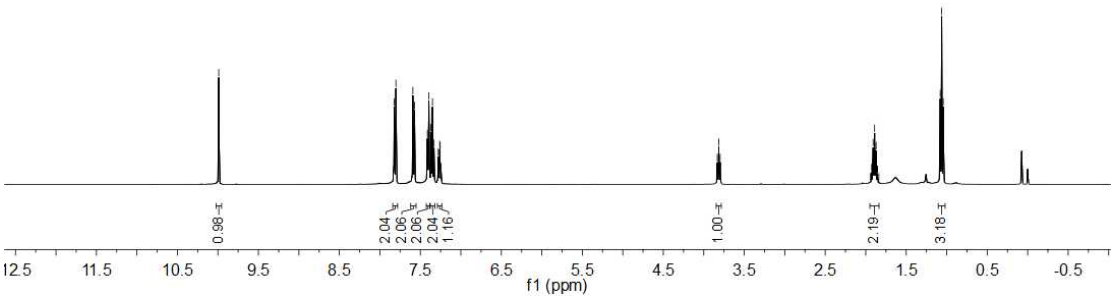

CN

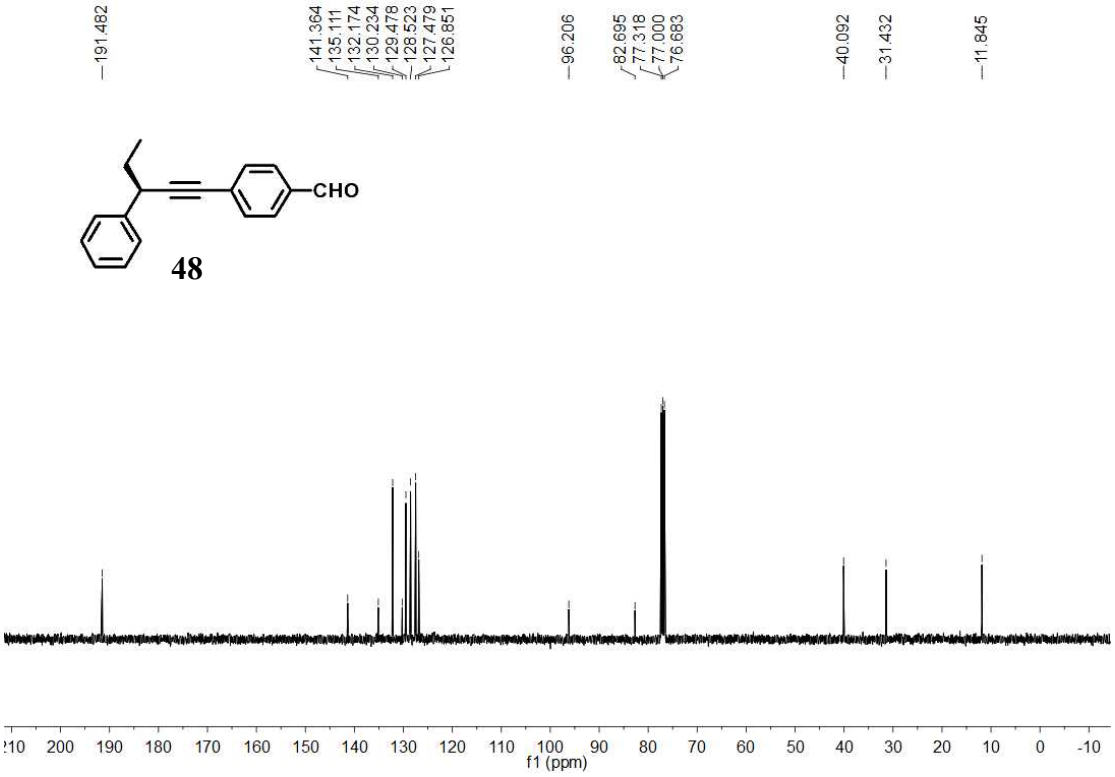
47


f1 (ppm)

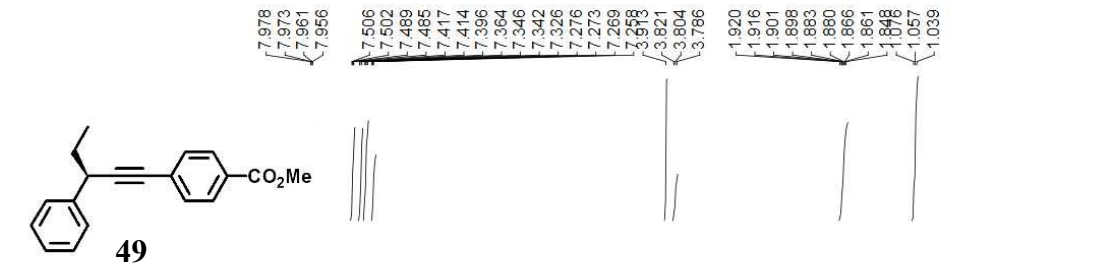

9.990
7.823
7.802
7.593
7.572
7.416
7.413
7.395
7.369
7.350
7.331
7.279
7.276
7.261
7.255
7.243
3.833
3.815
3.798
1.945
1.927
1.909
1.890
1.872
1.857
1.854
1.838
1.080
1.062
1.043
CHO

48

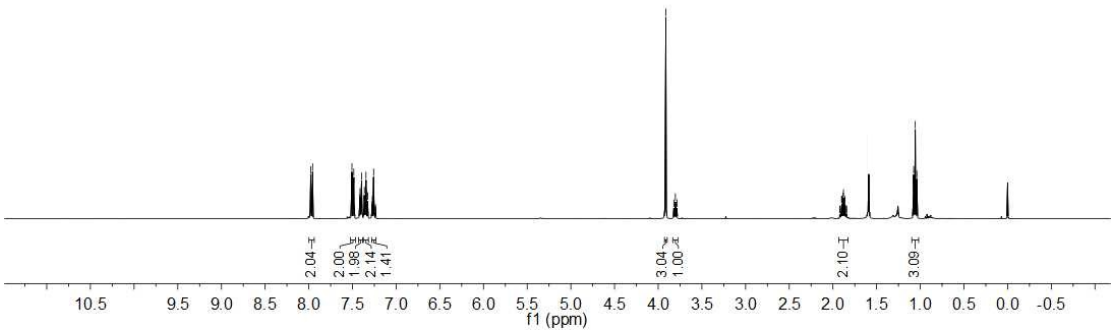

0.98
2.04
2.06
2.06
2.04
1.16
1.00
2.19
3.18
f1 (ppm)

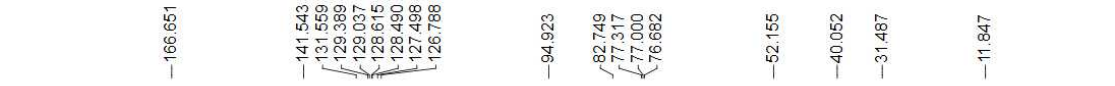

191.482
141.364
135.111
132.174
130.234
129.478
128.523
127.479
126.851
96.206
82.695
77.318
77.000
76.683
40.092
31.432
11.845
CHO
f1 (ppm)

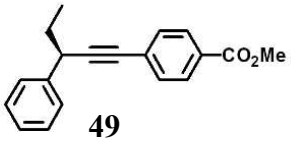
48


7.978
7.973
7.961
7.956
7.506
7.502
7.489
7.485
7.417
7.414
7.396
7.364
7.346
7.342
7.326
7.276
7.273
7.269
7.258
3.821
3.804
3.786
1.920
1.916
1.901
1.898
1.883
1.880
1.866
1.861
1.057
1.039
CO2Me

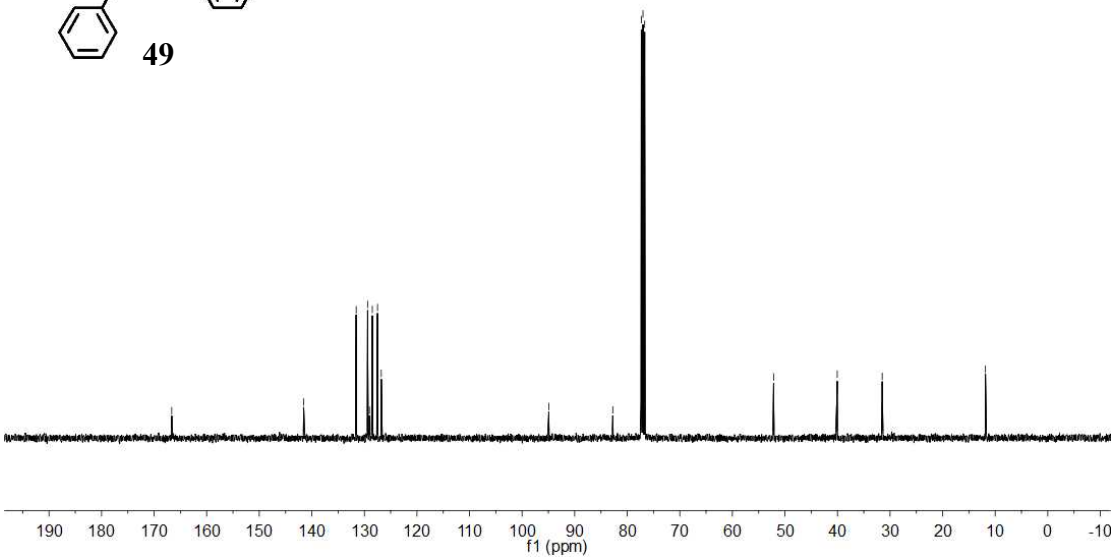
49

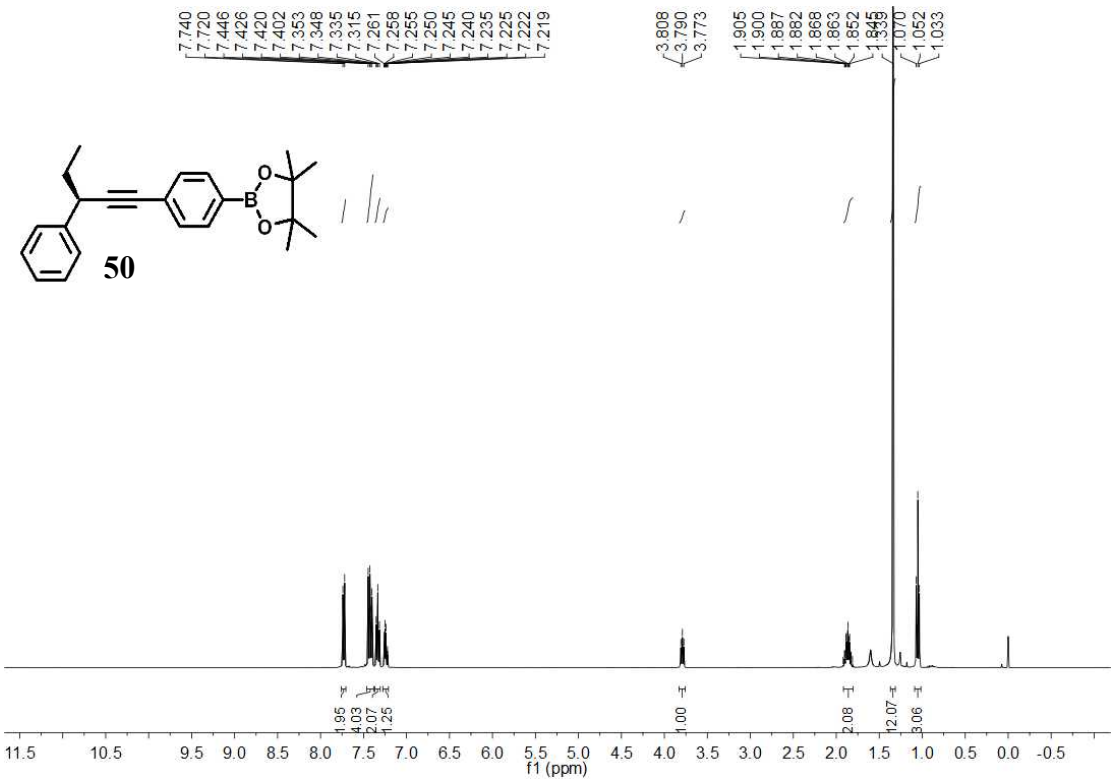

2.04
2.00
1.98
2.14
1.41
3.04
1.00
2.10
3.09
10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

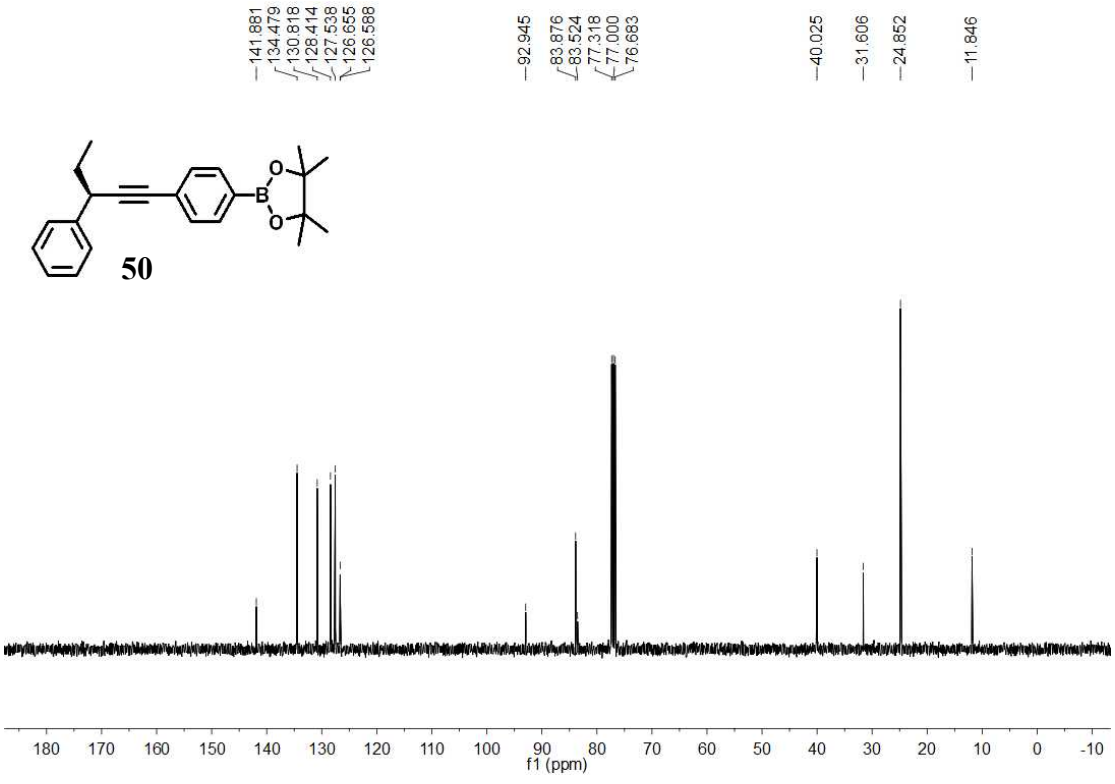

166.651
141.543
131.559
129.389
129.037
128.615
128.490
127.498
126.788
94.923
82.749
77.317
77.000
76.682
52.155
40.052
31.487
11.847

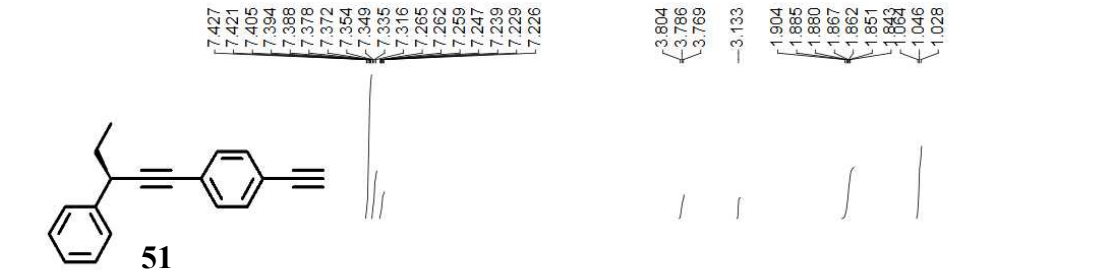

CO2Me

49

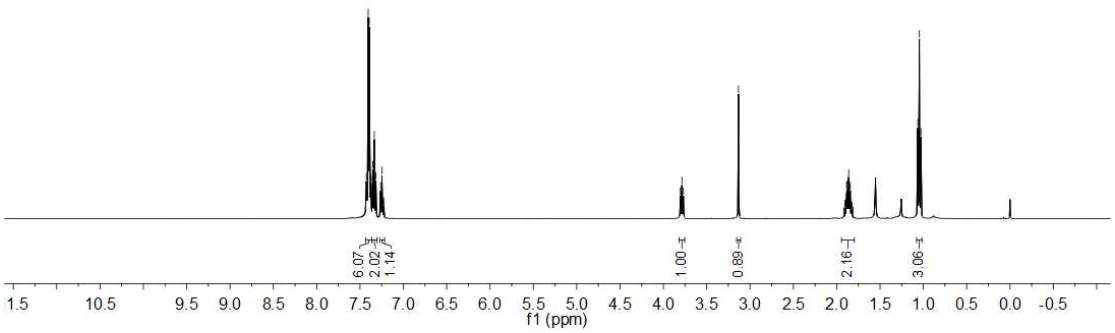

190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

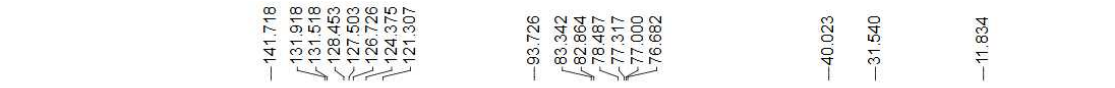

7.740
7.720
7.446
7.426
7.420
7.402
7.353
7.348
7.335
7.315
7.261
7.258
7.255
7.250
7.245
7.240
7.235
7.225
7.222
7.219
3.808
3.790
3.773
1.905
1.900
1.887
1.882
1.868
1.863
1.852
1.070
1.052
1.033
50
1.95
4.03
2.07
1.25
1.00
2.08
12.07
3.06
f1 (ppm)


141.881
134.479
130.818
128.414
127.538
126.655
126.568
92.945
83.876
83.524
77.318
77.000
76.683
40.025
31.606
24.852
11.846
50
f1 (ppm)

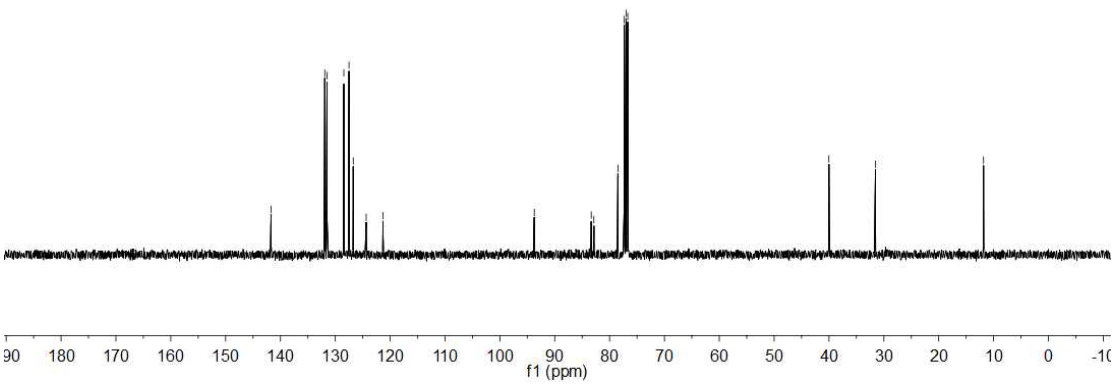

7.427
7.421
7.405
7.394
7.388
7.378
7.372
7.354
7.349
7.335
7.316
7.265
7.262
7.259
7.247
7.239
7.229
7.226
3.804
3.786
3.769
3.133
1.904
1.885
1.880
1.867
1.862
1.851
1.046
1.028

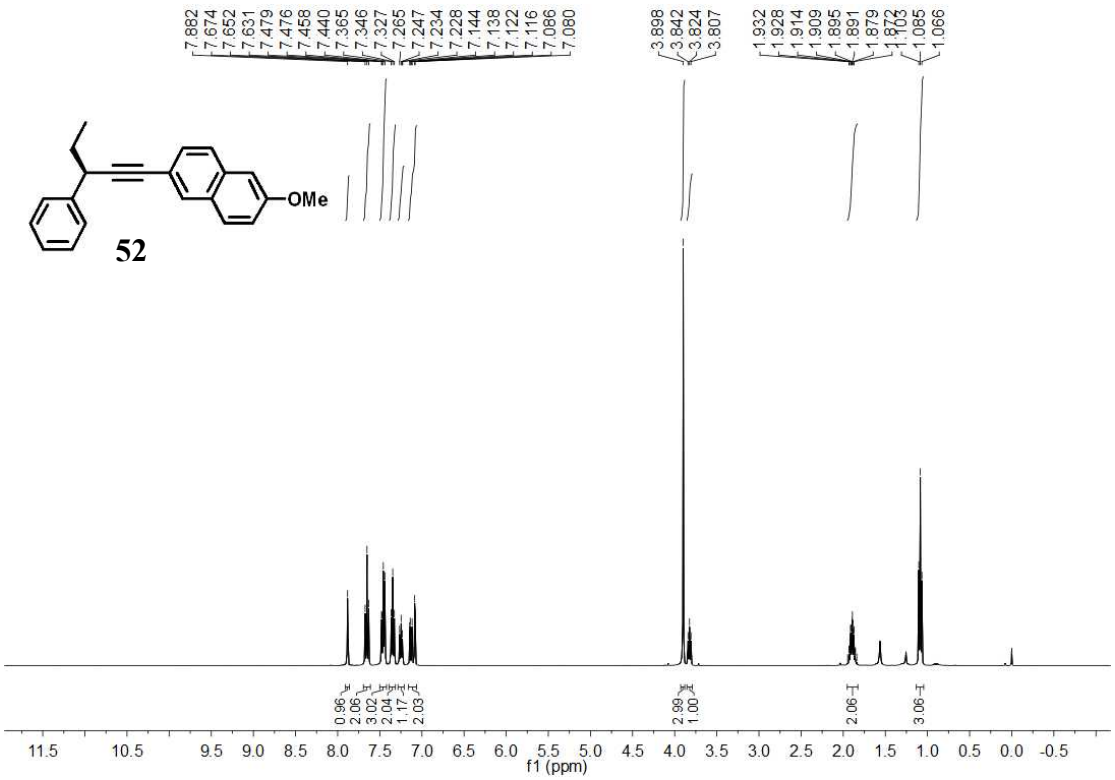
51

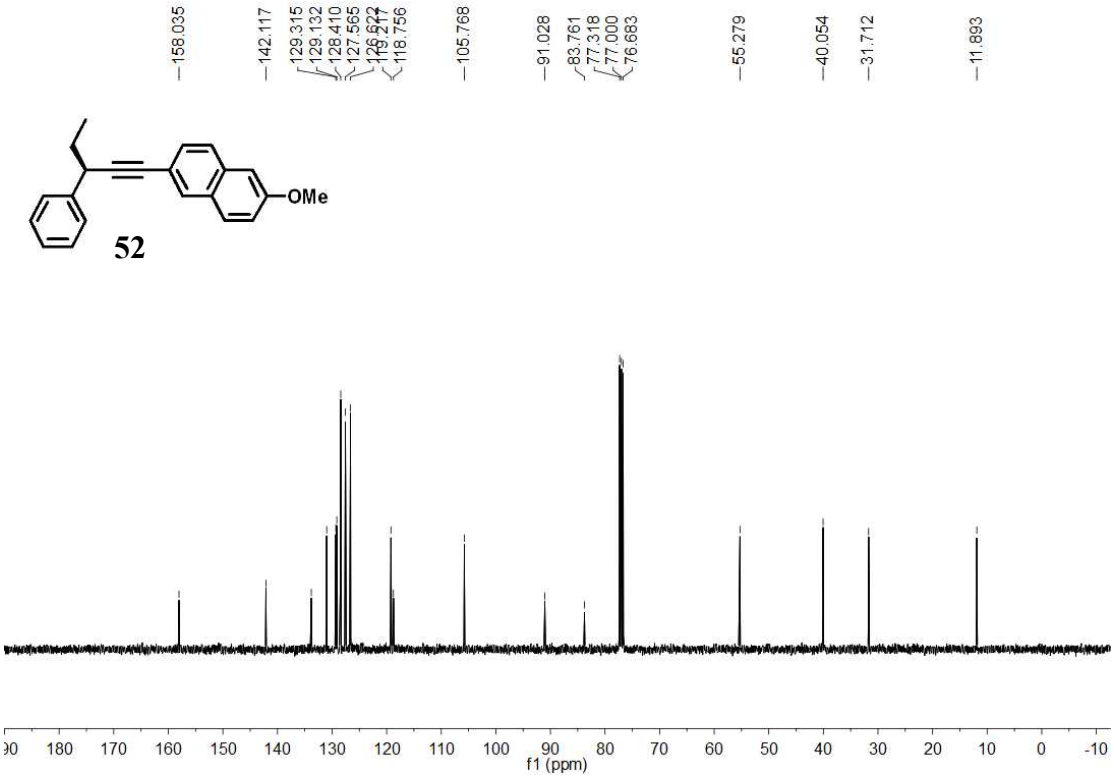

6.07
2.02
1.14
1.00
0.89
2.16
3.06
f1 (ppm)


141.718
131.918
131.518
128.453
127.503
126.726
124.375
121.307
93.726
83.342
82.864
78.487
77.317
77.000
76.682
40.023
31.540
11.834

51

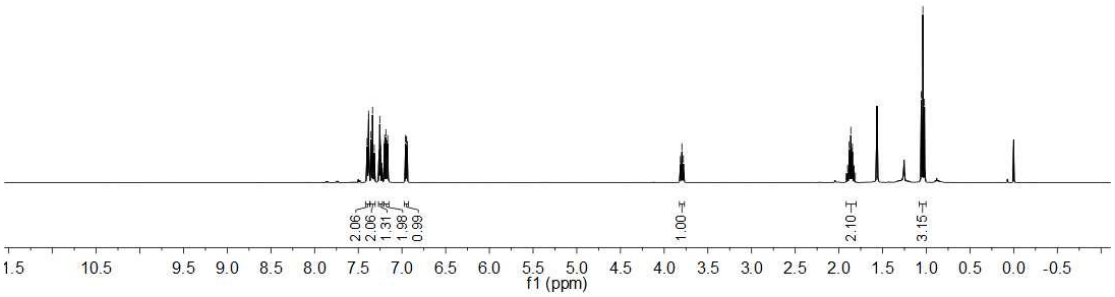

f1 (ppm)


7.882
7.674
7.652
7.631
7.479
7.476
7.458
7.440
7.365
7.346
7.327
7.265
7.247
7.234
7.228
7.144
7.138
7.122
7.116
7.086
7.080
3.898
3.842
3.824
3.807
1.932
1.928
1.914
1.909
1.895
1.891
1.879
1.872
1.103
1.085
1.066
OMe
52
0.96
2.06
3.02
2.04
1.17
2.03
2.99
1.00
2.06
3.06
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

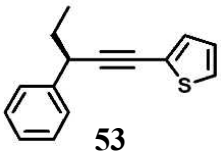

158.035
142.117
129.315
129.132
128.410
127.565
126.622
119.217
118.756
105.768
91.028
83.761
77.318
77.000
76.683
55.279
40.054
31.712
11.893
OMe
52
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.404
7.400
7.396
7.382
7.380
7.355
7.350
7.345
7.337
7.333
7.321
7.317
7.268
7.264
7.260
7.255
7.246
7.241
7.232
7.228
7.225
7.200
7.198
7.188
7.185
7.172
7.170
7.163
7.161
6.960
6.951
6.947
6.938
3.814
3.797
3.779
1.917
1.901
1.882
1.864
1.849
1.845
1.830
1.827
1.812
1.058
1.039
1.021

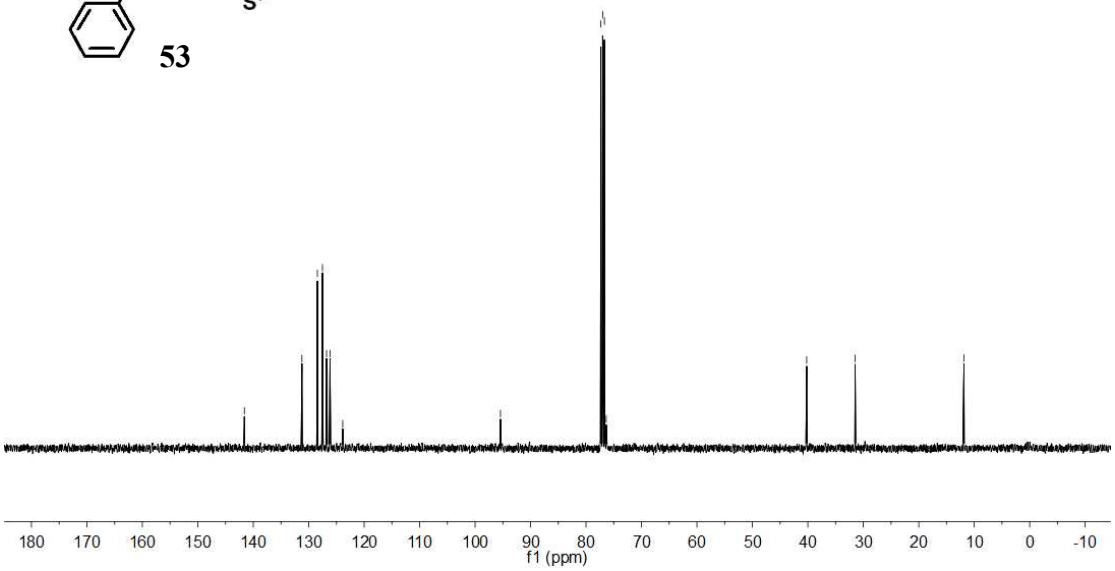
53

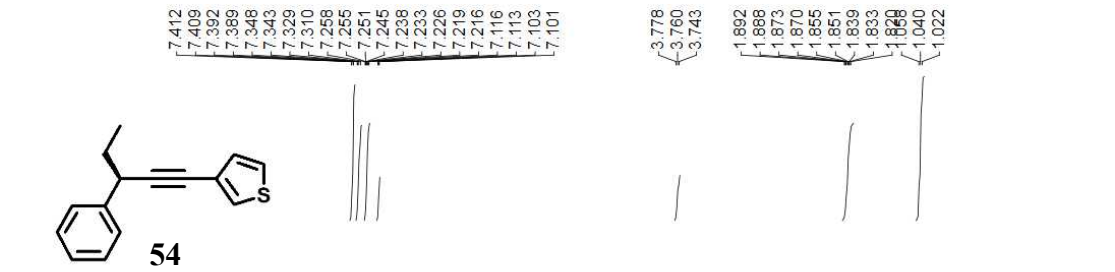

2.06
2.06
1.31
1.98
0.99
1.00
2.10
3.15
1.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


141.597
131.232
128.445
127.526
126.783
126.721
126.155
123.872
95.427
77.317
77.000
76.682
76.355
40.213
31.478
11.855

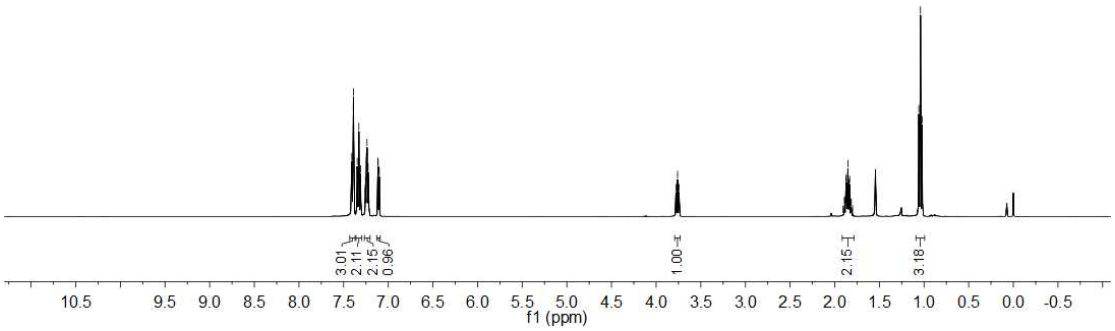


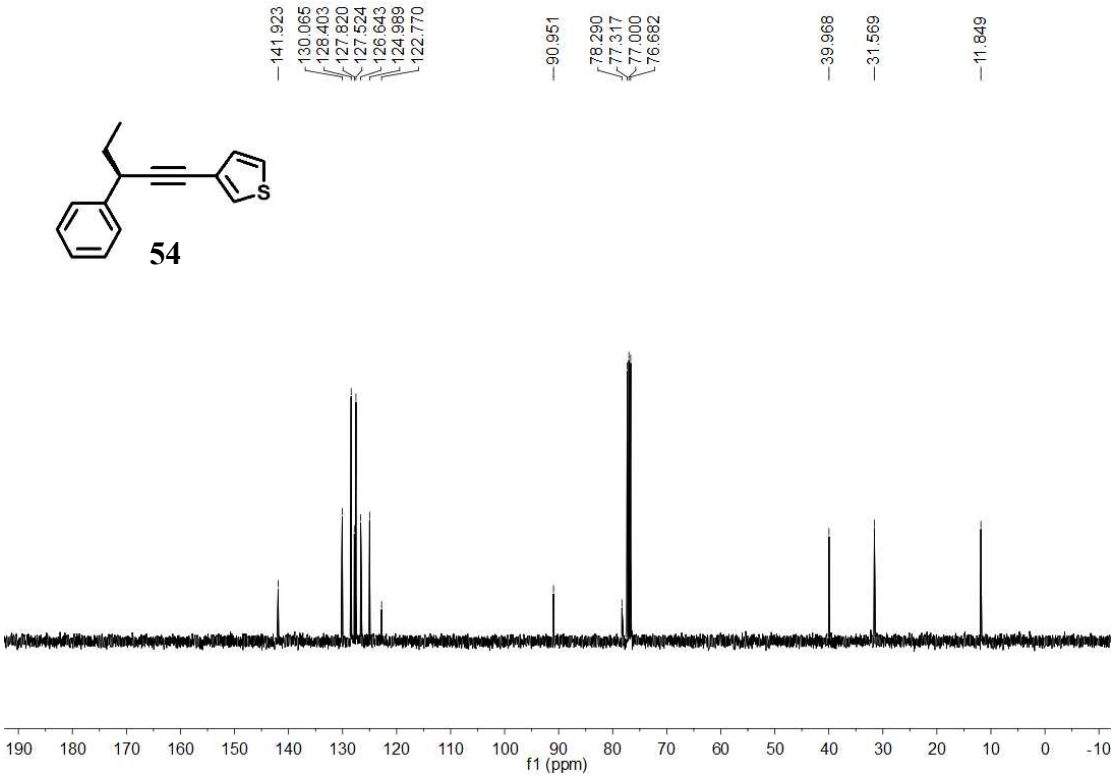
53


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

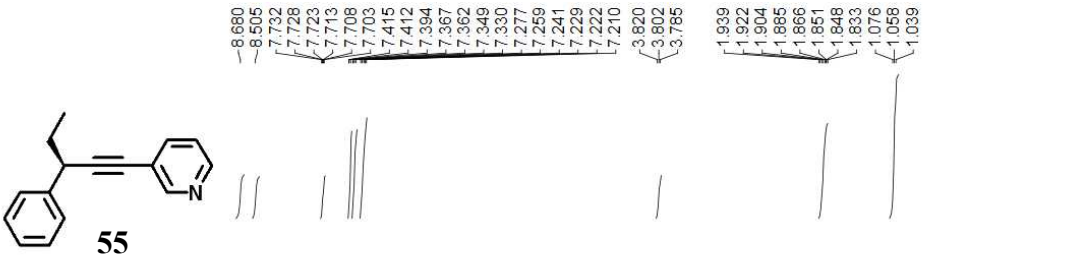

7.412
7.409
7.392
7.389
7.348
7.343
7.329
7.310
7.258
7.255
7.251
7.245
7.238
7.233
7.226
7.219
7.216
7.116
7.113
7.103
7.101
3.778
3.760
3.743
1.892
1.888
1.873
1.870
1.855
1.851
1.839
1.833
1.040
1.022

54


3.01
2.11
2.15
0.96
1.00
2.15
3.18
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

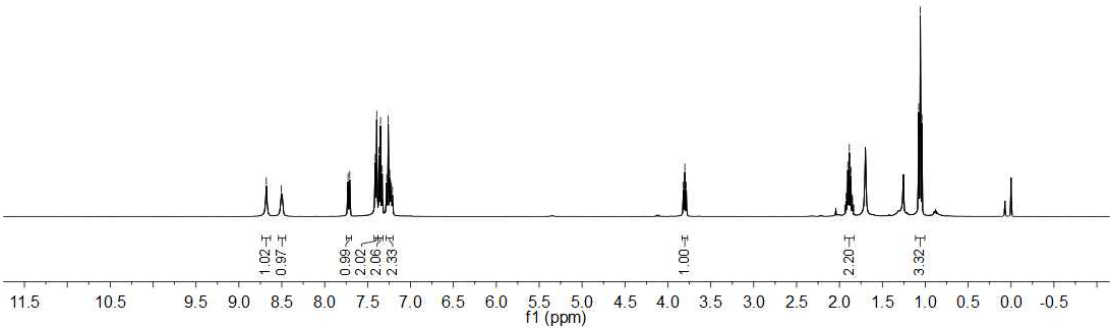

141.923
130.065
128.403
127.820
127.524
126.643
124.989
122.770
90.951
78.290
77.317
77.000
76.682
39.968
31.569
11.849
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

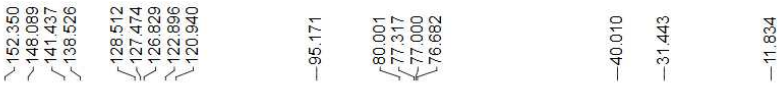
54

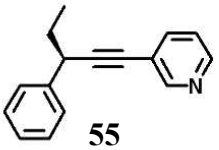

8.680
8.505
7.732
7.728
7.723
7.713
7.708
7.703
7.415
7.412
7.394
7.367
7.362
7.349
7.330
7.277
7.259
7.241
7.229
7.222
7.210
3.820
3.802
3.785
1.939
1.922
1.904
1.885
1.866
1.851
1.848
1.833
1.076
1.058
1.039

N

55

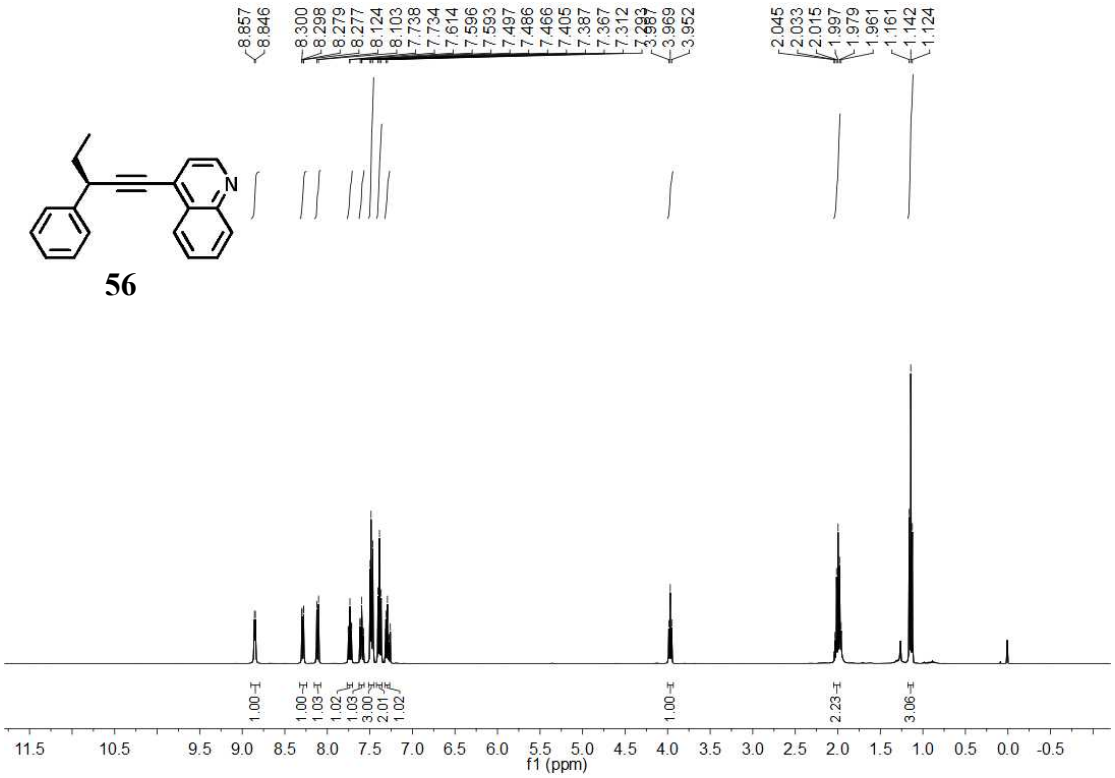

1.02
0.97
0.99
2.02
2.06
2.33
1.00
2.20
3.32
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

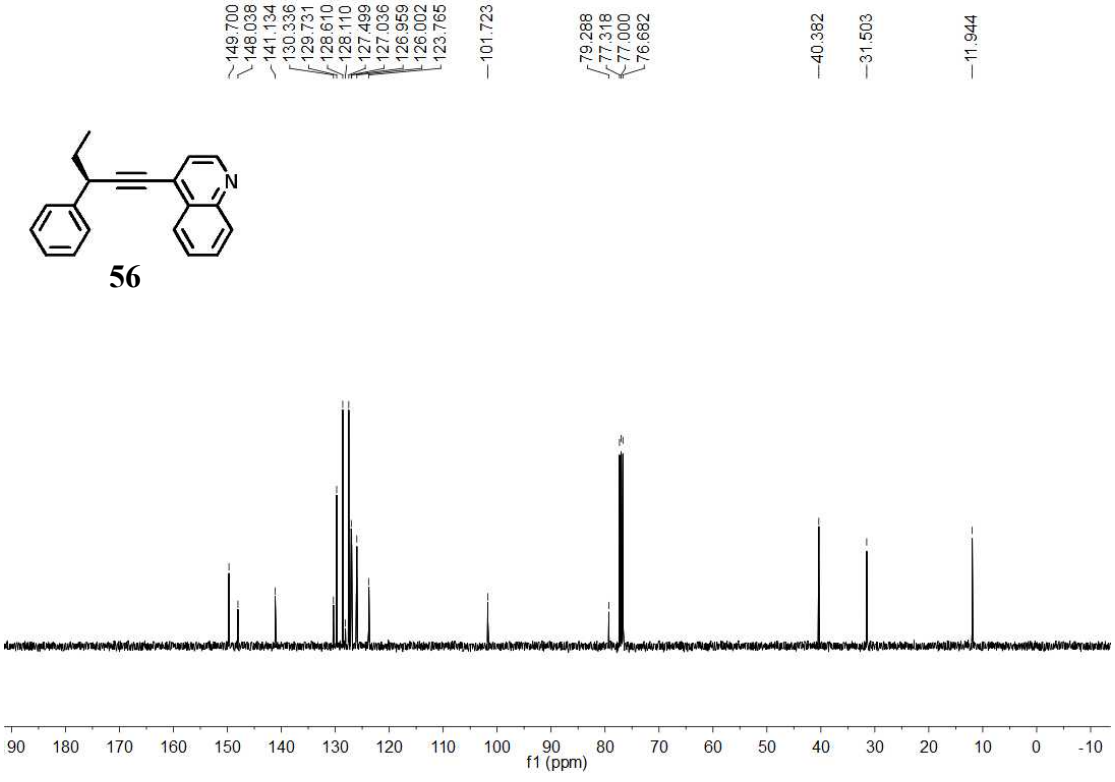

152.350
148.089
141.437
138.526
128.512
127.474
126.829
122.896
120.940
95.171
80.001
77.317
77.000
76.682
40.010
31.443
11.834

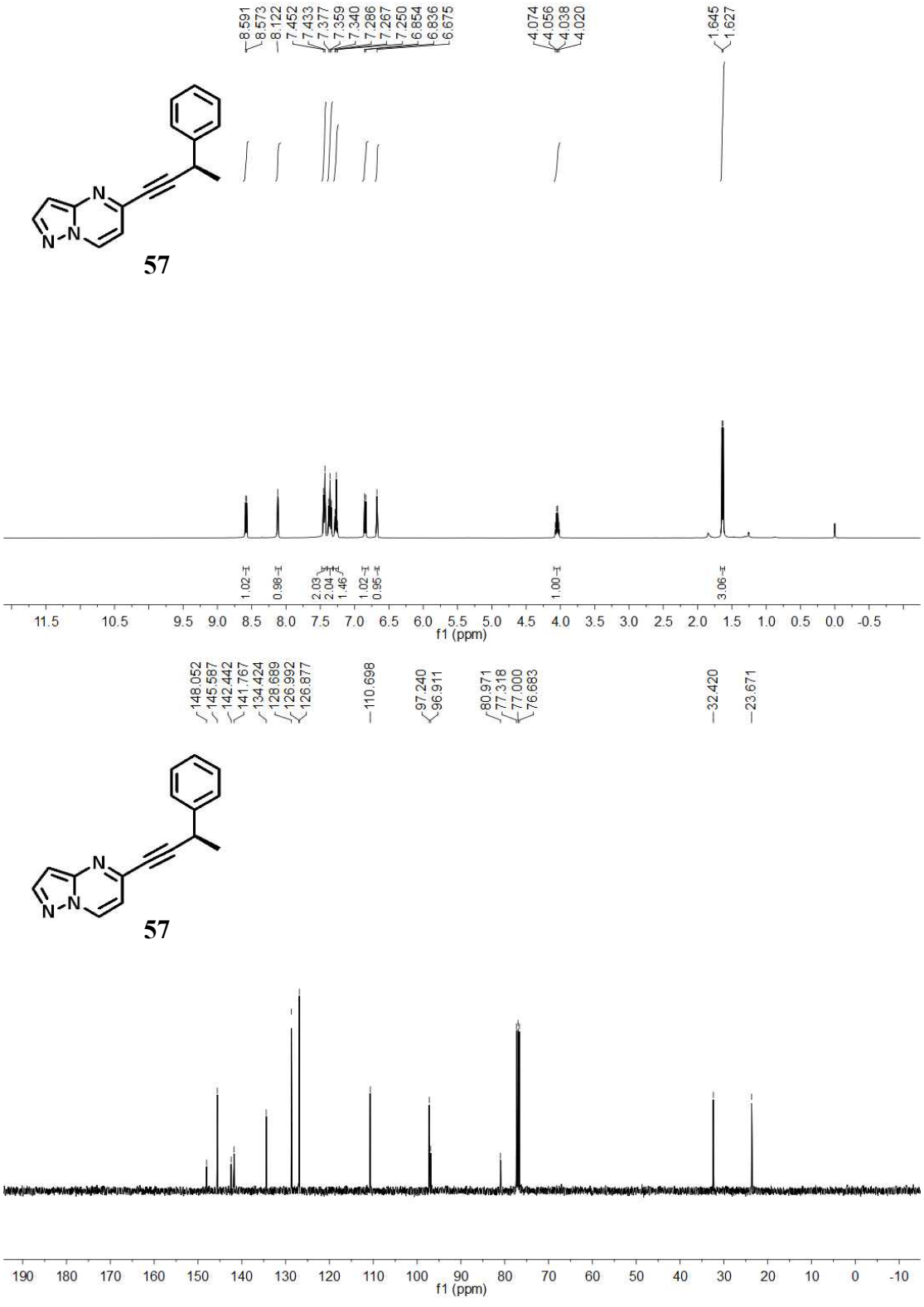

N

55

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

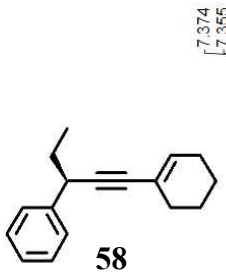

8.857
8.846
8.300
8.298
8.279
8.277
8.124
8.103
7.738
7.734
7.614
7.596
7.593
7.497
7.486
7.466
7.405
7.387
7.367
7.312
7.293
3.987
3.969
3.952
2.045
2.033
2.015
1.997
1.979
1.961
1.161
1.142
1.124
N
56
1.00
1.00
1.03
1.02
1.03
3.00
2.01
1.02
1.00
2.23
3.06
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


149.700
148.038
141.134
130.336
129.731
128.610
128.110
127.499
127.036
126.959
126.002
123.765
101.723
79.288
77.318
77.000
76.682
40.382
31.503
11.944
N
56
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


8.591
8.573
8.122
7.452
7.433
7.377
7.359
7.340
7.286
7.267
7.250
6.854
6.836
6.675
4.074
4.056
4.038
4.020
1.645
1.627
1.02
0.98
2.03
2.04
1.46
1.02
0.96
1.00
3.06
f1 (ppm)
148.052
145.587
142.442
141.767
134.424
128.689
126.992
126.877
110.698
97.240
96.911
80.971
77.318
77.000
76.683
32.420
23.671
f1 (ppm)

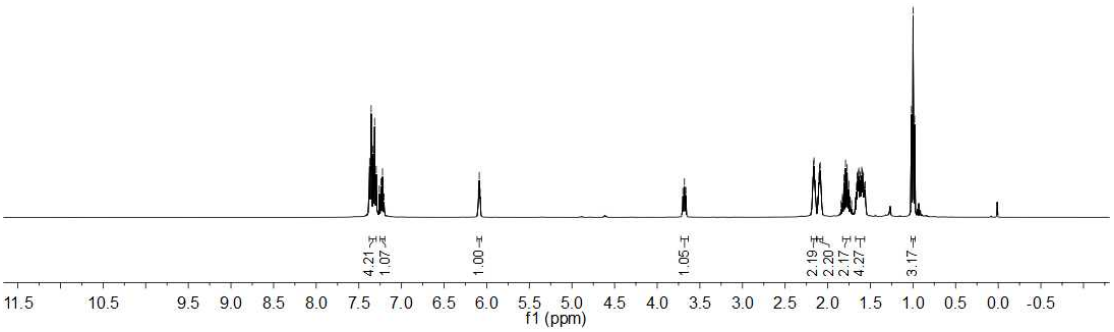
57

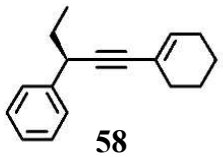
57



58

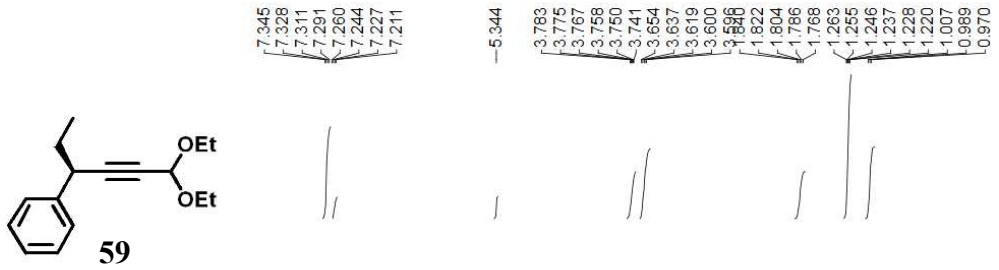
7.374
7.355
7.333
7.328
7.315
7.296
7.260
7.240
7.223
7.205
6.097
6.092
6.087
6.083
6.077
3.699
3.681
3.664
2.166
2.161
2.096
2.087
1.791
1.772
1.635
1.601
1.018
0.999
0.981


4.21
1.07
1.00
1.05
2.19
2.20
2.17
4.27
3.17
11.5 10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

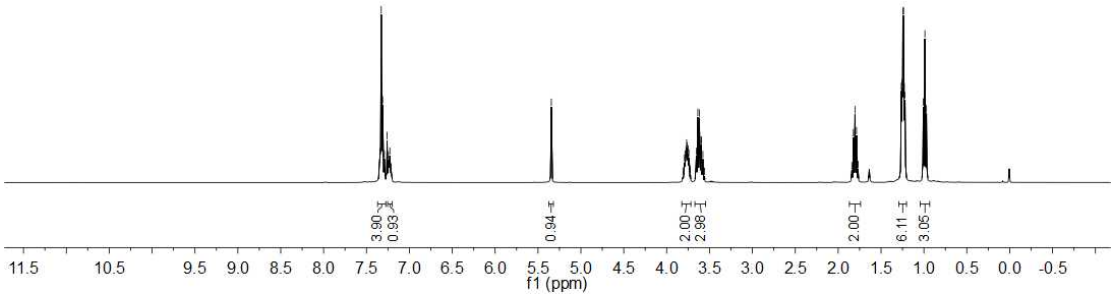


58

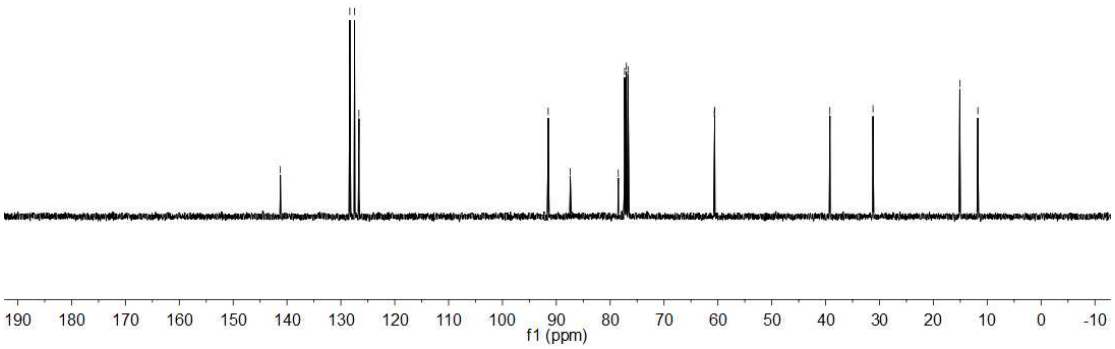
142.390
133.546
128.283
127.478
126.448
120.924
88.452
85.152
77.317
77.000
76.682
39.816
31.764
29.595
25.554
22.373
21.572
11.788
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

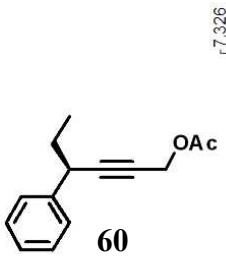


59



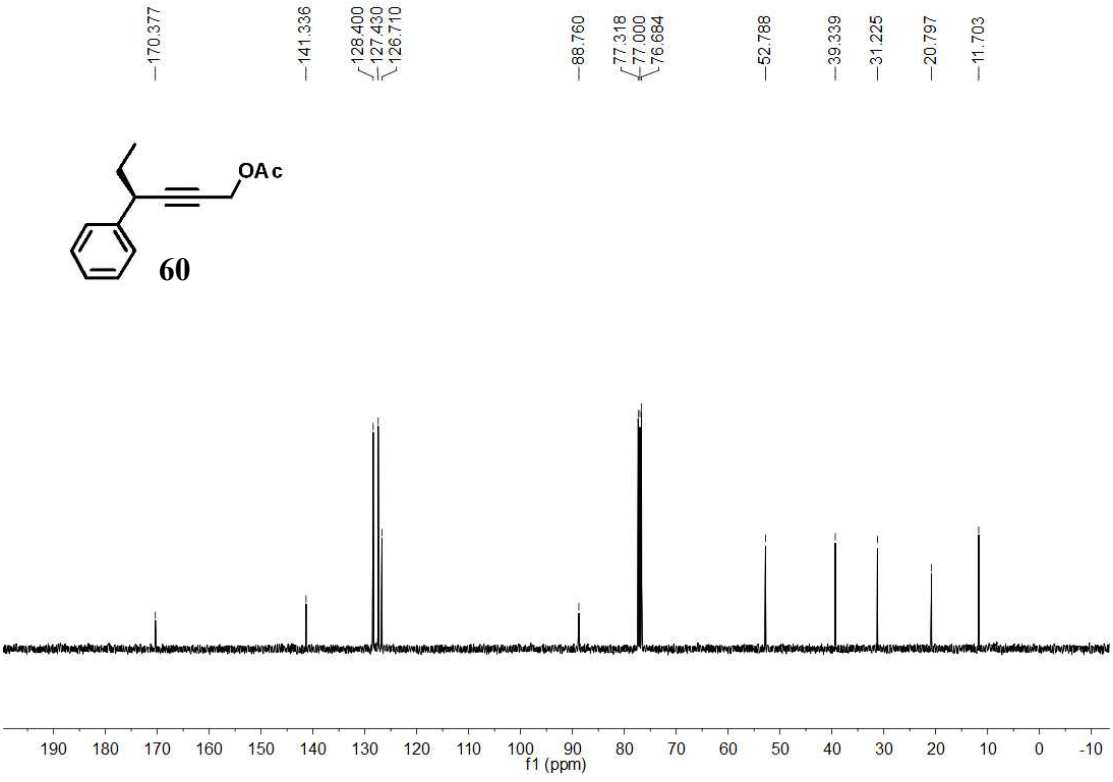
59




OAc

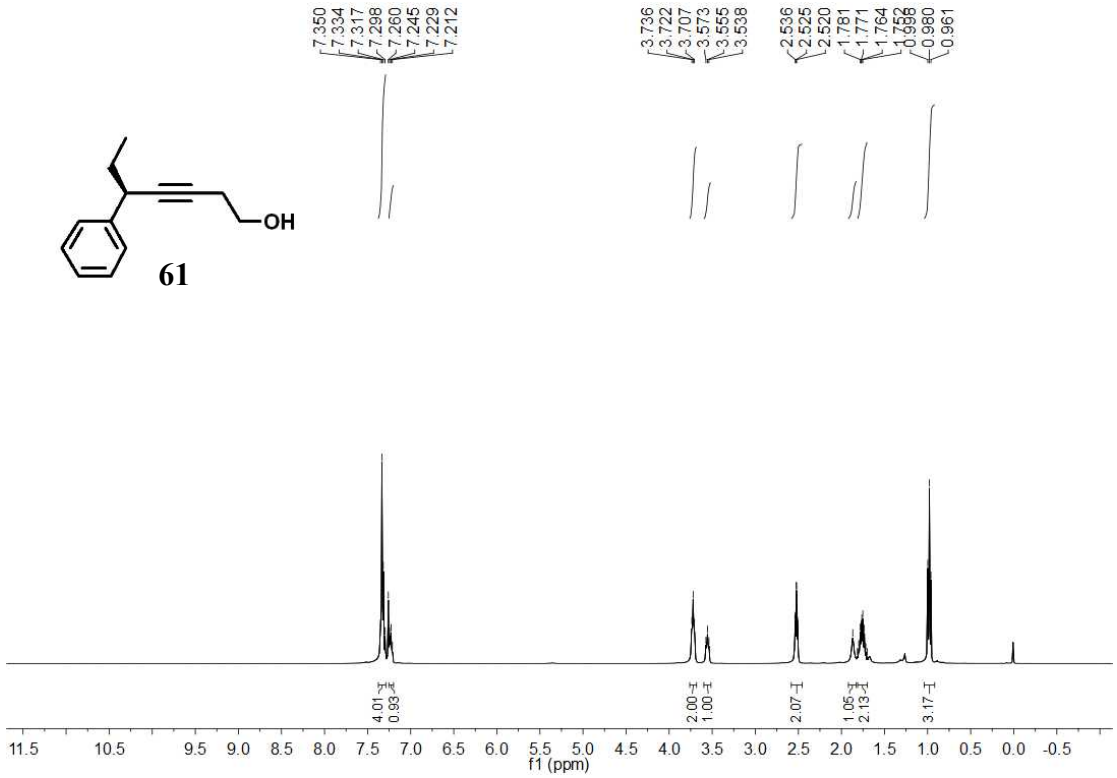
60

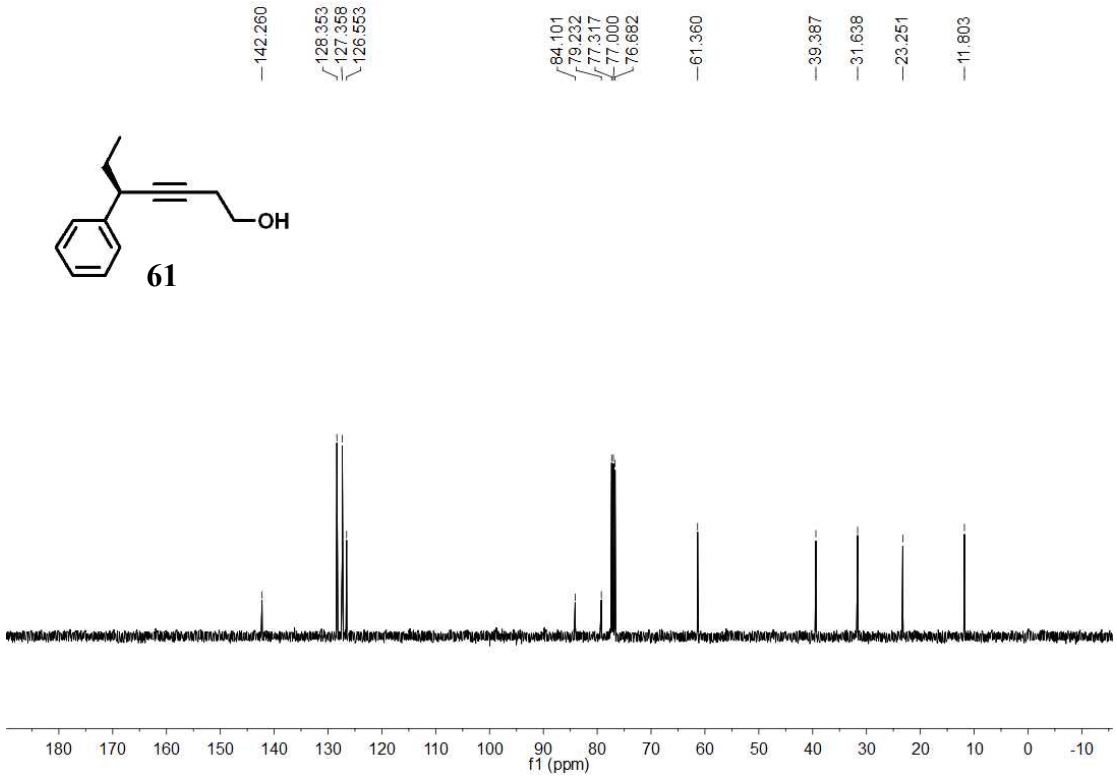
7.326
7.316
7.300
7.293
7.262
7.257
7.252
7.244
7.231
7.221
7.209
4.744
4.739
3.621
3.616
3.611
3.599
3.586
3.581
3.576
2.095
1.819
1.801
1.783
1.765
1.747
0.993
0.974
0.956
4.10
1.17
2.00
1.00
3.02
2.18
3.12
f1 (ppm)

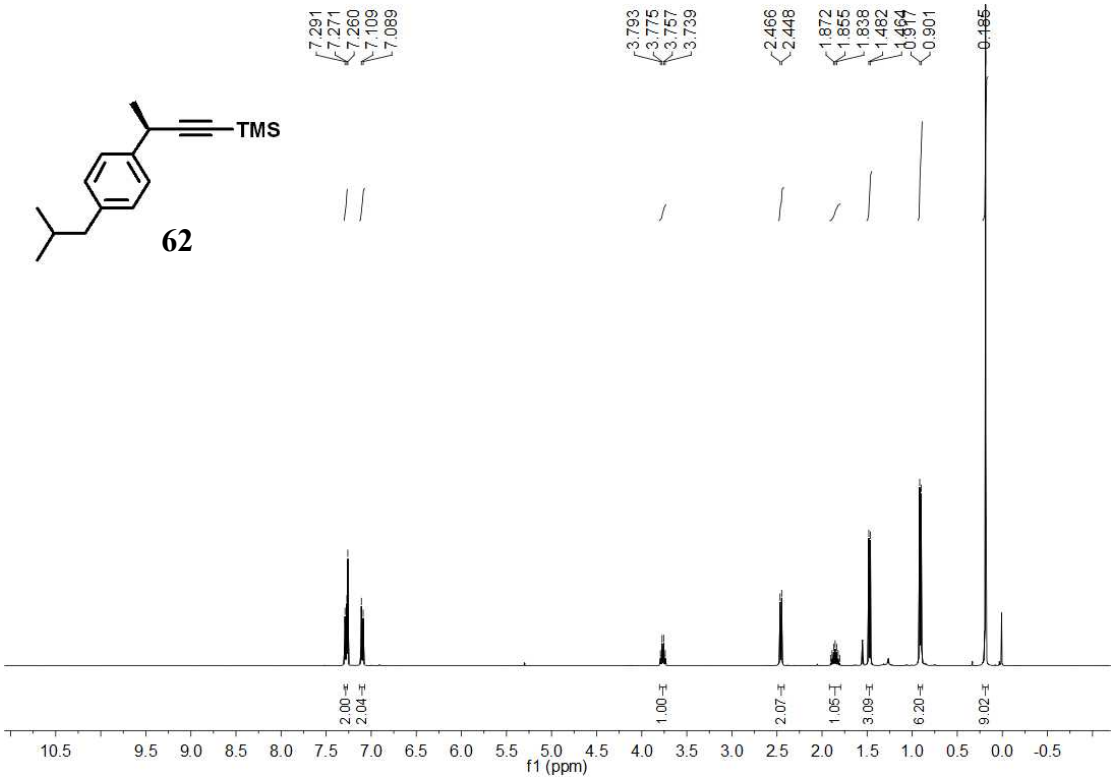

170.377
141.336
128.400
127.430
126.710
88.760
77.318
77.000
76.684
52.788
39.339
31.225
20.797
11.703
f1 (ppm)

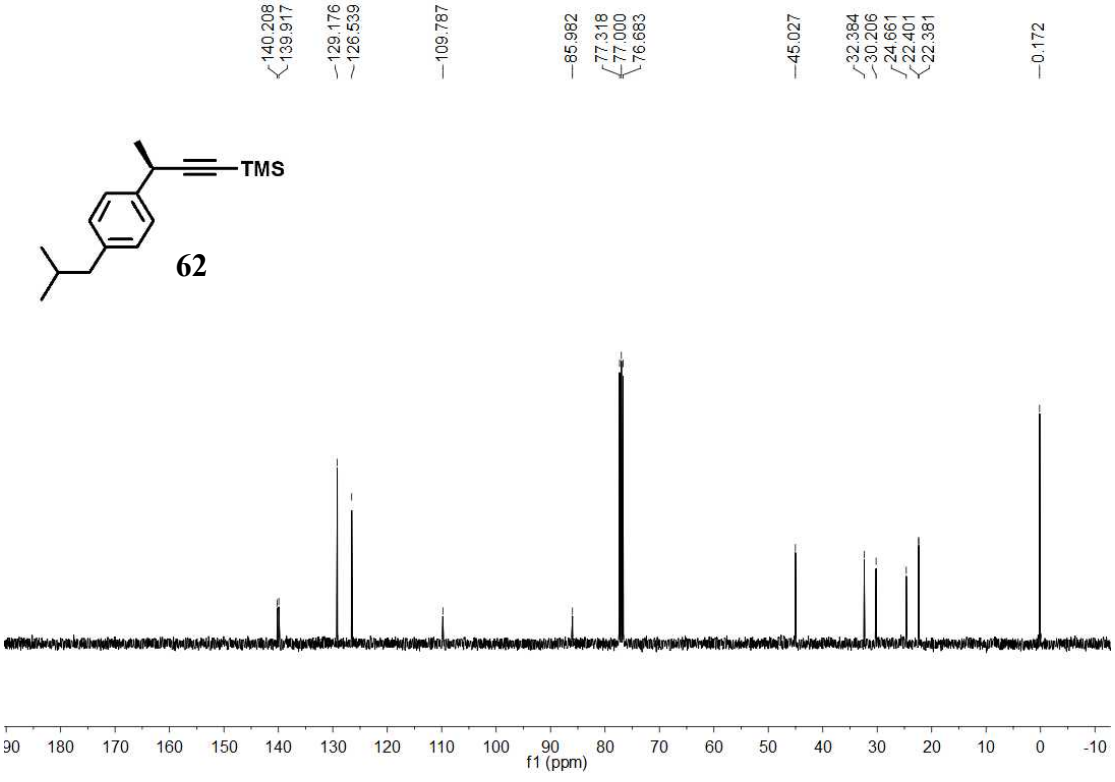
OAc

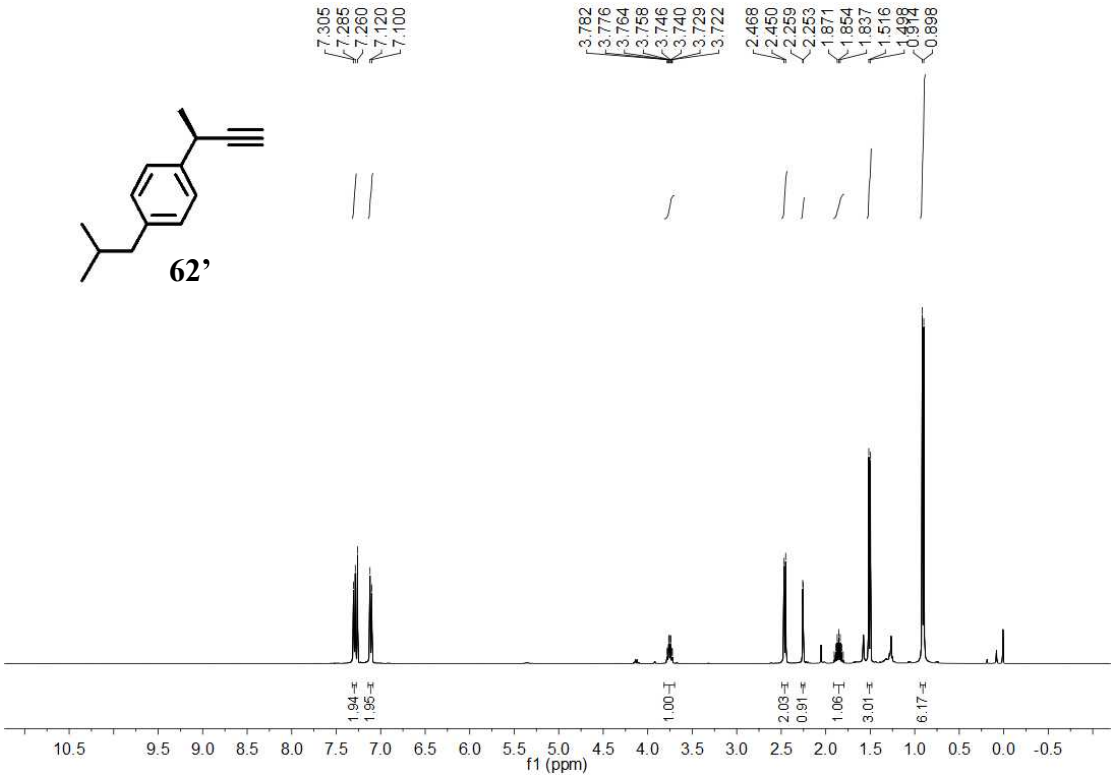
60

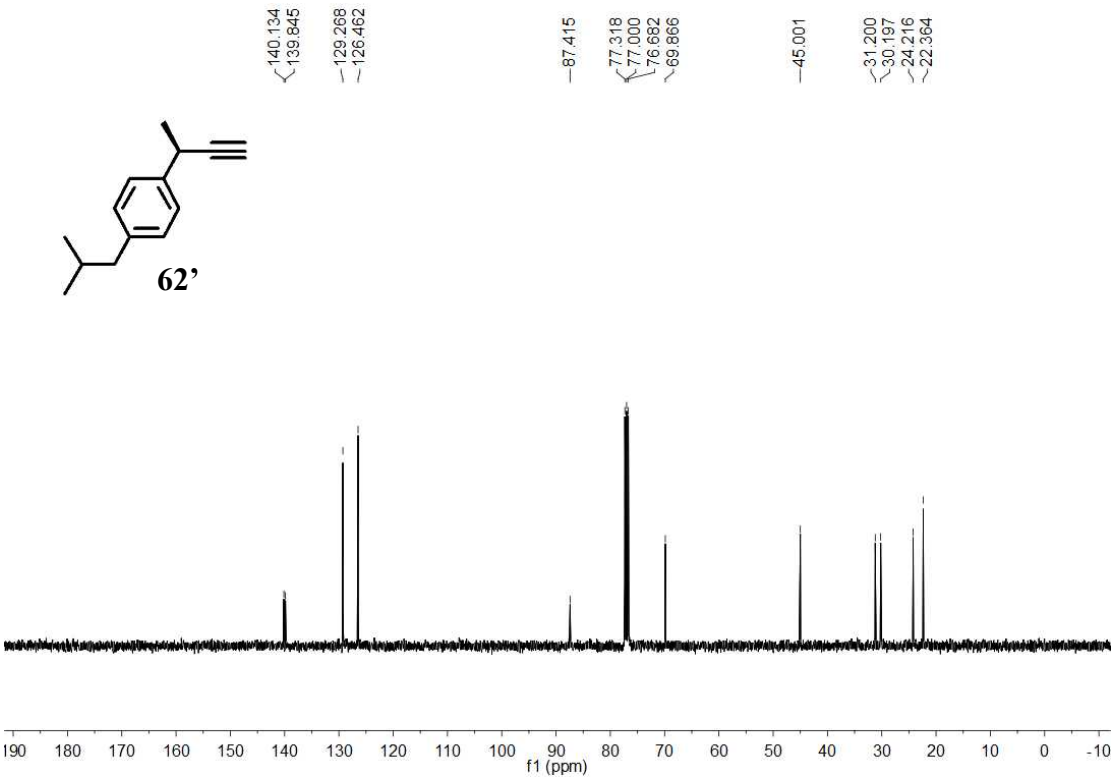

7.350
7.334
7.317
7.298
7.260
7.245
7.229
7.212
3.736
3.722
3.707
3.573
3.555
3.538
2.536
2.525
2.520
1.781
1.771
1.764
1.752
0.998
0.980
0.961
OH
61
4.01
0.93
2.00
1.00
2.07
1.05
2.13
3.17
f1 (ppm)

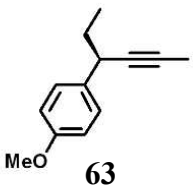

142.260
128.353
127.358
126.553
84.101
79.232
77.317
77.000
76.682
61.360
39.387
31.638
23.251
11.803
OH
61
f1 (ppm)


TMS
62
7.291
7.271
7.260
7.109
7.089
3.793
3.775
3.757
3.739
2.466
2.448
1.872
1.855
1.838
1.482
0.901
0.185
2.00
2.04
1.00
2.07
1.06
3.09
6.20
9.02
f1 (ppm)


140.208
139.917
129.176
126.539
109.787
85.982
77.318
77.000
76.683
45.027
32.384
30.206
24.661
22.401
22.381
0.172
TMS
62
f1 (ppm)

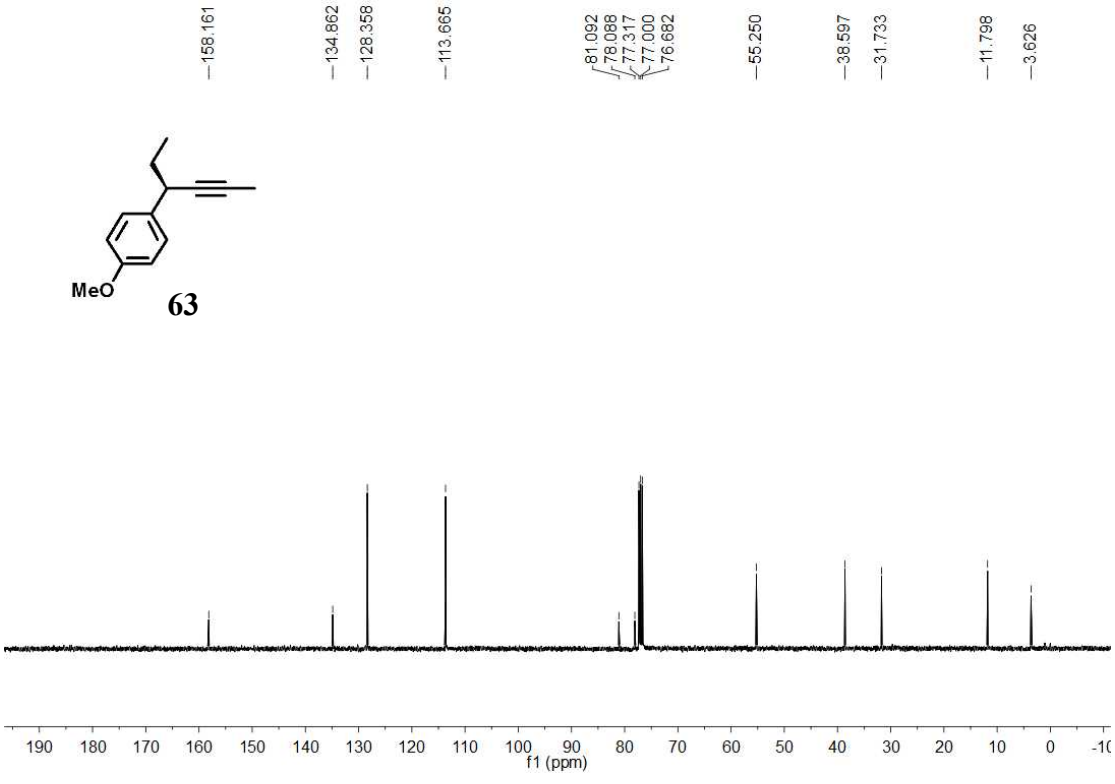

7.305
7.285
7.260
7.120
7.100
3.782
3.776
3.764
3.758
3.746
3.740
3.729
3.722
2.468
2.450
2.259
2.253
1.871
1.854
1.837
1.516
0.914
0.898
62’
1.94
1.95
1.00
2.03
0.91
1.06
3.01
6.17
f1 (ppm)


140.134
139.845
129.268
126.462
87.415
77.318
77.000
76.682
69.866
45.001
31.200
30.197
24.216
22.364
62’
f1 (ppm)


MeO

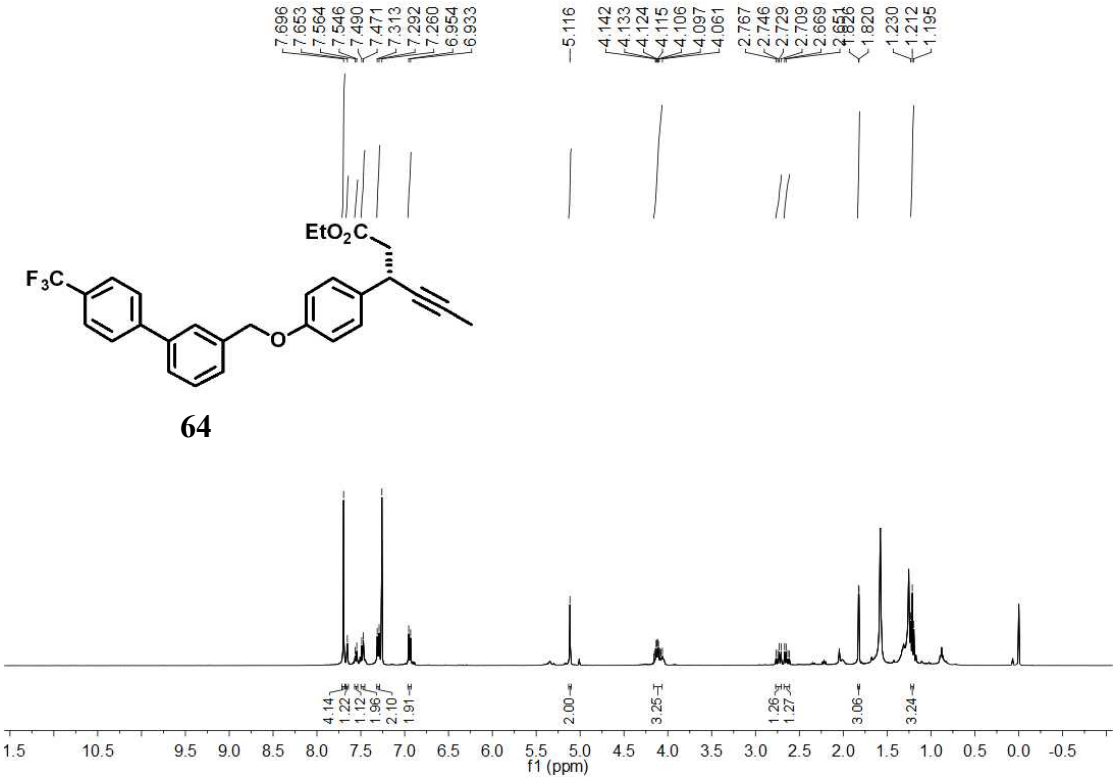
63

7.261
7.256
7.240
6.857
6.836
3.789
3.464
3.449
3.432
1.860
1.737
1.719
1.701
1.683
1.665
0.969
0.950
0.932
2.56
1.94
3.02
1.00
2.97
2.17
3.12
f1 (ppm)

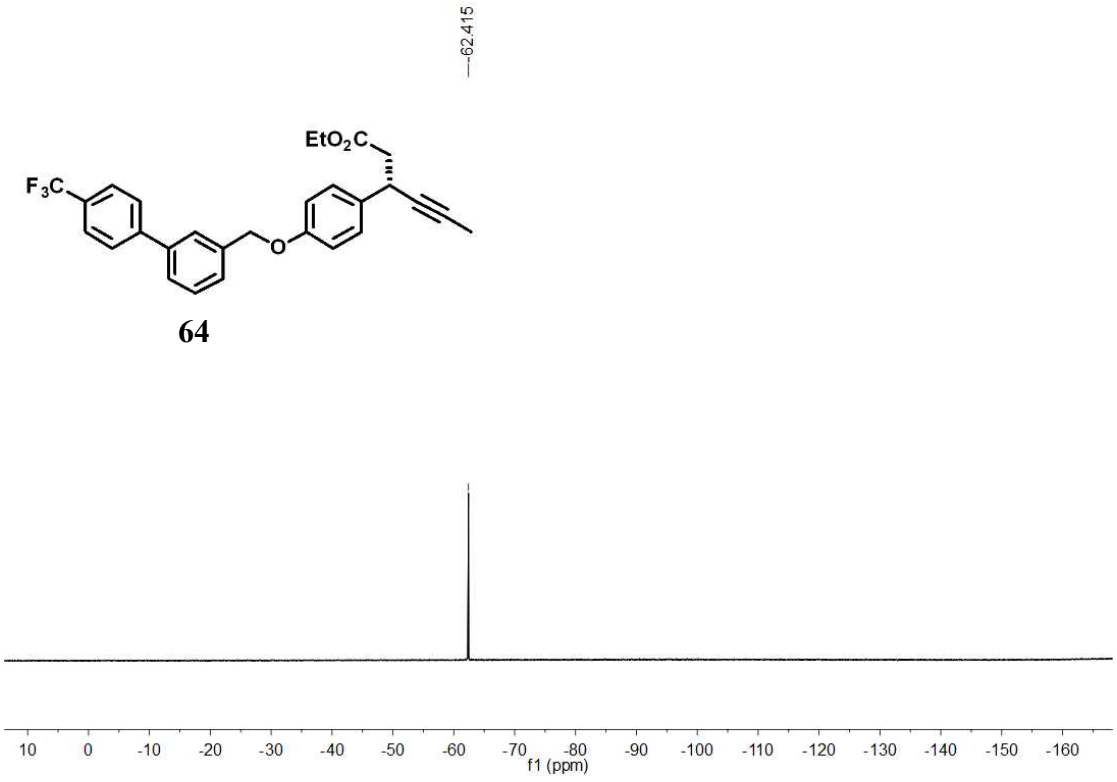

158.161
134.862
128.358
113.665
81.092
78.088
77.317
77.000
76.682
55.250
38.597
31.733
11.798
3.626
f1 (ppm)

MeO

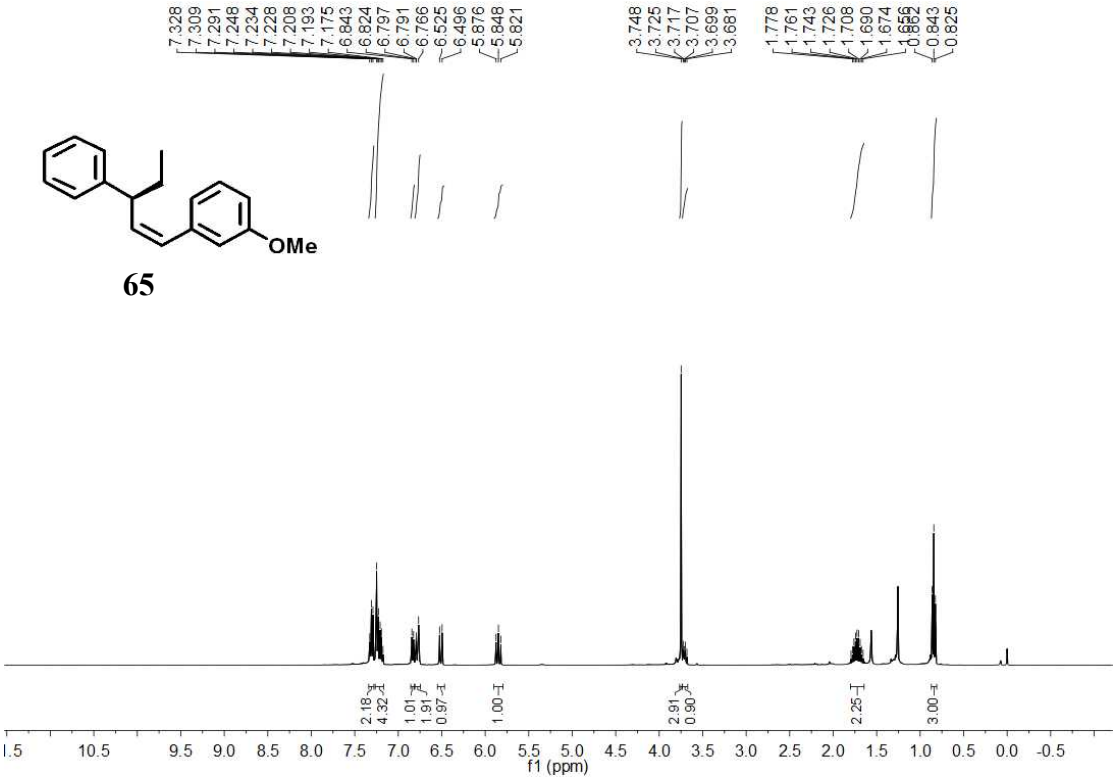
63


7.696
7.653
7.564
7.546
7.490
7.471
7.313
7.292
7.260
6.954
6.933
5.116
4.142
4.133
4.124
4.115
4.106
4.097
4.061
2.767
2.746
2.729
2.709
2.669
2.651
1.826
1.820
1.230
1.212
1.195
EtO2C
F3C
O
4.14
1.22
1.12
1.96
2.10
1.91
2.00
3.25
1.26
1.27
3.06
3.24
f1 (ppm)

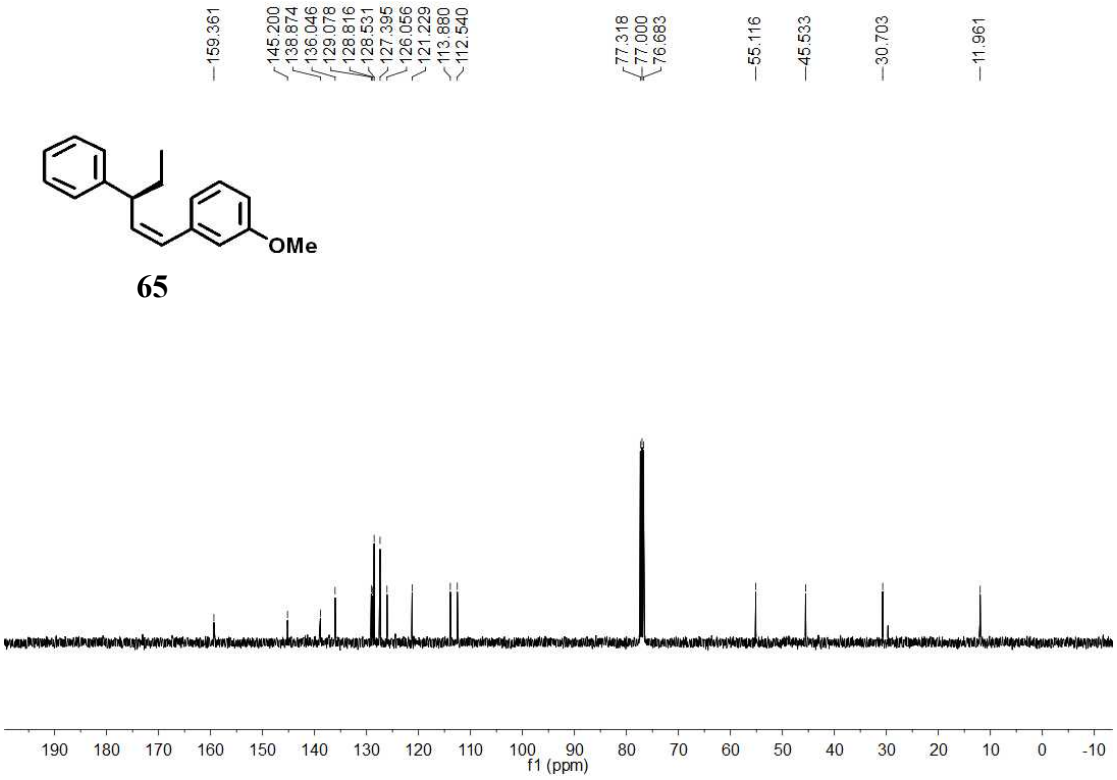
64


62.415
EtO2C
F3C
O
f1 (ppm)

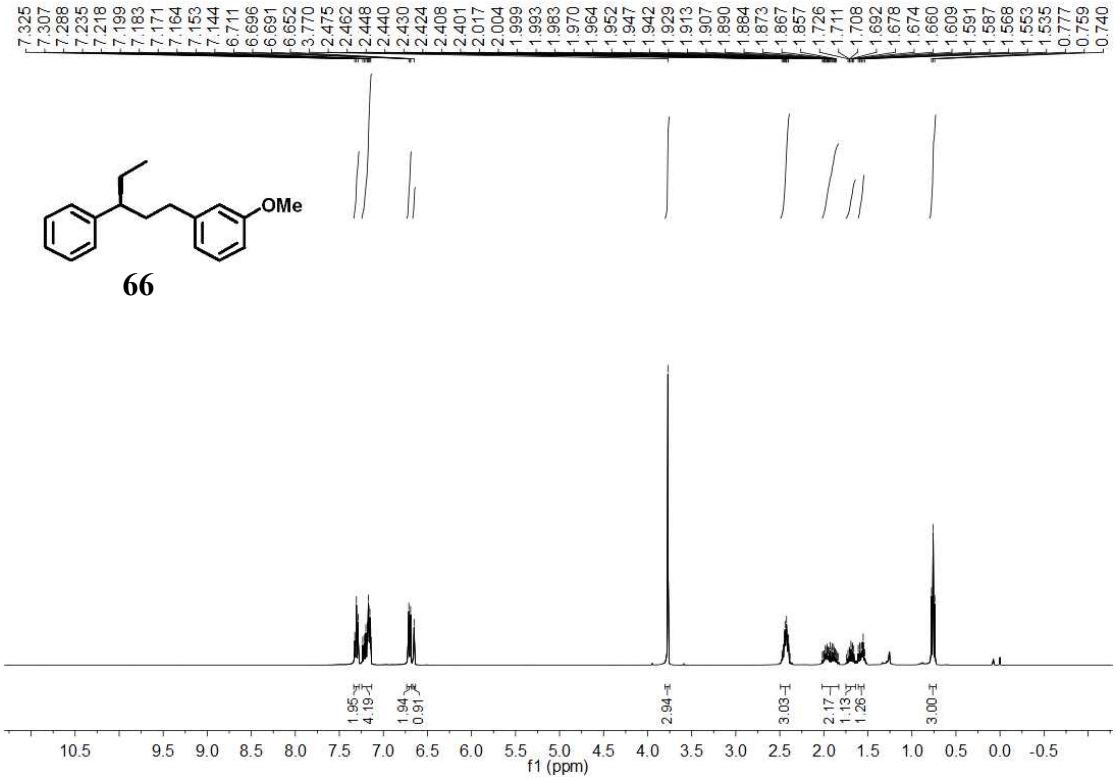
64


7.328
7.309
7.291
7.248
7.234
7.228
7.208
7.193
7.175
6.843
6.824
6.797
6.791
6.766
6.525
6.496
5.876
5.848
5.821
3.748
3.725
3.717
3.707
3.699
3.681
1.778
1.761
1.743
1.726
1.708
1.690
1.674
0.862
0.843
0.825
OMe
2.18
4.32
1.01
1.91
0.97
1.00
2.91
0.90
2.25
3.00
f1 (ppm)

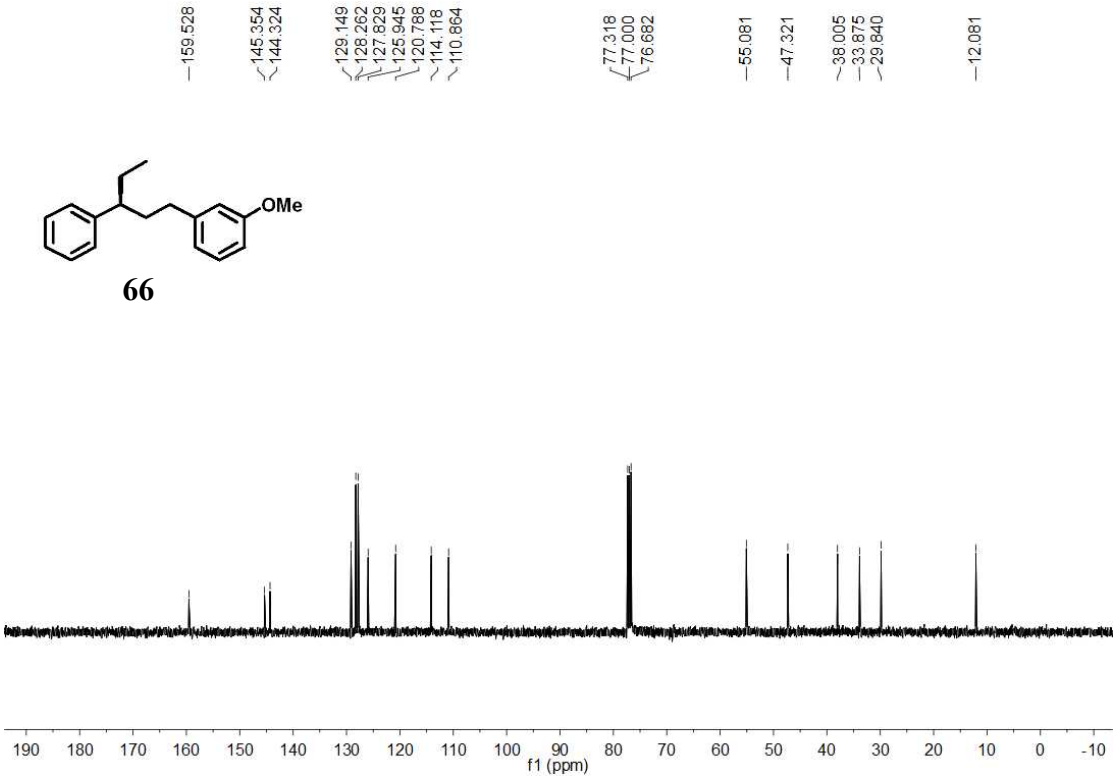
65


159.361
145.200
138.874
136.046
129.078
128.816
128.531
127.395
126.056
121.229
113.880
112.540
77.318
77.000
76.683
55.116
45.533
30.703
11.961
OMe
f1 (ppm)

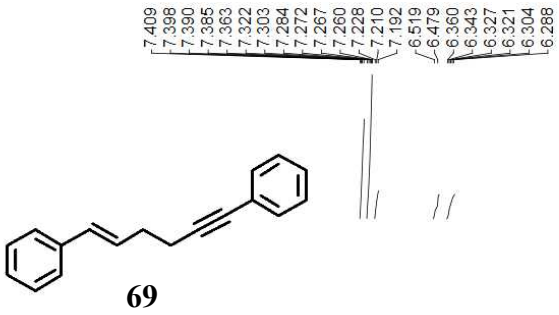
65


7.325
7.307
7.288
7.235
7.218
7.199
7.183
7.171
7.164
7.153
7.144
6.711
6.696
6.691
6.652
3.770
2.475
2.462
2.448
2.440
2.430
2.424
2.408
2.401
2.017
2.004
1.999
1.993
1.983
1.970
1.964
1.952
1.947
1.942
1.929
1.913
1.907
1.890
1.884
1.873
1.867
1.857
1.726
1.711
1.708
1.692
1.678
1.674
1.660
1.609
1.591
1.587
1.568
1.553
1.535
0.777
0.759
0.740
OMe
1.95
4.19
1.94
0.91
2.94
3.03
2.17
1.13
1.26
3.00
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

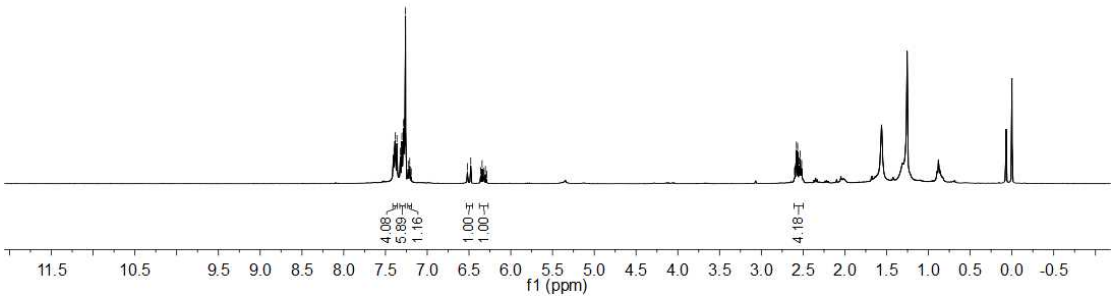
66

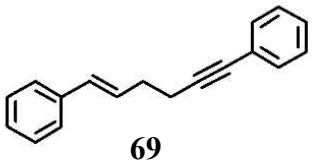

159.528
145.354
144.324
129.149
128.262
127.829
125.945
120.788
114.118
110.864
77.318
77.000
76.682
55.081
47.321
38.005
33.875
29.840
12.081
OMe
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

66


7.409
7.398
7.390
7.385
7.363
7.322
7.303
7.284
7.272
7.267
7.260
7.228
7.210
7.192
6.519
6.479
6.360
6.343
6.327
6.321
6.304
6.288
2.603
2.597
2.580
2.565
2.549
2.534
2.517

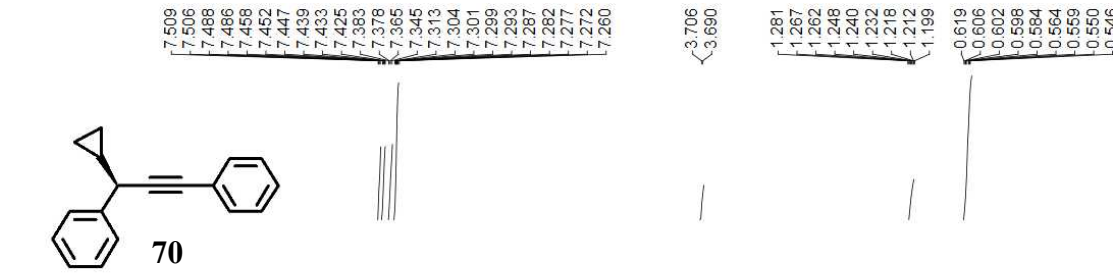
69


4.08
5.89
1.16
1.00
1.00
4.18
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

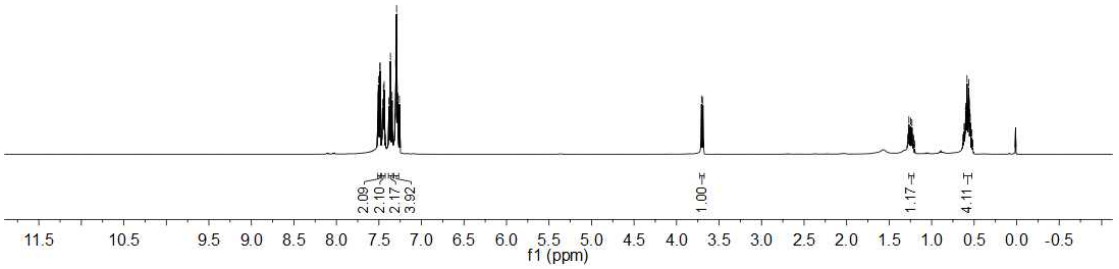


69

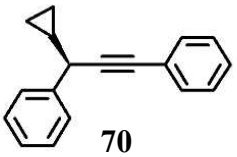
137.487
131.567
131.096
128.758
128.501
128.188
127.597
127.092
126.085
123.851
89.416
81.205
77.211
77.000
76.789
32.324
19.757
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.509
7.506
7.488
7.486
7.458
7.452
7.447
7.439
7.433
7.425
7.383
7.378
7.365
7.345
7.313
7.304
7.301
7.299
7.293
7.287
7.282
7.277
7.272
7.260
3.706
3.690
1.281
1.267
1.262
1.248
1.240
1.232
1.218
1.212
1.199
0.619
0.606
0.602
0.598
0.584
0.564
0.559
0.550

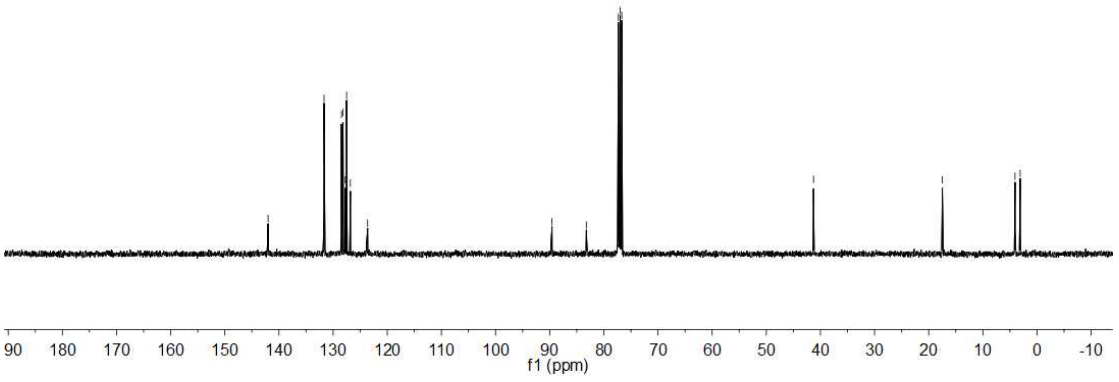
70


2.09
2.10
2.17
3.92
1.00
1.17
4.11
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

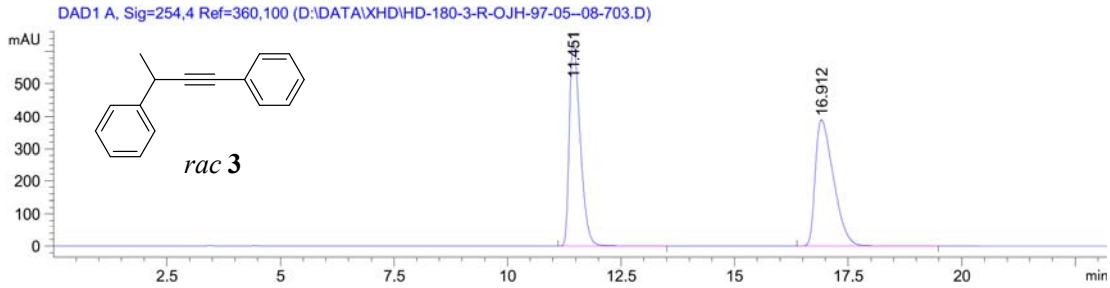

142.005
131.669
128.446
128.169
127.765
127.510
126.813
123.632
89.572
83.232
77.317
77.000
76.682
41.277
17.480
4.058
3.112



70

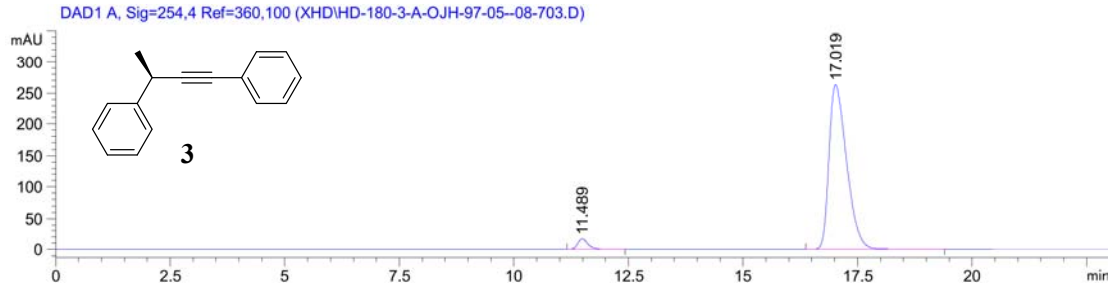

90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

13. HPLC spectra



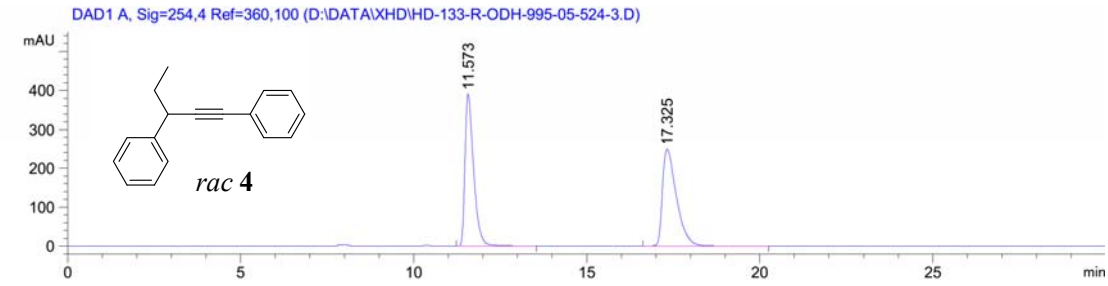
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.451	BB	0.2531	1.04525e4	631.57770	49.1012
2	16.912	BB	0.4311	1.08352e4	388.87234	50.8988
Totals :				2.12877e4	1020.45004	



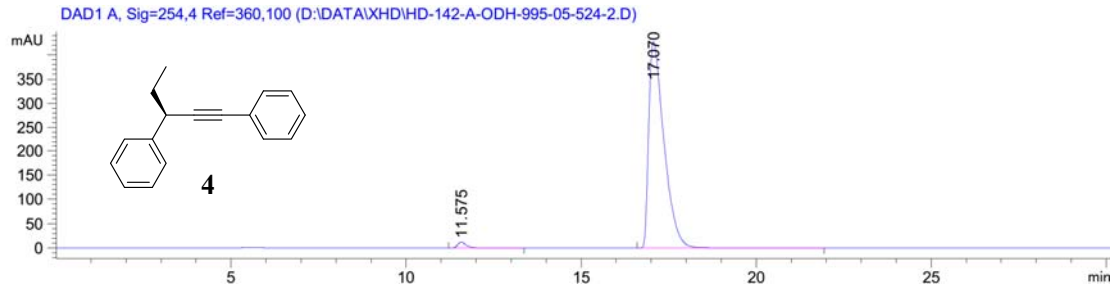
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.489	BB	0.2298	258.19003	16.93769	3.5304
2	17.019	BB	0.4143	7055.04590	263.56769	96.4696
Totals :				7313.23593	280.50538	



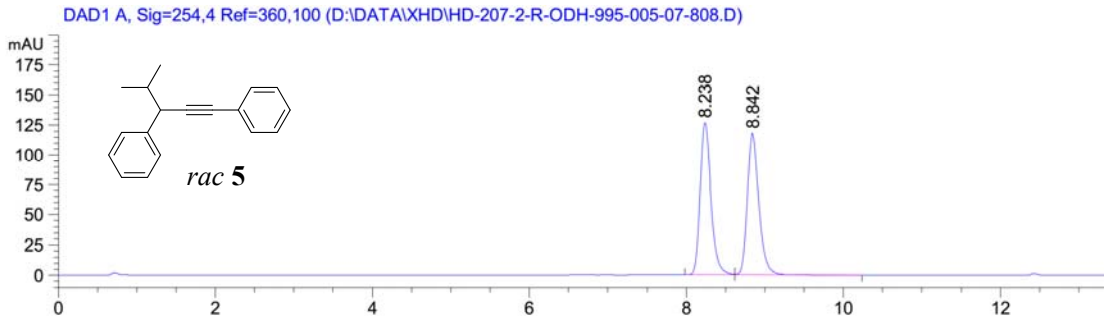
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.573	BB	0.2621	6775.78369	391.13312	49.3059
2	17.325	BB	0.4231	6966.55273	248.47195	50.6941
Totals :				1.37423e4	639.60507	



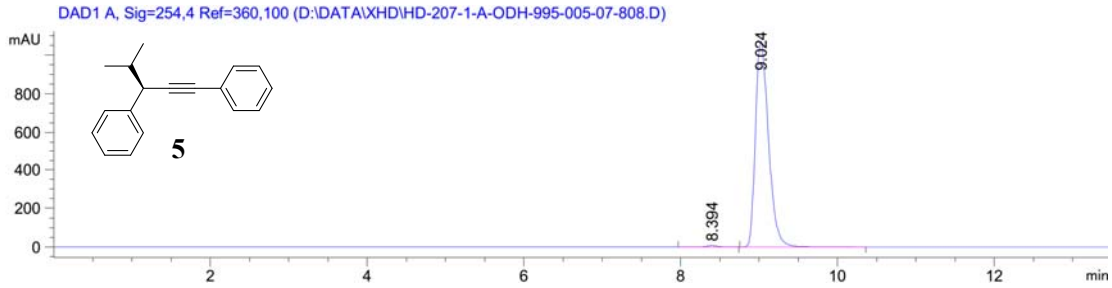
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.575	BB	0.2630	210.00005	12.31266	1.5981
2	17.070	BB	0.4575	1.29307e4	426.81030	98.4019
Totals :				1.31407e4	439.12296	



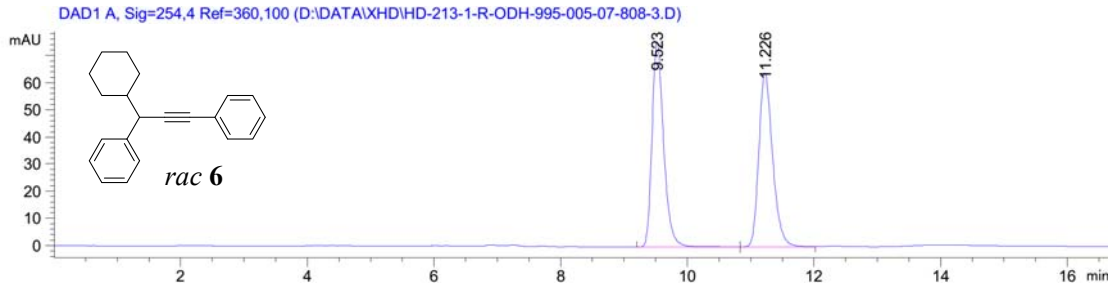
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.238	BV	0.1473	1208.14026	126.69585	49.7011
2	8.842	VB	0.1613	1222.67090	117.64048	50.2989
Totals :				2430.81116	244.33633	



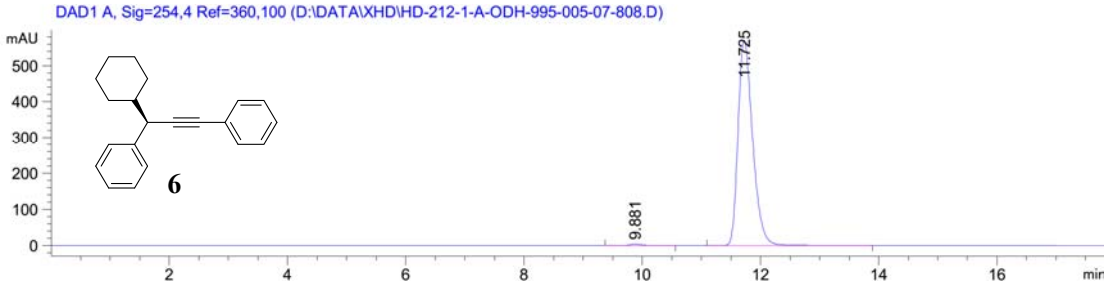
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.394	BB	0.1561	70.83384	7.11729	0.5663
2	9.024	BV	0.1841	1.24367e4	1066.27051	99.4337
Totals :				1.25076e4	1073.38780	



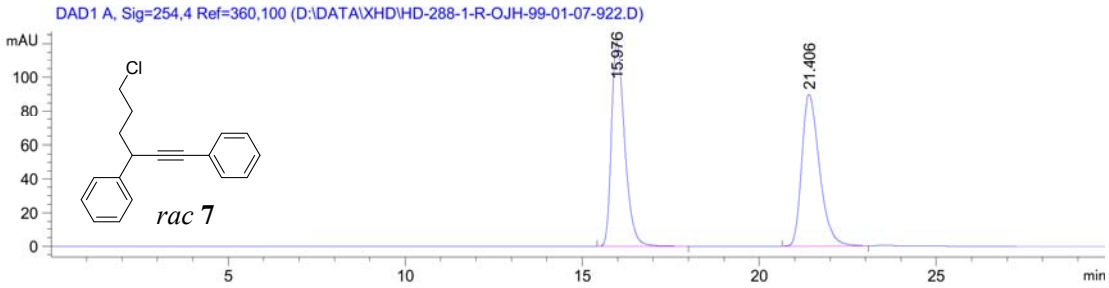
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.523	BB	0.1974	966.05292	75.45396	49.9102
2	11.226	BV	0.2325	969.52899	64.07447	50.0898
Totals :				1935.58191	139.52843	



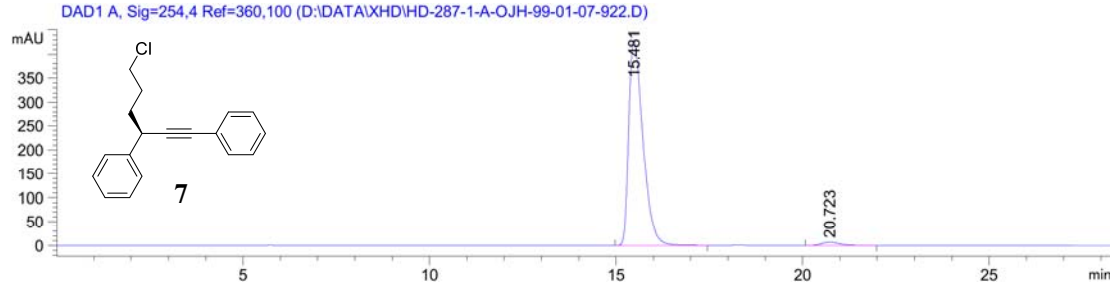
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.881	BB	0.2068	57.89194	4.25309	0.5897
2	11.725	BV	0.2637	9758.67871	569.99646	99.4103
Totals :				9816.57065	574.24955	



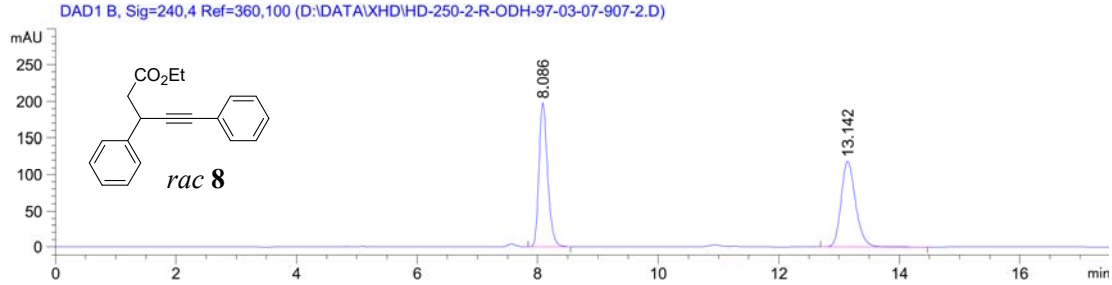
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.976	BB	0.3964	3135.25586	120.96627	50.0913
2	21.406	BB	0.5311	3123.82520	89.97477	49.9087
Totals :				6259.08105	210.94104	



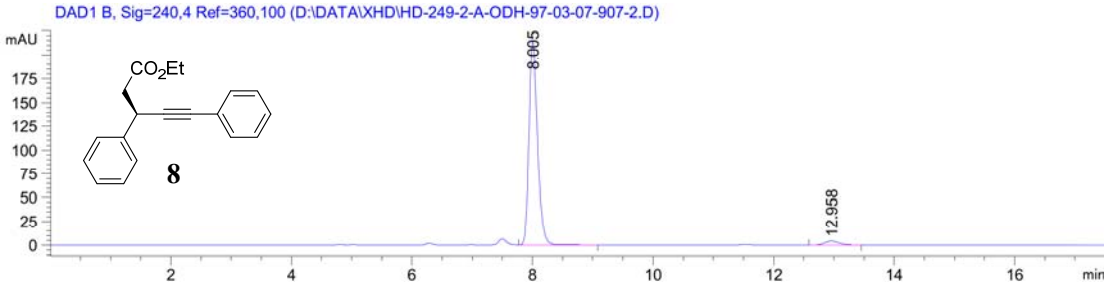
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.481	BB	0.4015	1.13086e4	429.03671	97.8884
2	20.723	BB	0.5189	243.94160	7.09948	2.1116
Totals :				1.15526e4	436.13619	



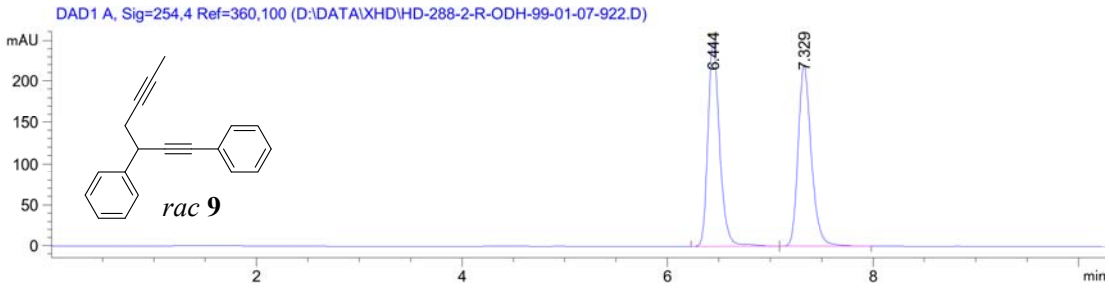
Signal 2: DAD1 B, Sig=240,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.086	BB	0.1517	1962.60669	197.88177	49.8281
2	13.142	BB	0.2564	1976.15051	118.62304	50.1719
Totals :				3938.75720	316.50481	



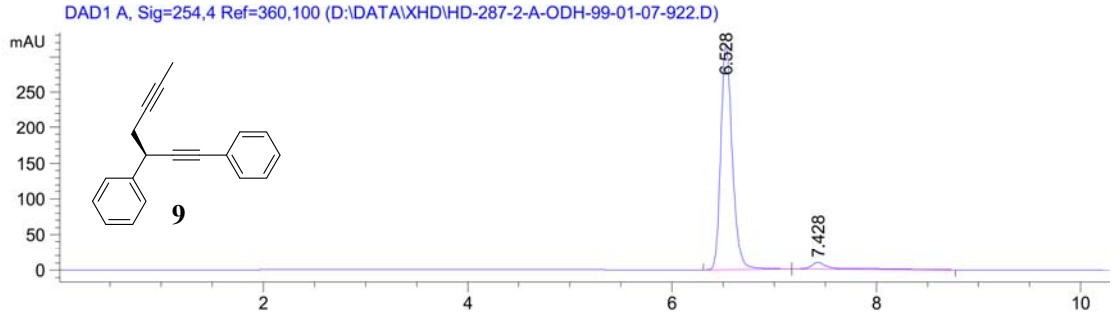
Signal 2: DAD1 B, Sig=240,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.005	BB	0.1480	2094.29419	214.41730	96.6518
2	12.958	BB	0.2546	72.55108	4.34861	3.3482
Totals :				2166.84527	218.76591	



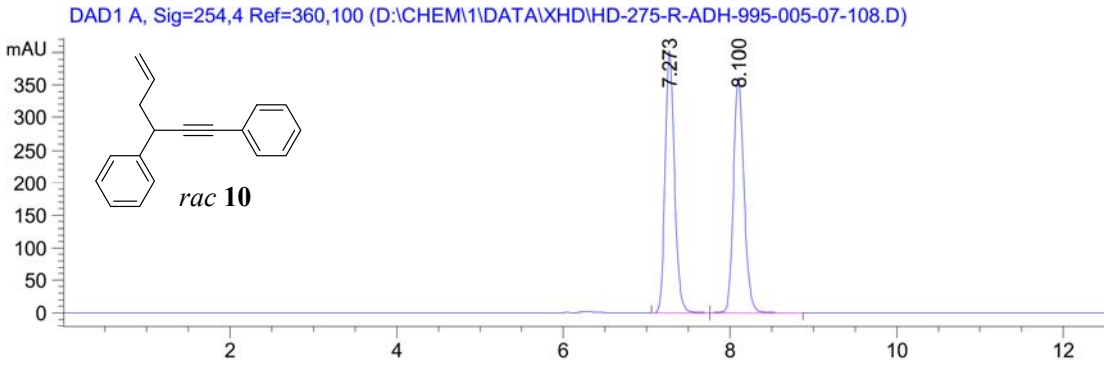
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.444	BB	0.1208	1981.47229	249.19753	50.0221
2	7.329	BB	0.1374	1979.72217	219.06058	49.9779
Totals :				3961.19446	468.25810	



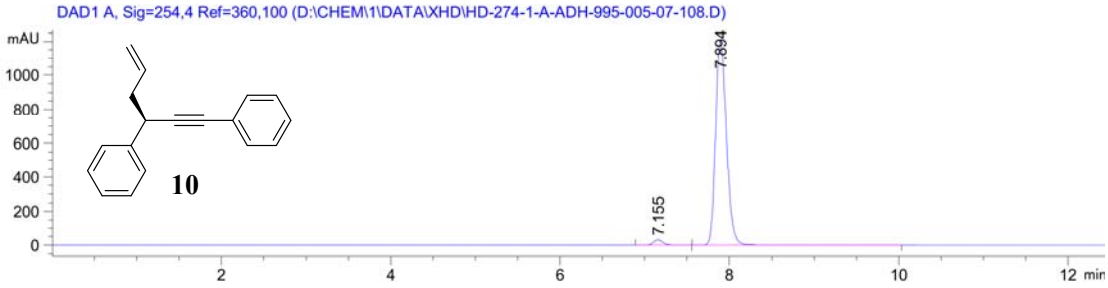
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.528	BB	0.1187	2471.37378	317.88901	95.2382
2	7.428	BB	0.1910	123.56570	8.95385	4.7618
Totals :				2594.93948	326.84286	



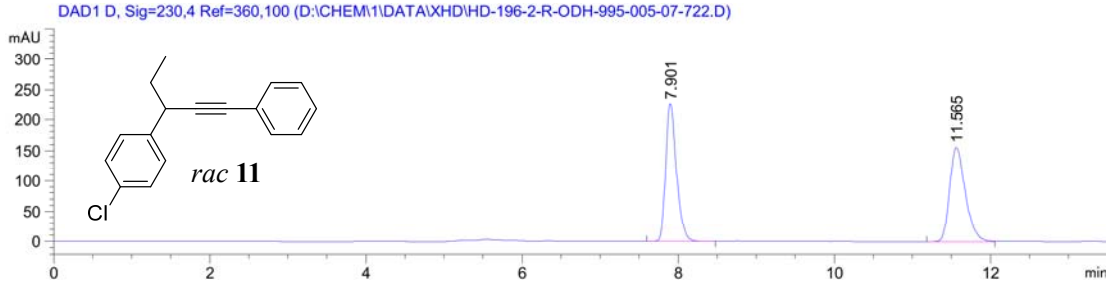
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.273	BB	0.1210	3137.54028	402.37854	49.8331
2	8.100	BB	0.1340	3158.55151	361.41068	50.1669
Totals :				6296.09180	763.78922	



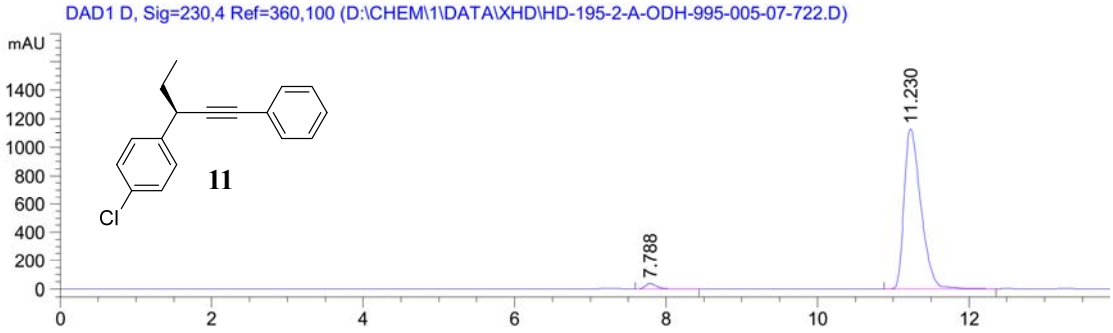
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.155	BB	0.1151	237.03439	31.75590	2.1532
2	7.894	BB	0.1380	1.07712e4	1207.91199	97.8468
Totals :				1.10083e4	1239.66789	



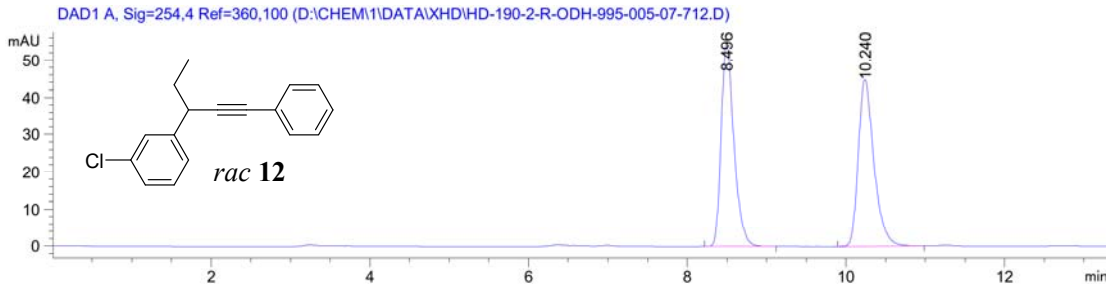
Signal 3: DAD1 D, Sig=230,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.901	BB	0.1463	2182.33105	226.63695	50.0363
2	11.565	BV	0.2154	2179.16797	155.61476	49.9637
Totals :				4361.49902	382.25171	



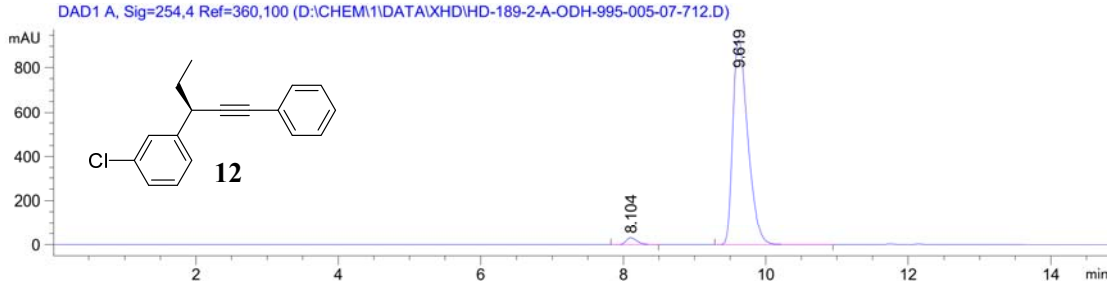
Signal 3: DAD1 D, Sig=230,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.788	VB	0.1481	371.85010	38.00632	2.0977
2	11.230	BV	0.2371	1.73547e4	1130.20020	97.9023
Totals :				1.77266e4	1168.20652	



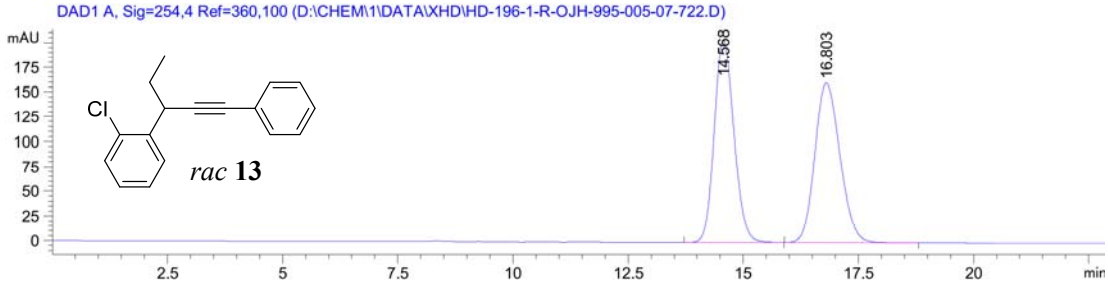
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.496	BB	0.1686	614.84637	54.93124	49.8986
2	10.240	BB	0.2067	617.34589	44.81832	50.1014
Totals :				1232.19226	99.74955	



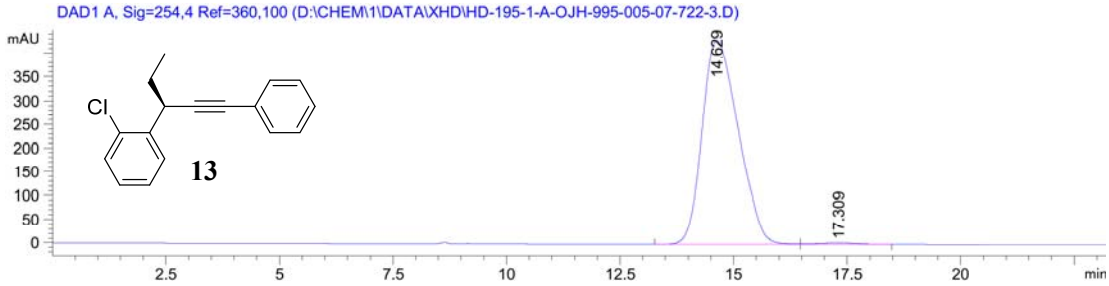
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.104	BB	0.1564	322.04242	31.20131	2.3435
2	9.619	BB	0.2227	1.34197e4	928.03546	97.6565
Totals :				1.37417e4	959.23677	



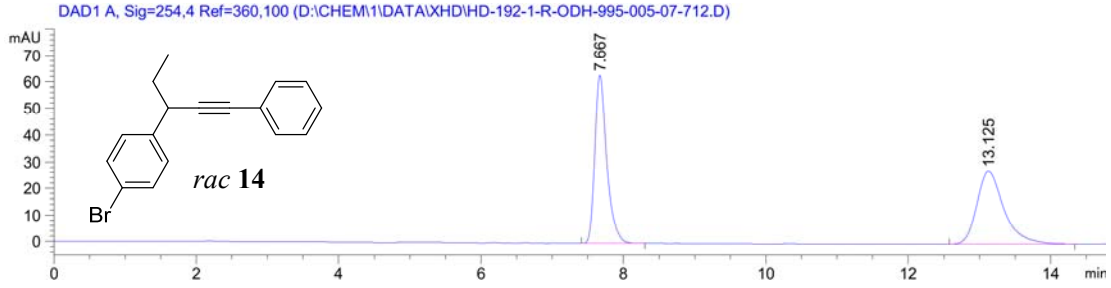
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.568	BB	0.4621	6091.39063	205.31598	49.8681
2	16.803	BB	0.5917	6123.62305	161.02007	50.1319
Totals :				1.22150e4	366.33604	



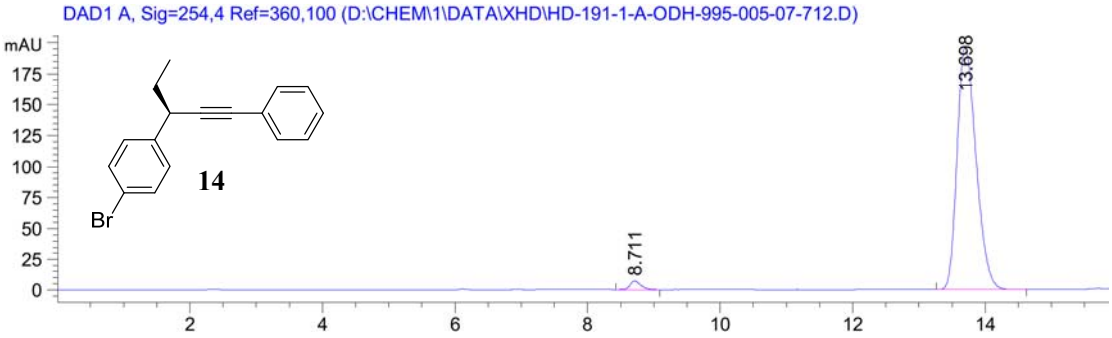
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.629	BV	0.8784	2.38821e4	431.04367	99.0945
2	17.309	VB	0.9400	218.21996	3.50659	0.9055
Totals :				2.41004e4	434.55026	



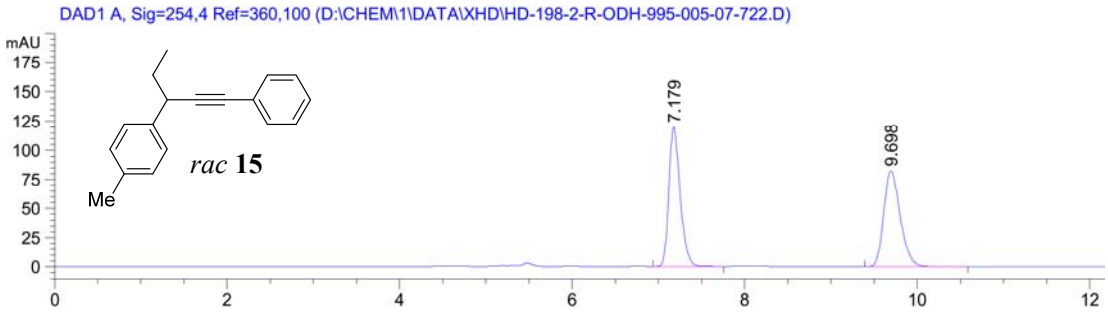
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.667	BB	0.1732	732.37317	63.21516	49.9649
2	13.125	BB	0.4022	733.40210	27.58067	50.0351
Totals :				1465.77527	90.79583	



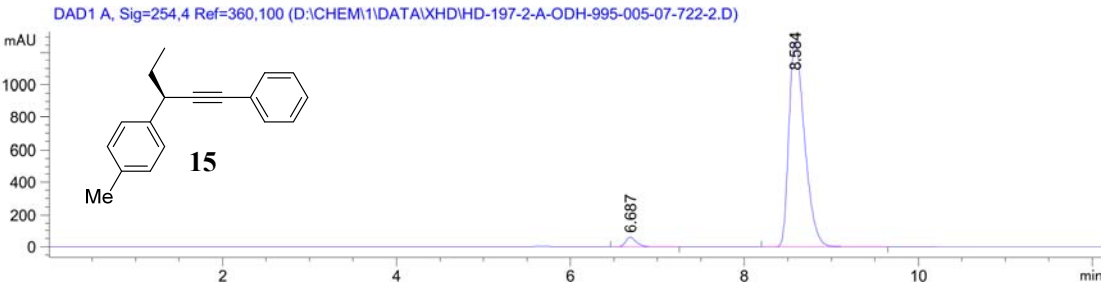
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.711	BB	0.1674	79.05783	7.12743	1.9850
2	13.698	BB	0.3102	3903.77417	196.14410	98.0150
Totals :				3982.83200	203.27153	



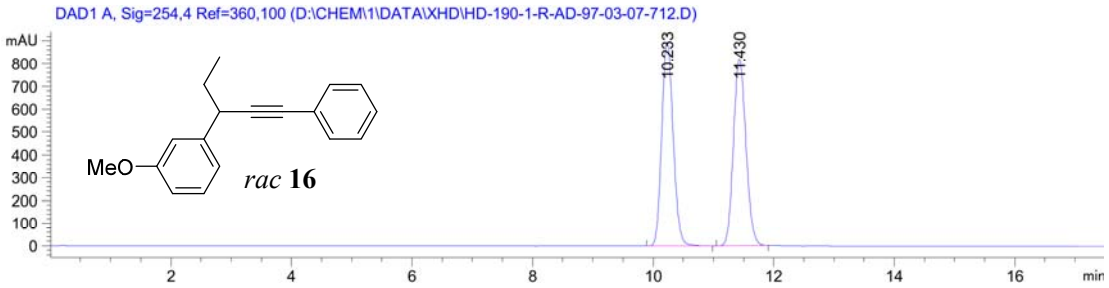
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.179	VV	0.1388	1097.91016	119.98072	50.2203
2	9.698	BB	0.2022	1088.27795	82.32094	49.7797
Totals :				2186.18811	202.30166	



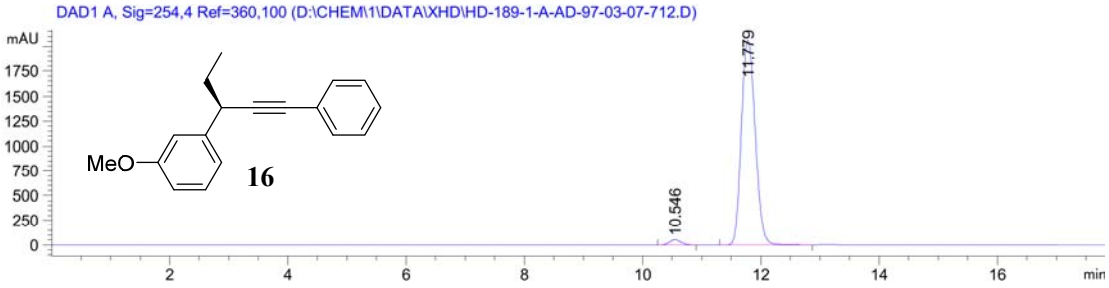
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.687	VB	0.1284	499.95093	59.25242	3.0369
2	8.584	BV	0.1929	1.59628e4	1267.41858	96.9631
Totals :				1.64628e4	1326.67100	



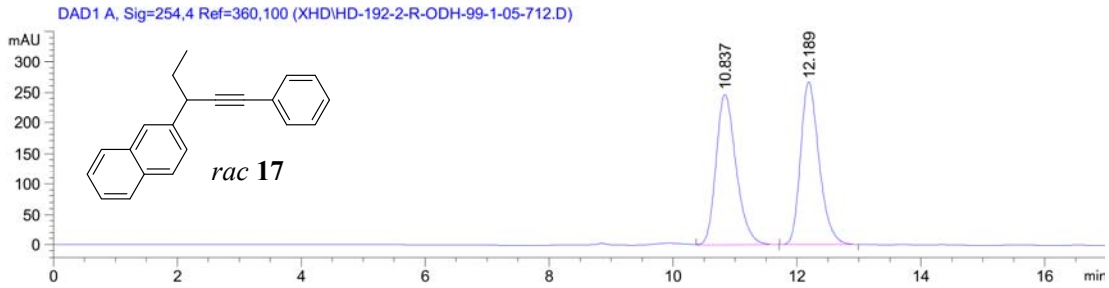
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.233	BB	0.2084	1.18611e4	896.11621	49.9979
2	11.430	BB	0.2264	1.18621e4	821.67535	50.0021
Totals :				2.37232e4	1717.79156	



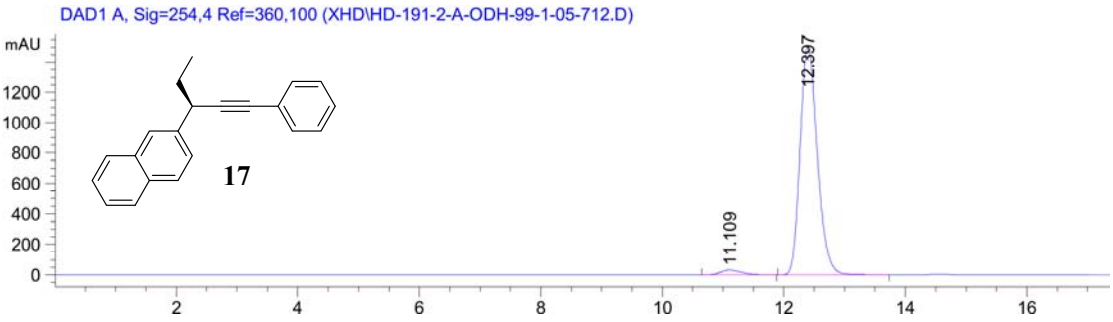
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.546	BB	0.2041	697.89124	53.52661	2.0315
2	11.779	BV	0.2583	3.36548e4	2063.56543	97.9685
Totals :				3.43527e4	2117.09204	



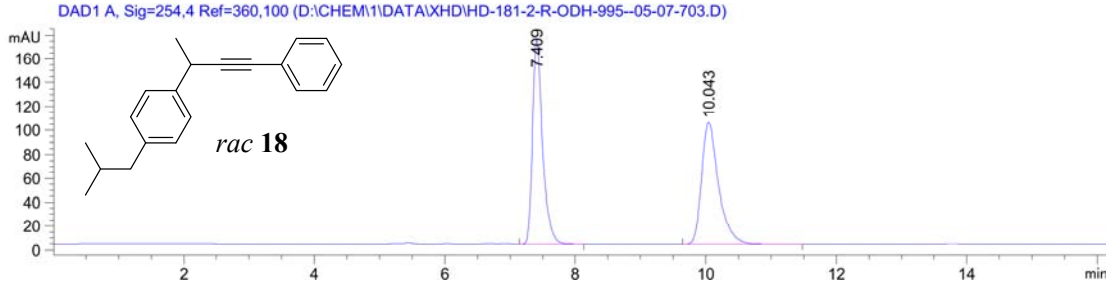
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.837	VB	0.3455	5585.55176	247.31053	50.1053
2	12.189	BB	0.3177	5562.08203	266.26132	49.8947
Totals :				1.11476e4	513.57185	



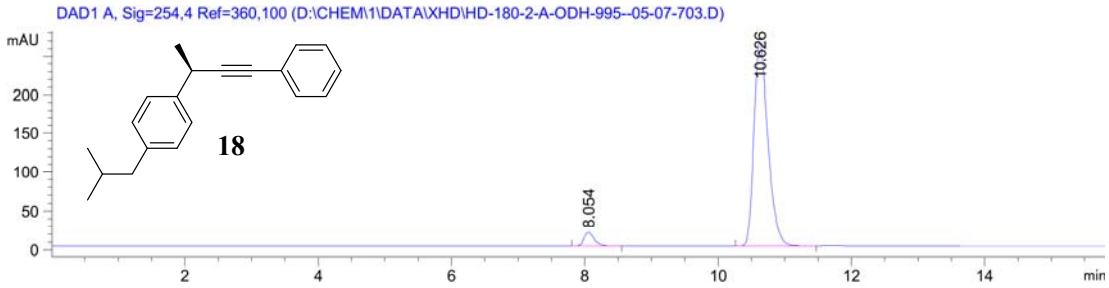
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.109	BB	0.3675	747.47437	31.42877	2.4735
2	12.397	BB	0.3042	2.94720e4	1506.47449	97.5265
Totals :				3.02195e4	1537.90326	



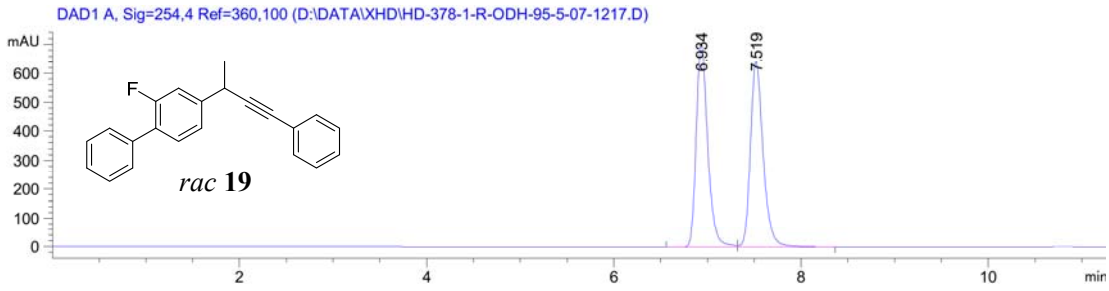
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.409	BB	0.1603	1831.47180	171.95747	49.8572
2	10.043	BB	0.2714	1841.96570	101.64752	50.1428
Totals :				3673.43750	273.60500	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

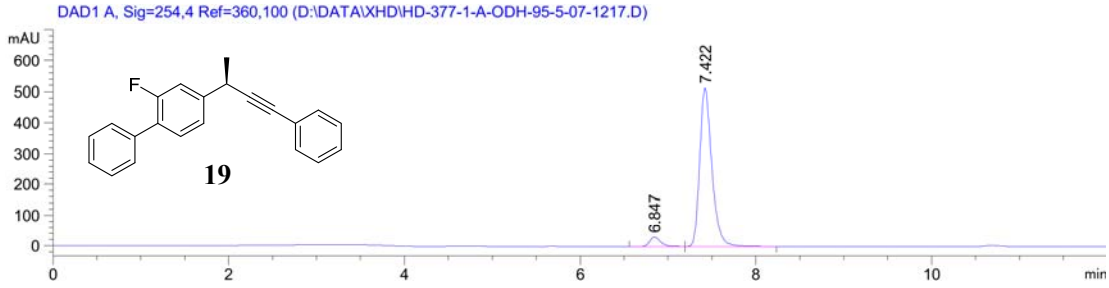
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.054	BB	0.1563	186.18045	18.05705	4.6331
2	10.626	BB	0.2214	3832.33521	263.98868	95.3669
Totals :				4018.51566	282.04573	



rac **19**

Signal 1: DAD1 A, Sig=254,4 Ref=360,100

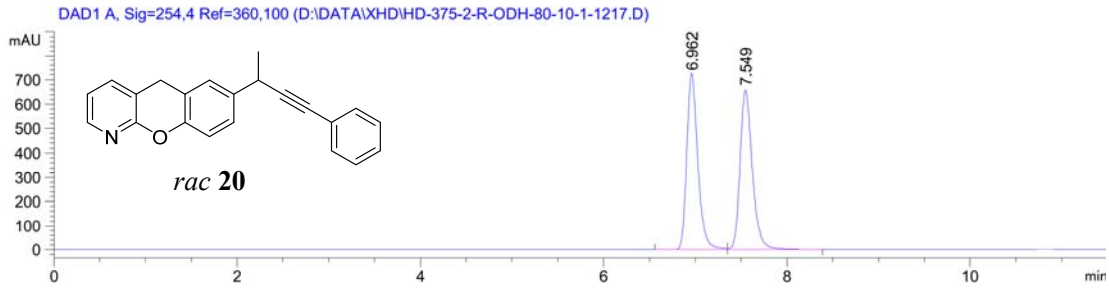
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.934	BV	0.1295	6033.58447	707.47205	49.7898
2	7.519	VV	0.1427	6084.52051	641.32257	50.2102
Totals :				1.21181e4	1348.79462	



19

Signal 1: DAD1 A, Sig=254,4 Ref=360,100

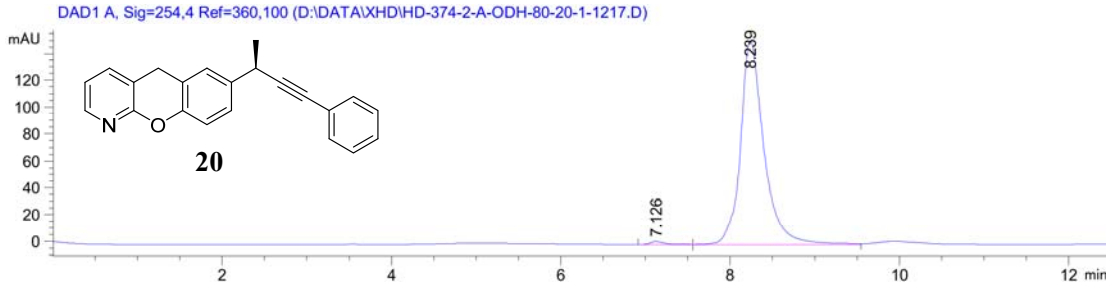
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.847	BV	0.1313	270.47659	31.14642	5.1869
2	7.422	VB	0.1463	4944.12695	513.62701	94.8131
Totals :				5214.60355	544.77343	



rac **20**

Signal 1: DAD1 A, Sig=254,4 Ref=360,100

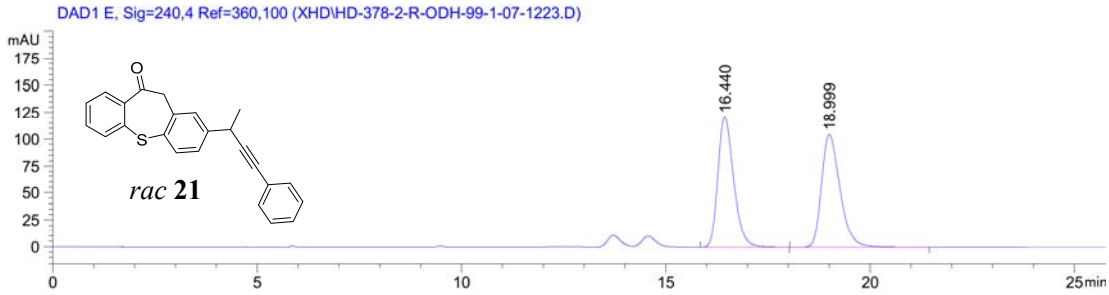
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.962	BV	0.1281	6102.81348	725.70984	49.7660
2	7.549	VV	0.1433	6160.20996	657.40430	50.2340
Totals :				1.22630e4	1383.11414	



20

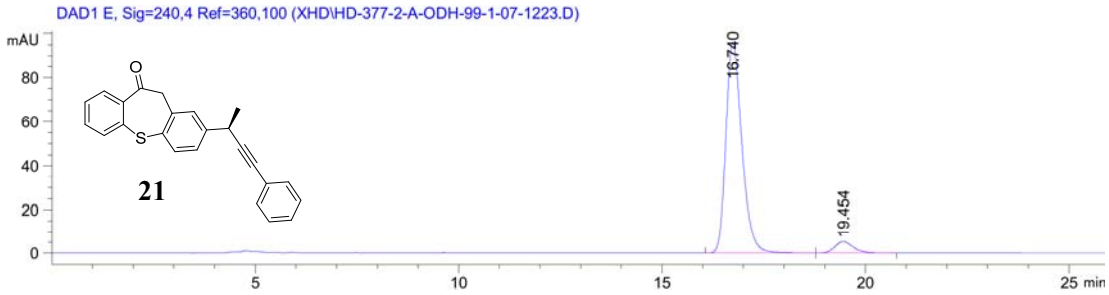
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.126	BB	0.1709	25.50886	2.23928	0.8617
2	8.239	BV	0.2824	2934.84790	152.55948	99.1383
Totals :				2960.35676	154.79875	



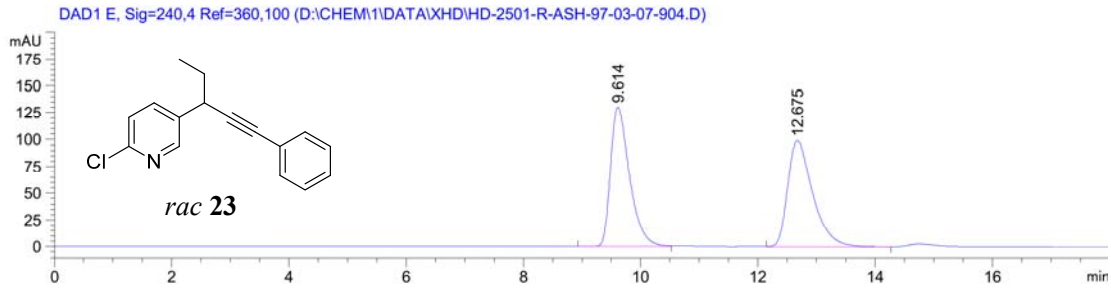
Signal 5: DAD1 E, Sig=240,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.440	BB	0.4122	3249.26440	121.41182	49.5960
2	18.999	BB	0.4843	3302.20605	104.60402	50.4040
Totals :				6551.47046	226.01584	



Signal 5: DAD1 E, Sig=240,4 Ref=360,100

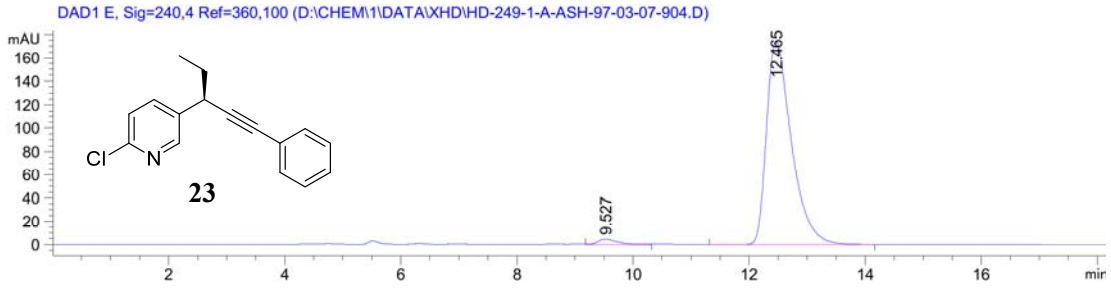
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.740	BV	0.4194	2635.20630	96.24438	94.0122
2	19.454	VB	0.4826	167.84167	5.31247	5.9878
Totals :				2803.04797	101.55685	



rac **23**

Signal 5: DAD1 E, Sig=240,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.614	BV	0.3440	2947.13159	130.22351	50.0039
2	12.675	VV	0.4508	2946.66797	99.12495	49.9961
Totals :				5893.79956	229.34846	



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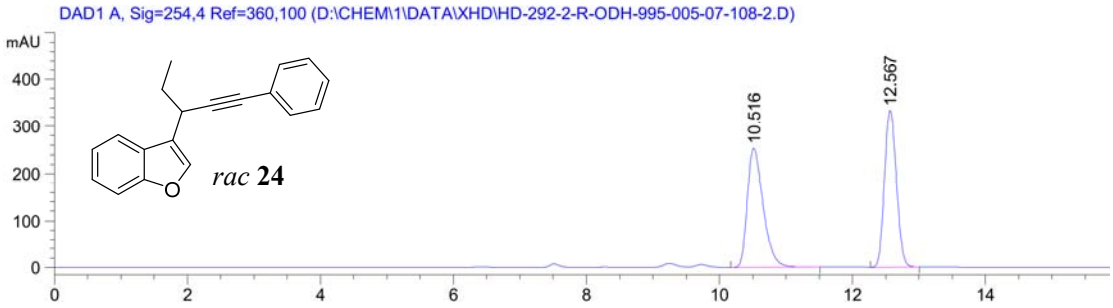
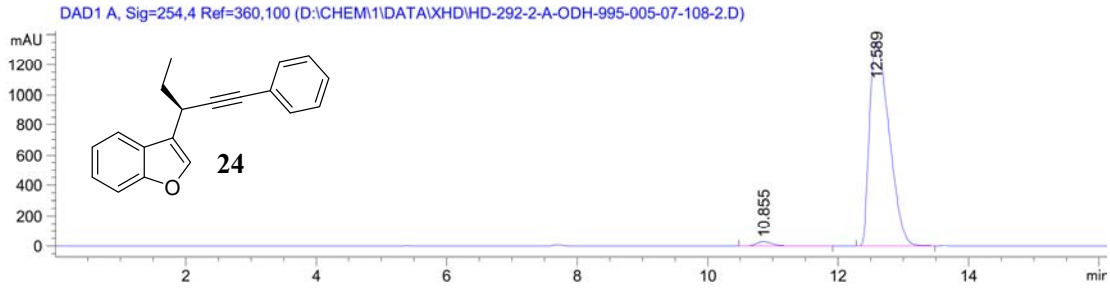
Signal 5: DAD1 E, Sig=240,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.527	VV	0.3428	102.88322	4.49958	1.9398
2	12.465	BV	0.4511	5201.03955	174.81360	98.0602
Totals :				5303.92278	179.31318	



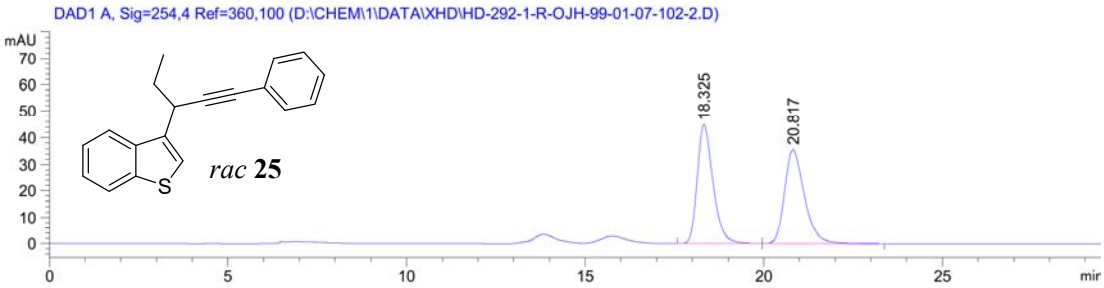
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.516	BB	0.2542	4212.61621	253.13699	50.2439
2	12.567	BB	0.1957	4171.71777	333.96585	49.7561
Totals :				8384.33398	587.10284	



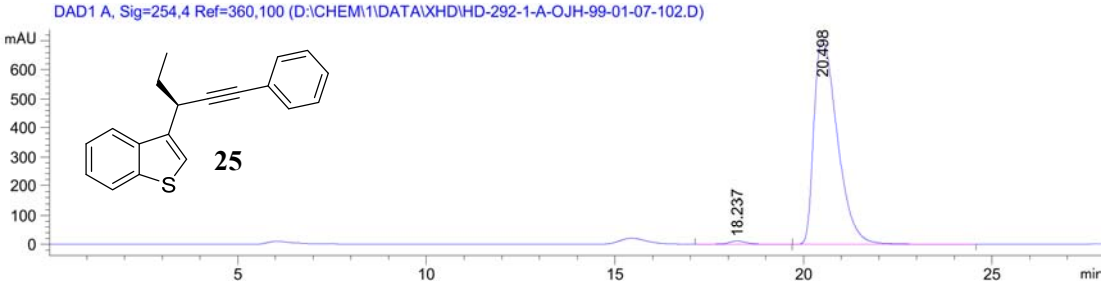
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.855	BB	0.2545	482.30731	29.23704	1.6910
2	12.589	BB	0.3340	2.80403e4	1352.04272	98.3090
Totals :				2.85226e4	1381.27976	



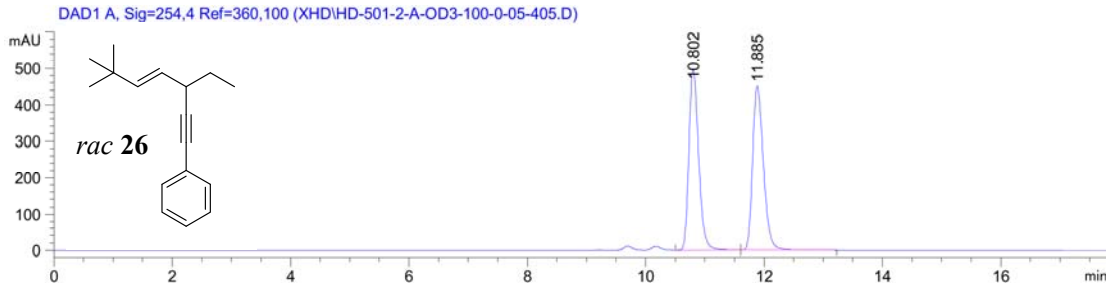
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.325	BB	0.4736	1391.97034	44.91646	50.1849
2	20.817	BB	0.5940	1381.71057	35.66548	49.8151
Totals :				2773.68091	80.58194	



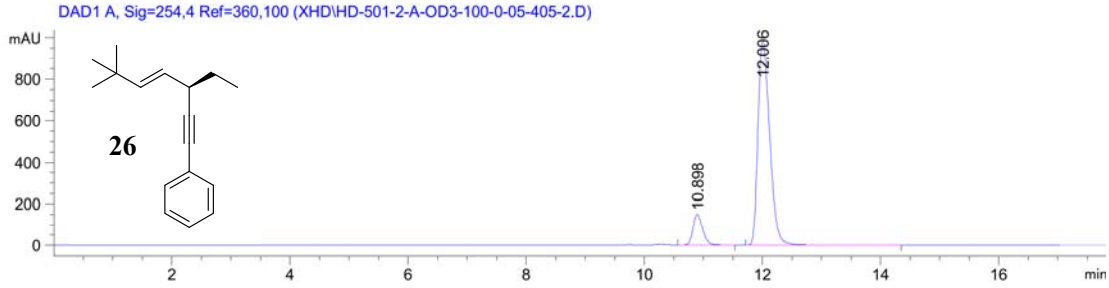
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.237	VB	0.5151	393.77368	11.39655	1.2798
2	20.498	BV	0.6687	3.03749e4	702.08319	98.7202
Totals :				3.07687e4	713.47974	



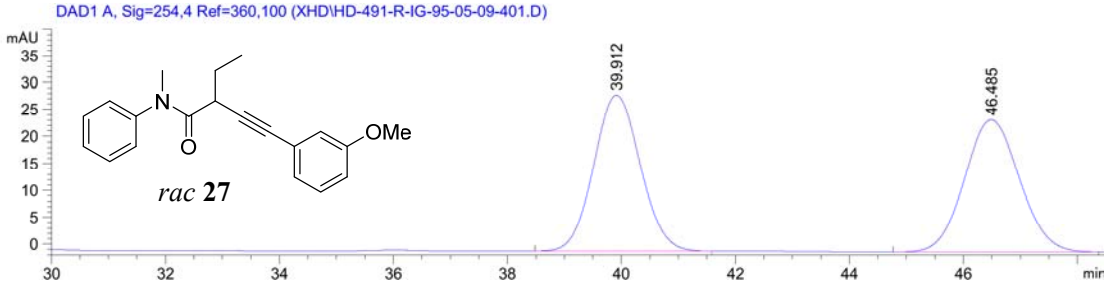
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.802	BB	0.1771	5676.90234	497.68698	49.8766
2	11.885	BB	0.1959	5704.99756	449.96069	50.1234
Totals :				1.13819e4	947.64767	



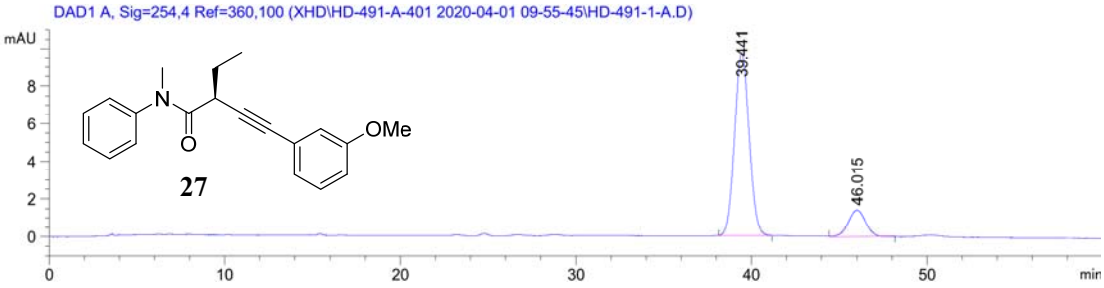
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.898	VB	0.1778	1734.65515	151.28131	11.2730
2	12.006	BB	0.2154	1.36531e4	986.99860	88.7270
Totals :				1.53877e4	1138.27991	



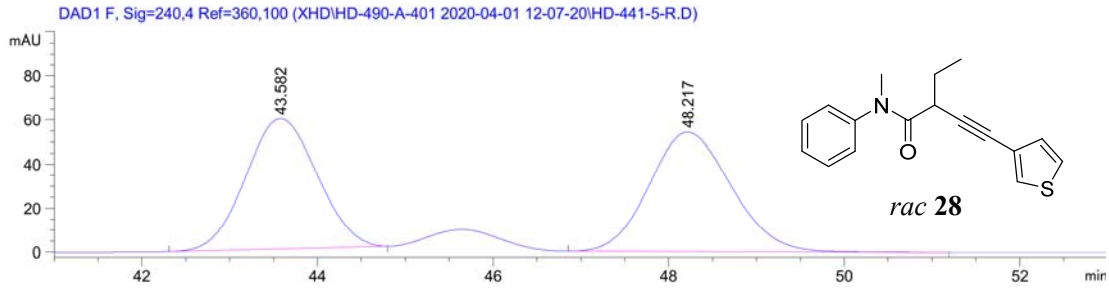
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	39.912	BB	0.8856	1648.83411	28.98965	49.9614
2	46.485	BB	1.0410	1651.38354	24.54158	50.0386
Totals :				3300.21765	53.53123	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

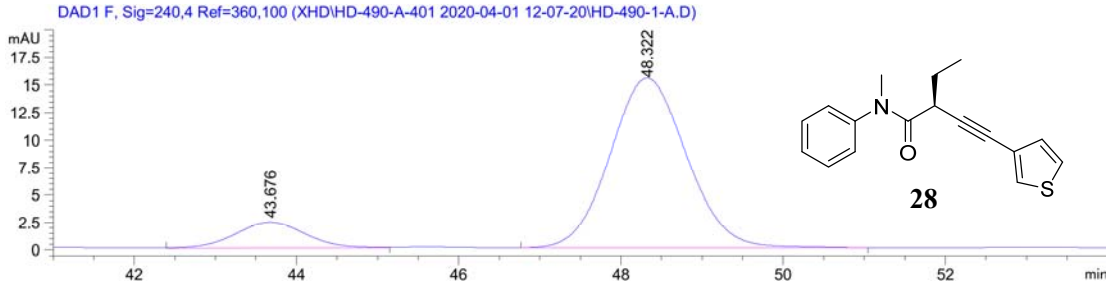
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	39.441	BB	0.8872	559.48083	9.69614	85.0907
2	46.015	MM R	1.1471	98.03036	1.42432	14.9093
Totals :				657.51119	11.12046	



rac **28**

Signal 6: DAD1 F, Sig=240,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	43.582	BB	0.8890	3350.97144	58.96780	48.6539
2	48.217	BB	1.0146	3536.38965	54.10306	51.3461
Totals :				6887.36108	113.07086	



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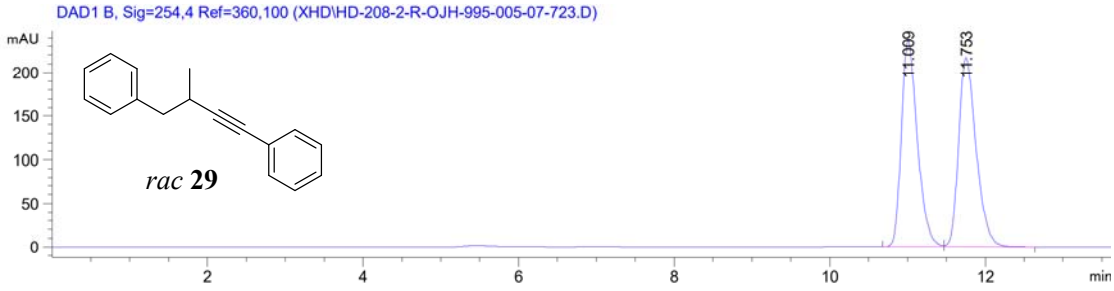
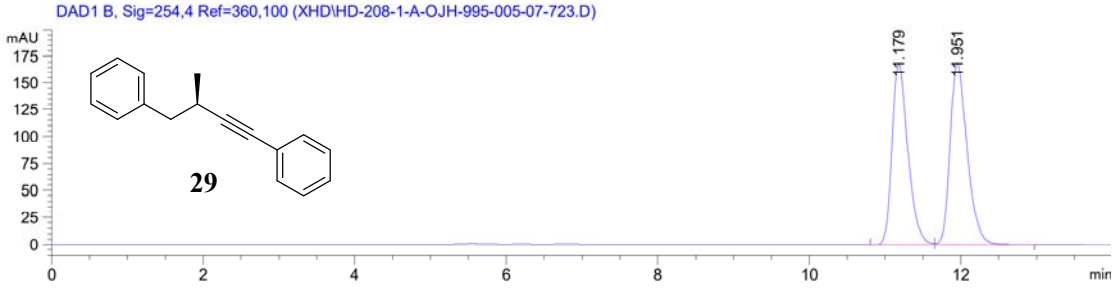
Signal 6: DAD1 F, Sig=240,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	43.676	MM R	1.0035	141.98506	2.35805	12.2424
2	48.322	BB	1.0011	1017.80072	15.43868	87.7576
Totals :				1159.78578	17.79674	



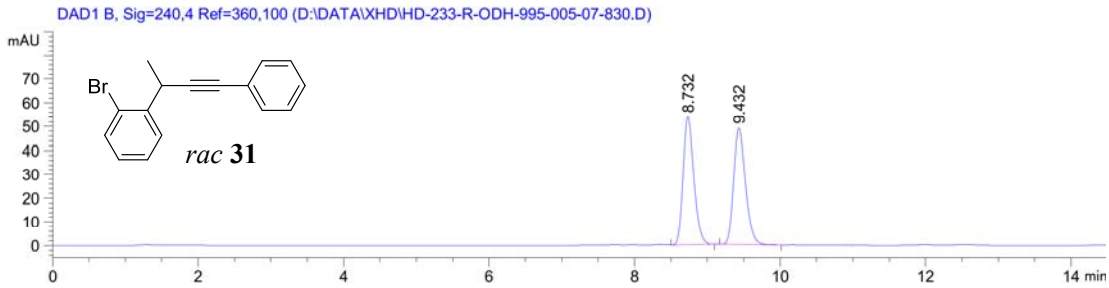
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.009	BV	0.2162	3363.47852	236.12163	49.8582
2	11.753	VB	0.2379	3382.61279	216.90707	50.1418
Totals :				6746.09131	453.02870	



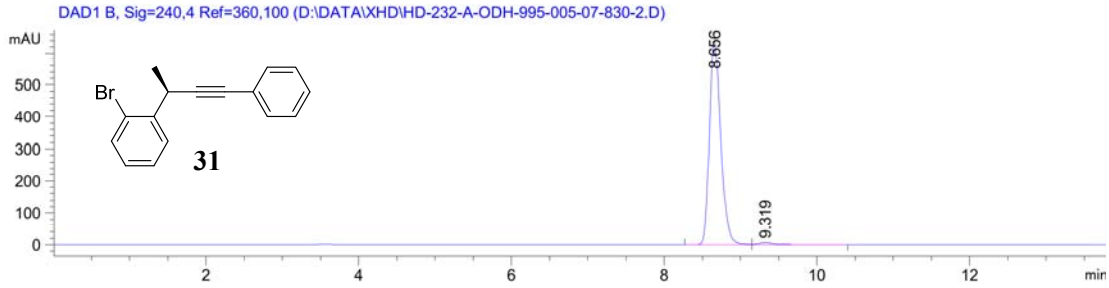
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.179	BV	0.2187	2431.72095	168.18225	48.0375
2	11.951	VB	0.2353	2630.40942	169.24474	51.9625
Totals :				5062.13037	337.42699	



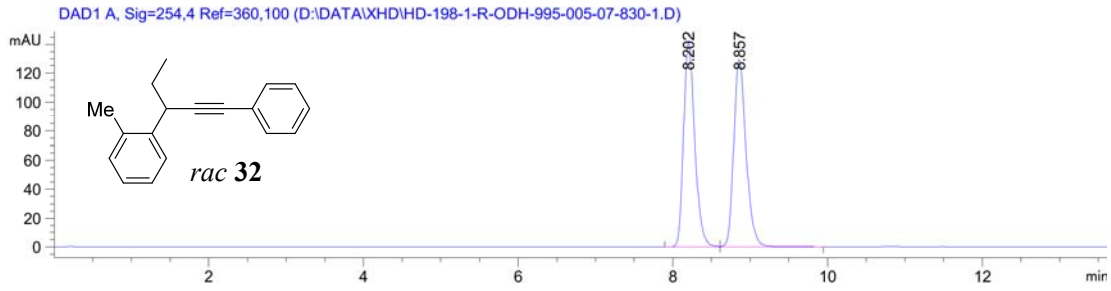
Signal 2: DAD1 B, Sig=240,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.732	BB	0.1591	556.27118	53.59978	49.9213
2	9.432	BB	0.1750	558.02576	48.93664	50.0787
Totals :				1114.29694	102.53642	



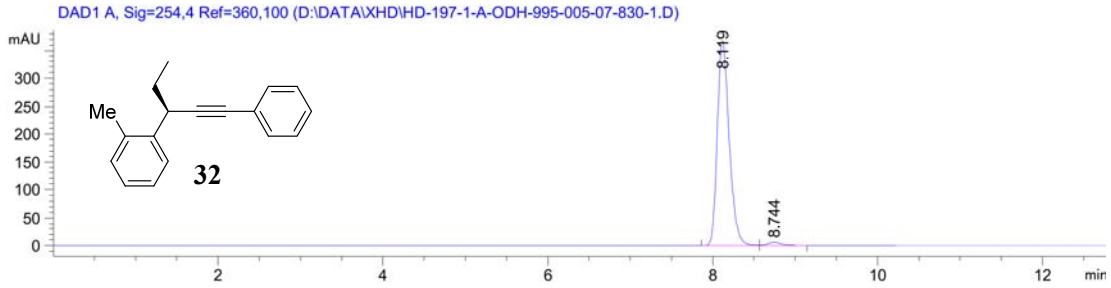
Signal 2: DAD1 B, Sig=240,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.656	BV	0.1558	6579.82178	640.59808	98.7241
2	9.319	VB	0.1976	85.03582	6.21492	1.2759
Totals :				6664.85760	646.81300	



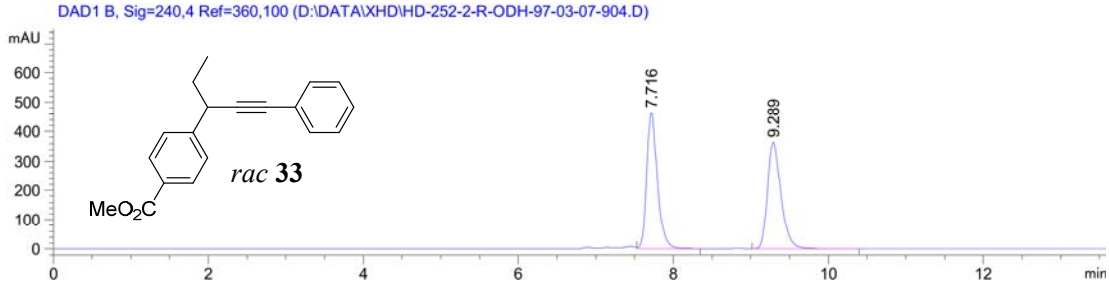
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.202	BV	0.1530	1421.47070	141.70264	49.7813
2	8.857	VB	0.1691	1433.95911	129.53770	50.2187
Totals :				2855.42981	271.24034	



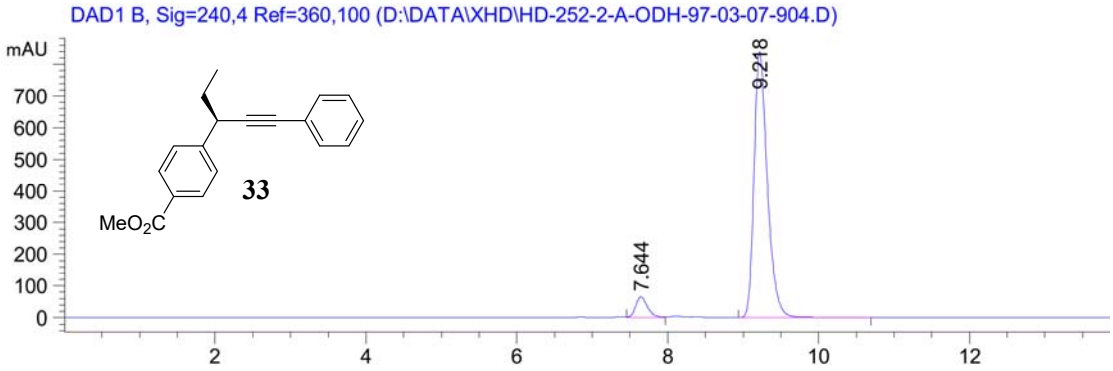
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.119	BV	0.1526	3680.53027	368.21539	98.2218
2	8.744	VB	0.1713	66.63286	5.82966	1.7782
Totals :				3747.16313	374.04505	



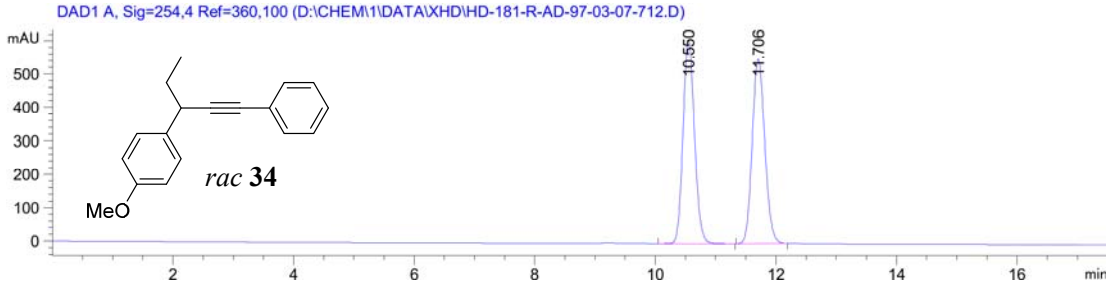
Signal 2: DAD1 B, Sig=240,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.716	VB	0.1437	4444.92188	464.44144	50.1005
2	9.289	VB	0.1843	4427.08203	362.96970	49.8995
Totals :				8872.00391	827.41113	



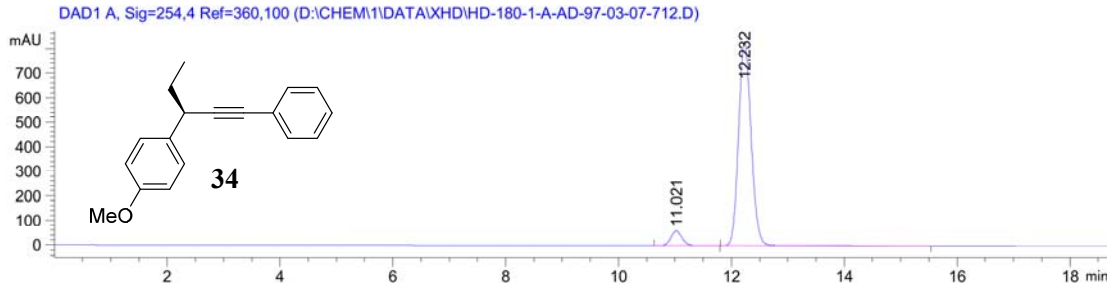
Signal 2: DAD1 B, Sig=240,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.644	VV	0.1639	700.30896	64.89249	6.3521
2	9.218	BB	0.1875	1.03246e4	839.47278	93.6479
Totals :				1.10249e4	904.36527	



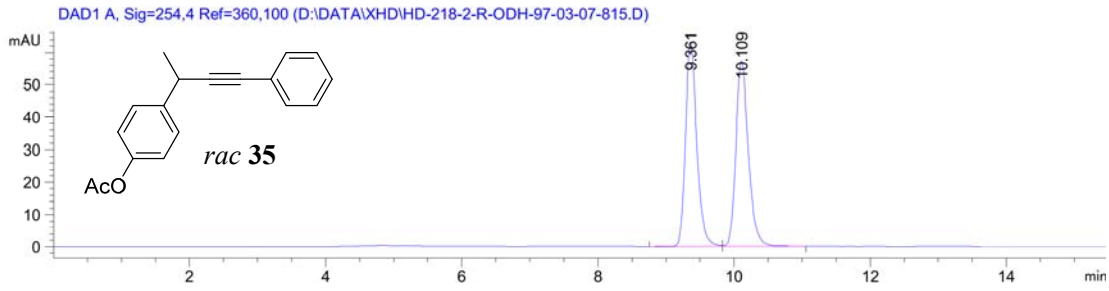
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.550	BB	0.2061	8088.94043	612.23254	50.3510
2	11.706	BB	0.2243	7976.15820	552.92542	49.6490
Totals :				1.60651e4	1165.15796	



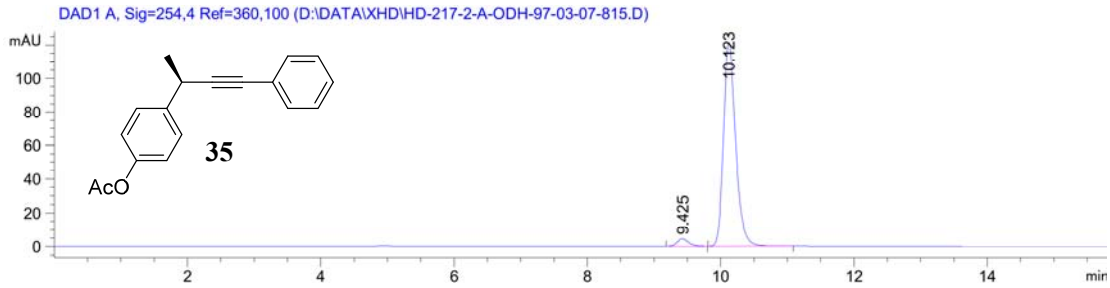
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.021	BB	0.2138	819.40558	59.82727	5.9997
2	12.232	BBA	0.2402	1.28379e4	831.09619	94.0003
Totals :				1.36573e4	890.92346	



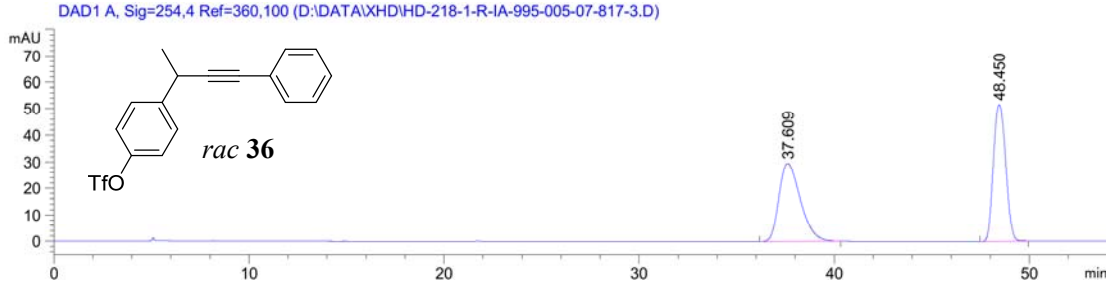
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.361	BV	0.1748	731.42035	63.28177	49.9233
2	10.109	VB	0.1931	733.66797	57.40298	50.0767
Totals :				1465.08832	120.68475	



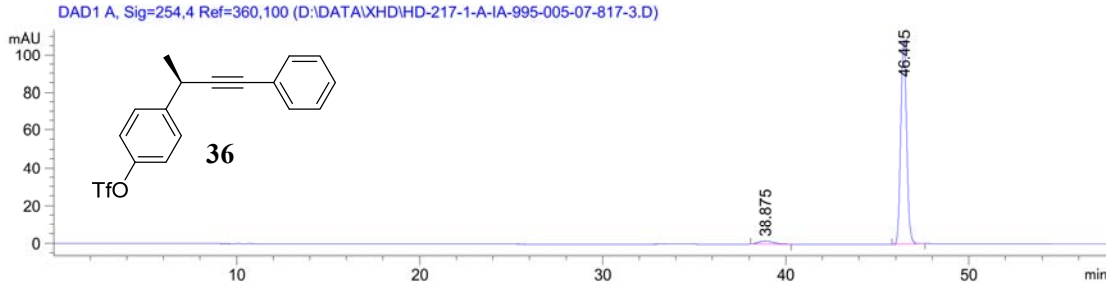
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.425	BB	0.1774	51.85070	4.46769	3.2652
2	10.123	BB	0.1914	1536.13745	121.59297	96.7348
Totals :				1587.98815	126.06066	



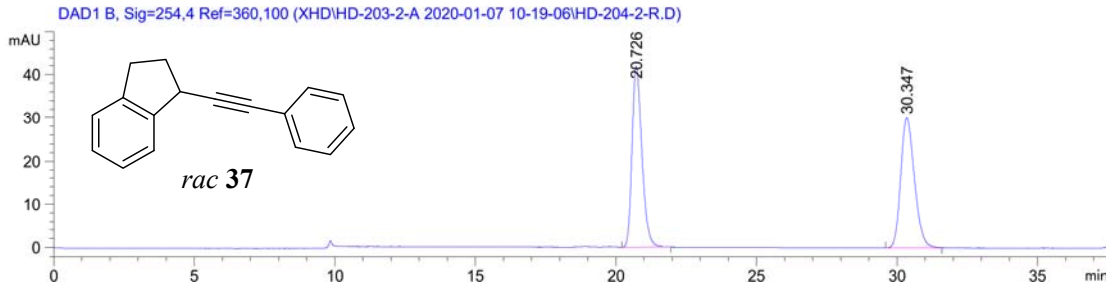
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	37.609	BB	1.1520	2264.83032	29.68773	49.9621
2	48.450	BB	0.7140	2268.26758	51.68632	50.0379
Totals :				4533.09790	81.37405	



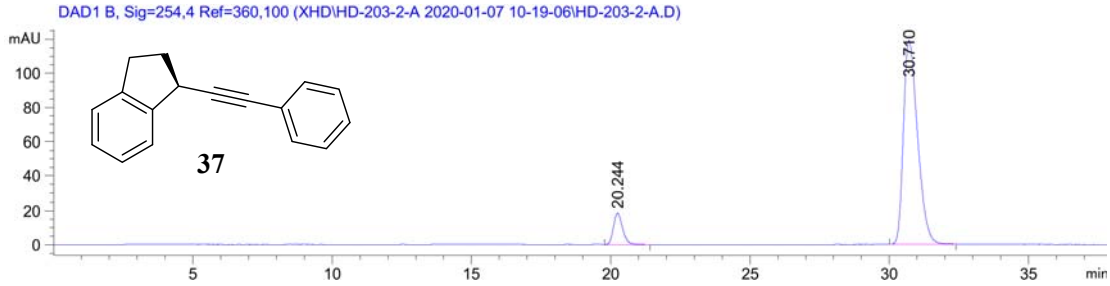
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	38.875	MM R	0.9846	90.04355	1.52427	3.5846
2	46.445	BB	0.3425	2421.88379	108.45319	96.4154
Totals :				2511.92734	109.97746	



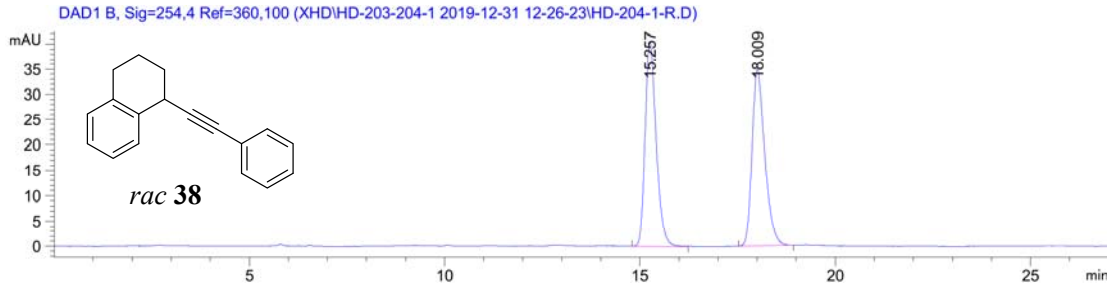
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.726	BB	0.3752	1020.36340	41.73885	50.1393
2	30.347	BB	0.5189	1014.69220	29.97383	49.8607
Totals :				2035.05560	71.71268	



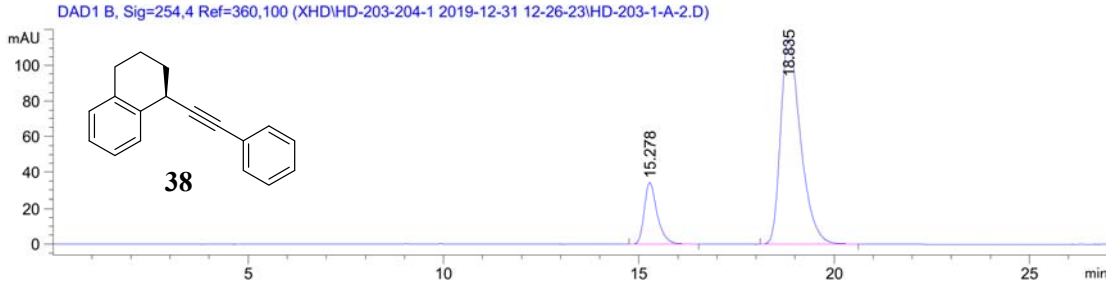
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.244	BB	0.3521	423.63586	18.57229	9.1671
2	30.710	BB	0.5344	4197.63770	119.32577	90.8329
Totals :				4621.27356	137.89806	



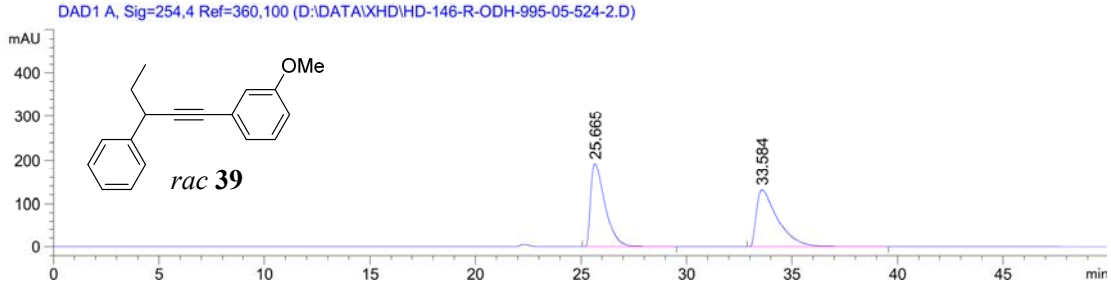
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.257	BB	0.3012	797.18793	40.58042	50.1597
2	18.009	BB	0.3380	792.11139	35.00698	49.8403
Totals :				1589.29932	75.58741	



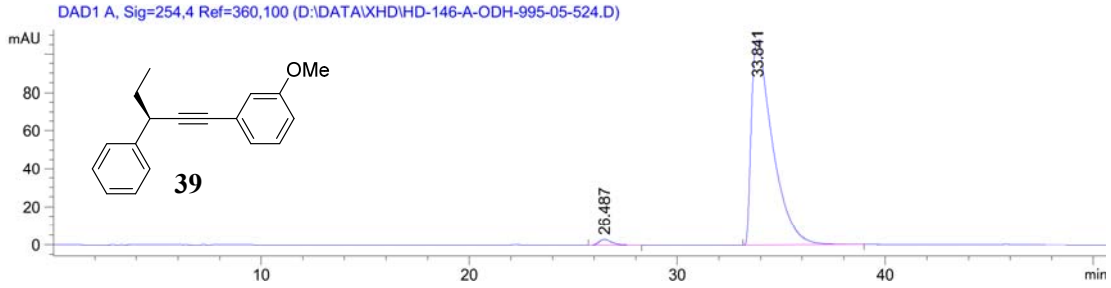
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.278	BB	0.3535	795.41681	34.17417	16.3506
2	18.835	BB	0.5384	4069.35205	114.57291	83.6494
Totals :				4864.76886	148.74707	



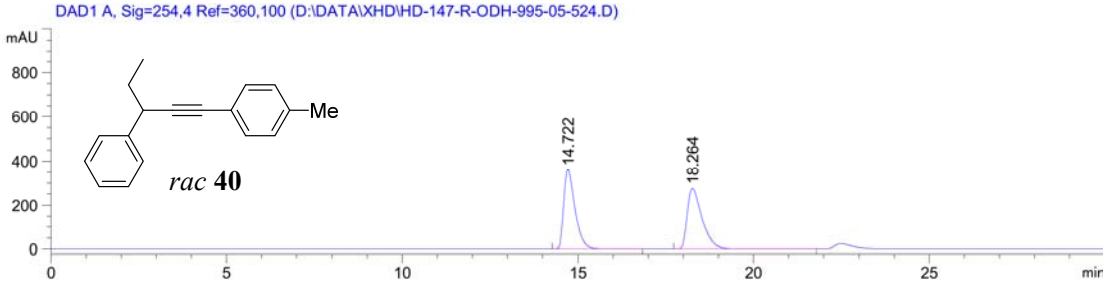
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	25.665	BB	0.7183	9137.25488	191.62433	49.7523
2	33.584	BB	1.0424	9228.22461	130.27808	50.2477
Totals :				1.83655e4	321.90240	



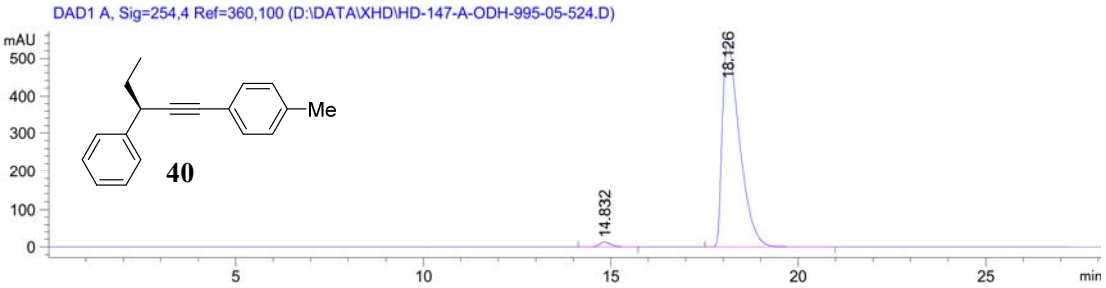
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	26.487	BB	0.6300	124.05807	2.96561	1.6060
2	33.841	BB	1.0388	7600.55029	107.50506	98.3940
Totals :				7724.60837	110.47067	



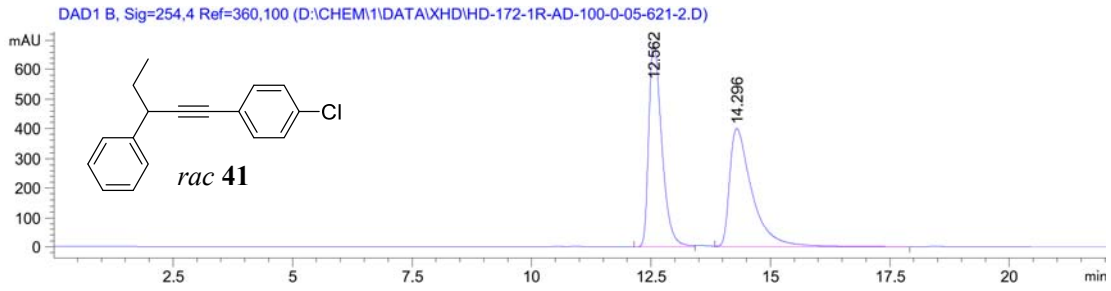
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.722	BV	0.3421	8105.09619	360.78421	49.9754
2	18.264	BB	0.4475	8113.06445	275.57626	50.0246
Totals :				1.62182e4	636.36047	



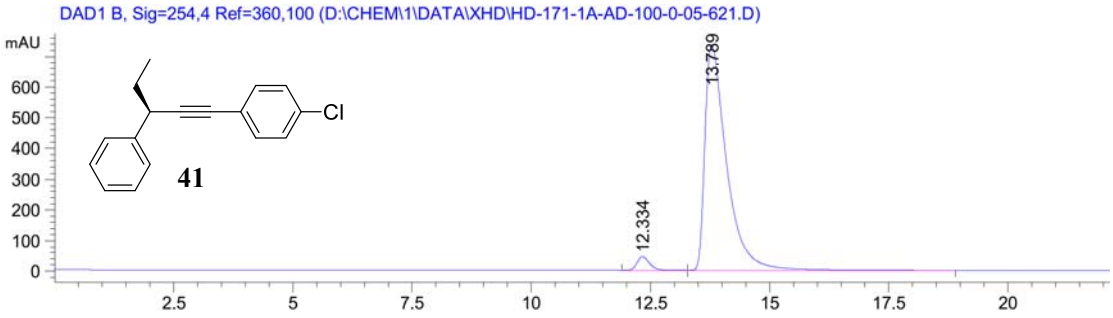
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.832	BV	0.3298	274.93457	12.84259	1.5575
2	18.126	VV	0.4852	1.73777e4	543.23956	98.4425
Totals :				1.76527e4	556.08215	



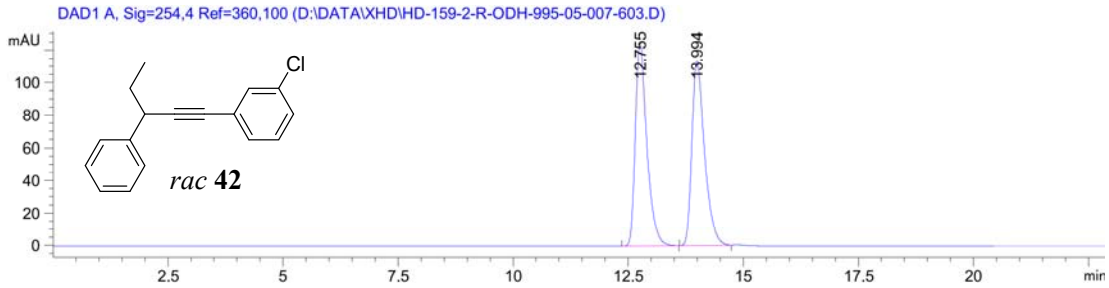
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.562	BV	0.2882	1.30684e4	692.28748	49.7751
2	14.296	VB	0.4901	1.31865e4	398.49579	50.2249
Totals :				2.62548e4	1090.78326	



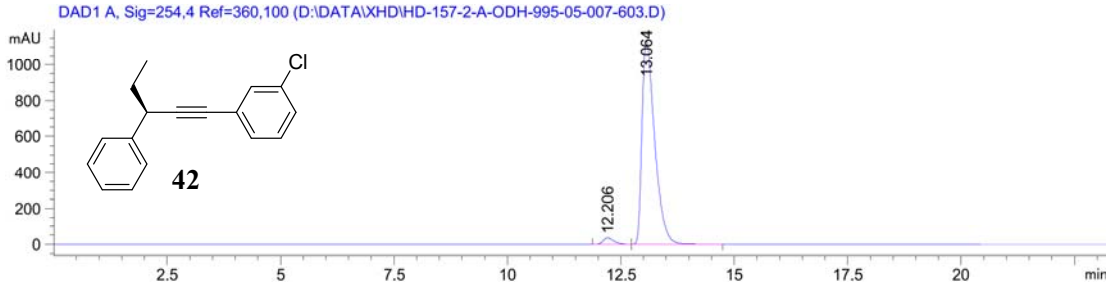
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.334	BB	0.2757	805.06354	44.36243	3.3349
2	13.789	BB	0.4736	2.33356e4	736.52789	96.6651
Totals :				2.41406e4	780.89032	



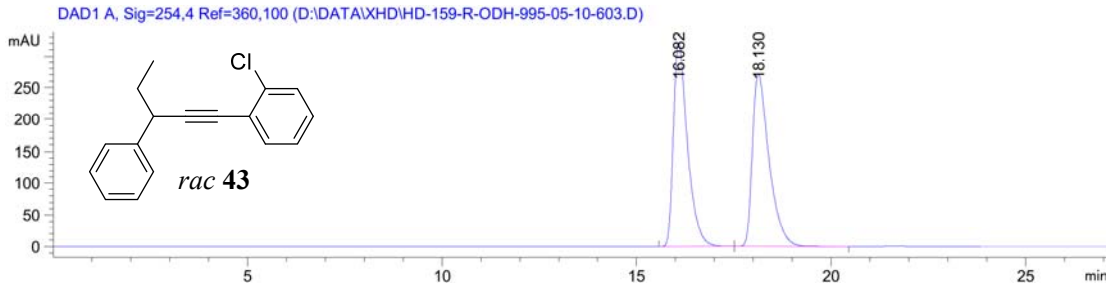
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.755	BB	0.2609	2181.30762	125.39645	50.0811
2	13.994	BB	0.2874	2174.23975	113.54329	49.9189
Totals :				4355.54736	238.93974	



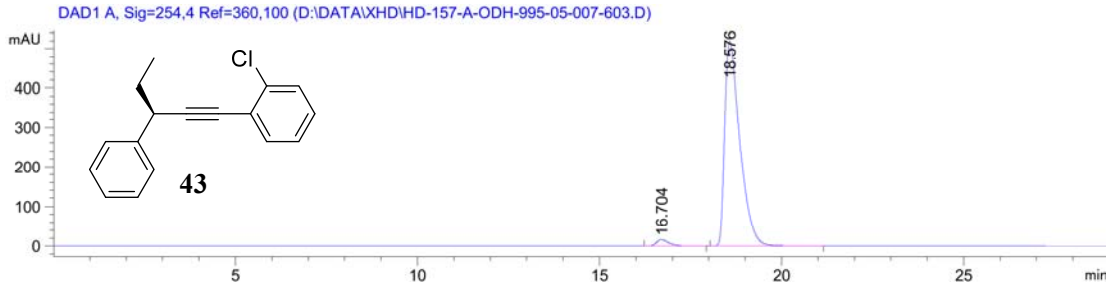
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.206	BV	0.2417	581.13727	36.12967	2.5660
2	13.064	VB	0.2920	2.20667e4	1139.16858	97.4340
Totals :				2.26479e4	1175.29825	



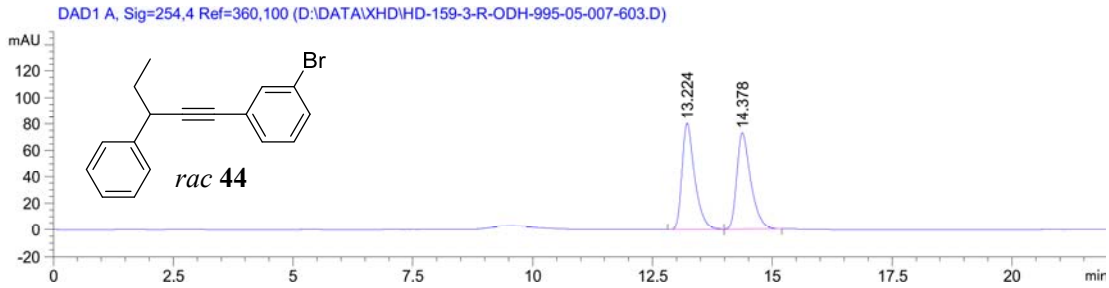
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.082	BB	0.3773	8091.87744	321.83011	49.9608
2	18.130	BB	0.4462	8104.58545	271.57565	50.0392
Totals :				1.61965e4	593.40576	



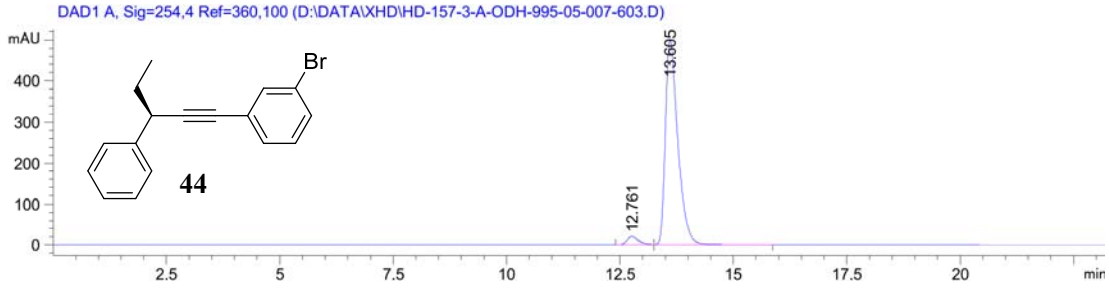
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.704	BB	0.3408	378.40775	16.54974	2.4547
2	18.576	BB	0.4354	1.50371e4	519.91754	97.5453
Totals :				1.54155e4	536.46728	



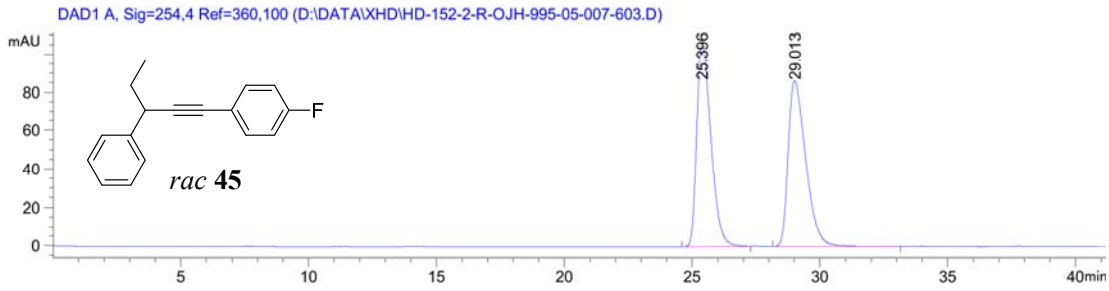
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.224	BB	0.2751	1480.46533	80.30376	50.0093
2	14.378	BB	0.3028	1479.91309	72.89776	49.9907
Totals :				2960.37842	153.20152	



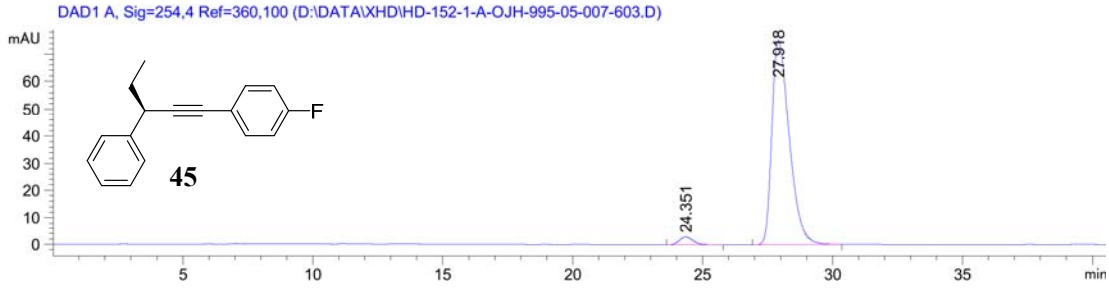
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.761	BV	0.2549	353.86914	20.75723	3.5725
2	13.605	VB	0.2869	9551.40332	499.84506	96.4275
Totals :				9905.27246	520.60229	



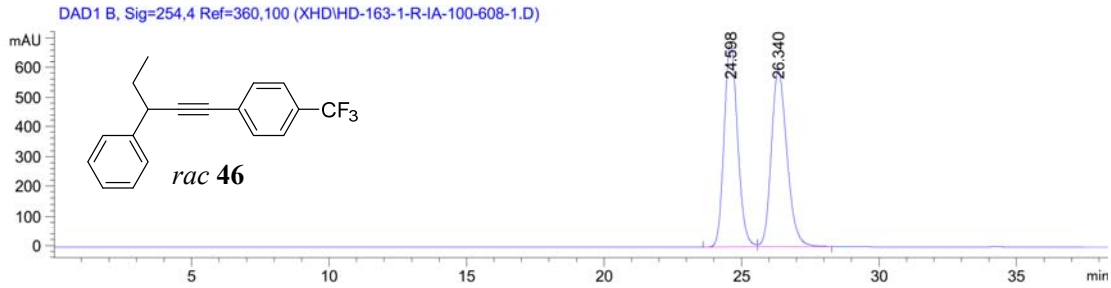
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	25.396	BB	0.5959	4111.97021	106.62293	49.8259
2	29.013	BB	0.7346	4140.70850	86.47428	50.1741
Totals :				8252.67871	193.09721	



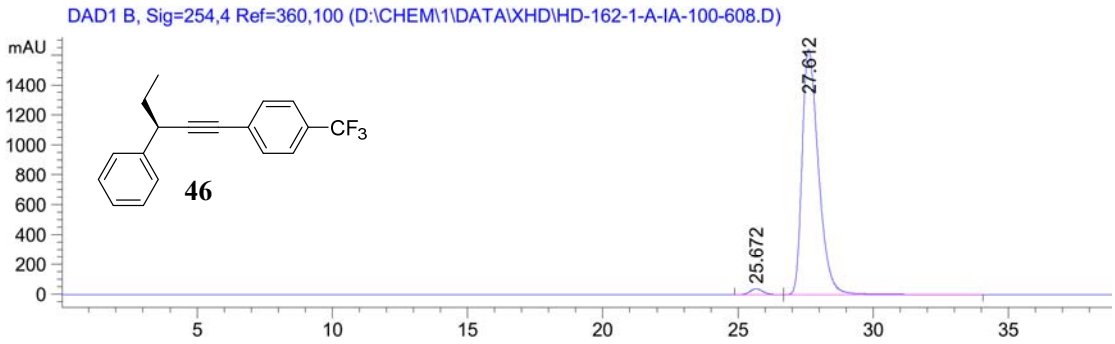
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	24.351	BB	0.5467	107.34194	2.93507	2.9629
2	27.918	BB	0.7145	3515.57813	75.32643	97.0371
Totals :				3622.92007	78.26150	



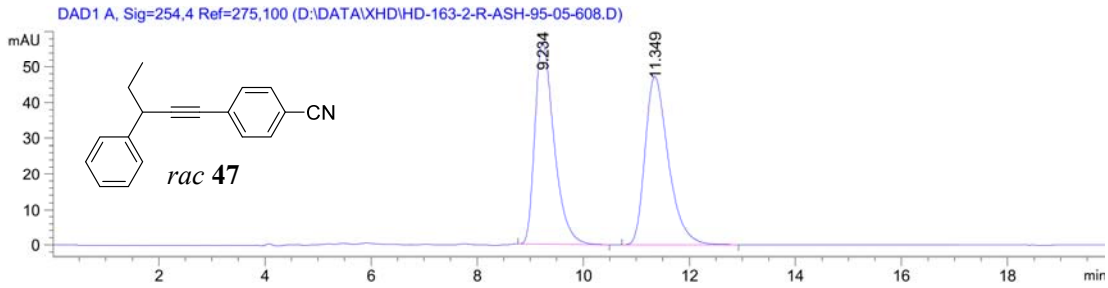
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	24.598	BV	0.5340	2.34461e4	690.73157	49.9323
2	26.340	VB	0.6091	2.35096e4	592.21149	50.0677
Totals :				4.69556e4	1282.94305	



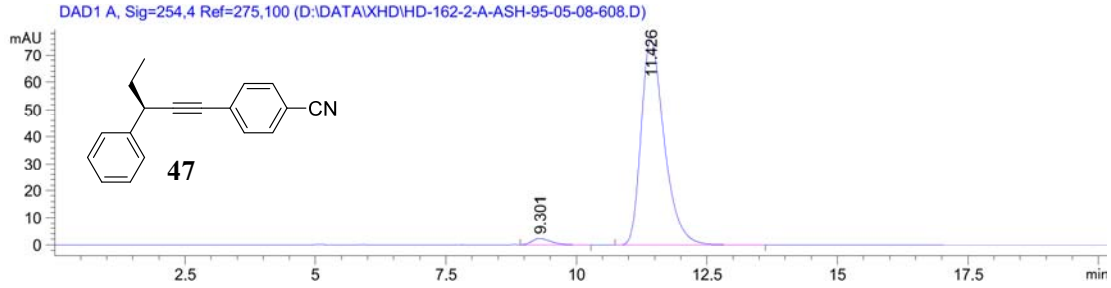
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	25.672	BV	0.5313	1348.76318	39.40878	1.9008
2	27.612	VV	0.6464	6.96081e4	1642.43896	98.0992
Totals :				7.09568e4	1681.84774	



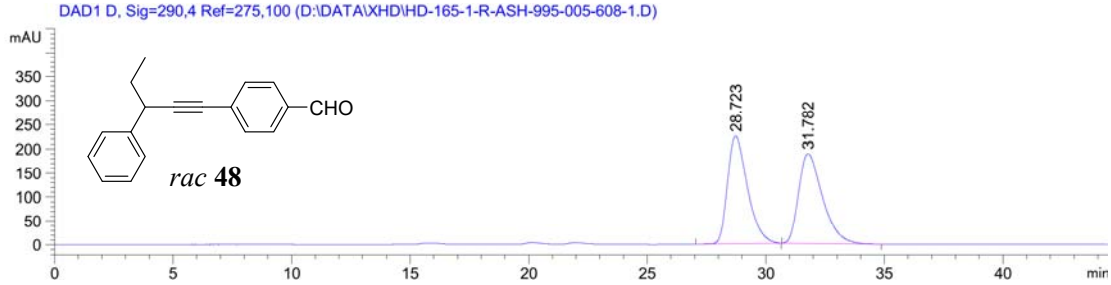
Signal 1: DAD1 A, Sig=254,4 Ref=275,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.234	BB	0.3826	1428.07458	56.93953	49.6868
2	11.349	BB	0.4671	1446.07800	47.25047	50.3132
Totals :				2874.15259	104.18999	



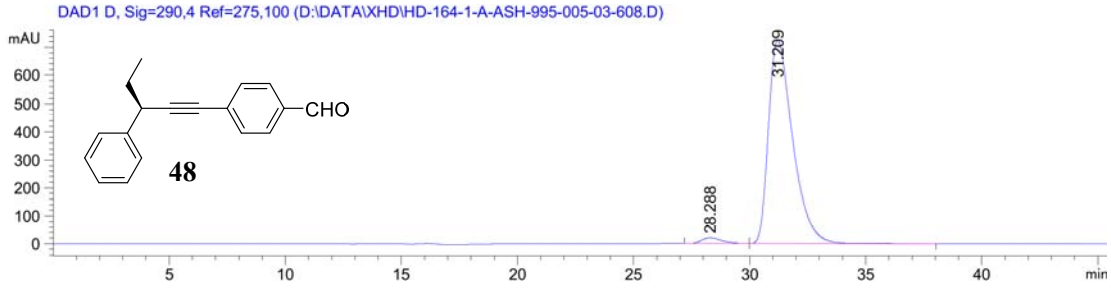
Signal 1: DAD1 A, Sig=254,4 Ref=275,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.301	BB	0.3709	57.14683	2.32362	2.3841
2	11.426	BB	0.4722	2339.80542	75.78040	97.6159
Totals :				2396.95225	78.10402	



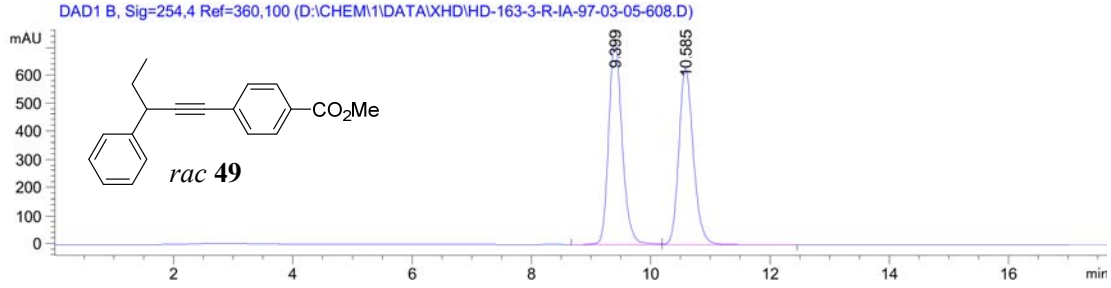
Signal 4: DAD1 D, Sig=290,4 Ref=275,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	28.723	BB	0.9040	1.31933e4	224.38988	50.0027
2	31.782	BB	1.0481	1.31918e4	187.66449	49.9973
Totals :				2.63851e4	412.05437	



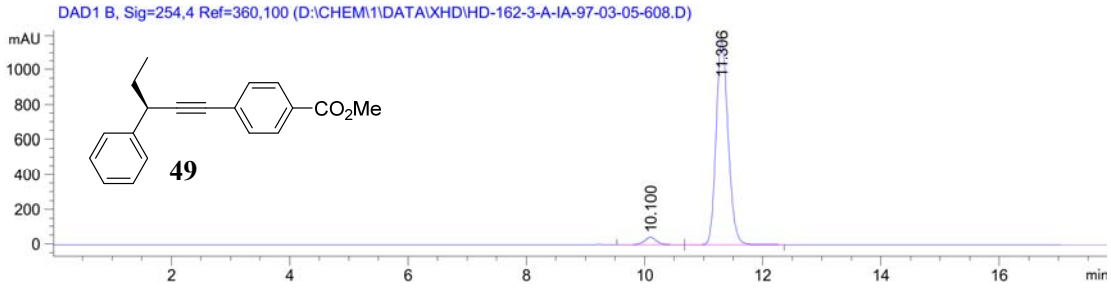
Signal 4: DAD1 D, Sig=290,4 Ref=275,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	28.288	BB	0.8976	1208.90747	20.45207	2.2478
2	31.209	BB	1.0997	5.25739e4	725.23651	97.7522
Totals :				5.37828e4	745.68858	



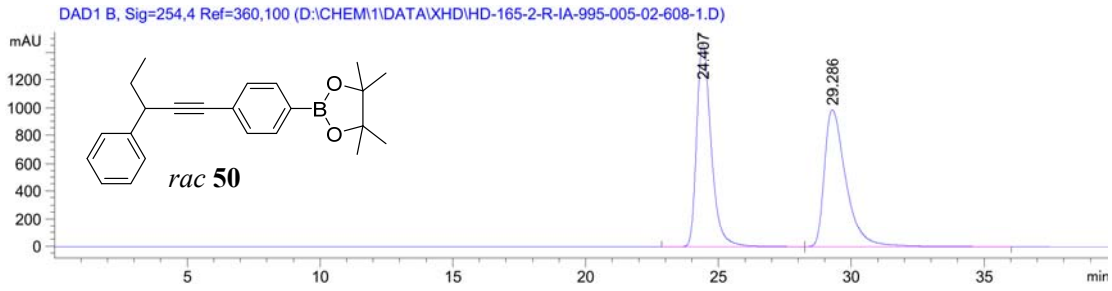
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.399	BV	0.2430	1.14698e4	731.35083	51.8653
2	10.585	VB	0.2618	1.06448e4	627.75586	48.1347
Totals :				2.21147e4	1359.10669	



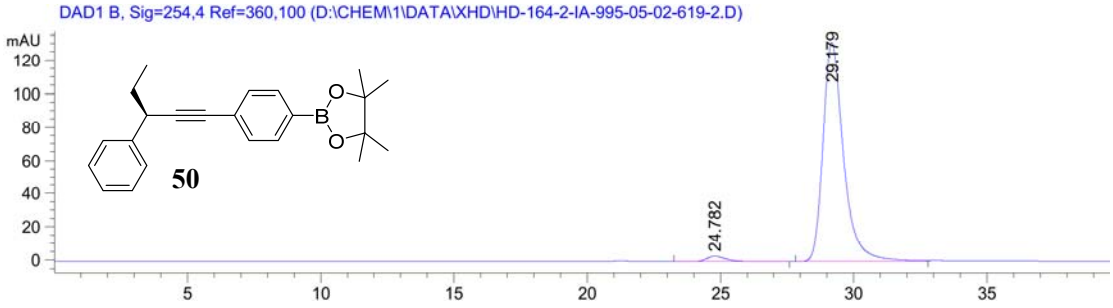
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.100	BB	0.2182	604.00775	42.40234	3.5015
2	11.306	BV	0.2215	1.66459e4	1173.22266	96.4985
Totals :				1.72499e4	1215.62500	



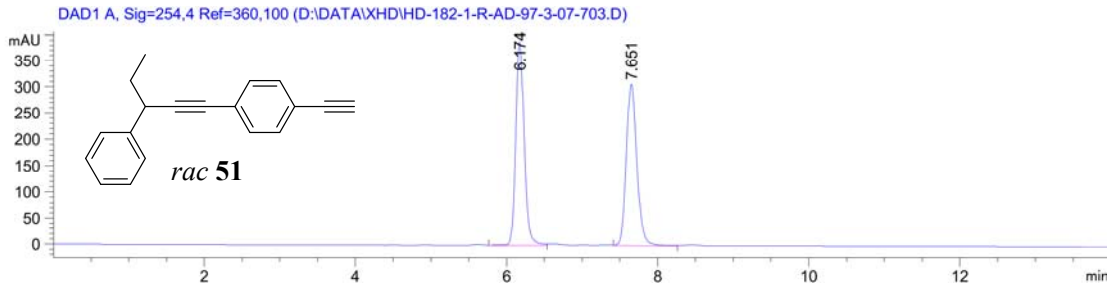
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	24.407	BB	0.5772	5.56960e4	1472.78284	49.9380
2	29.286	BV	0.8541	5.58343e4	989.84442	50.0620
Totals :				1.11530e5	2462.62726	



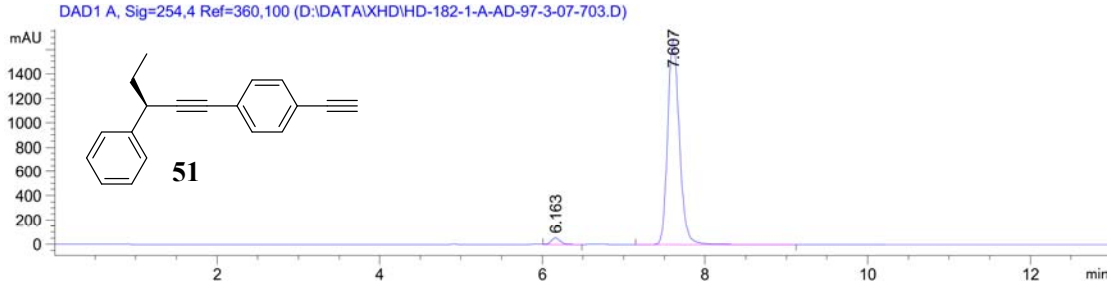
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	24.782	BB	0.7185	154.94252	3.19102	2.1503
2	29.179	BV	0.8095	7050.64648	131.50574	97.8497
Totals :				7205.58900	134.69676	



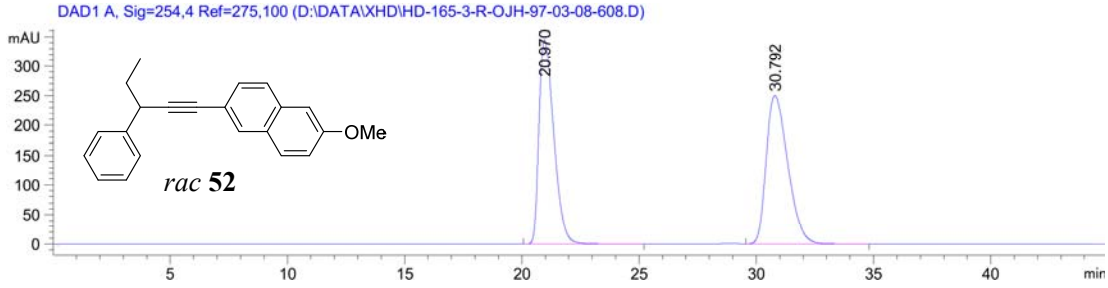
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.174	BV	0.1192	3041.91431	389.12375	50.1668
2	7.651	VV	0.1505	3021.68555	307.96439	49.8332
Totals :				6063.59985	697.08813	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.163	VV	0.1215	414.41406	52.85158	2.3954
2	7.607	BB	0.1549	1.68861e4	1685.51697	97.6046
Totals :				1.73006e4	1738.36855	



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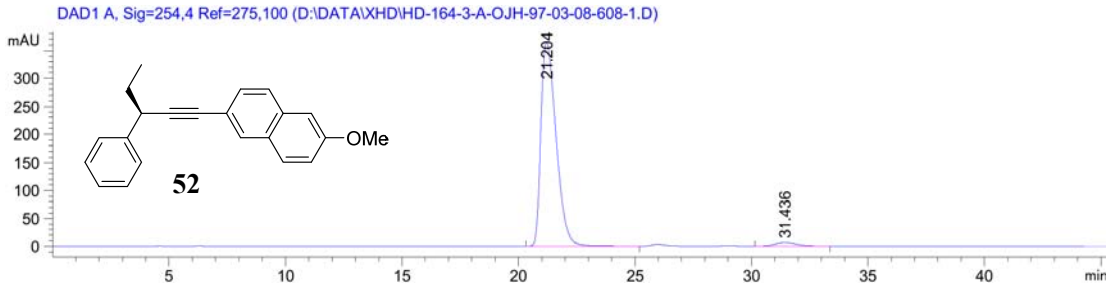
Signal 1: DAD1 A, Sig=254,4 Ref=275,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.970	BB	0.6864	1.51653e4	345.27274	48.6586
2	30.792	BB	0.9993	1.60014e4	250.49669	51.3414
Totals :				3.11667e4	595.76942	



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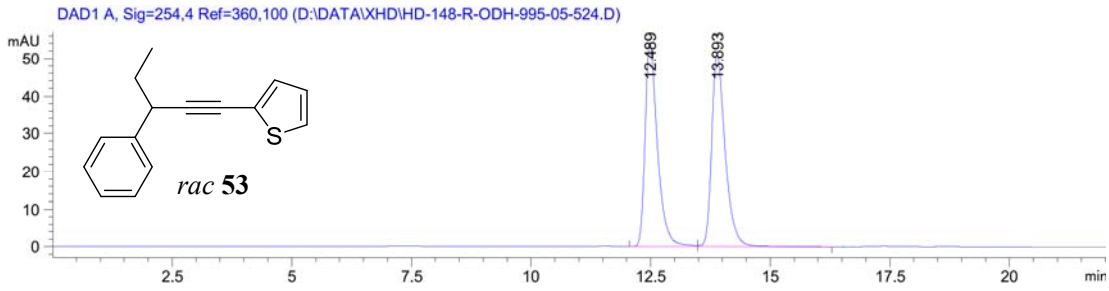
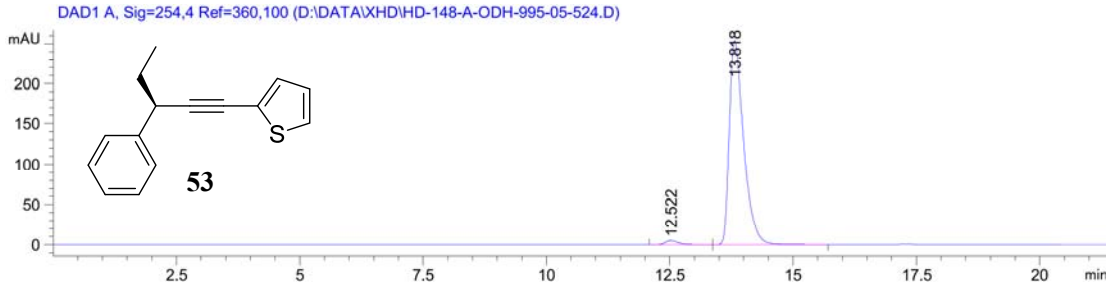
Signal 1: DAD1 A, Sig=254,4 Ref=275,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.204	BB	0.7072	1.65025e4	365.19394	97.6171
2	31.436	BB	0.8765	402.83447	6.72829	2.3829
Totals :				1.69054e4	371.92223	



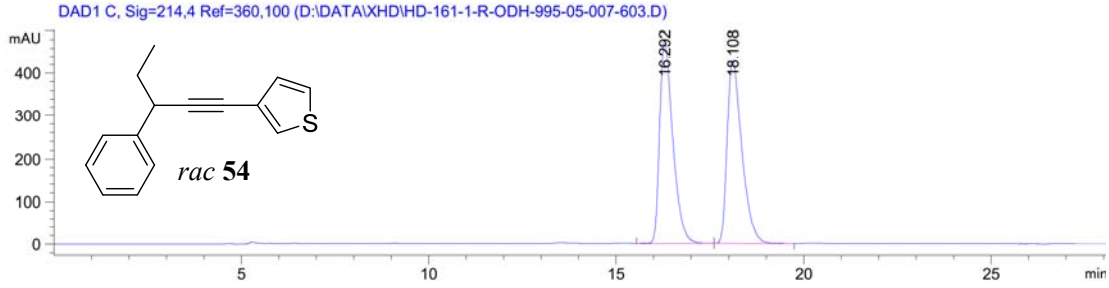
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.489	VV	0.2757	980.67621	54.04567	49.3770
2	13.893	VB	0.2937	1005.42493	51.07379	50.6230
Totals :				1986.10114	105.11945	



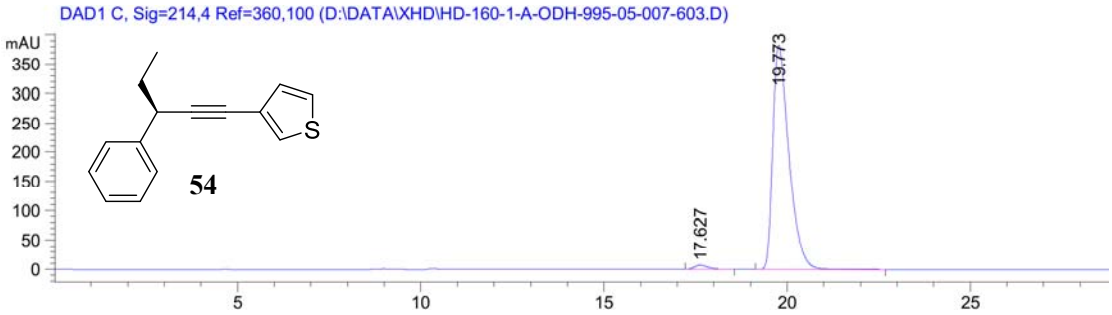
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.522	BV	0.2724	93.59621	5.04616	1.7931
2	13.818	VV	0.3081	5126.13574	253.28737	98.2069
Totals :				5219.73196	258.33353	



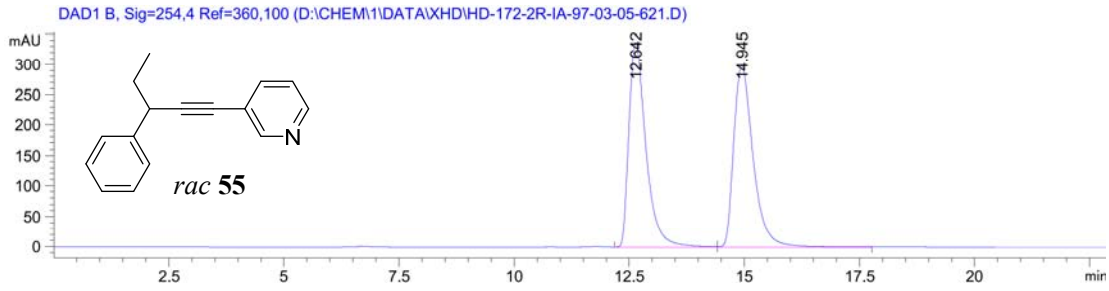
Signal 3: DAD1 C, Sig=214,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.292	BB	0.3664	1.16311e4	477.15085	49.9073
2	18.108	BB	0.4143	1.16744e4	427.85065	50.0927
Totals :				2.33055e4	905.00150	



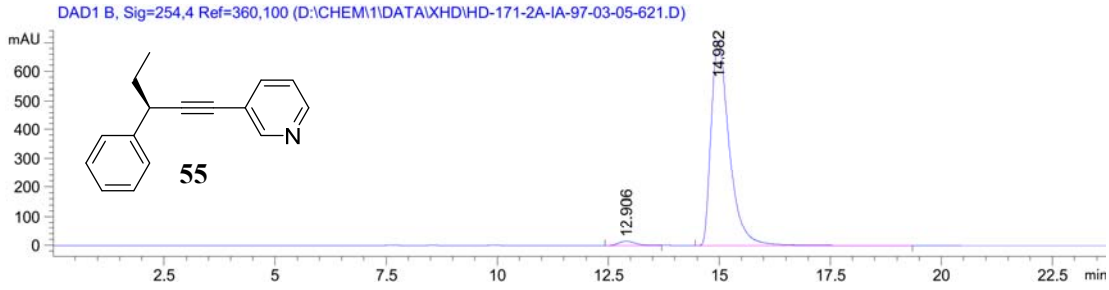
Signal 3: DAD1 C, Sig=214,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	17.627	BB	0.3775	169.18300	6.81889	1.4247
2	19.773	BB	0.4608	1.17062e4	382.78134	98.5753
Totals :				1.18754e4	389.60023	



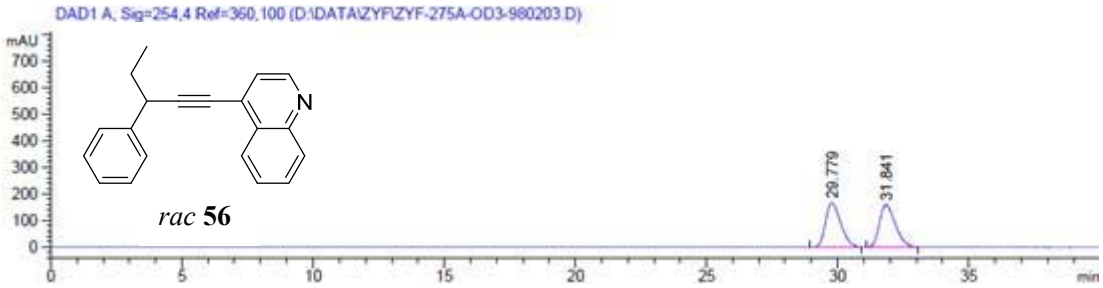
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.642	BV	0.3935	8731.62305	337.82025	49.6548
2	14.945	VV	0.4568	8853.02148	299.53043	50.3452
Totals :				1.75846e4	637.35068	



Signal 2: DAD1 B, Sig=254,4 Ref=360,100

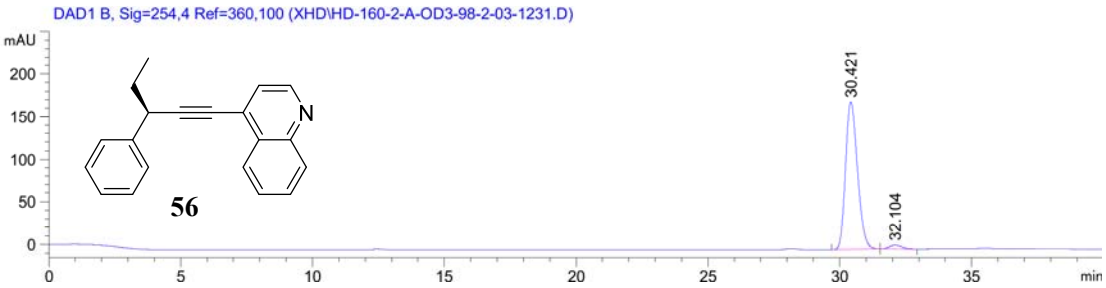
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.906	BV	0.4175	406.92044	14.95312	1.9745
2	14.982	VV	0.4365	2.02020e4	708.83459	98.0255
Totals :				2.06089e4	723.78771	



rac **56**

Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	29.779	BB	0.5944	6689.38721	167.34102	50.1421
2	31.841	BB	0.6395	6651.47559	158.54236	49.8579
Totals :				1.33409e4	325.88338	



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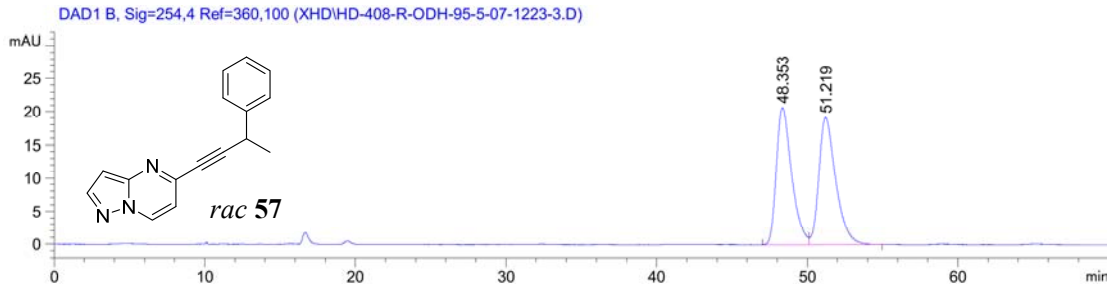
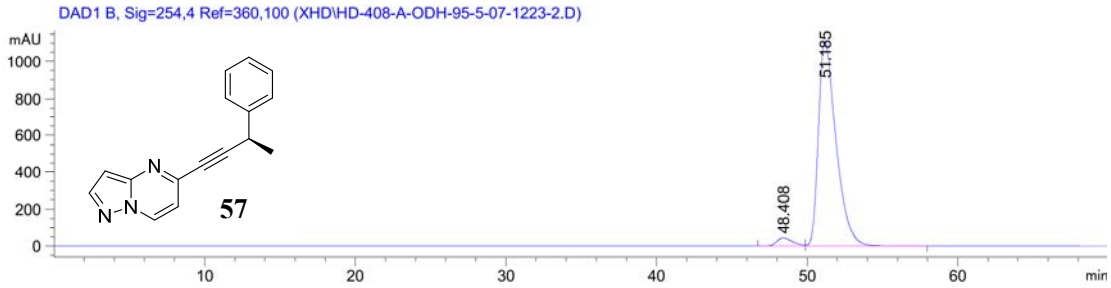
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	30.421	BB	0.4894	5460.33740	173.40587	97.3636
2	32.104	BB	0.4371	147.85175	4.67355	2.6364
Totals :				5608.18915	178.07942	



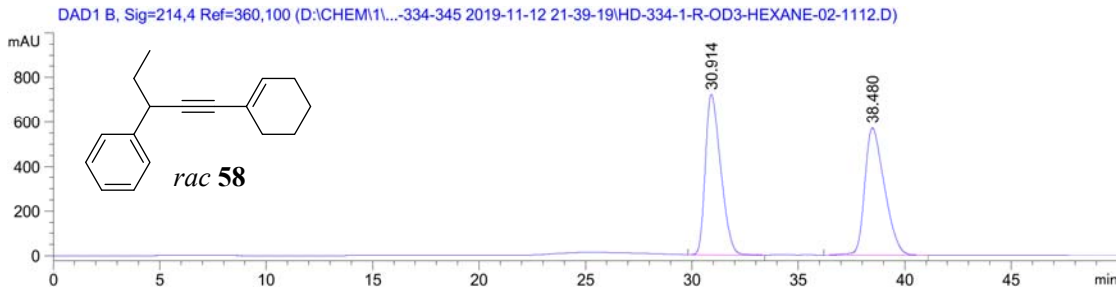
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	48.353	BV	1.0605	1472.47644	20.73572	49.3653
2	51.219	VB	1.1745	1510.34290	19.18501	50.6347
Totals :				2982.81934	39.92073	



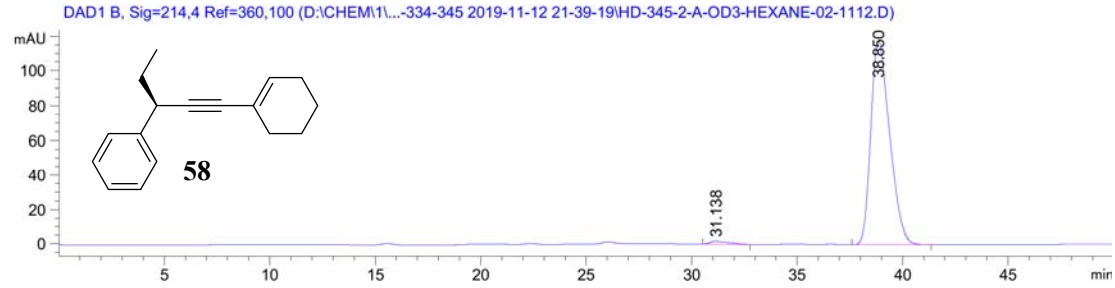
Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	48.408	BV	1.0715	3143.25708	44.10449	3.3642
2	51.185	VB	1.2200	9.02886e4	1111.11963	96.6358
Totals :				9.34318e4	1155.22412	



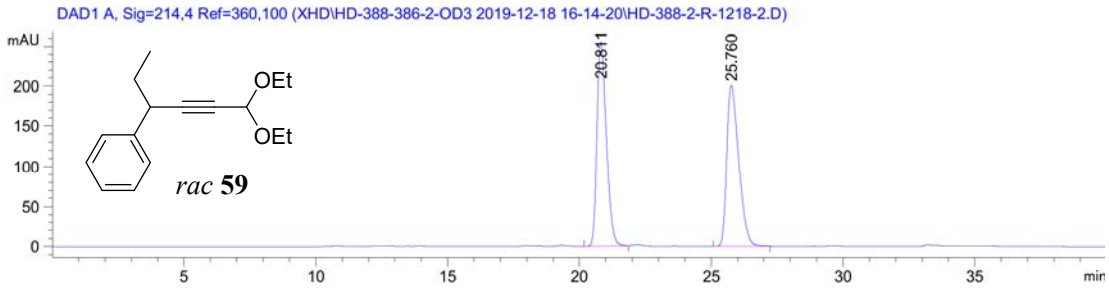
Signal 2: DAD1 B, Sig=214,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	30.914	BB	0.7602	3.59539e4	718.05603	49.5527
2	38.480	BB	0.9762	3.66029e4	569.24237	50.4473
Totals :				7.25568e4	1287.29840	



Signal 2: DAD1 B, Sig=214,4 Ref=360,100

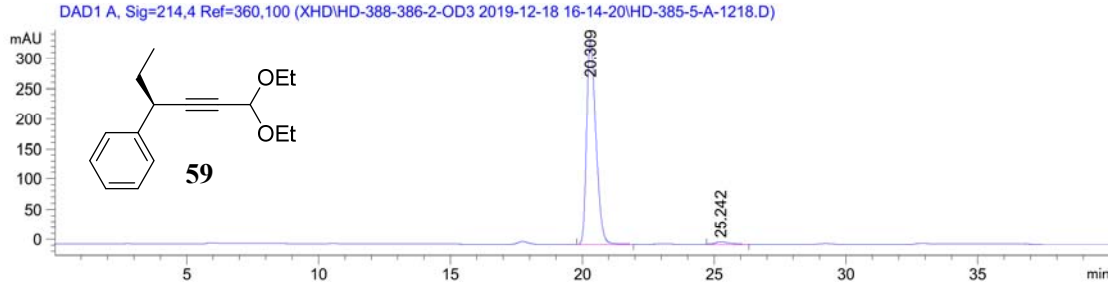
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	31.138	MM R	1.0957	113.01952	1.71913	1.5175
2	38.850	BB	0.9452	7334.76318	117.99655	98.4825
Totals :				7447.78270	119.71568	



rac **59**

Signal 1: DAD1 A, Sig=214,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.811	BB	0.3763	6306.20361	255.18086	49.9160
2	25.760	BB	0.4782	6327.41943	200.48511	50.0840
Totals :				1.26336e4	455.66597	



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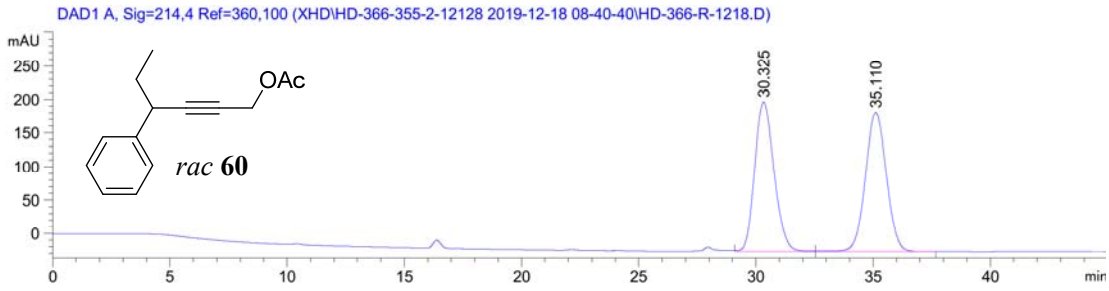
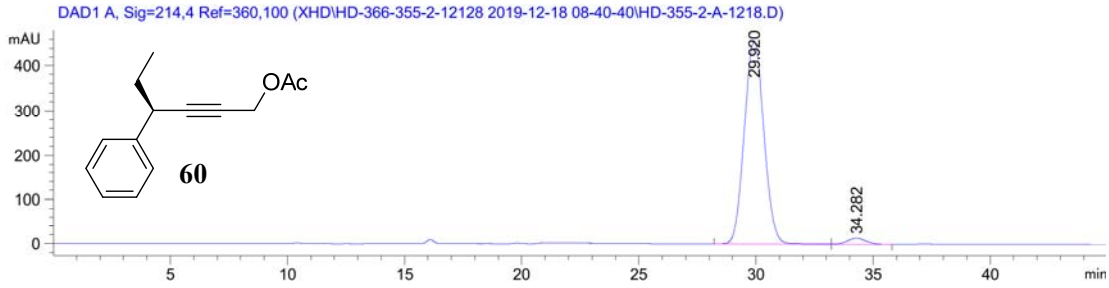
Signal 1: DAD1 A, Sig=214,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.309	BB	0.3757	8286.66211	338.37595	98.3438
2	25.242	BB	0.4244	139.55592	4.04602	1.6562
Totals :				8426.21803	342.42196	



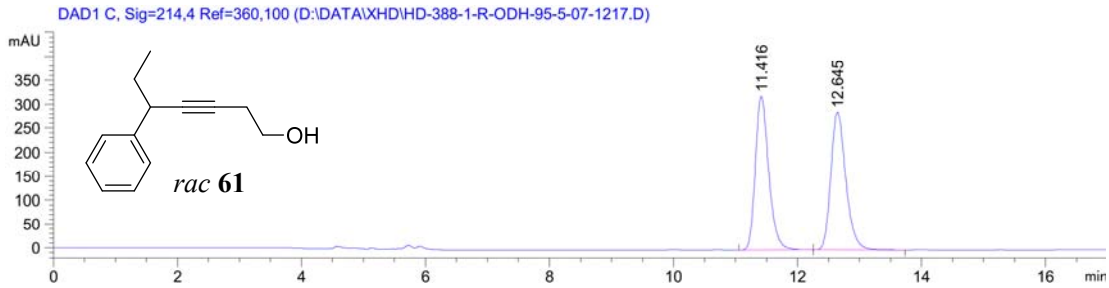
Signal 1: DAD1 A, Sig=214,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	30.325	VV	0.8961	1.28594e4	223.21736	49.7953
2	35.110	VB	0.9605	1.29651e4	207.63132	50.2047
Totals :				2.58244e4	430.84868	



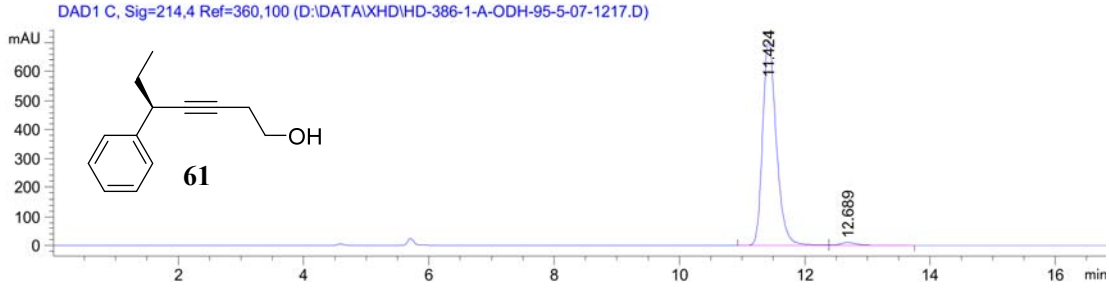
Signal 1: DAD1 A, Sig=214,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	29.920	BV	0.9021	2.66108e4	457.86212	97.2812
2	34.282	VB	0.8436	743.71826	13.65193	2.7188
Totals :				2.73545e4	471.51405	



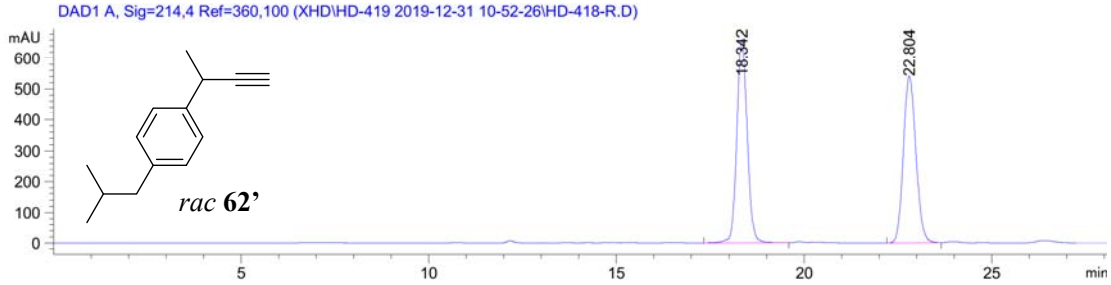
Signal 2: DAD1 C, Sig=214,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.416	BB	0.2288	4828.20703	322.17624	49.8926
2	12.645	BV	0.2564	4849.00146	288.10391	50.1074
Totals :				9677.20850	610.28015	



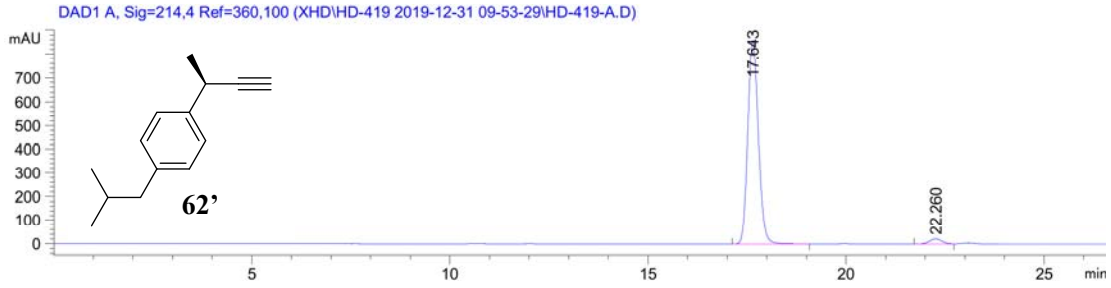
Signal 2: DAD1 C, Sig=214,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.424	BV	0.2307	1.07228e4	708.12616	98.3463
2	12.689	VV	0.2840	180.30696	9.39141	1.6537
Totals :				1.09031e4	717.51757	



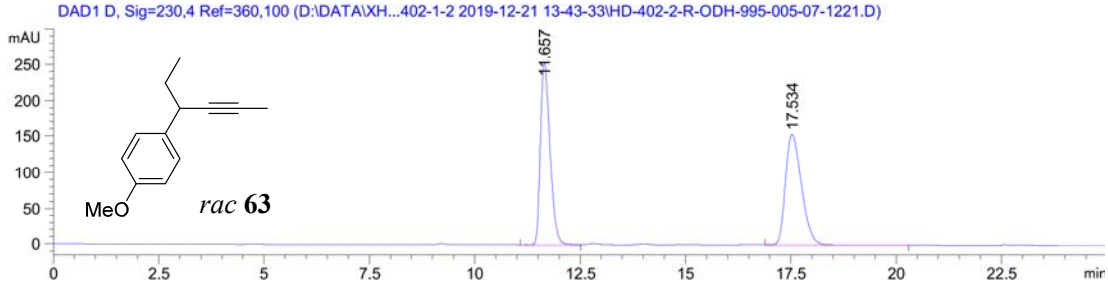
Signal 1: DAD1 A, Sig=214,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.342	BB	0.2998	1.28199e4	662.39044	50.5722
2	22.804	BB	0.3626	1.25298e4	540.27222	49.4278
Totals :				2.53497e4	1202.66266	



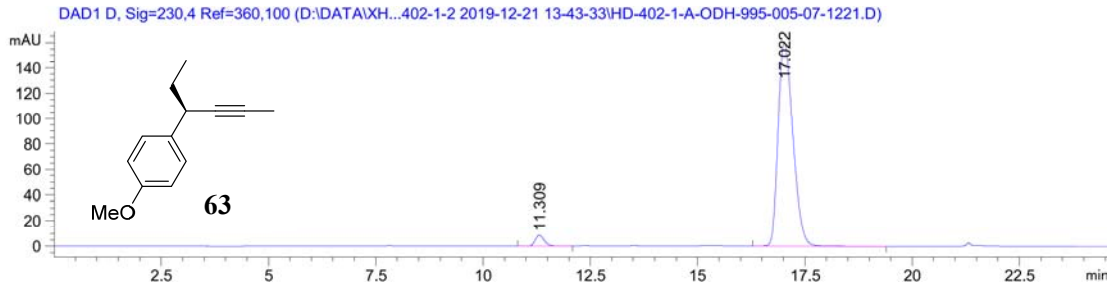
Signal 1: DAD1 A, Sig=214,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	17.643	BB	0.2896	1.60431e4	860.14917	97.1564
2	22.260	BB	0.3446	469.54657	21.51884	2.8436
Totals :				1.65126e4	881.66801	



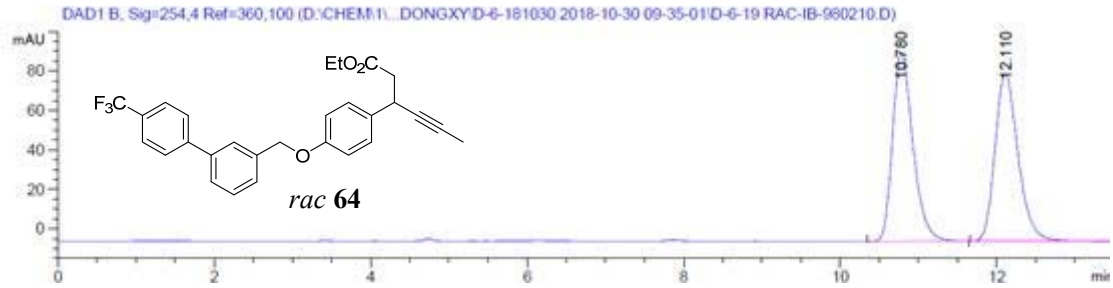
Signal 3: DAD1 D, Sig=230,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.657	BV	0.2445	4020.33325	254.16200	49.3931
2	17.534	VB	0.4193	4119.12695	154.38954	50.6069
Totals :				8139.46021	408.55154	



Signal 3: DAD1 D, Sig=230,4 Ref=360,100

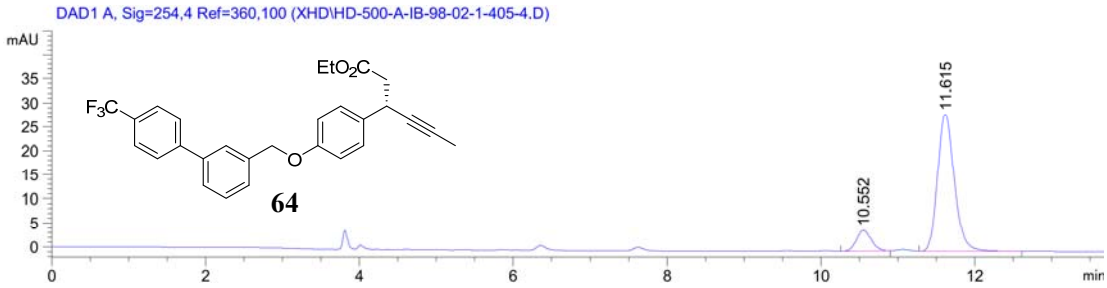
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.309	BV	0.2294	130.04753	8.74764	3.2647
2	17.022	VB	0.3756	3853.39160	160.80412	96.7353
Totals :				3983.43913	169.55177	



rac **64**

Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.780	BB	0.2755	1732.62378	95.55478	49.8964
2	12.110	BB	0.3152	1739.81921	84.84905	50.1036



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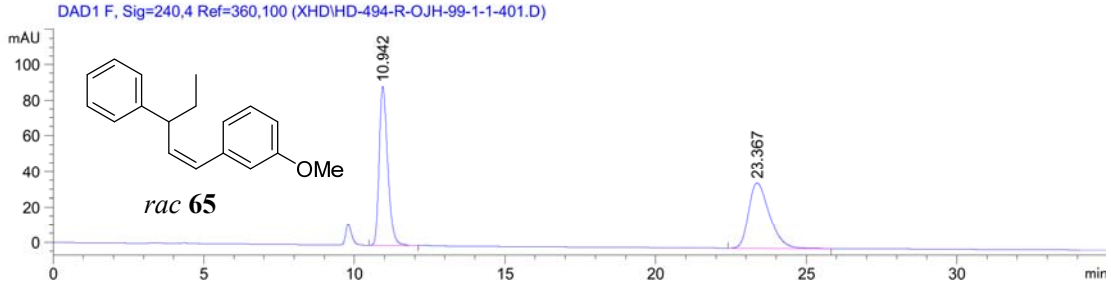
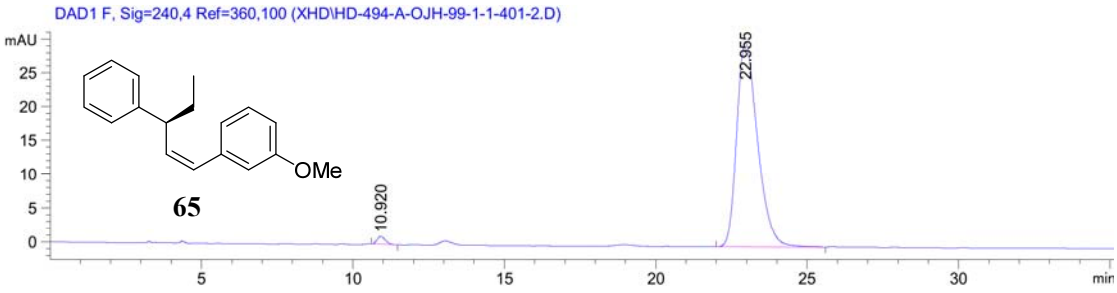
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.552	BB	0.2083	58.01698	4.33101	11.7734
2	11.615	BB	0.2333	434.76303	28.61264	88.2266
Totals :				492.78001	32.94365	



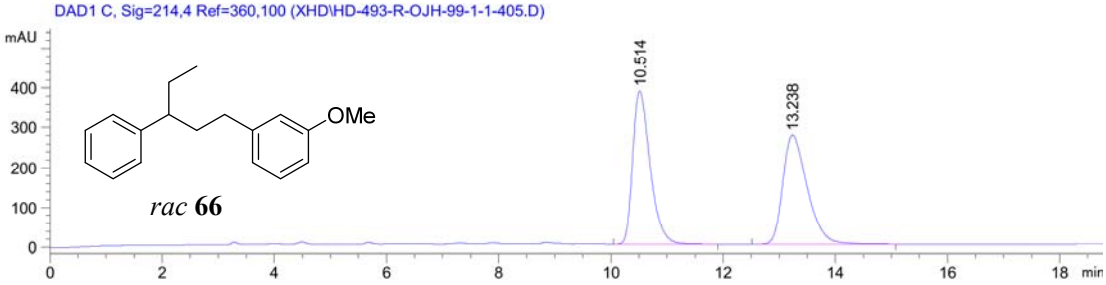
Signal 6: DAD1 F, Sig=240,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.942	BB	0.3019	1755.87610	89.08886	49.8720
2	23.367	BB	0.7375	1764.88770	36.66800	50.1280
Totals :				3520.76379	125.75686	



Signal 6: DAD1 F, Sig=240,4 Ref=360,100

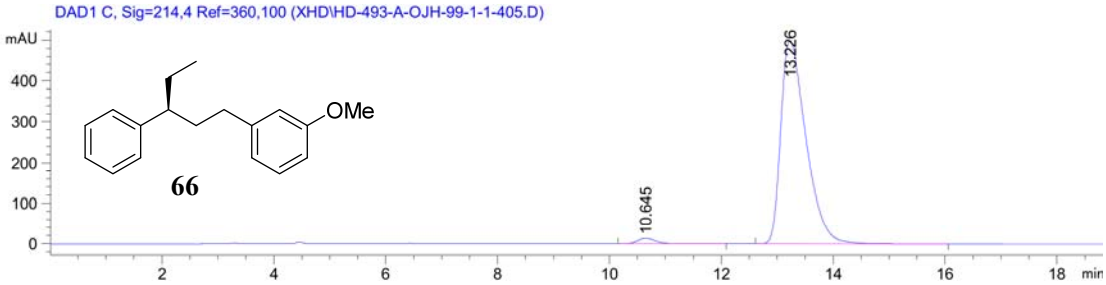
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.920	BB	0.2947	21.54159	1.14911	1.4697
2	22.955	BB	0.7296	1444.14819	30.32329	98.5303
Totals :				1465.68979	31.47240	



rac **66**

Signal 3: DAD1 C, Sig=214,4 Ref=360,100

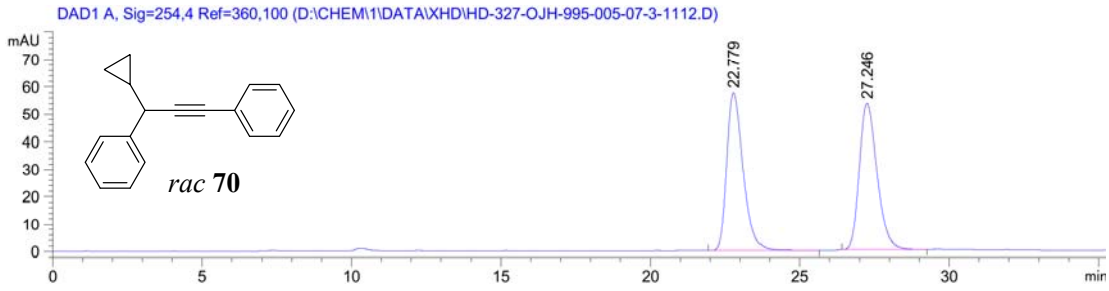
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.514	BB	0.3300	8320.85254	385.18195	50.0223
2	13.238	BB	0.4647	8313.43750	273.47012	49.9777
Totals :				1.66343e4	658.65207	



66

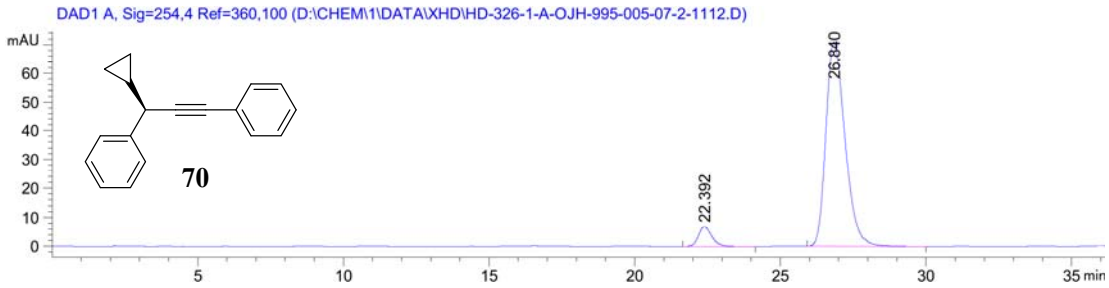
Signal 3: DAD1 C, Sig=214,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.645	BB	0.3433	303.43787	13.54809	1.9046
2	13.226	BB	0.4765	1.56280e4	500.17468	98.0954
Totals :				1.59314e4	513.72277	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

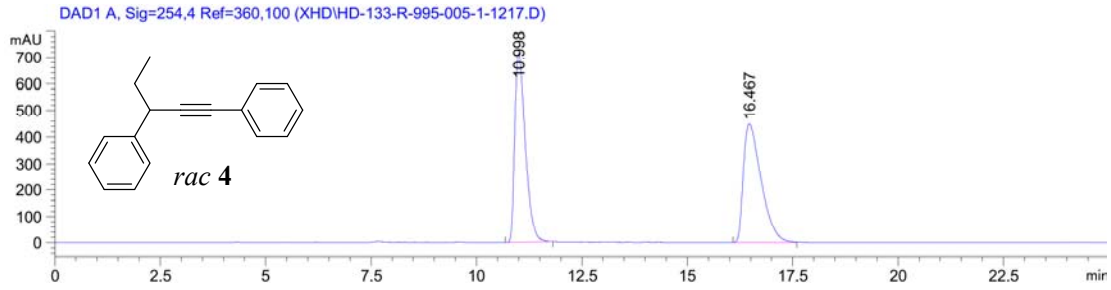
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.779	BB	0.5804	2198.17407	57.70641	49.9465
2	27.246	BB	0.6348	2202.88062	53.44888	50.0535
Totals :				4401.05469	111.15529	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

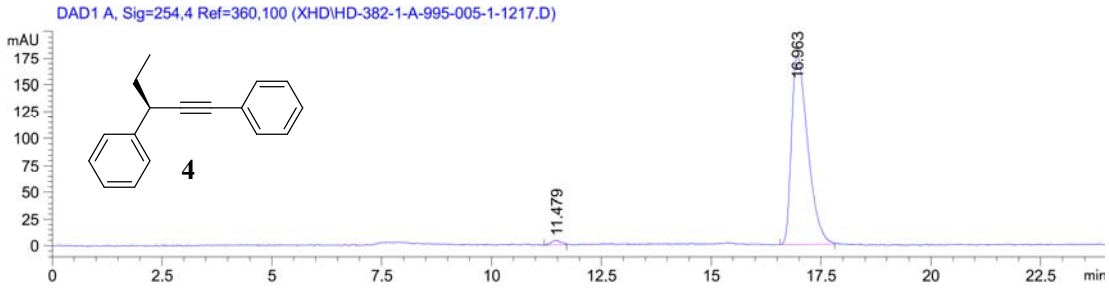
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.392	BB	0.4965	226.15912	6.97150	6.5256
2	26.840	BB	0.6994	3239.58228	71.13010	93.4744
Totals :				3465.74139	78.10159	

One-pot synthesis



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

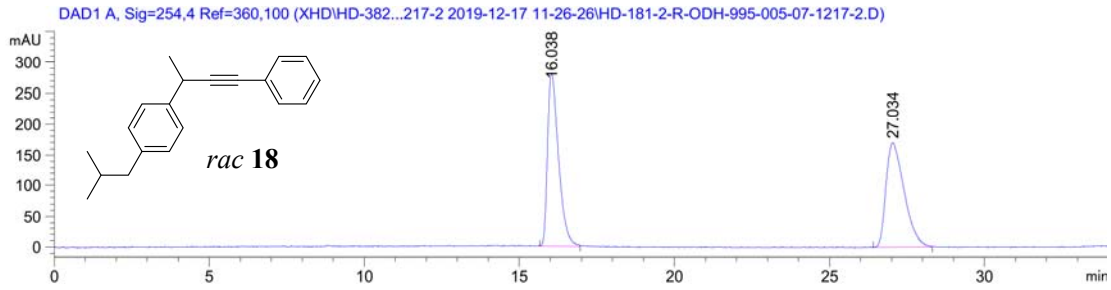
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.998	VV	0.2766	1.25504e4	715.70178	48.7394
2	16.467	VV	0.4315	1.31996e4	448.29694	51.2606
Totals :				2.57501e4	1163.99872	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

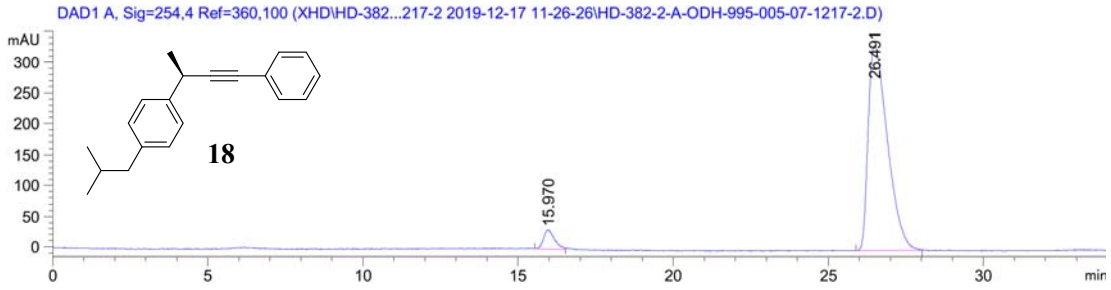
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.479	BV	0.1899	70.24247	4.50628	1.5123
2	16.963	BV	0.3832	4574.63037	177.19905	98.4877
Totals :				4644.87284	181.70533	

One-pot synthesis



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

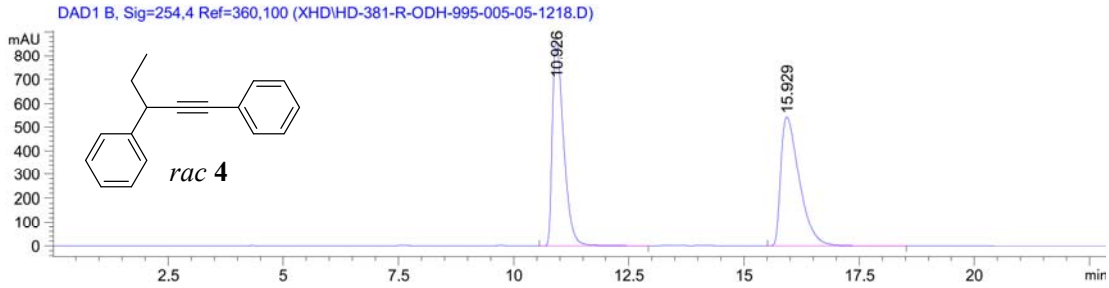
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.038	VV	0.3759	6914.56250	280.15863	49.9724
2	27.034	VV	0.5605	6922.19775	169.48204	50.0276
Totals :				1.38368e4	449.64067	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

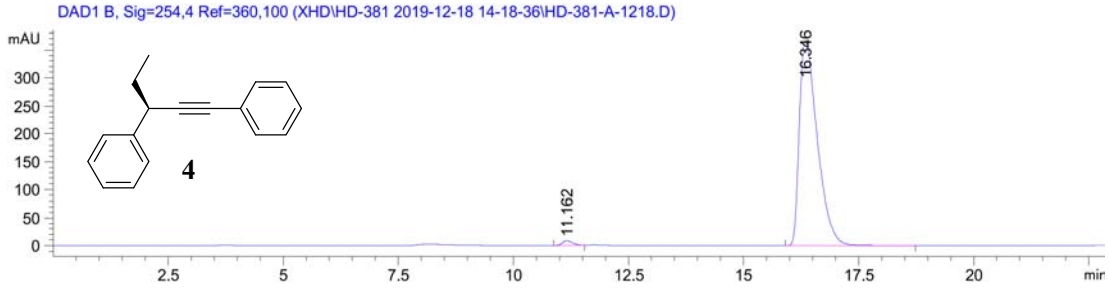
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.970	BV	0.3276	766.29358	30.86595	5.0577
2	26.491	BB	0.5862	1.43848e4	332.85953	94.9423
Totals :				1.51511e4	363.72547	

Large-scale synthesis



Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.926	BB	0.2603	1.46767e4	863.26874	49.2075
2	15.929	BB	0.4240	1.51495e4	542.19293	50.7925
Totals :				2.98262e4	1405.46167	



Signal 2: DAD1 B, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.162	BB	0.2345	124.32475	8.21722	1.2326
2	16.346	BB	0.4145	9962.19727	367.22672	98.7674
Totals :				1.00865e4	375.44394	